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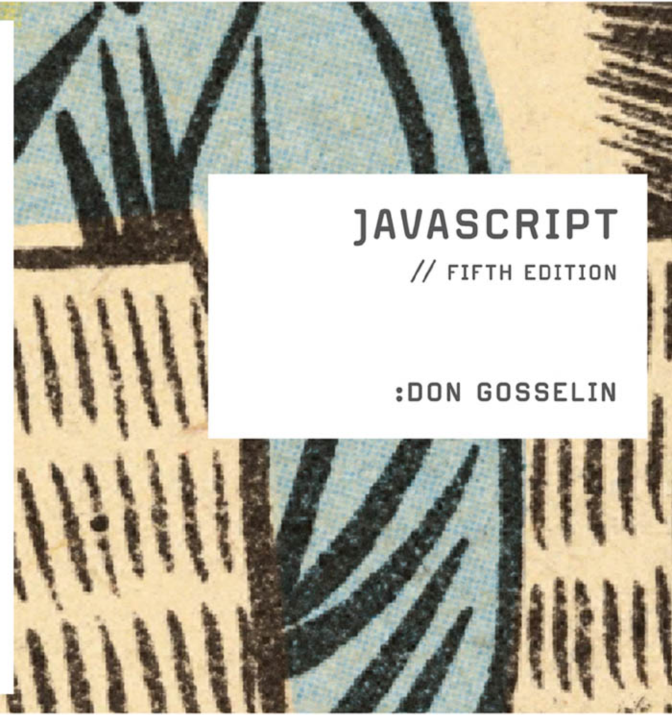

JAVASCRIPT

// FIFTH EDITION

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JAVASCRIPT

DON GOSSELIN

COURSE TECHNOLOGY
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COURSE TECHNOLOGY
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JavaScript, Fifth Edition
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I dedicate this book to my late grandparents,
John and Edith Howe, for teaching me how to laugh.

Brief Contents

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Preface

JavaScript is a client-side scripting language that allows Web page authors to develop interactive Web pages and sites. Although JavaScript is considered a programming language, it is also a critical part of Web page design and authoring. This is because the JavaScript language "lives" within a Web page's elements. The language is relatively easy to learn, allowing non-programmers to quickly incorporate JavaScript functionality into a Web page. In fact, because it is used extensively in the countless Web pages that are available on the World Wide Web, JavaScript is arguably the most widely used programming language in the world.

JavaScript, Fifth Edition teaches Web page development with JavaScript for students with little programming or database experience. Although no prior programming experience is required, knowledge of HTML and Web page design is helpful, but not required. This book covers the basics of ECMAScript Edition 3, which is compatible with recent Web browsers including Mozilla Firefox and Microsoft Internet Explorer, along with advanced topics including object-oriented programming, the Document Object Model (DOM), and AJAX. Further, this book presents JavaScript techniques using XHTML-compatible Web pages. After you complete this course, you will be able to use JavaScript to build professional quality, dynamic Web sites.

The Approach

This book introduces a variety of techniques, focusing on what you need to know to start writing JavaScript programs. In each chapter, you perform tasks that let you use a particular technique to build JavaScript programs. The step-by-step tasks are guided activities that reinforce the skills you learn in the chapter and build on your learning experience by providing additional ways to apply your knowledge in new situations. In addition to step-by-step tasks, each chapter includes objectives, short quizzes, comprehension checks, and reinforcement exercises that highlight major concepts and let you practice the techniques you learn. At the end of each chapter, you will also complete Discovery Projects that let you use the skills you learned in the chapter to write JavaScript programs on your own.

As with the last edition of this book, Web page examples and exercises are written in XHTML. Although you need to have a solid understanding of HTML to be successful with this book, you do not necessarily need to be an expert with XHTML. Because XHTML is almost identical to HTML, you can easily adapt any of your existing HTML skills to XHTML, and vice versa.

Overview of This Book

The examples and exercises in this book will help you achieve the following objectives:

- Use JavaScript with well-formed Web pages
- Work with JavaScript variables and data types and learn how to use the operations that can be performed on them.
- Add functions, events, and control structures to your JavaScript programs
- Write JavaScript code that controls the Web browser through the browser object model
- Use JavaScript to make sure data was entered properly into form fields and to perform other types of preprocessing before form data is sent to a server
- Include object-oriented programming techniques in your JavaScript programs
- Manipulate data in strings and arrays
- Trace and resolve errors in JavaScript programs
- Save state information using hidden form fields, query strings, and cookies
- Add animation and interactivity to your Web pages using the Document Object Model (DOM) and Dynamic HTML (DHTML)
- Dynamically update Web pages with AJAX

JavaScript presents twelve chapters that cover specific aspects of JavaScript programming. **Chapter 1** discusses basic concepts of the World Wide Web, introduces XHTML documents, and covers the basics of how to add JavaScript to well-formed Web pages. How to write basic JavaScript code, including how to use variables, data types, expressions, operators, and events, is also discussed in

Chapter 1. This early introduction of key JavaScript concepts gives students a framework for better understanding more advanced concepts and techniques later in this book, and allows them to work on more comprehensive projects from the start. **Chapter 2** covers functions, data types, and how to build expressions. **Chapter 3** explains how to store data in arrays and how to use structured logic in control structures and statements. **Chapter 4** teaches how to use JavaScript to manipulate the Web browser using the `Window`, `History`, `Location`, `Navigator`, and `Screen` objects. **Chapter 5** explains how to use JavaScript to make sure data was entered properly into form fields and how to perform other types of preprocessing before form data is sent to a server. **Chapter 6** presents object-object oriented programming concepts, including how to use JavaScript's built-in `Array`, `Date`, `Number`, and `Math` classes. **Chapter 7** covers advanced techniques for manipulating data in strings and arrays. **Chapter 8** provides a thorough discussion of debugging techniques, including how to use script debugging tools for Firefox and Internet Explorer. **Chapter 9** explains how to save state information using hidden form fields, query strings, and cookies, and also briefly discusses JavaScript security issues. **Chapter 10** and **Chapter 11** teach how to add animation and interactivity to your Web pages using the Document Object Model (DOM) and Dynamic HTML (DHTML). **Chapter 12** introduces the basics of how to use AJAX to dynamically update portions of a Web page with server-side data.

What's New in This Edition?

The fifth edition includes the following important new features:

- Significant revisions and improvements to the chapter projects and examples.
- The use of professionally designed Web pages for chapter projects. The goal of this book is to teach Web page authoring techniques, not Web page design techniques. In the real world, Web page authors often (but not always) receive completed Web pages from a Web page designer. For this reason, students work with professionally designed Web pages that they would encounter in a business setting.
- Instructions on working with XHTML moved to an appendix, providing a quick reference for students who need it, without slowing down general classroom instruction.
- A new streamlined layout that makes it easier to locate information quickly.

- An introduction to the basics of JavaScript in Chapter 1 that gives students a framework for understanding more advanced concepts and techniques later in this book, and allows them to work on more comprehensive projects from the start.
- An introduction to arrays in Chapter 3, "Building Arrays and Control Structures," that provides a better context for learning about arrays and control structures.

Features

JavaScript, Fifth Edition is a superior textbook because it also includes the following features:

CHAPTER OBJECTIVES: Each chapter begins with a list of the important concepts presented in the chapter. This list provides students with a quick reference to the contents of the chapter as well as a useful study aid.

FIGURES AND TABLES: Plentiful screenshots allow students to check their screens against the desired output. Tables consolidate important material for easy reference.

CODE EXAMPLES: Numerous code examples throughout each chapter are presented in any easy-to-read font, with key words shown in color.

NEW TERMS: New terms are printed in boldface to draw the reader's attention to new material.

HELP: These margin notes provide more information about the task the student is currently performing.

POINTER: These useful asides, located in the margin, provide students with practical advice and proven strategies related to the concept being discussed. They also contain cross-references to other sections in the book or to related Web sites.

NOTE: These margin elements provide additional helpful information on specific techniques and concepts.

CAREFUL: These cautionary notes point out troublesome issues related to a particular technique or concept.

SHORT QUIZ: Several short quizzes are included in each chapter. These quizzes, consisting of three to five questions, help ensure students understand the major points introduced in the chapter.

SUMMING UP: These brief overviews revisit the ideas covered in each chapter, providing students with a helpful study guide.

COMPREHENSION CHECK: At the end of each chapter, a set of twenty review questions reinforce the main ideas introduced in the chapter. These questions help students determine whether or not they have mastered the concepts presented in the chapter.

REINFORCEMENT EXERCISES: Although it is important to understand the concepts behind every technology, no amount of theory can improve on real-world experience. To this end, each chapter includes detailed Reinforcement Exercises that provide students with practical experience implementing technology skills in real-world situations.

DISCOVERY PROJECTS: These end-of-chapter projects are designed to help students apply what they have learned to business situations, much like those a professional Web developer would encounter. They give students the opportunity to independently synthesize and evaluate information, examine potential solutions, and make decisions about the best way to solve a problem.

Instructor Resources

The following supplemental materials are available when this book is used in a classroom setting. All of the instructor resources available with this book are provided to the instructor on a single CD-ROM.

ELECTRONIC INSTRUCTOR'S MANUAL. The Instructor's Manual that accompanies this textbook includes additional instructional material to assist in class preparation, including items such as Sample Syllabi, Chapter Outlines, Technical Notes, Lecture Notes, Quick Quizzes, Teaching Tips, Discussion Topics, and Additional Case Projects

EXAMVIEW®. This textbook is accompanied by ExamView, a powerful testing software package that allows instructors to create and administer printed, computer (LAN-based), and Internet exams. ExamView includes hundreds of questions that correspond to the topics covered in this text, enabling students to generate detailed study guides that include page references for further review. The computer-based and Internet testing components allow students to take exams at their computers, and also save the instructor time by grading each exam automatically.

POWERPOINT® PRESENTATIONS. This book comes with Microsoft PowerPoint slides for each chapter. These are included as a teaching aid for classroom presentation, to make available to students on the network for chapter review, or to be printed for classroom distribution. Instructors can add their own slides for additional topics they introduce to the class.

DATA FILES. Files that contain all of the data necessary for the Hands-on Projects and Case Projects are provided through the Course Technology Web site at *www.cengage.com/coursetechnology*, and are also available on the Instructor Resources CD-ROM.

SOLUTION FILES. Solutions to end-of-chapter Exercises and Projects are provided on the Instructor Resources CD and may also be found on the Course Technology Web site at *www.cengage.com/coursetechnology.* The solutions are password protected.

DISTANCE LEARNING. Course Technology is proud to present online test banks in WebCT and Blackboard to provide the most complete and dynamic learning experience possible. Instructors are encouraged to make the most of the course, both online and offline. For more information on how to access your online test bank, contact your local Course Technology sales representative.

Read This Before You Begin

The following information will help you as you prepare to use this textbook.

To the User of the Data Files

To complete the steps, exercises, and projects in this book, you will need data files that have been created specifically for this book. These data files are available through the Course Technology Web site at *www.cengage.com/coursetechnology* and are also provided on the Instructor Resources CD-ROM. Note that you can use a computer in your school lab or your own computer to complete the steps, exercises, and projects in this book.

Using Your Own Computer

You can use a computer in your school lab or your own computer to complete the chapters. To use your own computer, you will need the following:

- **A Web browser**. You can use any browser you like to view the solutions to this exercises in this text, as long as it is compatible with the standardized version of the DOM that is recommended by the World Wide Web Consortium (W3C). At the time of this writing, Firefox and Internet Explorer 5.0 and higher are compatible with the W3C DOM, although other browsers are also compatible.

- **A code-based HTML editor**, such as Adobe Dreamweaver, or a text editor such as Notepad on Windows, GNU Emacs on UNIX/Linux, or SimpleText on the Macintosh.
- **A Web server** (for Chapter 12) such as Apache HTTP Server or Microsoft Internet Information Services and PHP. Appendix A contains detailed instructions on how to install a Web server and PHP.

To the Instructor

To complete all the exercises and chapters in this book, your students must work with a set of user files, called data files, and download software from Web sites. The data files are included on the Instructor Resources CD-ROM. They may also be obtained electronically through the Course Technology Web site at *www.cengage.com/coursetechnology*. Have students follow the instructions in Chapter 1 to install the data files.

Course Technology Data Files

You are granted a license to copy the data files to any computer or computer network used by individuals who have purchased this book.

Visit Our World Wide Web Site

Additional materials designed especially for this book might be available for your course. Periodically search *www.cengage.com/coursetechnology* for more information and materials to accompany this text.

Got a Job In Computing . . . ?

We hope you enjoyed the Q&A on the inside front cover of this book. If you'd like to suggest that we interview a recent graduate you know who has landed an interesting job in computing, please send your suggestions via e-mail to Amy Jollymore, Acquisitions Editor, at *Amy.Jollymore@cengage.com*.

Acknowledgements

A text such as this represents the hard work of many people, not just the author. I would like to thank all the people who helped make this book a reality. First and foremost, I would like to thank Ann Shaffer, Development Editor; Alyssa Pratt, Senior Product Manager; and Amy Jollymore, Acquisitions Editor, for helping me get the job done. I would also like to thank Jill Braiewa, Senior Content Project Manager, and Tintu Thomas, Project Manager, who oversaw the process of turning the manuscript into a printed book. Also, many thanks to Chris Scriver, John Freitas, Serge Palladino, and Danielle Shaw, our excellent Quality Assurance team, who scrutinized every word and line of code.

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On the personal side, I would like to thank my family and friends for supporting me in my career; I don't see many of you nearly as often as I'd like, but you are always in my thoughts. My most important thanks always goes to my wonderful wife, Kathy, for her never ending support and encouragement, and to Noah the wonder dog.

Don Gosselin

CHAPTER 1

Introduction to JavaScript

In this chapter, you will:

- Study the history of the World Wide Web
- Learn about Web development
- Add basic JavaScript code to your Web pages
- Learn about the JavaScript programming language
- Add structure to your JavaScript programs

The original purpose of the World Wide Web (WWW) was to locate and display information. However, once the Web grew beyond a small academic and scientific community, people began to recognize that greater interactivity would make the Web more useful. As commercial applications of the Web grew, the demand for more interactive and visually appealing Web sites also grew.

To respond to the demand for greater interactivity, an entirely new Web programming language was needed. Netscape filled this need in the mid-1990s by developing the JavaScript programming language. Originally designed for use in the Navigator Web browser, JavaScript is now also used in most Web browsers, including Internet Explorer.

Although JavaScript is considered a programming language, it is also a critical part of Web page design and authoring. This is because the JavaScript language "lives" within a Web page's elements. In other words, the JavaScript code you write is usually placed within the elements that make up a Web page. JavaScript can turn static documents into applications such as games or calculators. JavaScript code can change the contents of a Web page after a browser has rendered it. It can also create visual effects such as animation, and it can control the Web browser window itself. None of this was possible before the creation of JavaScript.

In this chapter, you will learn the skills required to create basic JavaScript programs. In order to be successful in your JavaScript studies, you should already possess a strong knowledge of Web page-authoring techniques. The first part of this chapter provides a quick refresher on the history of the World Wide Web and the basics on how to create Web pages. Even if you are highly experienced with HTML, you might not be familiar with the formal terminology that is used in Web page authoring. For this reason, be certain to read through these sections to ensure that you understand the terminology used in this book.

For the most current Web page-authoring techniques, see Don Gosselin's *XHTML*, also published by Course Technology.

Introduction to the World Wide Web

The Internet is a vast network that connects computers all over the world. The original plans for the Internet grew out of a series of memos written by J. C. R. Licklider of the Massachusetts Institute of Technology (MIT), in August 1962, discussing his concept of a "Galactic Network." Licklider envisioned a global computer network through which users could access data and programs from any site on the network. The Internet was actually developed in the 1960s by the Advanced Research Projects Agency (or ARPA) of the U.S. Department of Defense, which later changed its name to Defense Advanced Research Projects Agency (or DARPA). The goal of the early Internet was to connect the main computer systems of various universities and research institutions that were funded by this agency. This first implementation of the Internet was referred to as the ARPANET. More computers were connected to the ARPANET in the years following its initial development in the 1960s, although access to the ARPANET was still restricted by the U.S. government primarily to academic researchers, scientists, and the military.

The 1980s saw the widespread development of local area networks (LANs) and the personal computer. Although at one time restricted to academia and the military, computers and networks soon became common in business and everyday life. By the end of the 1980s, businesses and individual computer users began to recognize the global communications capabilities and potential of the Internet, and they convinced the U.S. government to allow commercial access to the Internet.

In 1990 and 1991, Tim Berners-Lee created what would become the **World Wide Web**, or the **Web**, at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, as a way to easily access cross-referenced documents that existed on the CERN computer network. When other academics and scientists saw the usefulness of being able to easily access cross-referenced documents using Berners-Lee's system, the Web as we know it today was born. In fact, this method of accessing cross-referenced documents, known as **hypertext linking**, is probably the most important aspect of the Web because it allows you to open other Web pages quickly. A **hypertext link**, or **hyperlink** or **link**, contains a reference to a specific Web page that you can click to open that Web page.

If you want to learn more about the history of the Internet, the Internet Society (ISOC) maintains a list of links to Internet histories at *http://www.isoc.org/internet/history/*.

A common misconception is that the words "Web" and "Internet" are synonymous. The Web is only one *part* of the Internet and is a means of communicating on the Internet. The Internet is also composed of other communication elements such as e-mail systems that send and receive messages. However, because of its enormous influence on computing, communications, and the economy, the World Wide Web is arguably the most important part of the Internet today and is the primary focus of this book.

A document on the Web is called a **Web page** and is identified by a unique address called the **Uniform Resource Locator**, or **URL**. A URL is also commonly referred to as a **Web address**. A URL is a type of **Uniform Resource Identifier (URI)**, which is a generic term for many types of names and addresses on the World Wide Web. The term **Web site** refers to the location on the Internet of the Web pages and related files (such as graphic and video files) that belong to a company, organization, or individual. You display a Web page on your computer screen by using a program called a **Web browser**. A person can retrieve and open a Web page in a Web browser either by entering a

URL in the Web browser's Address box or by clicking a hypertext link. When a user wants to access a Web page, either by entering its URL in a browser's Address box or by clicking a link, the user's Web browser asks a Web server for the Web page in what is referred to as a **request**. A **Web server** is a computer that delivers Web pages. What the Web server returns to the user is called the **response**.

Prior to version 6, the Netscape Web browser was called Navigator or Netscape Navigator. With the release of version 6, however, Netscape dropped "Navigator" from the browser name, and now simply refers to its browser as "Netscape." For this reason, in this book "Navigator Web browser" refers to versions older than version 6, and "Netscape Web browser" refers to version 6 and later.

Understanding Web Browsers

You can choose from a number of different browsers, but at the time of this writing, Mozilla Firefox is the most popular browser on the market. Although Firefox is the most popular browser, it was not the first. NCSA Mosaic was created in 1993 at the University of Illinois and was the first program to allow users to navigate the Web by using a graphical user interface (GUI). In 1994, Netscape released Navigator, which soon controlled 75% of the market. Netscape maintained its control of the browser market until 1996, when Microsoft entered the market with the release of Internet Explorer, and the so-called browser wars began, in which Microsoft and Netscape fought for control of the browser market.

DHTML is actually a combination of HTML, Cascading Style Sheets, and JavaScript. The term Cascading Style Sheets (CSS), or style sheets, refers to a standard set by the W3C for managing Web page formatting.

The browser wars began over DHTML, which is a combination of various technologies, including HTML and JavaScript, which allows a Web page to change after it has been loaded by a browser. Examples of DHTML include the ability to position text and elements, change document background color, and create effects such as animation. Earlier versions of Internet Explorer and Navigator included DHTML elements that were incompatible. Furthermore, Microsoft and Netscape each wanted its version of DHTML to become the industry standard. To settle the argument, the World Wide Web Consortium set out to create a platform-independent and browser-neutral version of DHTML. The **World Wide Web Consortium**, or **W3C**, was established in 1994 at MIT to oversee the development of Web technology standards. While the W3C was drafting a recommendation for DHTML, versions 4 of Internet Explorer and Navigator each added a number of proprietary DHTML elements that were completely incompatible with the other browser. As a result, when working with advanced DHTML techniques such as animation, a programmer had to write a different set of HTML code for each browser. Unfortunately for Netscape, the W3C adopted as the formal standard the version of DHTML found in version 4 of Internet Explorer, which prompted many loyal Netscape followers to defect to Microsoft.

The W3C does not actually release a version of a particular technology. Instead, it issues a formal recommendation for a technology, which essentially means that the technology is (or will be) a recognized industry standard.

One great benefit of the browser wars is that it has forced the Web industry to rapidly develop and adopt advanced Web page standards (including JavaScript, CSS, and DHTML), which are consistent across browsers. In 2004, Internet Explorer appeared to be winning the browser wars, as it controlled 95% of the browser market. Yet, in the past few years, Internet Explorer has lost significant market share to a contentious newcomer, Mozilla Firefox. The Firefox Web browser is open source software developed by the Mozilla organization (*http://www.mozilla.org*). **Open source** refers to software for which the source code can be freely used and modified. At the time of this writing, Internet Explorer usage has slipped to approximately 41%, while Firefox now controls approximately 47% of the market (according to the W3 Schools browser statistics page at *http://www.w3schools.com/browsers/browsers_stats.asp*). One of the most fascinating aspects of Firefox is that it's essentially an open source version of the Netscape browser. So, in a figurative sense, the original Netscape browser has risen from the ashes to resume battle with its arch nemesis, Internet Explorer—and it's winning at the time of this writing. Healthy competition is good for any market, so hopefully the renewed hostilities in the browser wars will encourage vendors to continue improving browser quality and capabilities, and to adopt and adhere to Web page standards.

Creating Web Pages

Originally, people created Web pages using **Hypertext Markup Language**. Hypertext Markup Language, or **HTML**, is a markup language used to create the Web pages that appear on the World Wide Web. Web pages are also commonly referred to as **HTML pages** or **documents**. A **markup language** is a set of characters or symbols that defines a document's logical structure—that is, it specifies how a document should be printed or displayed. HTML is based on an older language called **Standard Generalized Markup Language**, or **SGML**, which defines the data in a document independent of how the data will be displayed. In other words, SGML separates the data in a document from the way that data is formatted. Each element in an SGML document is marked according to its type, such as paragraphs, headings, and so on. Like SGML, HTML was originally designed as a way of defining the elements in a document independent of how they would appear. HTML was not intended to be used as a method of designing the actual appearance of the pages in a Web browser. However, HTML gradually evolved into a language that is capable of defining how elements should appear in a Web browser.

This textbook uses the terms *Web pages* and *HTML documents* interchangeably.

Basic HTML Syntax

HTML documents are text documents that contain formatting instructions, called **tags**, which determine how data is displayed on a Web page. HTML tags range from formatting commands that make text appear in boldface or italics to controls that allow user input, such as option buttons and check boxes. Other HTML tags allow you to display graphic images and other objects in a document or Web page. Tags are enclosed in brackets (< >), and most consist of an opening tag and a closing tag that surround the text or other items they format or control. The closing tag must include a forward slash (/) immediately after the opening bracket to define it as a closing tag. For example, to make a line of text appear in boldface, you use the opening tag `<b>` and the closing tag `</b>`. Any text contained between this pair of tags appears in boldface when you open the HTML document in a Web browser.

A tag pair and any data it contains are referred to as an **element**. The information contained within an element's opening and closing tags is referred to as its **content**. Some elements do not require a closing tag. Elements that do not require a closing tag are called **empty elements** because you cannot use a tag pair to enclose text or other elements. For instance, the `<hr>` element, which inserts a horizontal rule on a Web page, does not include a closing tag. You simply place the `<hr>` element anywhere in an HTML document where you want the horizontal rule to appear.

HTML documents must have a file extension of .htm or .html.

There are literally hundreds of HTML elements. Table 1-1 lists some of the more common elements.

HTML element	Description
`<b></b>`	Formats the enclosed text in a bold typeface
`<body></body>`	Encloses the body of the HTML document
` `	Inserts a line break
`<center>`	Centers a paragraph in the middle of a Web page
`<head></head>`	Encloses the page header and contains information about the entire page
`<hn></hn>`	Indicates heading level elements, where *n* represents a number from 1 to 6
`<hr>`	Inserts a horizontal rule
`<html></html>`	Begins and ends an HTML document; these are required elements
`<i></i>`	Formats the enclosed text in an italic typeface
`<img src="..." alt="...">`	Inserts an image file
`<p></p>`	Identifies the enclosed text as a paragraph
`<u></u>`	Formats the enclosed text as underlined

Table 1-1 Common HTML elements

All HTML documents must use the `<html>` element as the root element. A **root element** contains all the other elements in a document. This element tells a Web browser to assemble any instructions between the tags into a Web page. The opening and closing

<html>...</html> tags are required and contain all the text and other elements that make up the HTML document.

Two other important HTML elements are the <head> element and the <body> element. The <head> element contains information that is used by the Web browser, and you place it at the beginning of an HTML document, after the opening <html> tag. You place several elements within the <head> element to help manage a document's content, including the <title> element, which contains text that appears in a browser's title bar. A <head> element must contain a <title> element. With the exception of the <title> element, elements contained in the <head> element do not affect the displaying of the HTML document. The <head> element and the elements it contains are referred to as the **document head**.

Following the document head is the <body> element. The <body> element and the text and elements it contains are referred to as the **document body**.

When you open an HTML document in a Web browser, the document is assembled and formatted according to the instructions contained in its elements. The process by which a Web browser assembles and formats an HTML document is called **parsing** or **rendering**. The following example shows how to make a paragraph appear in boldface in an HTML document:

```
<p><b>Herbal treatments for migraines may help reduce the
severity of pain and discomfort.</b></p>
```

HTML is not case sensitive, so you can use <B> in place of <b>. However, the next generation of HTML, a language called XHTML, is case sensitive, and you must use lowercase letters for elements. For this reason, this book uses lowercase letters for all elements. (You will learn about XHTML shortly.)

You use various parameters, called **attributes**, to configure many HTML elements. You place an attribute before the closing bracket of the opening tag, and separate it from the tag name or other attributes with a space. You assign a value to an attribute using the syntax *attribute*="*value*". For example, you can configure the <img> element, which embeds an image in an HTML document, with a number of attributes, including the src attribute. The src attribute specifies the filename of an image file or video clip. To include the src attribute within the <img> element, you type <img src="mygraphic.gif">.

When a Web browser parses or renders an HTML document, it ignores nonprinting characters such as tabs and line breaks; the final document that appears in the Web browser includes only recognized HTML elements and text. You cannot use line breaks in the body of an HTML document to insert spaces before and after a paragraph;

the browser recognizes only paragraph <p> and line break
 elements for this purpose. In addition, most Web browsers ignore multiple, contiguous spaces on a Web page and replace them with a single space. The following code shows the document head and a portion of the document body for the Web page shown in Figure 1-1.

```
<html>
<head>
    <title>X Fitness Center</title>
    <meta http-equiv="Content-Type"
    content="text/html; charset=us-ascii">
    <link href="css.css" type="text/css"
    rel="stylesheet">
</head>
<body leftmargin="0" topmargin="0"
marginwidth="0" marginheight="0">
    <table border="0" width="780" height="100%"
    cellpadding="0" cellspacing="0" align="center">
        <tr>
            <td>
                <table border="0" width="100%"
                cellpadding="0" cellspacing="0">
                    <tr>
                        <td>
                            <img src="i/head1.jpg"
                            width="380" height="301"
                            border="0"></td>
...
```

The Fitness Center Web page is available in your Examples folder for Chapter 1.

The majority of the screen captures of Web pages shown in this book were taken in Mozilla Firefox 3, running on the Windows XP operating system. Different Web browsers might render the parts of a Web page slightly differently from other browsers. The appearance of a Web browser itself can also vary across platforms. If you are using a Web browser other than Firefox and an operating system other than Windows XP, your Web pages and Web browser might not match the figures in this book.

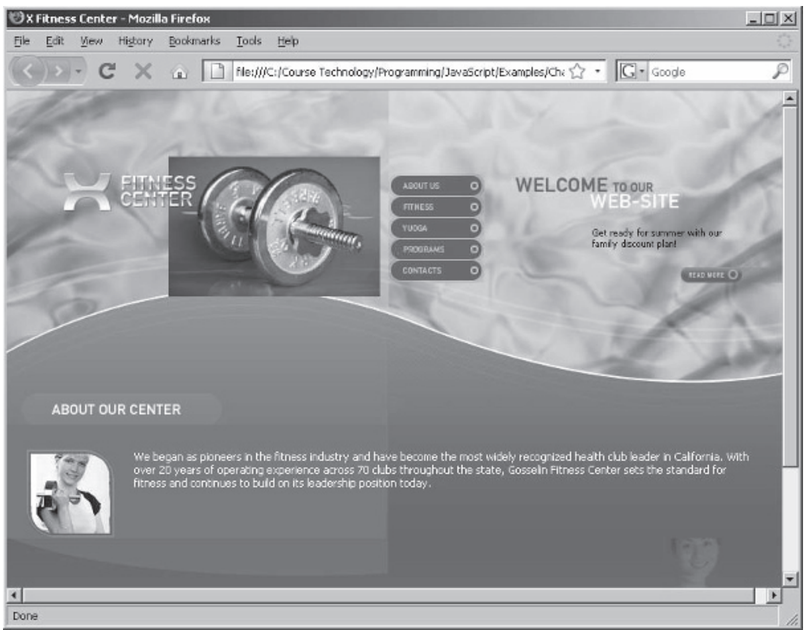


Figure 1-1 Fitness Center Web page

Creating an HTML Document

Because HTML documents are text files, you can create them in any text editor, such as Notepad or WordPad, or any word-processing application capable of creating simple text files. If you use a text editor to create an HTML document, you cannot view the final result until you open the document in a Web browser. Instead of a text editor or word processor, you could choose to use an HTML editor, which is an application designed specifically for creating HTML documents. Some popular HTML editors, such as Adobe Dreamweaver and Microsoft Expression Web, have graphical interfaces that allow you to create Web pages and immediately view the results, similar to the WYSIWYG (what-you-see-is-what-you-get) interface in word-processing programs. In addition, many current word-processing applications, including Microsoft Word and WordPerfect, allow you to save files as HTML documents.

Like text editors, HTML editors create simple text files, but they automate the process of applying elements. For example, suppose you are creating a document in Word. You can add boldface to a heading in the document simply by clicking a toolbar button. Then, when you save the document as an HTML document, Word automatically adds the `<b>` element to the text in the HTML document.

Many people who are new to creating Web pages are surprised by the fact that you cannot use a Web browser to create an HTML document.

Any HTML editor can greatly simplify the task of creating Web pages. However, HTML editors automatically add many unfamiliar elements and attributes to documents that might confuse you and distract from the learning process. For this reason, in this book you create Web pages using a simple text editor.

Working with XHTML and Well-Formed Web Pages

HTML first became an Internet standard in 1993 with the release of version 1.0. The next version of HTML, 2.0, was released in 1994 and included many core HTML features, such as forms and the ability to bold and italicize text. However, many of the standard features that are widely used today, such as using tables to organize text and graphics on a page, were not available until the release of HTML 3.2 in 1996. The current version of HTML, 4.01, was released in 1999. HTML 4.01, however, is the last version of the HTML language; it has been replaced with **Extensible Hypertext Markup Language**, or **XHTML**, which is the next generation markup language for creating the Web pages that appear on the World Wide Web.

HTML has been replaced because it is useful only for rendering documents in traditional Web browsers like Firefox or Internet Explorer.

That worked well as long as browsers running on computers were the main source of requests for files over the Web. These days, however, many types of devices besides computers use the Web. For example, mobile phones and personal digital assistants (PDAs) are commonly used to browse the Web. An application that is capable of retrieving and processing HTML and XHTML documents is called a **user agent**. A user agent can be a traditional Web browser or a device such as a mobile phone or PDA, or even an application such as a crawler for a search engine that simply collects and processes data instead of displaying it. Although user agents other than browsers can process HTML, they are not ideally suited to the task, primarily because HTML is more concerned with how data appears than with the data itself. As Web browsers have evolved over the years, they have added extensions (elements and attributes) to HTML to provide functionality for displaying and formatting Web pages. For instance, one extension to the original HTML language is the `<font>` element, which allows you to specify the font for data in an HTML document. The `<font>` element has nothing to do with the type of data in an HTML document. Instead, its sole purpose is to display data in a specific typeface within a Web browser. There is nothing wrong with continuing to author your Web pages using HTML and design elements such as the `<font>` element—provided that your Web pages will be opened only in a Web browser. However, many user agents (such as mobile phones and PDAs) are incapable of processing HTML elements that handle the displaying and formatting of data. User agents such as these require a language that truly defines data (such as a paragraph or heading) independently of the way it is displayed.

XHTML is based on Extensible Markup Language, or XML, which is used for creating Web pages and for defining and transmitting data between applications.

The Web page examples and exercises in this book are written in XHTML. Although you need to have a solid understanding of HTML to be successful with this book, you do not necessarily need to be an expert with XHTML. Because XHTML is almost identical to HTML, you can easily adapt any of your existing HTML skills to XHTML, and vice versa. If you are not familiar with XHTML, review Appendix C, "Working with Well-Formed Web Pages," before continuing with this chapter. Be sure you understand what a document type definition, or DTD, is. Also, you should thoroughly understand how to create well-formed documents and how to work with CSS.

To ensure backward compatibility with older browsers, you should save XHTML documents with an extension of .html or .htm, just like HTML documents.

Now you are ready to start creating a Web page that displays the menu page for a pizza restaurant. You can use any text editor, such as Notepad or WordPad. Most of the Web page's design comes from a style sheet that is already created for you in the DonsPizza folder in your Chapter folder for Chapter 1.

Before you begin the first exercise, be certain to extract the data files, which you can download from Course Technology's Web site at *http://www.course.com*. Use the 0538748877_Data.exe file to install the data files on Windows operating systems and the 0538748877_Data.jar file to install the data files on UNIX/Linux operating systems. The 0538748877_Data.exe and 0538748877_Data.jar files automatically create directories where you can store the exercises and projects you create in this book and install any necessary data files that you will need. By default, the directories and data files are installed for Windows platforms in C:\Course Technology\Programming\JavaScript\Data Files and for UNIX/Linux platforms in *usr/local/course/programming/javascript/data_files*. The data file directories contain separate directories for each chapter, which, in turn, contain the Chapter, Exercises, and Projects directories.

The Course Technology directory might also contain data files for other books you have used from Course Technology.

Save the exercises and projects you create in the main body of each chapter within the Chapter directory. Save the Hands-On Exercises and Discovery Projects you create at the end of each chapter in the Exercises and Projects directories, respectively.

To create the menu page for Don's Pizza:

1. Start your text editor and create a new document, if necessary.
2. Type the following declaration for the transitional DTD:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0
Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-
transitional.dtd">
```

3. Add to the end of the document the following elements to begin the HTML document. Remember that all HTML documents must begin and end with the `<html>` element.

```
<html xmlns="http://www.w3.org/1999/xhtml"
xml:lang="en" lang="en">
</html>
```

4. Next, add the following `<head>` and `<title>` elements between the `<html>...</html>` tag pair. The title appears in your Web browser's title bar. Remember that the `<head>` element must include the `<title>` element. The `<title>` element cannot exist outside the `<head>` element. The `<link>` element links to a style sheet named style.css.

```
<head>
<meta http-equiv="Content-Type"
    content="text/html; charset=iso-8859-1" />
    <title>Don's Pizza</title>
    <link href="style.css" rel="stylesheet"
        type="text/css" />
</head>
```

The arrow symbol at the end of a line of code indicates the code is broken in this book because of space limitations. But in your program, you must type the code on a single line.

5. Next, add the following elements above the closing </html> tag. The <body> element contains all of the elements that are rendered in a Web browser.

```
<body>
</body>
```

6. Add the following elements and text above the closing </body> element. The code contains standard HTML elements along with the text that is displayed in the Web browser.

```
<div id="main">
    <div id="content">
        <div id="menu">
            <div style="height: 402px" align="right">
                <img alt="" src="images/logo.jpg"
                style="margin-right: 28px;
                margin-top: 31px" />
            </div>
        </div>
        <div style="width: 401px; float: left">
            <div class="wes1">
            </div>
            <div class="wes2">
                <div style="height: 186px">
                    <img alt="" src="images/
                    centerfoto.jpg"
                    width="362" height="170"
                    style="margin-top: 16px" /></div>
                <div style="height: 38px">
                    <img alt="" src="images/menu.jpg"
                    width="362" height="38" /></div>
                <div style="margin-left: 20px; ↵
                    margin-top: 10px; height: 270px">
                    [Add code here]
                </div>
            </div>
            <div class="wes3">
            </div>
        </div>
    </div>
    <div id="footer" class="CR" align="center">
        &copy; All rights reserved. Don's Pizza.
        2010.</div>
</div>
```

7. Save the document as **menu.html** in the DonsPizza folder in your Chapter folder for Chapter 1. Some text editors automatically add their own extensions to a document. Notepad, for instance, adds an extension of .txt by default. Be sure your document is saved with an extension of .html. Keep the document open in your text editor.

Some Web servers do not correctly interpret spaces within the name of HTML files. For example, some Web servers may not correctly interpret a filename of Mortgage Brokers.html, with a space between Mortgage and Brokers. For this reason, filenames in this book do not include spaces.

8. Open the **menu.html** document in your Web browser. (You open a local document in most Web browsers by selecting Open or Open File from the File menu.) Figure 1-2 displays the menu.html document as it appears in Firefox.

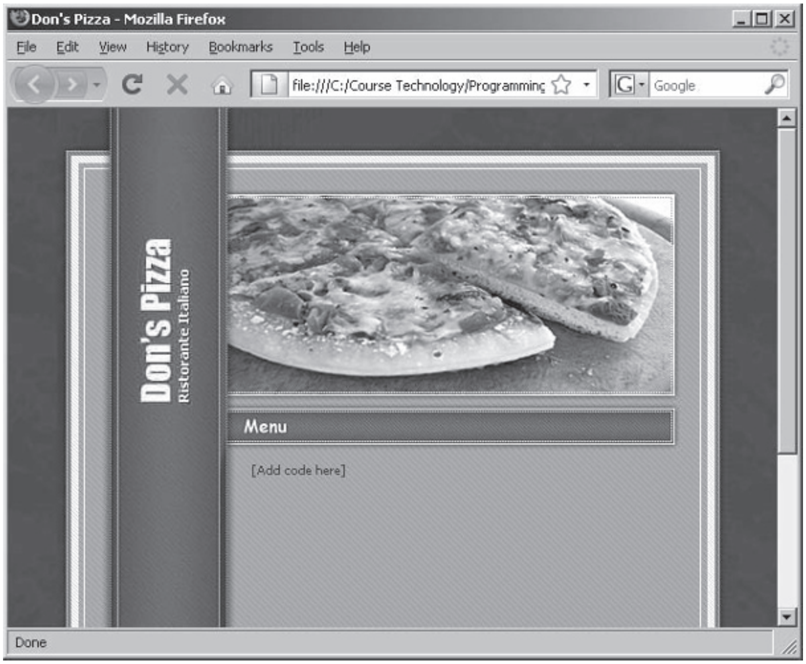


Figure 1-2 menu.html in Firefox

Many of the projects and examples in this book use professionally designed Web sites because, in real-world situations, a JavaScript programmer is often asked to add code to a preexisting Web site. However, do not worry about trying to understand the design elements that you see in this book. Instead, simply focus on how JavaScript interacts with the Web pages you work on.

9. Close your Web browser window.

Short Quiz 1

1. How and why did the World Wide Web evolve?
2. What prompted the browser wars?
3. What are the basic elements required for all Web pages?
4. What is a user agent?

Introduction to Web Development

Web page design, or **Web design**, refers to the visual design and creation of the documents that appear on the World Wide Web. Most businesses today—both prominent and small—have Web sites. To attract and retain visitors, and to stand out from the crowd, Web sites must be exciting and visually stimulating. High-quality Web design plays an important role in attracting first-time and repeat visitors. However, the visual aspect of a Web site is only one part of the story. Equally important is the content of the Web site and how that content is structured.

Another term that you might often see in relation to Web development is *Webmaster*. Although there is some dispute over exactly what the term means, typically Webmaster refers to a person who is responsible for the day-to-day maintenance of a Web site, including the monitoring of Web site traffic and ensuring that the Web site's hardware and software are running properly. The duties of a Webmaster often require knowledge of Web page design, authoring, and development.

Web design is an extremely important topic. However, this book is not about Web design, even though you will certainly learn many Web design concepts and techniques as you work through the chapters ahead. Instead, this book touches on both Web page authoring and Web development. **Web page authoring** (or **Web authoring**) refers to the creation and assembly of the tags, attributes, and data that make up a Web page. There is a subtle, but important, distinction between Web design and Web page authoring: Web design refers to the visual and graphical design aspects of creating Web pages, whereas a book on Web page authoring refers to the physical task of assembling the Web page tags and attributes. **Web development**, or **Web programming**, refers to the design of software applications for a Web site. Generally, a Web developer works "behind the scenes" to develop software applications that access databases and file systems, communicate with other applications, and perform other advanced tasks. The programs created by a Web developer will not necessarily be seen by a visitor to a Web site, although the visitor will certainly use a Web developer's programs, particularly if the Web site writes and reads data to and from a database. Although JavaScript lives more in the realm of Web page authoring, there is certainly some overlap between Web authoring and Web development, especially when it comes to sending and receiving data to and from a Web server.

If you would like to study the topic of Web page design itself, refer to Joel Sklar's excellent book, *Principles of Web Design, Fourth Edition*, published by Course Technology/Cengage Learning.

There are countless ways of combining the hundreds of HTML tags to create interesting Web pages. One technique that professional Web authors use to increase their HTML skill is examining the underlying HTML tags of a Web page that they admire. All Web browsers contain commands that allow you to view the underlying HTML code for a Web page that appears in the browser; in Firefox you select Page Source from the View menu, and in Internet Explorer you select the Source command from the View menu.

The open nature of HTML makes it possible for anyone to easily see how another Web author created a Web page. However, you should *never* copy another Web page author's work and attempt to pass it off as your own. As a responsible member of the Web community, you should examine the HTML code behind a Web page only to improve your own skills. The potential theft of another Web page author's hard work and intellectual property is no small concern. Not only is stealing another Web page author's code and Web page designs unscrupulous, but in many cases it is illegal, especially if the work is copyrighted. Throughout this book, you will examine the underlying HTML code from various published Web sites. However, remember that your reasons for examining existing HTML code should be to understand the techniques used to create specific elements on a Web page in order to improve your own skills, not to hijack someone else's hard work.

Understanding Client/Server Architecture

To be successful in Web development, you need to understand the basics of client/server architecture. There are many definitions of the terms *client* and *server*. In traditional client/server architecture, the **server** is usually some sort of database from which a client requests information. A server fulfills a request for information by managing the request or serving the requested information to the client—hence the term, client/server. A system consisting of a client and a server is known as a **two-tier system**.

One of the primary roles of the **client**, or **front end**, in a two-tier system is the presentation of an interface to the user. The user interface gathers information from the user, submits it to a server, or **back end**, then receives, formats, and presents the results returned from the server. The main responsibility of a server is usually data storage and management. On client/server systems, heavy processing, such as calculations, usually takes place on the server. As desktop computers become increasingly powerful, however, many client/server systems have begun placing at least some of the processing responsibilities on the client. In a typical client/server system, a client computer might contain a front end that is used for requesting information from a database on a server. The server locates records that meet the client request, performs some sort of processing, such as calculations on the data, and then returns the information to the client. The client computer can also perform some processing, such as building the queries that are sent to the server or formatting and presenting the returned data. Figure 1-3 illustrates the design of a two-tier client/server system.

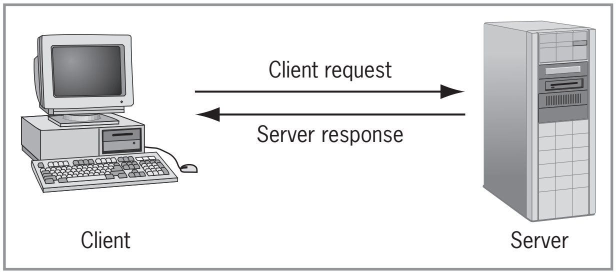


Figure 1-3 The design of a two-tier client/server system

The Web is built on a two-tier client/server system, in which a Web browser (the client) requests documents from a Web server. The Web browser is the client user interface. You can think of the Web server as a repository for Web pages. After a Web server returns the requested document, the Web browser (as the client user interface) is responsible for formatting and presenting the document to the user. The requests and responses through which a Web browser and Web server communicate happen with HTTP. For example, if a Web browser requests the URL *http://www.course.com*, the request is made with HTTP because the URL includes the HTTP protocol. The Web server then returns to the Web browser an HTTP response containing the response header and the HTML (or XHTML) for Course Technology's home page.

Two-tier client/server architecture is a physical arrangement in which the client and server are two separate computers. Three-tier client/server architecture is more conceptual than physical, because the storage tier can be located on the same server.

After you start adding databases and other types of applications to a Web server, the client/server system evolves into what is known as a three-tier client architecture. A **three-tier**, or **multitier**, **client/server system** consists of three distinct pieces: the client tier, the processing tier, and the data storage tier. The client tier, or user interface tier, is still the Web browser. However, the database portion of the two-tier client/server system is split into a processing tier and the data storage tier. The **processing tier**, or **middle tier**, handles the interaction between the Web browser client and the data storage tier. (The processing tier is also sometimes called the processing bridge.) Essentially, the client tier makes a request of a database on a Web server. The processing tier performs any necessary processing or calculations based on the request from the client tier, and then reads information from or writes information to the data storage tier. The processing tier also handles the return of any information to the client tier. Note that the processing tier is not the only place where processing can occur. The Web browser (client tier) still renders Web page documents (which requires processing), and the database or application in the data storage tier might also perform some processing. Figure 1-4 illustrates the design of a three-tier client/server system.

Multitier client/server architecture is also referred to as *n*-tier architecture.

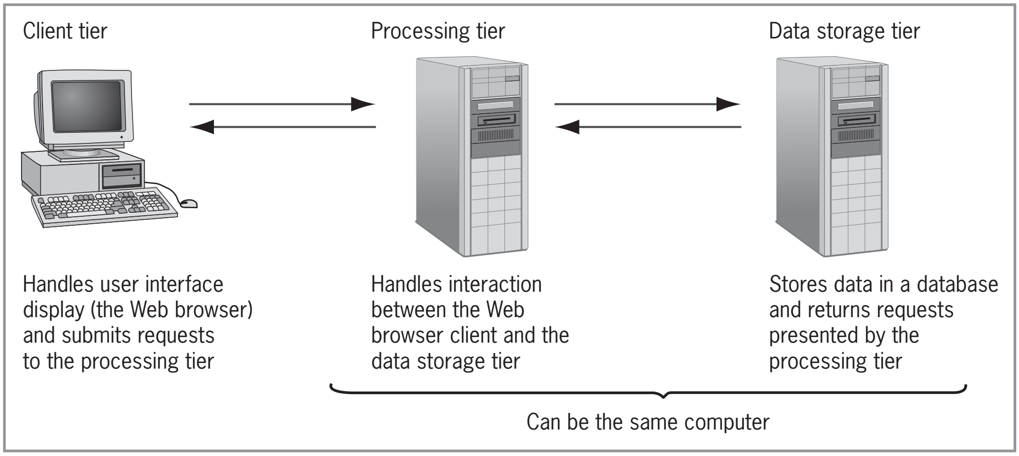


Figure 1-4 The design of a three-tier client/server system

JavaScript and Client-Side Scripting

As mentioned earlier, HTML was not originally intended to control the appearance of pages in a Web browser. When HTML was first developed, Web pages were **static**—that is, they couldn't change after the browser rendered them. However, after the Web grew beyond a small academic and scientific community, people began to recognize that greater interactivity and better visual design would make the Web more useful. As commercial applications of the Web grew, the demand for more interactive and visually appealing Web sites also grew.

HTML and XHTML could only be used to produce static documents. You can think of a static Web page written in HTML or XHTML as being approximately equivalent to a document created in a word-processing or desktop publishing program; the only thing you can do with it is view it or print it. Thus, to respond to the demand for greater interactivity, an entirely new Web programming language was needed. Netscape filled this need by developing JavaScript.

JavaScript is a client-side scripting language that allows Web page authors to develop interactive Web pages and sites. **Client-side scripting** refers to a scripting language that runs on a local browser (on the client tier) instead of on a Web server (on the processing tier). Originally designed for use in Navigator Web browsers, JavaScript is now also used in most other Web browsers, including Firefox and Internet Explorer.

The term **scripting language** is a general term that originally referred to fairly simple programming languages that did not contain the advanced programming capabilities of languages such as Java or C++. When it comes to Web development, the term scripting language refers to any type of language that is capable of programmatically controlling a Web page or returning some sort of response to a Web browser. It's important to note that, although the term scripting language originally referred to simple programming languages, today's Web-based scripting languages are anything but simple. The part of a browser that executes scripting language code is called the browser's **scripting engine**. A scripting engine is just one kind of interpreter, with the term **interpreter** referring generally to any program that executes scripting language code. When a scripting engine loads a Web page, it interprets any programs written in scripting languages, such as JavaScript. A Web browser that contains a scripting engine is called a **scripting host**. Firefox and Internet Explorer are examples of scripting hosts that can run JavaScript programs.

Many people think that JavaScript is related to or is a simplified version of the Java programming language. However, the languages are entirely different. Java is an advanced programming language that was created by Sun Microsystems and is considerably more difficult to master than JavaScript. Although Java can be used to create programs that can run from a Web page, Java programs are usually external programs that execute independently of a browser. In contrast, JavaScript programs always run within a Web page and control the browser.

JavaScript was first introduced in Navigator and was originally called LiveScript. With the release of Navigator 2.0, the name was changed to JavaScript 1.0. Subsequently, Microsoft released its own version of JavaScript in Internet Explorer 4.0 and named it JScript.

When Microsoft released JScript, several major problems occurred. First, the Netscape and Microsoft versions of the JavaScript language differed so greatly that programmers were required to write almost completely different JavaScript programs for Navigator and Internet Explorer. To avoid similar problems in the future, an international, standardized version of JavaScript, called **ECMAScript**, was created. The most recent version of ECMAScript is edition 3. Both Netscape JavaScript and Microsoft JScript conform to ECMAScript edition 3. Nevertheless, Netscape JavaScript and Microsoft JScript each include unique programming features that are not supported by the other language. In this book, you will learn to create JavaScript programs with ECMAScript edition 3, which is supported by all current Web browsers including Firefox, Netscape 6 and higher, and Internet Explorer 4 and higher.

Although JavaScript is considered a programming language, it is also a critical part of Web page authoring. This is because the JavaScript language "lives" within a Web page's elements. JavaScript gives you the ability to:

- Turn static Web pages into applications such as games or calculators.
- Change the contents of a Web page after a browser has rendered it.
- Create visual effects such as animation.
- Control the Web browser window itself.

For security reasons, the JavaScript programming language cannot be used outside of the Web browser. For example, to prevent mischievous scripts from stealing information, such as your e-mail address or credit card information you use for an online transaction, or from causing damage by changing or deleting files, JavaScript does not allow any file manipulation whatsoever. Similarly, JavaScript does not include any sort of mechanism for creating a network connection or accessing a database. This limitation prevents JavaScript programs from infiltrating a private network or intranet from which information might be stolen or damaged. Another helpful limitation is the fact that JavaScript cannot run system commands or execute programs on a client. The ability to read and write cookies is the only type of access to a client that JavaScript has. Web browsers, however, strictly govern cookies and do not allow access to cookies from outside the domain that created them. This security also means that you cannot use JavaScript to interact directly with Web servers that operate at the processing tier. Although the programmer can employ a few tricks (such as forms and query strings) to allow JavaScript to interact indirectly with a Web server, if you want true control over what's happening on the server, you need to use a server-side scripting language, as explained in the next section.

Understanding Server-Side Scripting

Server-side scripting refers to a scripting language that is executed from a Web server. Some of the more popular server-side scripting languages are PHP, Active Server Pages (ASP), and Java Server Pages (JSP). One of the primary reasons for using a server-side scripting language is to develop interactive Web sites that communicate with a database. Server-side scripting languages work in the processing tier and have the ability to handle communication between the client tier and the data storage tier. At the processing tier, a server-side scripting language usually prepares and processes the data in some way before submitting it to the data storage tier. Some of the more common uses of server-side scripting language that you have probably already seen on the Web include the following:

- Shopping carts
- Search engines
- Mailing lists and message boards
- Web-based e-mail systems
- Authentication and security mechanisms
- Web logs (blogs)
- Games and entertainment

Unlike JavaScript, a server-side scripting language can't access or manipulate a Web browser. In fact, a server-side scripting language cannot run on a client tier at all. Instead, a server-side scripting language exists and executes solely on a Web server, where it performs various types of processing or accesses databases. When a client requests a server-side script, the script is interpreted and executed by the scripting engine within the Web server software. After the script finishes executing, the Web server software translates the results of the script (such as the result of a calculation or the records returned from a database) into HTML or XHTML, which it then returns to the client. In other words, a client will never see the server-side script, only the HTML or XHTML that the Web server software returns from the script. Figure 1-5 illustrates how a Web server processes a server-side script.

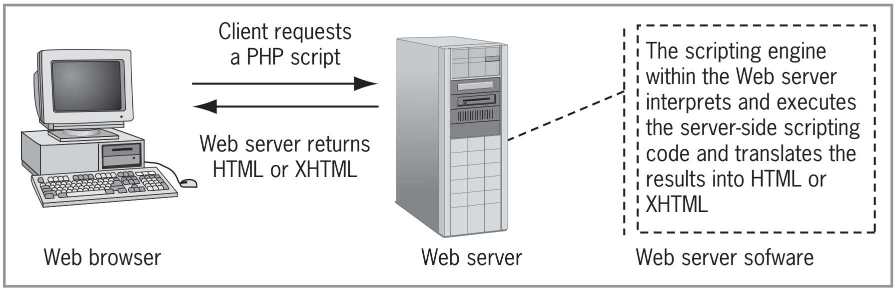


Figure 1-5 How a Web server processes a server-side script

Should You Use Client-Side or Server-Side Scripting?

An important question in the design of any client/server system is deciding how much processing to place on the client and how much to place on the server. In the context of Web site development, you must decide whether to use client-side JavaScript or a server-side script. This is an important consideration because the choice you make can greatly affect the performance of your program. In some cases, the decision is simple. For example, if you want to control the Web browser, you must use JavaScript. If you want to access a database on a Web server, you must use a server-side script. However, there are tasks that both languages can accomplish, such as validating forms and manipulating cookies. Furthermore, both languages can perform the same types of calculations and data processing.

A general rule of thumb is to allow the client to handle the user interface processing and light processing, such as data validation, but have the Web server perform intensive calculations and data storage. This division of labor is especially important when dealing with clients and servers over the Web. Unlike with clients on a private network, it's not possible to know in advance the computing capabilities of each client on the Web. You cannot assume that each client (browser) that accesses your client/server application (Web site) has the necessary power to perform the processing required by the application. For this reason, intensive processing should be performed on the server.

Because servers are usually much more powerful than client computers, your first instinct might be to let the server handle all processing and only use the client to display a user interface. Although you do not want to overwhelm clients with processing they cannot handle, it is important to perform as much processing as possible on the client for several reasons:

- Distributing processing among multiple clients creates applications that are more powerful, because the processing power is not limited to the capabilities of a single computer. Client computers become more powerful every day, and advanced capabilities such as JavaScript are now available in local Web browsers. Thus, it makes sense to use a Web application to harness some of this power and capability. A **Web application** is a program that executes on a server but that clients access through a Web page loaded in a browser.
- Local processing on client computers minimizes transfer times across the Internet and creates faster applications. If a client had to wait for all processing to be performed on the server, a Web application could be painfully slow over a busy Internet connection.
- Performing processing on client computers lightens the processing load on the server. If all processing in a three-tier client/server system is done on the server, the server for a popular Web site could become overwhelmed trying to process requests from numerous clients.

Short Quiz 2

1. What are the differences among Web page design, Web page authoring, and Web development?
2. What are the primary roles of the client and the server in two-tier system architecture?
3. What is the purpose of the processing tier in three-tier system architecture?
4. Why are scripts written with the JavaScript programming language restricted to executing only within a Web browser?

Adding JavaScript to Your Web Pages

The following sections introduce basic procedures for adding JavaScript to your Web pages.

Using the <script> Element

JavaScript programs run from within a Web page (either an HTML or XHTML document). That is, you type the code directly into the Web page code as a separate section. JavaScript programs contained within a Web page are often referred to as **scripts**. The **<script> element** tells the Web browser that the scripting engine must interpret the commands it contains. The **type** attribute of the `<script>` element tells the browser which scripting language and which version of the scripting language is being used. You assign a value of "text/javascript" to the `type` attribute to indicate that the script is written with JavaScript. You need to include the following code in a document to tell the Web browser that the statements that follow must be interpreted by the JavaScript scripting engine:

```
<script type="text/javascript">
statements
</script>
```

Next, you will add a script section to the Menu page for Don's Pizza.

To add a script section to the Menu page for the pizza restaurant:

1. Return to the **menu.html** document in your text editor.
2. Replace the [Add code here] line with the following script section:

   ```
   <script type="text/javascript">
   </script>
   ```

3. Save the **menu.html** document.

The individual lines of code, or **statements**, that make up a JavaScript program in a document are contained within the `<script>` element. The following script contains a single statement that writes the text "Can you hear me now?" to a Web browser window, using the `write()` method of the `Document` object, which you will study shortly:

```
document.write("<p>Can you hear me now?</p>");
```

Notice that the preceding statement ends in a semicolon. Many programming languages, including C++ and Java, require you to end all statements with a semicolon. JavaScript statements are not required to end in semicolons. Semicolons are strictly necessary only when you want to separate statements that are placed on a single line.

For example, the following script contains two statements on the same line, with each statement ending in a semicolon:

```
<script type="text/javascript">
document.write("<p>Can you "); document.write ("hear me
now?</p>");
</script>
```

As long you place each statement on its own line, separated from other lines with line breaks, you are not required to end statements with semicolons. The following code shows another example of the preceding script, but this time, each statement is placed on its own line, without an ending semicolon.

```
<script type="text/javascript">
document.write("<p>Can you ")
document.write("hear me now?</p>")
</script>
```

Even though the statements do not end in semicolons, the preceding script is legal. However, that's not the end of the story. Programmers often adopt conventions in their code that make the code easier for the programmer to read in a text editor. In the case of semicolons, it is considered good JavaScript programming practice to end any statement with a semicolon. The semicolon serves to identify the end of each statement, making it easier for the programmer to read his or her own code (and for other programmers to read the code later on). Therefore, be sure to end all of your JavaScript statements with semicolons.

Although this book covers JavaScript, you can also use other scripting languages with Web pages. To use VBScript in your Web pages, you would use the following code: `<script type="text/vbscript">` *`VBScript code`* `</script>`. Do not confuse JScript with VBScript. As you have read, JScript is Microsoft's version of the JavaScript scripting language. To specify the JScript language, you specify JavaScript as the `type` attribute.

If you anticipate that your JavaScript programs will run only in Internet Explorer, then you can specify "JScript" as your scripting language by using the statement `<script type="JScript">`. However, few browsers other than Internet Explorer will recognize "JScript" as a valid type attribute for the `<script>` element; it is safer always to use "JavaScript."

Understanding JavaScript Objects

Before you can use `<script>` elements to create a JavaScript program, you need to learn some basic terminology that is commonly used in JavaScript programming and in other kinds of programming languages. In addition to being an interpreted scripting language, JavaScript is considered an object-based programming language. An **object** is programming code and data that can be treated as an individual unit or component. For example, you might create a `CarLoan` object that calculates the number of payments required to pay off a car loan. The `CarLoan` object may also store information such as the principal loan amount and the interest rate. Individual statements used in a computer program are often grouped into logical units called **procedures**, which are used to perform specific tasks. For example, a procedure may contain a group of statements that calculate the sales tax based on sales total. The procedures associated with an object are called **methods**. A **property** is a piece of data, such as a color or a name, that is associated with an object. In the `CarLoan`

HTML documents use the `language` attribute to tell the browser which scripting language and which version of the scripting language is being used. However, the `language` attribute is deprecated, so be sure to use the `type` attribute with your XHTML documents.

object example, the programming code that calculates the number of payments required to pay off the loan is a method. The principal loan amount and the interest rate are properties of the `CarLoan` object.

To incorporate an object and an associated method in JavaScript code, you type the object's name, followed by a period, followed by the method. For example, the following code shows the `CarLoan` object, followed by a period, followed by a method named `calcPayments()`, which calculates the number of payments required to pay off the loan:

```
carLoan.calcPayments();
```

For many methods, you also need to provide some more specific information, called an **argument**, between the parentheses. Some methods require numerous arguments, whereas others don't require any. Providing an argument for a method is referred to as **passing arguments**. For example, the `calcPayments()` method may require an argument that specifies the amount paid each month toward the loan. In that case, the JavaScript statement would look like this:

```
carLoan.calcPayments(800);
```

You use an object's properties in much the same way you use a method, by appending the property name to the object with a period. However, a property name is not followed by parentheses. One of the biggest differences between methods and properties is that a property does not actually do anything; you only use properties to store data. You assign a value to a property using an equal sign, as in the following example:

```
carLoan.interest = .08;
```

The next part of this chapter focuses on the `write()` and `writeln()` methods as a way of helping you understand how to program with JavaScript.

Using the `write()` and `writeln()` Methods

JavaScript treats many things as objects. One of the most commonly used objects in JavaScript programming is the `Document` object. The `Document` object represents the content of a browser's window. Any text, graphics, or other information displayed in a Web page is part of the `Document` object. One of the most common uses of the `Document` object is to add new text to a Web page. You create new text on a Web page with the **`write()` method** or the **`writeln()` method** of the `Document` object. For example, you could use the `write()` method to render a Web page containing custom information such as a user's name or the result of a calculation.

You should understand that the only reason to use the `write()` and `writeln()` methods is to add new text to a Web page while it is being rendered. For example, you may want to display a new Web page based on information a user enters into a form. A user may enter, say, sales information into a form for an online transaction. Using the entered information, you can create a new Web page that displays his or her sales total, order confirmation, and so on. If you simply want to display text in a Web browser when the document is first rendered, there is no need to use anything but standard XHTML elements. The procedures for dynamically gathering information are a little too complicated for this introductory chapter. However, in this chapter you will use the `write()` and `writeln()` methods to display text in a Web browser when the document is first rendered in order to learn the basics of creating JavaScript programs.

Different methods require different kinds of arguments. For example, the `write()` and `writeln()` methods of the `Document` object require a text string as an argument. A **text string**, or **literal string**, is text that is contained within double or single quotation marks. The text string argument of the `write()` and `writeln()` methods specifies the text that the `Document` object uses to create new text on a Web page. For example, `document.write("Can you hear me now?");` displays the text "Can you hear me now?" in the Web browser window (without the quotation marks). Note that you must place literal strings on a single line. If you include a line break within a literal string, you receive an error message.

The `write()` and `writeln()` methods perform essentially the same function that you perform when you manually add text to the body of a standard Web page document. Whether you add text to a document by using standard elements, such as the `<p>` element, or by using the `write()` or `writeln()` methods, the text is added according to the order in which the statements appear in the document.

The only difference between the `write()` and `writeln()` methods is that the `writeln()` method adds a line break after the line of text. Line breaks, however, are only recognized inside the `<pre>` element. In other words, in order to use line breaks with the `writeln()` method, you must place the method within a `<pre>` element. The following code contains a script that prints some text in a Web browser by using the `writeln()` method of the `Document` object. Notice that the `<script>` element is enclosed within a `<pre>` element. Figure 1-6 shows the output.

If you are using a version of Internet Explorer higher than 4, you need to turn on error notification by selecting Internet Options from the Tools menu and clicking the Advanced tab. In the Browsing category on the Advanced tab, make sure the Display a notification about every script error check box is selected, and click the OK button to close the dialog box. To view errors in Firefox, select Error Console from the Tools menu.

Programmers often talk about code that "writes to" or "prints to" a Web browser window. For example, you might say that a piece of code writes a text string to the Web browser window. This is just another way of saying that the code displays the text string in the Web browser window.

Note the use of semicolons at the end of each statement. Remember that it is considered good JavaScript programming practice to end every statement with a semicolon.

```
<pre style="color: blue; font-family: Arial;↵
    font-size: .8em; font-weight: normal">
<script type="text/javascript">
document.writeln("United States National Motto");
document.writeln("<em>In God We Trust</em>");
</script>
</pre>
```

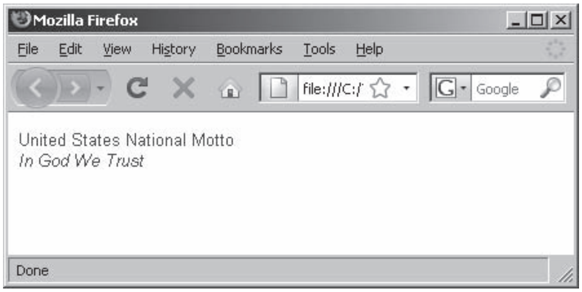


Figure 1-6 Output of a script that uses the `writeln()` method of the `Document` object

Notice that the second `writeln()` statement includes the XHTML element `<em>`. You can include any elements you like as part of an argument for the `write()` or `writeln()` methods, including elements such as the `<p>` and `<br>` elements. This means that you can use `write()` statements to add line breaks to the text you create with a script instead of using `writeln()` statements within a `<pre>` element. The following code shows a modified version of the previous script, but this time it uses `write()` statements and does not include a `<pre>` element. The line break in the text is created by adding a `<br />` element to the end of the first line of text.

```
<script type="text/javascript">
document.write("<p>United States National Motto<br />");
document.write("<em>In God We Trust</em></p>");
</script>
```

Next, you will add text and elements to the menu.html file by using `write()` methods of the `Document` object.

To add text and elements to the menu.html file by using `write()` methods of the `Document` object:

1. Return to the **menu.html** document in your text editor.

2. Add to the script section the following `document.write()` statements, which print the text and elements that display the daily special:

```
document.write("<p><strong>Today's ↵
    special</strong>: ");
document.write("Buy a large meat ↵
    lover's pizza<br />");
document.write("and receive a free Caesar salad ");
document.write("and two liters of Diet Pepsi!</p>");
```

Remember that the only reason you are using `write()` statements to add text to a Web page when it is first rendered is to learn the basics of JavaScript.

3. Save the **menu.html** document and open it in your Web browser. The image in your browser should appear similar to Figure 1-7.

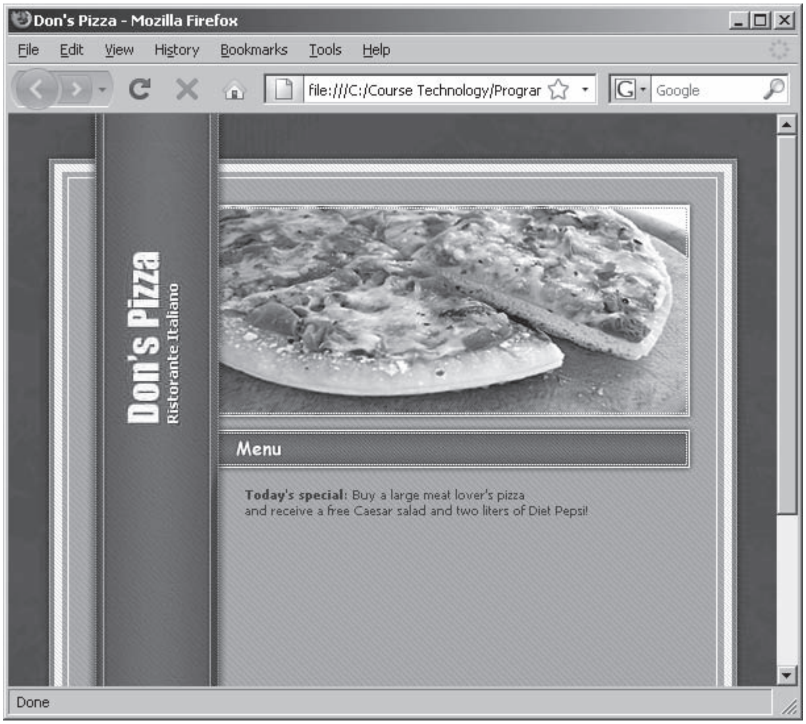


Figure 1-7 menu.html displaying daily special generated with `document.write()` statements

4. Close your Web browser window.

Case Sensitivity in JavaScript

Like XHTML, JavaScript is case sensitive, and within JavaScript code, object names must always be all lowercase. This can be a source of some confusion, because in written explanations about JavaScript, the names of objects are usually referred to with an initial capital letter. For example, throughout this book, the `Document` object is referred to with an uppercase `D`. However, you must use a lowercase `d` when referring to the `Document` object in a script. The statement `Document.write("Can you hear me now?");` causes an error message because the JavaScript interpreter cannot recognize an object named `Document` with an uppercase `D`.

Similarly, the following statements will also cause errors:

```
DOCUMENT.write("Can you hear me now?");
Document.Write("Can you hear me now?");
document.WRITE("Can you hear me now?");
```

Adding Comments to a JavaScript Program

When you create a program, whether in JavaScript or any other programming language, it is considered good programming practice to add comments to your code. In this section, you will learn how to create JavaScript comments. **Comments** are nonprinting lines that you place in your code to contain various types of remarks, including the name of the program, your name and the date you created the program, notes to yourself, or instructions to future programmers who may need to modify your work. When you are working with long scripts, comments make it easier to decipher how a program is structured.

JavaScript supports two kinds of comments: line comments and block comments. A **line comment** hides a single line of code. To create a line comment, add two slashes `//` before the text you want to use as a comment. The `//` characters instruct the JavaScript interpreter to ignore all text immediately following the slashes to the end of the line. You can place a line comment either at the end of a line of code or on its own line. **Block comments** hide multiple lines of code. You create a block comment by adding `/*` to the first line that you want included in the block, and you close a comment block by typing `*/` after the last character in the block. Any text or lines between the opening `/*` characters and the closing `*/` characters are ignored by the JavaScript interpreter. The following code shows a `<script>` element containing line and block comments. If you open a document that contains the following script in a Web browser, the browser does not render the text marked with comments.

```
<script type="text/javascript">
/*
This line is part of the block comment.
This line is also part of the block comment.
*/
document.writeln("<h1>Comments Example</h1>"); // Line ↵
comments can follow code statements
// This line comment takes up an entire line.
/* This is another way of creating a block comment. */
</script>
```

Comments in JavaScript use the same syntax as comments created in C++, Java, and other programming languages.

Next, you will add comments to the Menu page for the pizza restaurant.

To add comments to the Menu page for the pizza restaurant:

1. Return to the **menu.html** document in your text editor.
2. Add the following block comment immediately after the opening <script> tag:

   ```
   /*
   JavaScript code for Chapter 1.
   The purpose of this code is simply to demonstrate
   how to add a script section to a Web page.
   */
   ```

3. Next, add the following line comments immediately after the block comment, taking care to replace "*your name*" with your first and last name and "*today's date*" with the current date:

   ```
   // your name
   // today's date
   ```

4. Save the **menu.html** document, and then open it in your Web browser to confirm that the comments are not displayed.
5. Close your Web browser window.

Short Quiz 3

1. What element do you use to add JavaScript code to a Web page and how is it structured?
2. What is an object as the term is used in programming languages?
3. Explain how to include comments in your JavaScript code.

Writing Basic JavaScript Code

In this section, you will learn how to write basic JavaScript code, starting with variables.

Using Variables

ECMAScript Edition 3 allows you to create constants using the const keyword. A constant contains information that does not change during the course of program execution. (You can think of a constant as a variable with a value that does not change.) However, at the time of this writing, few browsers support the `const` keyword, so you will not study it in this chapter.

The values a program stores in computer memory are commonly called **variables**. Technically speaking, though, a variable is actually a specific location in the computer's memory. Data stored in a specific variable often changes. You can think of a variable as similar to a storage locker—a program can put any value into it and then retrieve the value later for use in calculations. To use a variable in a program, you first have to write a statement that creates the variable and assigns it a name. For example, you may have a program that creates a variable named `curTime` and then stores the current time in that variable. Each time the program runs, the current time is different, so the value varies.

Programmers often talk about "assigning a value to a variable," which is the same as storing a value in a variable. For example, a shopping cart program might include variables that store customer names and purchase totals. Each variable will contain different values at different times, depending on the name of the customer and the items he or she is purchasing.

Assigning Variable Names

Some older versions of Web browsers, including Navigator 2.02 and Internet Explorer 3.02, do not recognize the dollar sign in variable names. If you want your scripts to interact seamlessly with older Web browsers, avoid using the dollar sign in variable names.

The name you assign to a variable is called an **identifier**. You must observe the following rules and conventions when naming a variable:

- Identifiers must begin with an uppercase or lowercase ASCII letter, dollar sign ($), or underscore (_).
- You can use numbers in an identifier but not as the first character.
- You cannot include spaces in an identifier.
- You cannot use reserved words for identifiers.

Reserved words (also called **keywords**) are special words that are part of the JavaScript language syntax. As just noted, reserved words cannot be used for identifiers. Table 1-2 lists the JavaScript reserved words.

abstract	else	instanceof	switch
boolean	enum	int	synchronized
break	export	interface	this
byte	extends	long	throw
case	false	native	throws
catch	final	new	transient
char	finally	null	true
class	float	package	try
const	for	private	typeof
continue	function	protected	var
debugger	goto	public	void
default	if	return	volatile
delete	implements	short	while
do	import	static	with
double	in	super	

Table 1-2 JavaScript reserved words

Variable names, like other JavaScript code, are case sensitive. Therefore, the variable name `myVariable` is a completely different variable than one named `myvariable`, `MyVariable`, or `MYVARIABLE`. If you receive an error when running a script, be sure that you are using the correct case when referring to any variables in your code.

It's common practice to use an underscore (_) character to separate individual words within a variable name, as in `my_variable_name`. Another option is to use a lowercase letter for the first letter of the first word in a variable name, with subsequent words starting with an initial cap, as in `myVariableName`.

Declaring and Initializing Variables

Before you can use a variable in your code, you have to create it. In JavaScript, you usually use the reserved keyword `var` to create variables. For example, to create a variable named `myVariable`, you use this statement:

```
var myVariable;
```

Using the preceding statement to create a variable is called **declaring** the variable. When you declare a variable, you can also assign a specific value to, or **initialize**, the variable using the following syntax. The equal sign in a variable declaration assigns a value to the variable.

```
var variable_name = value;
```

The equal sign (=) in the preceding statement is called an **assignment operator** because it assigns the value on the right side of the expression to the variable on the left side of the expression. The value you assign to a variable can be a literal string or a numeric value. For example, the following statement assigns the literal string "Don" to the variable `myName`:

```
var myName = "Don";
```

You are not required to use the `var` keyword to declare a variable. However, omission of the `var` keyword affects where a variable can be used in a script. Regardless of where in your script you intend to use a variable, it is good programming practice to always use the `var` keyword when declaring a variable.

When you assign a literal string value to a variable, you must enclose the text in quotation marks, just as when you use a literal string with the `document.write()` or `document.writeln()` methods. However, when you assign a numeric value to a variable, do not enclose the value in quotation marks or JavaScript will treat the value as a string instead of a number. The following statement assigns the numeric value .05 to the `salesTax` variable:

```
var salesTax = .05;
```

You can declare multiple variables in the statement using a single `var` keyword followed by a series of variable names and assigned values separated by commas. For example, the following statement creates several variables using a single `var` keyword:

```
var orderNumber = "RP09030218", salesTotal = 47.58,
     salesTax = .05;
```

Notice in the preceding example that each variable is assigned a value. Although you can assign a value when a variable is declared, you are not required to do so. Your script may assign the value later, or you may use a variable to store user input. However, your script will not run correctly if it attempts to use a variable that has not been initialized. Therefore, it is good programming practice to always initialize your variables when you declare them.

In addition to assigning literal strings and numeric values to a variable, you can also assign the value of one variable to another. For instance, in the following code, the first statement creates a variable named `salesTotal` without assigning it an initial value. The second statement creates another variable, named `curOrder`, and assigns to it a numeric value of 47.58. The third statement then assigns the value of the `curOrder` variable to the `salesTotal` variable.

```
var salesTotal = 0;
var curOrder = 47.58;
salesTotal = curOrder;
```

Displaying Variables

To print a variable (that is, display its value on the screen), you pass the variable name to the `document.write()` or `document.writeln()` method but without enclosing it in quotation marks, as follows:

```
document.write("<p>Your sales total is $"
      + salesTotal + ".</p>");
```

Notice in the preceding code that the `document.write()` method uses a plus sign (+) to combine a literal string with a variable containing a numeric value. You will learn more about performing similar operations as you progress through this chapter. However, you need to understand that using a plus sign to combine literal strings with variables containing numeric values does not add them together, as in an arithmetic operation. Rather, it combines the values to create a new string, which is then printed to the screen. Figure 1-8 shows how the script appears in a Web browser.

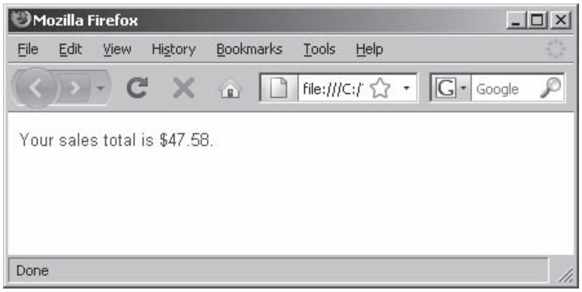


Figure 1-8 Results of script that assigns the value of one variable to another

In addition to using a plus sign to combine a literal string with the numeric value of a variable, you can also use a plus sign to perform arithmetic operations involving variables that contain numeric values. For instance, the following code declares two variables and assigns to them numeric values. The third statement declares another variable and assigns to it the sum of the values stored in the other variables. If you were to print the value of the `grandTotal` variable after assigning to it the sum of the `salesTotal` and `shipping` variables, it would print a value of "57.58", as shown in Figure 1-9.

```
var salesTotal = 47.58;
var shipping = 10;
var grandTotal = salesTotal + shipping;
document.write("<p>Your sales total plus shipping is $"
     + grandTotal + ".</p>");
```

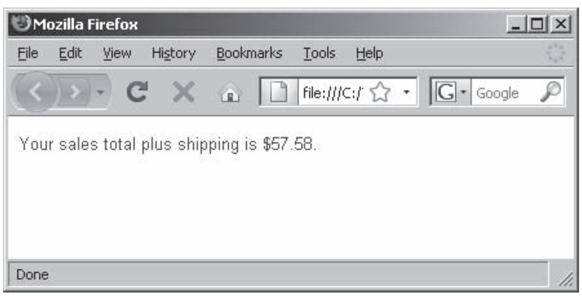


Figure 1-9 Results of script that adds the values of two variables

Modifying Variables

Regardless of whether or not you assign a value to a variable when it is declared, you can change the variable's value at any point in a script by using a statement that includes the variable's name, followed by an equal sign, followed by the value you want to assign to the variable. The following code declares a variable named `salesTotal`, assigns it an initial value of 47.58, and prints it using a `document.write()` method. The fourth statement changes the value of the `salesTotal` variable by adding its value with the value of another variable, named `shipping`. The fifth statement prints the new value of the `salesTotal` variable. Notice that it's only necessary to declare the `salesTotal` variable (using the `var` keyword) once. Figure 1-10 shows the output in a Web browser.

```
var salesTotal = 47.58;
document.write("<p>Your sales total is $" + salesTotal
     + ".</p>");
var shipping = 10;
salesTotal = salesTotal + shipping;
document.write("<p>Your sales total plus shipping is $"
     + salesTotal + ".</p>");
```

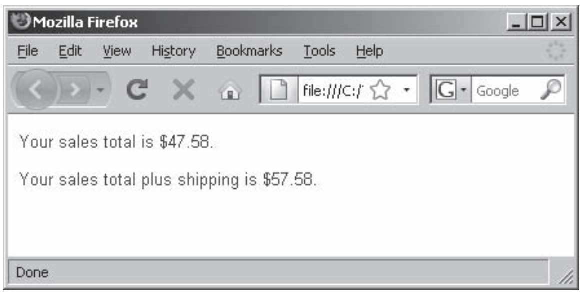


Figure 1-10 Results of script that includes a changing variable

Next, you will add some variables to the script in the menu.html file that contain descriptions of various specialty pizzas.

To add some variables to the script in the menu.html:

1. Return to the **menu.html** file in your text editor.
2. Add the following variables to the end of the script section:

```
var vegetarian = "Lots of mushrooms, black olives, ↵
    bell peppers, onions, artichoke hearts, ↵
    and fresh tomatoes. "
var hawaiian = "Overloaded with juicy pineapple, ↵
    smoked bacon, sliced ham, roasted red peppers, ↵
    provolone cheese, and mozzarella cheese on a ↵
    cheesy Parmesan crust."
```

The arrow symbol at the end of a line of code indicates the code is broken in this book because of space limitations. But in your program, you must type the code on a single line

```
var meatLovers = "Loads of pepperoni, savory Italian ↵
    sausage, smoked bacon, hamburger, mushrooms, ↵
    and extra cheese."
var theWorks = "An irresistible combination of ↵
    pepperoni, ham, spicy Italian sausage, ↵
    fresh-sliced onions and green peppers, ↵
    gourmet baby portabella mushrooms, and ripe ↵
    black olives."
var fourCheese = "Thin-crust pizza with a ↵
    four-cheese blend of mozzarella, Parmesan, ↵
    Romano, and Asiago, along with our special seasoning."
```

3. Save the **menu.html** document. Later in this section, you will add code that displays the values assigned to each of the variables you added in the last step.

Building Expressions

Variables and data become most useful when you use them in an expression. An **expression** is a literal value or variable or a combination of literal values, variables, operators, and other expressions that can be evaluated by the JavaScript interpreter to produce a result. You use operands and operators to create expressions in JavaScript. **Operands** are variables and literals contained in an expression. A **literal** is a value such as a literal string or a number. **Operators**, such as the addition operator (+) and multiplication operator (*), are symbols used in expressions to manipulate operands. You have worked with several simple expressions so far that combine operators and operands. Consider the following statement:

```
votingAge = 18;
```

This statement is an expression that results in the value 18 being assigned to `votingAge`. The operands in the expression are the `votingAge` variable name and the integer value 18. The operator is the equal sign (=). The equal sign operator is a special kind of operator, called an assignment operator, because it assigns the value 18 on the right side of the expression to the variable (`votingAge`) on the left side of the expression.

Understanding Events

One of the primary ways in which JavaScript is executed on a Web page is through events. An **event** is a specific circumstance (such as an action performed by a user, or an action performed by the browser) that is monitored by JavaScript and that your script can respond to in some way. As you will see in this section, you can use JavaScript events to allow users to interact with your Web pages. The most common events are actions that users perform. For example, when a user clicks a form button, a `click` event is generated. You can think of an event as a trigger that fires specific JavaScript code in response to a given situation. User-generated events, however, are not the only kinds of events monitored by JavaScript. Events that are not direct results of user actions, such as the `load` event, are also monitored. The `load` event, which is triggered automatically by a Web browser, occurs when a document finishes loading in a Web browser. Table 1-3 lists some JavaScript events and explains what triggers them.

Event	Triggered When
`abort`	The loading of an image is interrupted
`blur`	An element, such as a radio button, becomes inactive
`click`	The user clicks an element once
`change`	The value of an element, such as text box, changes
`error`	An error occurs when a document or image is being loaded
`focus`	An element, such as a command button, becomes active
`load`	A document or image loads
`mouseout`	The mouse moves off an element
`mouseover`	The mouse moves over an element
`reset`	A form's fields are reset to its default values
`select`	A user selects a field in a form
`submit`	A user submits a form
`unload`	A document unloads

Table 1-3 JavaScript events

Working with Elements and Events

Events are associated with XHTML elements. The events that are available to an element vary. The `click` event, for example, is available for the `<a>` element and form controls created with the `<input>` element. In comparison, the `<body>` element does not have a `click` event, but it does have a `load` event, which occurs when a Web page finishes loading, and an `unload` event, which occurs when a Web page is unloaded.

When an event occurs, your script executes the code that responds to that particular event. Code that executes in response to a specific event is called an **event handler**. You include event handler code as an attribute of the element that initiates the event. For example, you can add to a `<button>` element a `click` attribute that is assigned some sort of JavaScript code, such as code that changes the color of some portion of a Web page. The syntax of an event handler within an element is:

```
<element event_handler ="JavaScript code">
```


Event handler names are the same as the name of the event itself, plus a prefix of "on". For example, the event handler for the `click` event is `onclick`, and the event handler for the `load` event is `onload`. Like all XHTML code, event handler names are case sensitive and must be written using all lowercase letters in order for a document to be well formed. Table 1-4 lists various XHTML elements and their associated event handlers.

Element	Description	Event
`<a>`	Anchor	`onfocus, onblur, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<img>`	Image	`onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<body>`	Document body	`onload, onunload, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<form>`	Form	`onsubmit, onreset, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<input>`	Form control	`tabindex, accesskey, onfocus, onblur, onselect, onchange, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<textarea>`	Text area	`onfocus, onblur, onselect, onchange, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<select>`	Selection	`onfocus, onblur, onchange`

Table 1-4 XHTML elements and their associated events

The JavaScript code for an event handler is contained within the quotation marks following the name of the JavaScript event handler. The following code uses the `<input>` element to create a push button. The element also includes an `onclick` event handler that executes the JavaScript `window.alert()` method, in response to a `click` event (which occurs when the button is clicked). The **`window.alert()` method** displays a pop-up dialog box with an OK button. You pass the `window.alert()` method a literal string containing the text you want to display. The syntax for the `alert()` method is `window.alert(message);`. The value of the literal string or variable is then displayed in the alert dialog box, as shown in Figure 1-11.

```
<input type="button"
     onclick="window.alert('You clicked a button!')">
```

Figure 1-11 Alert dialog box

Typically, the code executed by the `onclick` event handler—the `window.alert()` method—is contained within double quotation marks. In the preceding example, however, the literal string being passed is contained in single quotation marks. This is because the `window.alert()`method itself is already enclosed in double quotation marks.

The `window.alert()`method is the only statement being executed in the preceding event handler. You can, however, include multiple JavaScript statements in an event handler, as long as semicolons separate the statements. For example, to include two statements in the event handler example—a statement that creates a variable and another statement that uses the `window.alert()` method to display the variable—you would type the following:

```
<input type="button"
   onclick="var message='You clicked a button';
   window.alert(message)">
```

When you refer to a form using the value assigned to its `name` attribute, you must use the transitional DTD, because the name attribute of the `<form>` element is deprecated in XHTML. In Chapter 5, you will learn how to create and refer to forms that conform to the strict DTD.

Referencing Web Page Elements

You can use JavaScript to access any element on a Web page by appending the element's name to the name of any elements in which it is nested, starting with the `Document` object. Specific properties of an element can then be appended to the element name. This allows you to retrieve information about an element or change the values assigned to its attributes. For example, form elements such as text boxes have `value` properties that you can use to set or retrieve the value entered into the field. Suppose you have a form with a `name` attribute that is assigned a value of "invoice"; also, suppose the form contains a text box with a `name` attribute that is assigned a value of "salesTotal". You can change the value of the text box by using a statement similar to `document.invoice.salesTotal.value = value;`.

Next, you will add a form to the menu.html file that displays radio buttons for each of the specialty pizzas that Don's Pizza sells: vegetarian, Hawaiian, meat lovers, The Works, and four cheese. When a user clicks one of the radio buttons, the contents of each of the variables you added in the last exercise will display in a `<textarea>` element.

To add a form to the menu.html file:

1. Return to the **menu.html** file in your text editor.
2. Add the following form immediately after the closing `</script>` tag:

```
<form name="pizzaList" action="" method="get">
</form>
```

3. Add the following text and elements to the form you just created. Each of the radio buttons includes an `onclick` event handler that assigns the value of the associated variable (that you created earlier in this section) to a `<textarea>` element named `pizzaDesc`. You will create the `pizzaDesc` `<textarea>` element next.

```
<p>
    Click the buttons for a description of each
    pizza.</p>
<p>
    <input type="radio" name="pizzas" onclick=
    "document.pizzaList.pizzaDesc.value=vegetarian" />
    Vegetarian<br />
    <input type="radio" name="pizzas" onclick=
    "document.pizzaList.pizzaDesc.value=hawaiian" />
    Hawaiian<br />
    <input type="radio" name="pizzas" onclick=
    "document.pizzaList.pizzaDesc.value=meatLovers" />
    Meat Lovers<br />
    <input type="radio" name="pizzas" onclick=
    "document.pizzaList.pizzaDesc.value=theWorks" />
    The Works<br />
    <input type="radio" name="pizzas" onclick=
    "document.pizzaList.pizzaDesc.value=fourCheese" />
    Four Cheese</p>
```

4. Add the following text and elements to the end of the form to create the `<textarea>` element that will display the pizza descriptions. The `<textarea>` element contains a style attribute that formats it to appear as a label.

```
<p>
    <textarea name="pizzaDesc" cols="75" rows="20"
    style="background-color: Transparent; border: ↵
    none; overflow: hidden; font: 10px tahoma; ↵
    color: #3F3F3F"></textarea></p>
```

5. Save the **menu.html** document, open it in your Web browser, and then test the radio buttons. Each pizza's description should appear in the text area when you click its associated radio button. If the page doesn't load, or if you receive error messages, make sure that you typed all the JavaScript code in the correct case. (Remember that JavaScript is case sensitive.) Also check to see that you have entered all of the opening and closing tags for each element. Figure 1-12 shows how the page appears after selecting the vegetarian pizza.

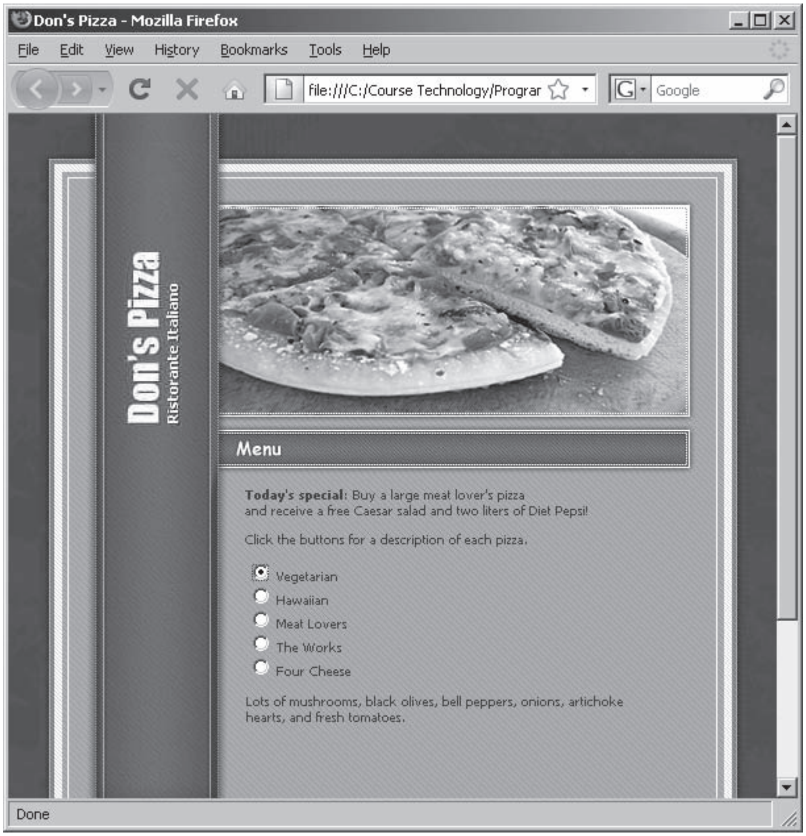


Figure 1-12 menu.html Web page after selecting the vegetarian pizza

6. Close your Web browser window.

Short Quiz 4

1. What rules must you observe when naming a variable in JavaScript?
2. Why should you initialize a variable when you first declare it?
3. What is the difference between operands and operators?
4. What is an event?
5. How do you reference Web page elements with JavaScript?

Structuring JavaScript Code

When you add JavaScript code to a document, you need to follow certain rules regarding the placement and organization of that code. The following sections describe some important rules to keep in mind when structuring your JavaScript code.

Including a `<script>` Element for Each Code Section

You can include as many script sections as you like within a document. However, when you include multiple script sections in a document, you must include a `<script>` element for each section. The following document includes two separate script sections. The script sections create the information that is displayed beneath the `<h2>` heading elements. Figure 1-13 shows the output.

```
<h1>Multiple Script Sections</h1>
<h2>First Script Section</h2>
<script type="text/javascript">
document.write("<p>Output from the first script section.</p>");
</script>
<h2>Second Script Section</h2>
<script type="text/javascript">
document.write("<p>Output from the second script
section.</p>");
</script>
```

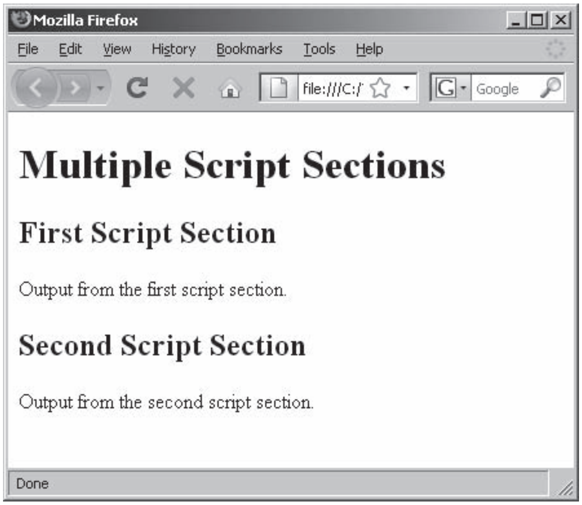


Figure 1-13 Output of a document with two JavaScript sections

Placing JavaScript in the Document Head or Document Body

You can place `<script>` elements in either the document head or document body. Where you place your `<script>` elements varies, depending on the program you are writing. The statements in a script are rendered in the order in which they appear in the document. As a general rule, then, it is a good idea to place as much of your JavaScript code as possible in the document head, because the head of a document is rendered before the document body. When placed in the document head, JavaScript code is processed before the main body of the document is displayed. It is especially important to place JavaScript code in the document head when your code performs behind-the-scenes tasks that are required by script sections located in the document body.

Next, you will move the variable declarations in the menu.html file to a script section in the document head.

To move the variable declarations to a script section in the document head:

1. Return to the **menu.html** document in your text editor.
2. Create a new script section immediately above the closing `</head>` tag, as follows:

```
<script type="text/javascript">
</script>
```

3. Cut the variable declaration statements from the script section in the document body to your clipboard and then paste them into the script section in the document head.
4. Save the **menu.html** document, open it in your Web browser, and test the functionality. The script should function the same as it did before you added the new script sections.
5. Close your Web browser window.

Creating a JavaScript Source File

JavaScript is often incorporated directly into a Web page. However, you can also save JavaScript code in an external file called a **JavaScript source** file. You can then write a statement in the document that executes (or calls) the code saved in the source file. When a browser encounters a line calling a JavaScript source file, it looks in the JavaScript source file and executes it.

A JavaScript source file is usually designated by the file extension .js and contains only JavaScript statements, although it can legally have any extension that you like. It does not contain a `<script>` element. Instead, the `<script>` element is located within the document that calls the source file. To access JavaScript code that is saved in an external file, you use the `src` attribute of the `<script>` element. You assign to the `src` attribute the URL of a JavaScript source file. For example, to call a JavaScript source file named scripts.js, you would include the following code in a document:

```
<script type="text/javascript" src="scripts.js">
</script>
```

JavaScript source files cannot include XHTML elements. If you include XHTML elements in a JavaScript source file, it will be ignored or an error message will be generated, depending on which Web browser you use. In addition, when you specify a source file in your document using the `src` attribute, the browser ignores any other JavaScript code located within the `<script>` element. For example, consider the following JavaScript code. In this case, the JavaScript source file specified by the `src` attribute of the `<script>` element executes properly, but the `write()` statement is ignored.

```
<script type="text/javascript" src="scripts.js">
document.write("<p>This statement will be ignored.</p>");
</script>
```

If the JavaScript code you intend to use in a document is fairly short, then it is usually easier to include JavaScript code in a `<script>` element within the document itself. However, for longer JavaScript code, it is easier to include the code in a .js source file. There are several reasons you may want to use a .js source file instead of adding the code directly to a document.

- Your document will be neater. Lengthy JavaScript code in a document can be confusing. You may not be able to tell at a glance where the XHTML code ends and the JavaScript code begins.
- The JavaScript code can be shared among multiple Web pages. For example, your Web site may contain pages that allow users to order an item. Each Web page displays a different item but uses the same JavaScript code to gather order information. Instead of recreating the JavaScript order information code within each document, the Web pages can share a central JavaScript source file. Sharing a single source file among multiple documents reduces disk space. In addition, when you share a source file among multiple documents, a Web browser needs to keep only one copy of the file in memory, which reduces system overhead.
- JavaScript source files hide JavaScript code from incompatible browsers. If your document contains JavaScript code, an incompatible browser displays that code as if it were standard text. By contrast, if you put your code in a source file, incompatible browsers simply ignore it.

You can use a combination of embedded JavaScript code and JavaScript source files in your documents. The ability to combine embedded JavaScript code and JavaScript source files in a single Web page is advantageous if you have multiple Web pages, each of which requires individual JavaScript code statements, but all of which also share a single JavaScript source file.

Suppose you have a Web site with multiple Web pages. Each page displays a product that your company sells. You may have a JavaScript source file that collects order information, such as a person's name and address, that is shared by each of the product Web pages. Each individual product page may also require other kinds of order information that you need to collect using JavaScript code. For example, one of your products may be a shirt, for which you need to collect size and color information. On another Web page, you may sell jellybeans, for which you need to collect quantity and flavor information. Each of these products can share a central JavaScript source file to collect standard information, but each may also include embedded JavaScript code to collect product-specific information.

Next, you will move the variable declaration statements from the script section in the document head of the menu.html file to a JavaScript source file.

To move the variable declaration statements from the script section in the document head of the menu.html file to a JavaScript source file:

1. Cut the variable declaration statements from the script section in the document head to your clipboard.
2. Create a new document in your text editor and then paste the variable declaration statements into the file.
3. Save the document as **pizza.js** in the DonsPizza folder in your Chapter folder for Chapter 1 and then close it.
4. Now return to the **menu.html** document in your text editor.
5. Add an `src` attribute to the opening `<script>` tag in the document head, so it calls the external JavaScript source file:

   ```
   <script type="text/javascript" src="pizza.js">
   </script>
   ```
6. Save the **menu.html** document, open it in your Web browser, and test the functionality. The script should function the same as it did before you created the JavaScript source file.
7. Close your Web browser window.

Validating Web Pages

When you open an XHTML document that is not well formed in a Web browser, the browser simply ignores the errors, as it would with an HTML document with errors, and renders the Web page as best it can. The Web browser cannot tell whether the XHTML document is well formed. To ensure that a Web page is well formed and that its elements are valid, you need to use a validating parser. A **validating parser** is a program that checks whether a Web page is well formed and whether the document conforms to a specific DTD. The term **validation** refers to the process of verifying that your document is well-formed and checking that the elements in your document are correctly written according to the element definitions in a specific DTD. If you do not validate a document and it contains errors, most Web browsers will probably treat it as an HTML document, ignore the errors, and render the page anyway. However, validation can help you spot errors in your code. Even the most experienced Web page authors frequently introduce typos or some other types of errors into a document that prevent the document from being well formed.

Various Web development tools, including Dreamweaver, offer validation capabilities. In addition, several validating services can be found online. One of the best available is W3C Markup Validation

Service, a free service that validates both HTML and XHTML. The W3C Markup Validation Service is located at *http://validator.w3.org/*. The service allows you to validate a Web page by entering its URI or by uploading a document from your computer. The main page of W3C Markup Validation Service is shown in Figure 1-14.

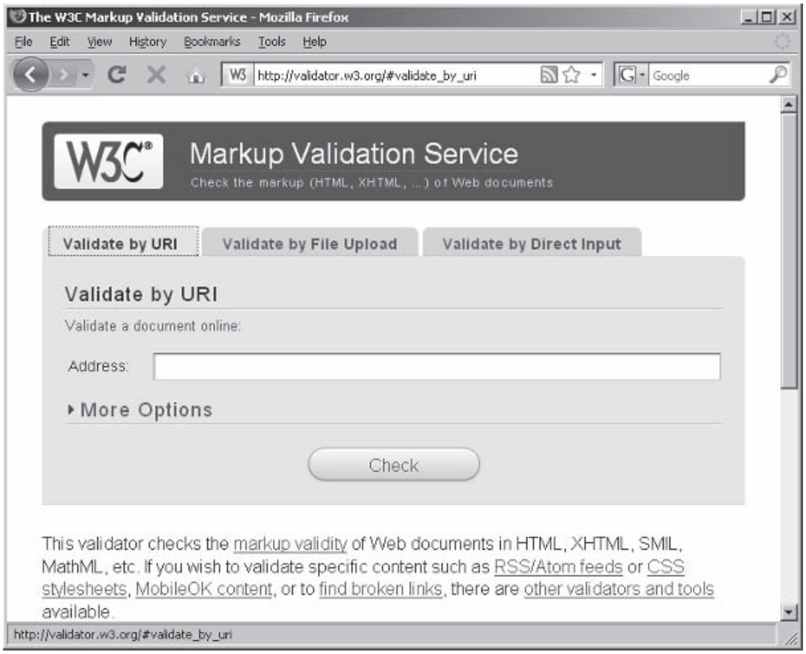


Figure 1-14 W3C Markup Validation Service Web page

Writing Valid JavaScript Code

You should always strive to create Web pages that conform to the rules and requirements of XHTML. However, JavaScript can prevent an XHTML document from being well formed because some JavaScript statements contain symbols such as the less-than symbol (<) symbol, the greater-than symbol (>), and the ampersand (&). This is not a problem with HTML documents, because the statements in a `<script>` element are interpreted as character data instead of as markup. A section of a document that is not interpreted as markup is referred to as **character data**, or **CDATA**. If you were to validate an HTML document containing a script section, the document would validate successfully because the validator would ignore the script section and not attempt to interpret the text and symbols in the JavaScript statements as HTML elements or attributes. By contrast, with XHTML documents, the statements in a `<script>` element are treated as **parsed character data**, or **PCDATA**, which identifies a section of a document that is interpreted as markup. Because JavaScript code in an XHTML document is treated as PCDATA, if you attempt to validate an XHTML document that contains a script section, it will fail the validation. To avoid this problem, you can do one of two things. One option is to move your code into a source file, which prevents the validator from attempting to parse the JavaScript statements. Alternatively, if you prefer to keep the JavaScript code within the document, you can enclose the code within a `<script>` element within a `CDATA` section, which marks sections of a document as CDATA. The syntax for including a CDATA section on a Web page is as follows:

```
<![CDATA[
statements to mark as CDATA
]]>
```

The following example contains JavaScript code that is enclosed within a CDATA section. Figure 1-15 shows the output.

```
...
<body>
<script type="text/javascript">
<![CDATA[
document.write("<h1>Order Confirmation</h1>");
document.write("<p>Your order has been received.</p>");
document.write("<p>Thank you for your business!</p>");
]]>
</script>
</body>
</html>
```

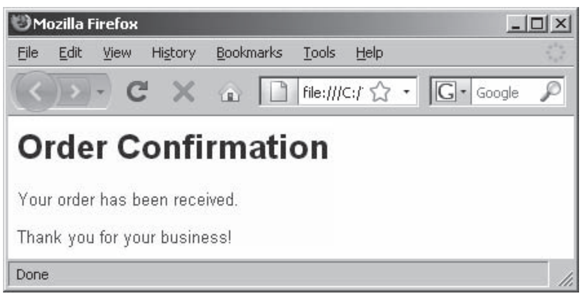


Figure 1-15 Output of Web page with hidden JavaScript code

JavaScript is compatible with virtually all current Web browsers. However, it is possible that someone may open a Web page containing JavaScript on an older Web browser that does not recognize CDATA sections. If a browser does not recognize CDATA sections, any JavaScript contained within a CDATA section will not run. To avoid this problem, you can enclose the opening and closing portions of a CDATA section within block comments, as shown in the following example:

```
...
<body>
<script type="text/javascript">
/* <![CDATA[ */
document.write("<h1>Order Confirmation</h1>");
document.write("<p>Your order has been received.</p>");
document.write("<p>Thank you for your business!</p>");
/* ]]> */
</script>
</body>
</html>
```

Next, you will modify the script section in the menu.html page so that they are hidden from incompatible browsers and are well formed.

To modify the script section in the menu.html page so that they are hidden from incompatible browsers and are well formed:

1. Return to the **menu.html** document in your text editor.
2. Modify the script section in the document body as follows, so the code is contained within a CDATA section to ensure that the Web page can be validated:

```
<script type="text/javascript">
    /* <![CDATA[ */
    /*
    JavaScript code for Chapter 1.
    The purpose of this code is simply to demonstrate
    how to add a script section to a Web page.
    */
    // Don Gosselin
    // January 1, 2010
    document.write("<p><strong>Today's ↵
        special </strong>: ");
    document.write("buy a large meat ↵
        lover's pizza<br />");
    document.write("and receive a free ↵
        Caesar salad ");
    document.write("and two liters of
        Diet Pepsi!</p>");
    /* ]]> */
    </script>
```

3. Save the **menu.html** document.
4. Start your Web browser, and enter the Web address for the W3C Markup Validation Service: **http://validator.w3.org/**. Then, click the **Validate by File Upload** tab.

5. In the Validate by File Upload tab, click the **Browse** button to display the File Upload dialog box. In the File Upload dialog box, locate the **menu.html** document in the DonsPizza folder, located in your Chapter folder for Chapter 1. Once you locate the document, double-click it or click it once and select the **Open** button. The drive, folder path, and filename should appear in the File text box on the upload page. Click the **Check** button. The W3C Markup Validation Service validates the document and returns the results displayed in Figure 1-16. If you receive any errors, fix them, resave the document, and then revalidate the page.

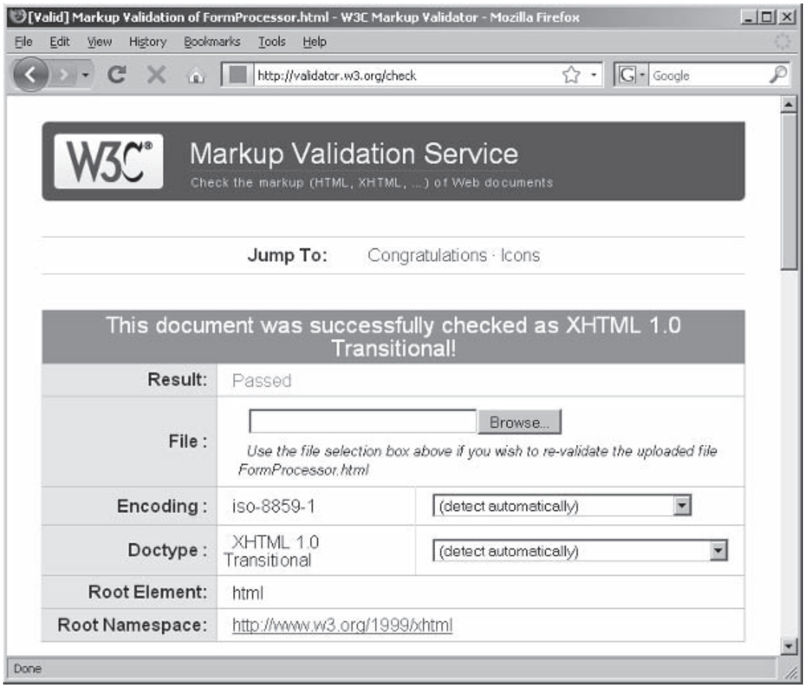


Figure 1-16 Validation results for the menu.html page

6. Once the document is valid, open it in your Web browser and test the functionality. The script should function the same as it did before you added the `CDATA` section.

7. Close your Web browser window and the menu.html document in your text editor.

Short Quiz 5

1. Why should you place `<script>` elements in the document head?

2. Why would you place JavaScript in a separate source file?
3. How should you format your JavaScript code so that it does not prevent a Web page from being invalid?

Summing Up

- In 1990 and 1991, Tim Berners-Lee created what would become the World Wide Web, or the Web, at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, as a way to easily access cross-referenced documents that existed on the CERN computer network. This method of accessing cross-referenced documents, known as hypertext linking, is probably the most important aspect of the Web because it allows you to open other Web pages quickly.
- A document on the Web is called a Web page and is identified by a unique address called the Uniform Resource Locator, or URL. A URL is a type of Uniform Resource Identifier (URI), which is a generic term for many types of names and addresses on the World Wide Web.
- The World Wide Web Consortium, or W3C, was established in 1994 at MIT to oversee the development of Web technology standards.
- Hypertext Markup Language, or HTML, is a markup language used to create the Web pages that appear on the World Wide Web. HTML documents are text documents that contain formatting instructions, called tags, which determine how data is displayed on a Web page. A tag pair and any data it contains are referred to as an element.
- The process by which a Web browser assembles and formats an HTML document is called parsing or rendering.
- Web page authoring (or Web authoring) refers to the creation and assembly of the tags, attributes, and data that make up a Web page.

- Web development, or Web programming, refers to the design of software applications for a Web site.
- In traditional client/server architecture, the server is usually some sort of database from which a client requests information.
- A system consisting of a client and a server is known as a two-tier system. The Web is built on a two-tier client/server system, in which a Web browser (the client) requests documents from a Web server.
- A three-tier, or multitier, client/server system consists of three distinct pieces: the client tier, the processing tier, and the data storage tier.
- JavaScript is a client-side scripting language that allows Web page authors to develop interactive Web pages and sites. Client-side scripting refers to a scripting language that runs on a local browser (on the client tier) instead of on a Web server (on the processing tier).
- The part of a browser that executes scripting language code is called the browser's scripting engine. A scripting engine is just one kind of interpreter, with the term interpreter referring generally to any program that executes scripting language code. A Web browser that contains a scripting engine is called a scripting host. Firefox and Internet Explorer are examples of scripting hosts that can run JavaScript programs.
- For security reasons, the JavaScript programming language cannot be used outside of the Web browser.
- Server-side scripting refers to a scripting language that is executed from a Web server.
- A general rule of thumb is to allow the client to handle the user interface processing and light processing, such as data validation, but have the Web server perform intensive calculations and data storage.
- The `<script>` element tells the Web browser that the scripting engine must interpret the commands it contains. The individual lines of code, or statements, that make up a JavaScript program in a document are contained within the `<script>` element.
- An object is programming code and data that can be treated as an individual unit or component. The procedures associated with an object are called methods. A property is a piece of data, such as a color or a name that is associated with an object.

- Comments are nonprinting lines that you place in your code to contain various types of remarks, including the name of the program, your name, and the date you created the program, notes to yourself, or instructions to future programmers who may need to modify your work.
- The values a program stores in computer memory are commonly called variables.
- Reserved words (also called keywords) are special words that are part of the JavaScript language syntax.
- An expression is a literal value or variable or a combination of literal values, variables, operators, and other expressions that can be evaluated by the JavaScript interpreter to produce a result.
- Operands are variables and literals contained in an expression.
- An event is a specific circumstance (such as an action performed by a user, or an action performed by the browser) that is monitored by JavaScript and that your script can respond to in some way. Code that executes in response to a specific event is called an event handler.
- You can save JavaScript code in an external file called a JavaScript source file.
- A validating parser is a program that checks whether a Web page is well formed and whether the document conforms to a specific DTD.
- To ensure that you can validate an XHTML document that contains a script section, you can move code into a source file or enclose the code within a `<script>` element within a `CDATA` section.

Comprehension Check

1. Which of the following is a reference to a specific Web page that you can click to open that Web page? (Choose all that apply.)
   a. hypertext link
   b. hyperlink
   c. link
   d. jump

2. When a user wants to access a Web page, either by entering its URL in a browser's Address box or by clicking a link, the user's Web browser asks a Web server for the Web page in what is referred to as a(n) ________________.

    a. demand

    b. call

    c. order

    d. request

3. The Web server returns a ________________ to the user.

    a. delivery

    b. posting

    c. response

    d. transfer

4. Elements that do not require a closing tag are called ________________ elements.

    a. closed

    b. empty

    c. permanent

    d. constant

5. What is the root element of an HTML document?

    a. `<head>`

    b. `<body>`

    c. `<html>`

    d. `<script>`

6. The process by which a Web browser assembles or formats an HTML document is called ________________. (Choose all that apply.)

    a. compiling

    b. interpreting

    c. parsing

    d. rendering

7. A system consisting of a client and a server is known as a ________________.
   a. mainframe topology
   b. double-system architecture
   c. two-tier system
   d. wide area network
8. What is usually the primary role of a client?
   a. locating records that match a request
   b. heavy processing, such as calculations
   c. data storage
   d. the presentation of an interface to the user
9. Which of the following functions does the processing tier *not* handle in a three-tier client/server system?
   a. processing and calculations
   b. reading and writing of information to the data storage tier
   c. the return of any information to the client tier
   d. data storage
10. Which function can a client safely handle?
    a. data validation
    b. data storage
    c. intensive processing
    d. heavy calculations
11. What value do you assign to the `type` attribute of the `<script>` element to tell the browser to use JavaScript?
    a. lang/javascript
    b. text/javascript
    c. javascript
    d. jscript
12. JavaScript statements must end in semicolons. True or false?

13. Which of the following statements causes an error? (Choose all that apply.)

   a. `Document.write("The show must go on!");`

   b. `document.write("The show must go on!");`

   c. `document.Write("The show must go on!");`

   d. `Document.Write("The show must go on!");`

14. Which of the following are valid identifiers? (Choose all that apply.)

   a. `var $InterestRate = .05;`

   b. `var 2008Interest Rate = .05;`

   c. `var interestRate = .05;`

   d. `var _interestRate = .05;`

15. Which of the following statements correctly prints the value of a variable named `profitMargin`? (Choose all that apply.)

   a. `document.write(profitMargin);`

   b.
```
document.write("<p>Quarterly profits ↵
    have increased by + profitMargin + </p>");
```

   c. `document.write("<p>profitMargin</p>");`

   d.
```
document.write("<p>Quarterly profits ↵
    have increased by " + profitMargin + "</p>");
```

16. Code that executes in response to a specific event is called a(n) ________________.

   a. method

   b. event handler

   c. response

   d. procedure

17. Which of the following statements assigns California to a text box named `state` on a form named `userInfo`?

   a. `document.state.value`

   b. `userInfo.state.value`

   c. `document.userInfo.state`

   d. `document.userInfo.state.value`

18. JavaScript source files must use a file extension of .js. True or false?

19. What is the difference between character data and parsed character data? What does this have to do with JavaScript?

20. A section of a document that is not interpreted as markup is referred to as ________________.

    a. PDATA

    b. CDATA

    c. PCDATA

    d. CPDATA

Reinforcement Exercises

Exercise 1-1

In this exercise, you will create a Web page that displays information about the country of Azerbaijan. The Web page will be an HTML document that does not conform to XHTML.

1. Create a new document in your text editor and type the `<html>` element, document head, and `<body>` element. Use "Azerbaijan" as the content of the `<title>` element. Your document should appear as follows:

```
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Azerbaijan</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

2. Next, add the following text and elements to the document body. Notice that the document includes the deprecated `<center>` and `<font>` elements.

```
<center><font face="arial" color="navy">
<h1>Azerbaijan</h1>
<p><b>Official name</b>: <i>Republic of
Azerbaijan</i><br />
<b>Ethnic groups</b>: <i>Azeri 90%, Dagestani 3%,
Russian 3%, Armenian 2%</i><br />
<b>Principal languages</b>: <i>Azeri (official),
Russian, Armenian</i><br /></p>
</font></center>
```

3. Save the document as **Azerbaijan.html** in the Exercises folder for Chapter 1, then open it in your Web browser and examine how the elements are rendered.

4. Close your Web browser window and return to the **Azerbaijan.html** document in your text editor.

5. Change the `<i>` and `<b>` elements in the document body to the `<em>` and `<strong>` phrase elements. The document body should appear as follows:

```
<center><font face="arial" color="navy">
<h1>Azerbaijan</h1>
<p><strong>Official name</strong>: <em>Republic of
Azerbaijan</em><br />
<strong>Ethnic groups</strong>: <em>Azeri 90%,
Dagestani 3%, Russian 3%, Armenian 2%</em><br />
< strong >Principal languages</ strong >: <em>Azeri
(official), Russian, Armenian</em><br /></p>
</font></center>
```

6. Save the document as **Azerbaijan.html** document, close it in your text editor, and then open it in your Web browser and examine how the elements are rendered. The document should appear the same as before you changed the `<i>` and `<b>` elements to the `<em>` and `<strong>` phrase elements.

7. Close your Web browser window and the Azerbaijan.html document in your text editor.

Exercise 1-2

In this exercise, you will create a Web page that displays ultraviolet index forecast information. The Web page will conform to the strict DTD.

1. Create a new document in your text editor, and type the <html> element, document head, and <body> element. Use "Ultraviolet (UV) Index Forecast" as the content of the <title> element. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC
    "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Ultraviolet (UV) Index Forecast</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

2. Add the following text and elements to the document body. The elements build a table that displays the ultraviolet index forecast information.

```
<h1>Ultraviolet (UV) Index Forecast</h1>
<table width="100%" border="1">
<tr align="left"><th>UV
Index</th><th>Exposure</th><th>Minimum
Precautions</th></tr>
<tr><td>0-2</td><td>Minimal</td><td>SPF 15 sun
screen</td></tr>
<tr><td>3-4</td><td>Low</td><td>Sun screen and
hat</td></tr>
<tr><td>5-6</td><td>Moderate</td><td>Sun screen,
hat, UV sunglasses</td></tr>
<tr><td>7-9</td><td>High</td><td>Sun screen, hat,
UV sunglasses, avoid sun between 10am and
4am</td></tr>
</table>
```

3. Save the document as **UVIndex.html** in the Exercises folder for Chapter 1.

4. Use the W3C Markup Validation Service to validate the **UVIndex.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

5. Close your Web browser window and the UVIndex.html document in your text editor.

Exercise 1-3

In this exercise, you will create a Web page that describes the Super Bowl and that contains inline styles. The Web page will conform to the strict DTD.

1. Create a new document in your text editor, and type the `<html>` element, document head, and `<body>` element. Use "Super Bowl" as the content of the `<title>` element. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC
    "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Super Bowl</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

2. Modify the opening `<body>` tag so it contains inline styles as follows:

```
<body style="color: black; background: white; ↵
    margin-bottom: 6ex; font-family: Verdana, ↵
    Arial, Helvetica, sans-serif; font-size: 12px">
```

3. Add the following heading element to the document body. The `<h1>` element contains a `style` attribute that defines several inline styles for the heading.

```
<h1 style="color: #039; background: white; ↵
    margin-bottom: 2ex">Super Bowl</h1>
```

4. Add the following paragraph to the document body. The <p> element also contains a `style` attribute that defines several inline styles for the heading.

```
<p style="margin-left: 6em;margin-right:6em">
The Super Bowl is the end-of-season
championship game in American football.
This game takes place between the winners
of the two major American leagues: the National
Football Conference (NFC) and the American
Football Conference (AFC). The first Super Bowl
took place in 1967 and now takes place every
February following the regular season.</p>
```

5. Save the document as **SuperBowlInline.html** in the Exercises folder for Chapter 1, and then open it in your Web browser and examine how the elements and styles are rendered.

6. Close your Web browser window, but leave the SuperBowlInline.html document open in your text editor.

Exercise 1-4

In this exercise, you will modify the Super Bowl Web page so that it uses an internal style sheet instead of inline styles.

1. Return to the **SuperBowlInline.html** document in your text editor and immediately save it as **SuperBowlInternal.html** in the Exercises folder for Chapter 1.

2. Add the following internal style sheet to the document head, immediately above the </head> tag. This style sheet contains the same inline styles that you added in the last exercise.

```
<style type="text/css">
body {
  color: black;
  background: white;
  margin-bottom: 6ex;
  font-family: Verdana, Arial, Helvetica, sans-serif;
  font-size: 12px;
}
h1 {
  color: #039;
  background: white;
  margin-bottom: 2ex;
}
```

```
p {
      margin-left: 6em;
      margin-right: 6em;
}
</style>
```

3. Delete the inline styles from the <h1>, <body>, and <p> tags.

4. Save the **SuperBowlInternal.html** document and open it in your Web browser. The elements should appear the same as they did before you converted the inline styles to an internal style sheet.

5. Close your Web browser window, but leave the SuperbowlInternal.html document open in your text editor.

Exercise 1-5

In this exercise, you will modify the Super Bowl Web page so that it uses an external style sheet instead of an internal style sheet.

1. Return to the **SuperBowlInternal.html** document in your text editor and immediately save it as **SuperBowlExternal.html** in the Exercises folder for Chapter 1.

2. Copy the style declarations to your Clipboard, but be sure not to copy the <style> or </style> tags.

3. Create a new document in your text editor and paste the style declarations from your Clipboard.

4. Save the document as **superbowl_styles.css** in the Exercises folder for Chapter 1, and then close it in your text editor.

5. Return to the **SuperBowlExternal.html** document in your text editor, and delete the <style> element and the declarations it contains.

6. Add the following <link> element to the document head, immediately above the </head> tag. This element links to the external superbowl_styles.css style sheet.

   ```
   <link rel="stylesheet" href=" superbowl_styles.css"
         type="text/css" />
   ```

7. Save the **SuperBowlExternal.html** document, and open it in your Web browser.

8. Use the W3C Markup Validation Service to validate the **SuperBowlExternal.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered. The elements should appear the same as they did before you converted the internal style sheet to an external style sheet.

9. Close your Web browser window.

Exercise 1-6

In this exercise you will create a Web page that uses `document.write()` statements in a script section to print dietary recommendations for a healthy heart. The Web page will conform to the strict DTD.

1. Create a new document in your text editor, and type the `<html>` element, document head, and `<body>` element. Use "Dietary Recommendations" as the content of the `<title>` element. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC
    "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Dietary Recommendations</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

2. Add the following text and elements to the document body:

```
<h1>Dietary Recommendations</h1>
<p>The American Heart Association recommends the
following dietary guidelines for a healthy heart:</p>
```

3. Add the following script section to the end of the document body. The script section contains a CDATA section to ensure that the Web page is valid and includes block comments that will contain your name, the current date, and "Exercise 1-6". Be sure to add your name and the current date where indicated.

```
<script type="text/javascript">
/* <![CDATA[ */
/*
your name
current date
Exercise 1-6
*/
/* ]]> */
</script>
```

4. Add the following `document.write()` statements to the script section, immediately after the statement containing the closing block comment characters (*/). These statements use an unordered list element to print dietary recommendations for a healthy heart.

```
document.write("<ul>");
document.write("<li>Eat less fat</li>")
document.write("<li>Avoid sugary and processed ↵
    foods</li>")
document.write("<li>Eat plenty of
fiber-rich foods</li>")
document.write("<li>Cut down on salt</li>")
document.write("<li>Eat at least 400g of fruit and ↵
    vegetables each day</li>")
document.write("<ul>");
```

5. Save the document as **HealthyHeart.html** in the Exercises folder for Chapter 1.

6. Use the W3C Markup Validation Service to validate the **HealthyHeart.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window.

Exercise 1-7

In this exercise, you will create a Web page that uses variables to display information about the five largest islands in the world.

1. Create a new document in your text editor, and type the strict DTD `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use "Largest Islands" as the content of the `<title>` element.

2. Add the following `<h1>` element to the document body:

```
<h1>Largest Islands</h1>
```

3. Add the following script section to the end of the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. In the script section, type the following statements that declare variables containing the names and sizes of the world's five largest islands:

```
var island1Name = "Greenland";
var island2Name = "New Guinea";
var island3Name = "Borneo";
var island4Name = "Madagascar";
var island5Name = "Baffin";
var island1Size = 2175600;
var island2Size = 790000;
var island3Size = 737000;
var island4Size = 587000;
var island5Size = 507000;
```

5. Next, add the following statements to the end of the script section that print the values stored in each of the variables you declared and initialized in the last step:

```
document.write("<p>The largest island in the world is "
    + island1Name + " with " + island1Size +
    " miles. </p>");
document.write("<p>The second island in the world is "
    + island2Name + " with " + island2Size +
    " miles. </p>");
document.write("<p>The third island in the world is "
    + island3Name + " with " + island3Size +
    " miles.</p>");
document.write("<p>The fourth island in the world is "
    + island4Name + " with " + island4Size +
    " miles.</p>");
document.write("<p>The fifth island in the world is "
    + island5Name + " with " + island5Size +
    " miles. </p>");
```

6. Save the document as **LargestIslands.html** in the Exercises folder for Chapter 1 and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window, but leave the LargestIslands.html document open in your text editor.

Exercise 1-8

In this exercise, you will create a Web page the displays an alert dialog box when the user clicks a command button.

1. Create a new document in your text editor, and type the strict DTD <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use "Alert Box" as the content of the <title> element.

2. Add the following heading element and form to the document body:

```
<h1>Alert Box</h1>
<form action="">
</form>
```

3. Add the following command button to the form. Notice that the button includes an `onclick` event handler that displays an alert dialog box with the text "Welcome to my Web site."

```
<p><input type="button" value="Click Me"
onclick="alert('Welcome to my Web site')" /></p>
```

4. Save the document as **AlertBox.html** in your Exercises folder for Chapter 1.

5. Use the W3C Markup Validation Service to validate the **AlertBox.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and click the **Click Me** button. You should see the alert dialog box displaying the text "Welcome to my Web site."

6. Click the **OK** button to close the alert dialog box and then close your Web browser window.

Exercise 1-9

In this exercise, you will create a Web page that contains a list of news headlines in a list box. When a user clicks a headline, the associated story will display in a <textarea> element.

1. Create a new document in your text editor, and type the transitional DTD <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use "News Items" as the content of the <title> element.

2. Add the following form to the document body:

```
<form action="" name="newsHeadlines">
</form>
```

3. Add the following table to the form. Each item in the selection list displays a news headline. Clicking on a headline assigns a variable for the associated news article to the <textarea> element named news. You will create the variables next.

```
<table border="0" width="100%">
<tr valign="top">
<td>
<select name="headline" multiple="multiple"
style="height: 93px">
    <option onclick="document.newsHeadlines ↵
        .news.value=newsItem1">
    Investigation of building standards in
    quake zone</option>
    <option onclick="document.newsHeadlines ↵
        .news.value=newsItem2">
    Obama sees signs of economic progess</option>
    <option onclick="document.newsHeadlines ↵
        .news.value=newsItem3">
    Apple App Downloads Approach 1 Billion</option>
    <option onclick="document.newsHeadlines ↵
        .news.value=newsItem4">
    Jones, Braves beat winless Nationals 8-5</option>
    <option onclick="document.newsHeadlines ↵
        .news.value=newsItem5">
    America's uninsured haven't shown collective
    power</option>
</select>
</td>
<td>
<textarea name="news" cols="50" rows="10"
style="background-color: Transparent"></textarea>
</td>
</tr>
</table>
```

4. Add the following script section to the end of the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following variable declarations to the script section:

```
var newsItem1 = "L'AQUILA, ITALY (AP) - L'Aquila's ↵
    chief prosecutor announced an investigation ↵
    into allegations of shoddy construction as workers ↵
    continued to scour the rubble for people still ↵
    missing after a devastating earthquake five days ago. ↵
    http://in.reuters.com/article/idUSWBT01103020090411";
var newsItem2 = "WASHINGTON (Reuters) - President ↵
    Barack Obama said on Friday the recession-hit US ↵
    economy was showing 'glimmers of hope' despite ↵
    remaining under strain and promised further steps ↵
    in coming weeks to tackle the financial crisis. ↵
    http://in.reuters.com/article/idUSWBT01103020090411 ";
var newsItem3 = "(eWeek.com) - Apple is close to ↵
    hitting 1 billion downloads from its App Store and ↵
    plans on a prize giveaway for whoever downloads ↵
    the billionth application that includes a MacBook Pro ↵
    and an iPod Touch. http://www.eweek.com/c/a/ ↵
    Application-Development/eWeek-Newsbreak ↵
    -April-13-2009/";
var newsItem4 = "ATLANTA (AP) - Chipper Jones ↵
    drove in two runs, including a tiebreaking single, ↵
    and the Atlanta Braves beat Washington 8-5 on ↵
    Sunday to hand the Nationals their sixth straight ↵
    loss to start the season. http://www.newsvine.com/ ↵
    _news/2009/04/11/2667835-jones-braves-beat-winless ↵
    -nationals-8-5?category=sports";
var newsItem5 = "ATLANTA (AP) - The Washington ↵
    Nationals would like a restart. The Atlanta Braves ↵
    just want to keep the winning pace they've set ↵
    during the first week of the season. ↵
    http://sports.yahoo.com/mlb/recap?gid=290412115";
```

6. Save the document as **NewsItems.html** in your Exercises folder for Chapter 1.

7. Use the W3C Markup Validation Service to validate the **NewsItems.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and test the script by clicking on each new heading in the selection list. Each headline's associated story should appear in the `<textarea>` element.

8. Close your Web browser window.

Exercise 1-10

In this exercise, you will move the variable declaration statements from the script section in the document head of the NewsItems.html file to a JavaScript source file.

1. Return to the **NewsItems.html** file in your text editor, and cut the variable declaration statements from the script section in the document head; it is placed on your clipboard.
2. Create a new document in your text editor and then paste the variable declaration statements into the file.
3. Save the document as **newsitems.js** in your Exercises folder for Chapter 1 and then close it.
4. Now return to the **NewsItems.html** document in your text editor.
5. Add an `src` attribute to the opening `<script>` tag in the document head, so it calls the external JavaScript source file:

```
<script type="text/javascript" src="newsitems.js">
</script>
```

6. Save the **NewsItems.html** document, open it in your Web browser, and test the functionality. The script should function the same as it did before you created the JavaScript source file.
7. Close your Web browser window and the NewsItems.html document in your text editor.

Discovery Projects

Save your Discovery Projects files in the Projects folder for Chapter 1. Be sure to validate the files you create with the W3C Markup Validation Service.

Project 1-1

Create a Web page for a store that rents computers by the hour. Use the strict DTD and an internal style sheet. Format the heading level styles in olive and the paragraphs in blue. Format the heading and body elements using sans-serif fonts, such as Arial and Helvetica.

Include headings, such as Services Offered, Hours of Operation, Rental Charges, and Accepted Forms of Payment. Within the Rental Charges heading, create a table that lists the cost of different types of computer platforms, such as Windows, Linux, and Macintosh. Format the rows in the table so that they alternate from white to gray. Within the gray rows, format the text to be white. Within the white rows, format the text to be black. You will need to set the `color` and `background-color` properties for the table's `<tr>` elements using class selectors. Save the Web page as **ComputerCenter.html**.

Project 1-2

Create a Web page for a company that rents horses. Use the strict DTD and an external style sheet. Format the heading elements in navy and the paragraphs in black. Use the body selector to format all of the text in the body using serif fonts such as Garamond and Times New Roman. Use whatever size you like for the heading and paragraph font sizes. Include at least three paragraphs that describe the services the company offers. Format each paragraph so its line height is spaced at 150%. Also, format the first word in every paragraph so it is 30% larger than the surrounding text, formatted in blue, and uses a sans-serif font such as Arial. Save the Web page as **HorseRentals.html** and the style sheet as **horses.css**.

Project 1-3

Create a document with an `<h1>` element containing the text "Forestville Funding" and an `<h2>` element containing the text "Auto Loan Rates." Use the strict DTD and link the document to the js_styles.css style sheet, located in your Projects folder for Chapter 1. Add a script section containing a CDATA section to the document body. Within the CDATA section, use the `document.write()` statement to print the following auto loan rate information: 5.85% (24 Month Terms), 6.25% (36 Month Terms), and 7.65% (48 Month Terms). Print each line as an item in an unordered list by using the `<ul>` and `<li>` elements. Use another `document.write()` statement to print a `<p>` element after the unordered list that contains the text "Minimum down payment: 10%." Add JavaScript comments with your name, today's date, and Project 1-3. Include code to hide the JavaScript code from incompatible browsers. Save the document as **AutoRates.html**.

Project 1-4

Create a document with three script sections: one in the document head and two in the document body. Use the strict DTD and link the document to the js_styles.css style sheet, located in your Projects folder for Chapter 1. Be sure to include CDATA sections within the script sections. In the script section in the document head, include a `document.write()` statement that prints a line that reads `"<h1>Don's Jungle Tours</h1>"`. Be sure to include the heading element. Add `<h2>Adventure</h2>` above the first script section and `<h2>Excellence</h2>` above the second script section. Add JavaScript comments with your name, today's date, and Case Project 1-4. In the first script section in the document body, use five `document.write()` statements to print an unordered list containing the following three lines: "Ecotourism is our specialty", "Get up close and personal with nature", and "Destinations include Africa, South America, and Asia". The second script section in the document body should call a JavaScript source file that prints the following two lines as list items: "Best quality and price" and "Authentic in-country experience". Save the Web page document as **JungleTours.html** and the JavaScript source file as **travel.js**.

Project 1-5

The Projects folder for Chapter 1 contains a Web page named **HighestWaterfalls.html** that uses `document.write()` statements to print a table containing the names, locations, and height of the 10 highest waterfalls in the world. Both the XHTML elements and the JavaScript statements contain errors that prevent the Web page from being validated against the strict DTD and the `document.write()` statements from functioning. Save the document as **HighestWaterfalls_Corrected.html**, and identify and fix the problems in the file. Be sure that the document is validated against the strict DTD; prints the names, locations, and heights for all 10 waterfalls; and does not generate any JavaScript errors.

Project 1-6

In this chapter you learned how to reference form elements by appending the form name, the element names, and the value property to the Document object. For example, to access the value in a text box named firstName on a form named customerInfo, you use the statement document.customerInfo.firstName.value. Using similar syntax, you can use the src property to dynamically change an image. For example, you can access an image (<img>) element named productImage through its src property using the statement document.productImage.src. Your Projects folder for Chapter 1 contains image files for the flags of 10 countries: argentina.jpg, australia.jpg, bolivia.jpg, cuba.jpg, finland.jpg, france.jpg, italy.jpg, peru.jpg, syria.jpg, and tunisia.jpg. Create a Web page that contains a table with two columns in a single row. In the first column, create a list of radio buttons that contains the name of each of the 10 countries. In the second column, display the flag of the selected country in an anchor element. Use onclick event handlers to display the flag image for each selected country. When the page first loads, the image should be blank. Save the Web page document as **Flags.html**.

CHAPTER 2

Working with Functions, Data Types, and Operators

In this chapter, you will:

- Learn how to use functions to organize your JavaScript code
- Study data types
- Use expressions and operators
- Study operator precedence

So far, the code you have written has consisted of simple statements placed within script sections. However, almost all programming languages, including JavaScript, allow you to group programming statements in logical units. In JavaScript, groups of statements that you can execute as a single unit are called functions. You'll learn how to use functions in this chapter.

In addition to functions, one of the most important aspects of programming is the ability to store values in computer memory and to manipulate those values. In the last chapter, you learned how to store values in computer memory using variables. The values, or data, contained in variables are classified into categories known as data types. In this chapter, you will learn about JavaScript data types and the operations that can be performed on them.

Working with Functions

In Chapter 1, you learned that procedures associated with an object are called methods. In JavaScript programming, you can write your own procedures, called **functions**, which refer to a related group of JavaScript statements that are executed as a single unit. Functions are virtually identical to methods except that they are not associated with an object the way the `write()` method is associated with the `Document` object. Functions, like all JavaScript code, must be contained within a `<script>` element. In the following section, you'll learn more about incorporating functions in your scripts.

Defining Functions

Before you can use a function in a JavaScript program, you must first create, or define, it. The lines that make up a function are called the **function definition**. The syntax for defining a function is:

```
function name_of_function(parameters) {
     statements;
}
```

Parameters are placed within the parentheses that follow a function name. A **parameter** is a variable that is used within a function. Placing a parameter name within the parentheses of a function definition is the equivalent of declaring a new variable. However, you do not need to include the `var` keyword. For example, suppose that you want to write a function named `calculate_square_root()` that calculates the square root of a number contained in a parameter

Functions do not have to contain parameters. Many functions only perform a task and do not require external data. For example, you might create a function that displays the same message each time a user visits your Web site; this type of function only needs to be executed and does not require any other information.

named `number`. The function name would then be written as `calculate_square_root(number)`. In this case, the function declaration is declaring a new parameter (which is a variable) named `number`. Functions can contain multiple parameters separated by commas. To add three separate number parameters to the `calculate_square_root()` function, you would write the function name as `calculate_square_root(number1, number2, number3)`. Note that parameters (such as the `number1`, `number2`, and `number3`) receive their values when you call the function from elsewhere in your program. (You will learn how to call functions in the next section.)

Following the parentheses that contain the function parameters is a set of curly braces (called function braces) that contain the function statements. Function statements are the statements that do the actual work of the function (such as calculating the square root of the parameter, or displaying a message on the screen) and must be contained within the function braces. The following is an example of a function that prints the names of several students using the `write()` methods of the `Document` object. (Recall that functions are very similar to the methods associated with an object.)

```
function printStudentNames(student1, student2, student3) {
     document.write("<p>" + student1 + "</p>");
     document.write("<p>" + student2 + "</p>");
     document.write("<p>" + student3 + "</p>");
}
```

Notice how the preceding function is structured. The opening curly brace is on the same line as the function name, and the closing curly brace is on its own line following the function statements. Each statement between the curly braces is indented one-half inch. This structure is the preferred format among many JavaScript programmers. However, for simple functions it is sometimes easier to include the function name, curly braces, and statements on the same line. (Recall that JavaScript ignores line breaks, spaces, and tabs.) The only syntax requirement for spacing in JavaScript is that semicolons separate statements on the same line.

A JavaScript program is composed of all the `<script>` sections within a document; each individual `<script>` section is not necessarily its own individual JavaScript program (although it could be if there are no other `<script>` sections in the document).

Always put your functions within the document head, and place calls to a function within the body section. As you recall, the document head is always rendered before the document body. Thus, placing functions in the head section and function calls in the body section ensures that functions are created before they are actually called. If your program does attempt to call a function before it has been created, you will receive an error.

Next, you will work on an existing Web site for a wedding-hosting company named CV Wedding Hall. You can find the CV Wedding Hall files in a folder named CVWeddingHall in your Chapter folder for Chapter 2. The Web site contains two pages: a page that can be used to estimate wedding costs and a guest book page. First, you will work on the guest book page. You won't actually be able to save the guest list by submitting it to a server-side script. Instead, you will just use the page in order to practice some of the techniques that are taught in this chapter.

To start working on the guest book page:

1. Open the **guestbook.html** file, located in a folder named CVWeddingHall in your Chapter folder for Chapter 2, in your text editor.

2. Locate the text **[Add code here]** and replace it with the following form. You will use this form to add guests to the <textarea> element.

```
<form action="" method="post" name="newGuest">
<p>
    Guest
    <input type="text" name="guestName"
    style="width: 240px" /> 
    <br />
    Relationship
    <input type="text" name="relationship"
    style="width: 210px" />
    <input type="button" value="Add Guest" /></p>
      <p>
            <textarea name="guests"></textarea>
      </p>
</form>
```

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following function definition to the script section. The statements within the function definition build a text variable named `guestInfo`, which contains the guest name and relationship. This string is then assigned as the value of the <textarea> element.

```
function addGuest(){
    var guestInfo = document.newGuest.guestName.value
        + ", ";
     guestInfo += document.newGuest.relationship.value;
     document.newGuest.guests.value = guestInfo;
}
```


5. Save the **guestbook.html** file and leave it open in your text editor.

Calling Functions

A function definition does not execute automatically. Creating a function definition only names the function, specifies its parameters, and organizes the statements it will execute. To execute a function, you must invoke, or **call**, it from elsewhere in your program. The code that calls a function is referred to as a **function call** and consists of the function name followed by parentheses, which in turn contains any variables or values to be assigned to the function parameters. The variables or values that you place in the parentheses of the function call statement are called **arguments** or **actual parameters**. Sending arguments to the parameters of a called function is called **passing arguments**. When you pass arguments to a function, the value of each argument is then assigned to the value of the corresponding parameter in the function definition. (Again, remember that parameters are simply variables that are declared within a function definition.)

Next, you will add a function call to the `onclick` event handler of the Add Guest button.

To call the `addGuest()` function:

1. Return to the **guestbook.html** file in your text editor.
2. Locate the button control in the form and add the following `onclick` event handler:

   ```
   onclick="addGuest()"
   ```

3. Save the document as **guestbook.html** file, and open it in your Web browser. Add a name and relationship to the Guest and Relationship fields, and click the Add Guest button. Figure 2-1 shows how the page appears after adding a guest.

Figure 2-1 Guest book page after adding a guest

After you learn how to work with strings, later in this chapter, you will be able to add multiple guests to the guest book page.

4. Close your Web browser window.

In many instances, you may want your program to receive the results from a called function and then use those results in other code. For instance, consider a function that calculates the average of a series of numbers that are passed to it as arguments. Such a function would be useless if your program could not print or use the result elsewhere. As another example, suppose that you have created a function that simply prints the name of a student. Now suppose that you want to alter the program so that it uses the student name in another section of code. You can return a value from a function to a calling statement by assigning the calling statement to a variable. The following statement calls a function named `averageNumbers()` and assigns the return value to a variable named `returnValue`. The statement also passes three literal values to the function.

```
var returnValue = averageNumbers(1, 2, 3);
```

To actually return a value to a `returnValue` variable, the code must include a return statement within the `averageNumbers()` function. A **return statement** is a statement that returns a value to the statement that called the function. To use a return statement, you use the `return` keyword with the variable or value you want to send to the calling statement. The following script contains the averageNumbers() function, which calculates the average of three numbers. The script also includes a return statement that returns the value (contained in the result variable) to the calling statement:

A function does not necessarily have to return a value.

```
function averageNumbers(a, b, c) {
     var sum_of_numbers = a + b + c;
     var result = sum_of_numbers / 3;
     return result;
}
```

Next, you will add a function call to the onclick event handler of the Add Guest button. You will also modify the addGuest() function so that the guest name and relationship are passed to it as arguments, and so it returns a string to the function call.

To call the addGuest() function:

1. Return to the **guestbook.html** file in your text editor.
2. Modify the addGuest() function definition so that it includes two parameters: name and relationship. Then, modify the statements that build the guestInfo variable so that they reference the parameters instead of the form values. Also, replace the last statement that assigns the guestInfo variable to the <textarea> element with a statement that returns the variable to the function. Your modified function should appear as follows:

```
function addGuest(name, relationship) {
     var guestInfo = name + ", ";
     guestInfo += relationship;
     return guestInfo;
}
```

3. Modify the onclick event handler in the button control so it includes two statements. The first statement in the event handler calls the addGuest() function and passes to it the values of the name and relationship fields. The second statement then assigns the returned value to the <textarea> field. The modified event handler should appear as follows:

Be sure to type the string to the right on a single line.

```
onclick="var newGuest=addGuest( ↵
     document.newGuest.guestName.value, ↵
     document.newGuest.relationship.value); ↵
     document.newGuest.guests.value=newGuest"
```

4. Save the **guestbook.html** file, and open it again in your Web browser. The script should function the same as it did before you modified the function and event handler.
5. Close your Web browser window.

Understanding Variable Scope

When you use a variable in a JavaScript program, particularly a complex JavaScript program, you need to be aware of the **variable's scope**—that is, you need to think about where in your program a declared variable can be used. A variable's scope can be either global or local. A **global variable** is one that is declared outside a function and is available to all parts of your program. A **local variable** is declared inside a function and is only available within the function in which it is declared. Local variables cease to exist when the function ends. If you attempt to use a local variable outside the function in which it is declared, you will receive an error message.

The parameters within the parentheses of a function declaration are local variables.

You must use the `var` keyword when you declare a local variable. However, when you declare a global variable, the `var` keyword is optional. For example, you can write the statement `var myVariable = "This is a variable.";` as `myVariable = "This is a variable.";`. If you declare a variable within a function and do not include the `var` keyword, the variable automatically becomes a global variable. However, it is considered good programming technique to always use the `var` keyword when declaring variables because it makes it clear in your code when and where you intend to start using the variable. It is also considered poor programming technique to declare a global variable inside of a function by not using the `var` keyword because it makes it harder to identify the global variables in your scripts. Using the `var` keyword forces you to explicitly declare your global variables outside of any functions and local variables within a function.

The following script includes a global variable named `salesPrice` and a function containing two variable declarations. The first variable declaration in the function, for the `shippingPrice` variable, is a global variable because it does not include the `var` keyword. The second variable declaration in the function, for the `totalPrice` variable, is a local variable because it does include the `var` keyword. Both the global variable and the function are contained in a script section in the document head. When the function is called from the document body, the global variables and the local variable print successfully from within the function. After the call to the function, the global variables again print successfully from the document body. However, when the script tries to print the local variable from the document body, an error message is generated because the local variable ceases to exist when the function ends.

```
...
<head>
<title>Calculate Sales Price</title>
<meta http-equiv="content-type" content="text/html; ↵
    charset=iso-8859-1" />
<script type="text/javascript">
/* <![CDATA[ */
var salesPrice = 100.00;
function applyShipping() {
      shippingPrice = 8.95;
      var totalPrice = salesPrice + shippingPrice;
      document.write("<p>The sales price is $"
           + salesPrice + "<br />"); // prints successfully
      document.write("The shipping price is $"
           + shippingPrice + "<br />"); // prints successfully
      document.write("The sales price plus shipping is $"
            + totalPrice + "</p>"); // prints successfully
}
/* ]]> */
</script>
</head>
<body>
<script type="text/javascript">
/* <![CDATA[ */
applyShipping();
      document.write("<p>The sales price is $"
           + salesPrice + "<br />"); // prints successfully
      document.write("The shipping price is $"
           + shippingPrice + "<br />"); // error message
      document.write("The sales price plus shipping is $"
            + totalPrice + "</p>"); // prints successfully
/* ]]> */
</script>
</body>
</html>
```

Remember that it is considered poor programming practice to intentionally declare a global variable inside of a function by eliminating the `var` keyword. The only intention of the `shippingPrice` variable in the preceding example is to illustrate variable scope. If the example really needed the `shippingPrice` variable to be a global variable, then it should be declared at the global level with the `salesPrice` variable.

When a program contains a global variable and a local variable with the same name, the local variable takes precedence when its function is called. However, the value assigned to a local variable of the same name is not assigned to a global variable of the same name. In the following code, the global variable `pitcher` is assigned a value of "Josh Beckett" before the function that contains a local variable of the same name is called. Once the function is called, the local `pitcher` variable is assigned a value of "Tim Lincecum". After the function ends, "Tim Lincecum" is still the value of the global `pitcher` variable. Figure 2-2 shows the output in a Web browser.

```
var pitcher = "Josh Beckett";
function duplicateVariableNames() {
     var pitcher = "Tim Lincecum";
         document.write("<p>" + pitcher + "</p>");
         // value printed is Tim Lincecum
}
```

```
duplicateVariableNames();
document.write("<p>" + pitcher + "</p>");
// value printed is Josh Beckett
```

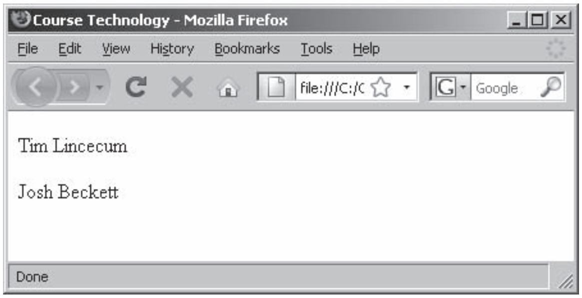


Figure 2-2 Output of a program that contains a global variable and a local variable with the same name

Although the code that displays the output shown in Figure 2-2 is syntactically correct, it is poor programming practice to use the same name for local and global variables because it makes your scripts confusing, and it is difficult to track which version of the variable is currently being used by the program.

Next, you will add global variables to the index.html page of the CV Wedding Hall site. The index.html page will contain a calculator for estimating the cost of a wedding reception. The global variables you add will store the number of guests who will be attending, the number of required limousines, the cost of live music, flowers, and an open bar, and, finally, the total estimate. You will complete the index.html page later in this chapter.

To add global variables to the index.html page of the CV Wedding Hall site:

1. Open the **index.html** file, located in a folder named CVWeddingHall in your Chapter folder for Chapter 2, in your text editor.
2. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Save the **index.html** file and leave it open in your text editor.

Using Built-in JavaScript Functions

In addition to custom functions that you create yourself, JavaScript allows you to use the built-in functions listed in Table 2-1.

Function	Description
`decodeURI(string)`	Decodes text strings encoded with `encodeURI()`
`decodeURIComponent(string)`	Decodes text strings encoded with `encodeURIComponent()`
`encodeURI(string)`	Encodes a text string so that it becomes a valid URI
`encodeURIComponent(string)`	Encodes a text string so that it becomes a valid URI component
`eval(string)`	Evaluates expressions contained within strings
`isFinite(number)`	Determines whether a number is finite
`isNaN(number)`	Determines whether a value is the special value NaN (Not a Number)
`parseFloat(string)`	Converts string literals to floating-point numbers
`parseInt(string)`	Converts string literals to integers

Table 2-1 Built-in JavaScript functions

In this book, you will examine several of the built-in JavaScript functions as you need them. For now, you just need to understand that you call built-in JavaScript functions in the same way you call a custom function. For example, the following code calls the `isNaN()` function to determine whether the `socialSecurityNumber` variable is *not* a number. Because the Social Security number assigned to the `socialSecurityNumber` variable contains dashes, it is not a true number. Therefore, the `isNaN()` function returns a value of true to the `checkVar` variable.

```
var socialSecurityNumber = "123-45-6789";
var checkVar = isNaN(socialSecurityNumber);
document.write(checkVar);
```

Short Quiz 1

1. What is the difference between arguments and parameters?
2. How do you execute a function?
3. Why would you want to return a value from a function?
4. What is variable scope?

Working with Data Types

Variables can contain many different kinds of values—for example, the time of day, a dollar amount, or a person's name. A **data type** is the specific category of information that a variable contains. The concept of data types is often difficult for beginning programmers to grasp because in real life you don't often distinguish among different types of information. If someone asks you for your name, your age, or the current time, you don't usually stop to consider that your name is a text string and that your age and the current time are numbers. However, a variable's specific data type is very important in programming because the data type helps determine how much memory the computer allocates for the data stored in the variable. The data type also governs the kinds of operations that can be performed on a variable.

Data types that can be assigned only a single value are called **primitive types**. JavaScript supports the five primitive data types described in Table 2-2.

Data type	Description
Number	Positive or negative numbers with or without decimal places, or number written using exponential notation
Boolean	A logical value of true or false
String	Text such as "Hello World"
Undefined	A variable that has never had a value assigned to it, has not been declared, or does not exist
Null	An empty value

Table 2-2 Primitive JavaScript data types

The `null` value is a data type as well as a value that can be assigned to a variable. Assigning the value "null" to a variable indicates the variable does not contain a usable value. A variable with a value of "null" has a value assigned to it—null is really the value "no value." You assign the "null" value to a variable when you want to ensure that the variable does not contain any data. In contrast, an `undefined` variable is a variable that has never had a value assigned to it, has not been declared, or does not exist. The value `undefined` indicates that the variable has never been assigned a value—not even the `null` value. One use for an `undefined` variable is to determine whether a value is being used by another part of your script. As an example of an `undefined` variable, the following code declares a variable named `stateTax` variable without a value. When the second statement uses the `document.write()` method to print the `stateTax` variable, a value of “undefined” is printed because the variable has not yet been assigned a value. The variable is then assigned a value of 40, printed to the screen, and then a value of “null”, which is also printed to the screen. Figure 2-3 shows the output in a Web browser.

```
var stateTax;
document.write("<p>Your state tax is $"
     + stateTax + ".</p>");
stateTax = 40;
document.write("<p>Your state tax is $"
     + stateTax + ".</p>");
stateTax = null;
document.write("<p>Your state tax is $"
     + stateTax + ".</p>");
```

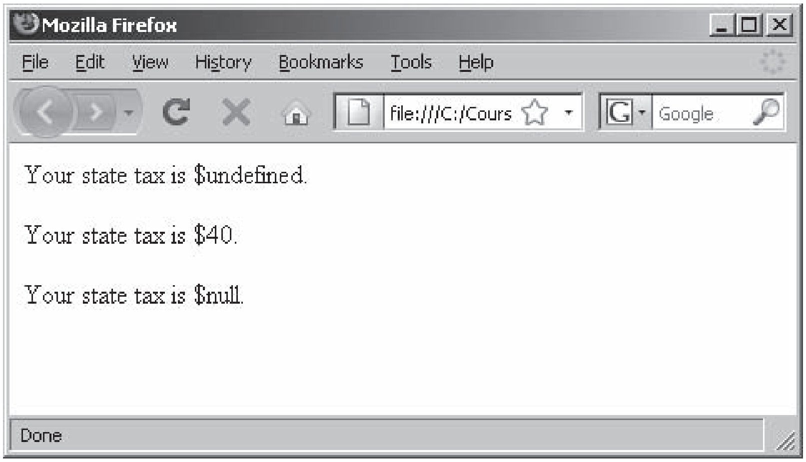


Figure 2-3 Variable assigned values of “undefined” and “null”

The JavaScript language also supports a more advanced type, `Object`, which is used for creating a collection of properties. You will learn about the `Object` type in Chapter 6.

Many programming languages require that you declare the type of data that a variable contains. Programming languages that require you to declare the data types of variables are called **strongly typed programming languages**. Strong typing is also known as **static typing**, because data types do not change after they have been declared. Programming languages that do not require you to declare the data types of variables are called **loosely typed programming languages**. Loose typing is also known as **dynamic typing** because data types can change after they have been declared. JavaScript is a loosely typed programming language. In JavaScript, you are not required to declare the data type of variables and, in fact, are not allowed to do so. Instead, the JavaScript interpreter automatically determines what type of data is stored in a variable and assigns the variable’s data type accordingly. The following code demonstrates how a variable's data type changes automatically each time the variable is assigned a new literal value:

```
diffTypes = "Hello World"; // String
diffTypes = 8;             // Integer number
diffTypes = 5.367;         // Floating-point number
diffTypes = true;          // Boolean
diffTypes = null;          // null
```

The next two sections focus on two especially important data types: numeric and Boolean data types.

Understanding Numeric Data Types

Numeric data types are an important part of any programming language and are particularly useful for arithmetic calculations. JavaScript supports two numeric data types: integers and floating-point numbers. An **integer** is a positive or negative number with no decimal places. Integer values in JavaScript can range from -9007199254740990 (-2^{53}) to 9007199254740990 (2^{53}). The numbers -250, -13, 0, 2, 6, 10, 100, and 10000 are examples of integers. The numbers -6.16, -4.4, 3.17, .52, 10.5, and 2.7541 are not integers; they are floating-point numbers because they contain decimal places. A **floating-point number** is a number that contains decimal places or that is written in exponential notation. **Exponential notation**, or **scientific notation**, is a shortened format for writing very large numbers or numbers with many decimal places. Numbers written in exponential notation are represented by a value between 1 and 10 multiplied by 10 raised to some power. The value of 10 is written with an uppercase or lowercase *E*. For example, the number 200,000,000,000 can be written in exponential notation as 2.0e11, which means "two times ten to the eleventh power." Floating-point values in JavaScript range from approximately ±1.7976931348623157 x 10^{308} to ± 5 x 10^{-324}.

Floating-point values that exceed the largest positive value of ±1.7976931348623157 × 10^{308} result in a special value of `Infinity`. Floating-point values that exceed the smallest negative value of ±5 × 10^{-324} result in a value of `-Infinity`.

Next, you will create a script that uses variables containing integers, floating-point numbers, and exponential numbers to print the 20 prefixes of the metric system. A metric prefix, or SI prefix, is a name that precedes a metric unit of measure. For example, the metric prefix for centimeter is *centi*; it denotes a value of 1/100th. In other words, a centimeter is the equivalent of 1/100th of a meter.

To create a script that prints metric prefixes:

1. Create a new document in your text editor.
2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Metric Prefixes" as the content of the `<title>` element.

Include a <link> element that links to the js_styles.css style sheet in your Chapter folder. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Metric Prefixes</title>
<meta http-equiv="content-type" content="text/html; ↵
    charset=iso-8859-1" />
<link rel="stylesheet" href="js_styles.css"
type="text/css" />
</head>
<body>
</body>
</html>
```

3. Add the following heading element to the document body:

```
<h1>Metric Prefixes</h1>
```

4. Add the following script section to the end of the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. In the script section, add the following variable declarations for the 20 metric prefixes:

```
var yotta = 1e24;
var zetta = 1e21;
var exa = 1e18;
var peta = 1e15;
var tera = 1e12;
var giga = 1e9;
var mega = 1e6;
var kilo = 1000;
var hecto = 100;
var deca = 10;
var deci = .1;
var centi = .01;
var milli = .001;
var micro = 1e-6;
var nano = 1e-9;
var pico = 1e-12;
var femto = 1e-15;
var atto = 1e-18;
var zepto = 1e-21;
var yocto = 1e-24;
```

6. Add to the end of the script section the following statements to print the value of each metric prefix variable as cells in a table:

```
document.write("<table border='1' ↵
    width='100%'><tr><th> ↵
    Prefix</th><th>Decimal Equivalent</th></tr>");
document.write("<tr><td>Yotta</td><td>"
    + yotta + "</td></tr>");
document.write("<tr><td>Zetta</td><td>"
    + zetta + "</td></tr>");
document.write("<tr><td>Exa</td><td>"
    + exa + "</td></tr>");
document.write("<tr><td>Peta</td><td>"
    + peta + "</td></tr>");
document.write("<tr><td>Tera</td><td>"
    + tera + "</td></tr>");
document.write("<tr><td>Giga</td><td>"
    + giga + "</td></tr>");
document.write("<tr><td>Mega</td><td>"
    + mega + "</td></tr>");
document.write("<tr><td>Kilo</td><td>"
    + kilo + "</td></tr>");
document.write("<tr><td>Hecto</td><td>"
    + hecto + "</td></tr>");
document.write("<tr><td>Deca</td><td>"
    + deca + "</td></tr>");
document.write("<tr><td>Deci</td><td>"
    + deci + "</td></tr>");
document.write("<tr><td>Centi</td><td>"
    + centi + "</td></tr>");
document.write("<tr><td>Milli</td><td>"
    + milli + "</td></tr>");
document.write("<tr><td>Micro</td><td>"
    + micro + "</td></tr>");
document.write("<tr><td>Nano</td><td>"
    + nano + "</td></tr>");
document.write("<tr><td>Pico</td><td>"
    + pico + "</td></tr>");
document.write("<tr><td>Femto</td><td>"
    + femto + "</td></tr>");
document.write("<tr><td>Atto</td><td>"
    + atto + "</td></tr>");
document.write("<tr><td>Zepto</td><td>"
    + zepto + "</td></tr>");
document.write("<tr><td>Yocto</td><td>"
    + yocto + "</td></tr>");
document.write("</table>");
```

7. Save the document as **MetricPrefixes.html** in the Chapter folder for Chapter 2, and then validate it with the W3C Markup Validation Service at **http://validator.w3.org/**. Once the file is valid, close it in your text editor.

8. Open the **MetricPrefixes.html** document in your Web browser. Figure 2-4 shows how the document looks in a Web browser.

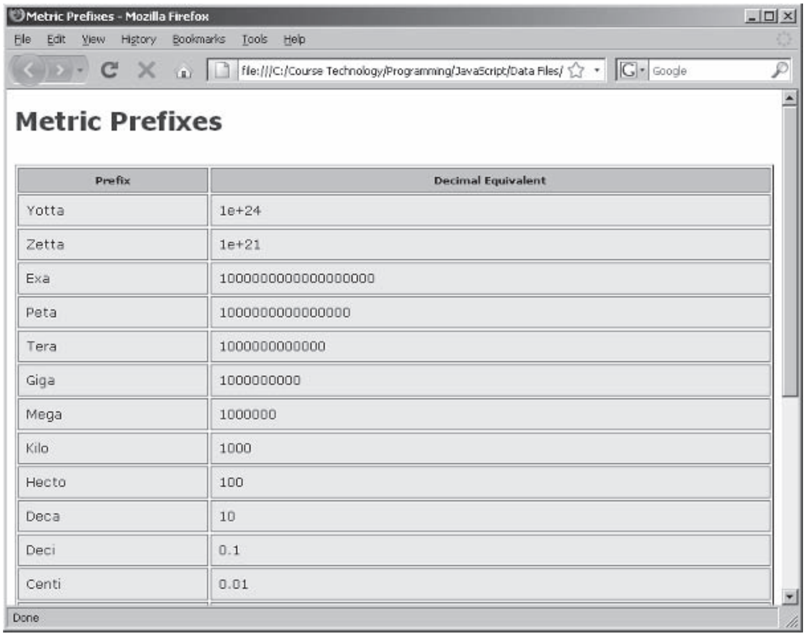


Figure 2-4 MetricPrefixes.html document in a Web browser

Most Web browsers automatically display very large numbers, such as the values represented by the zetta and yotta metric prefixes, in exponential format.

9. Close your Web browser window.

Using Boolean Values

A **Boolean value** is a logical value of true or false. You can also think of a Boolean value as being yes or no, or on or off. Boolean values are most often used for deciding which parts of a program should execute and for comparing data. In JavaScript programming, you can only use the words true and false to indicate Boolean values. In other programming languages, you can use the integer values of 1 and 0 to indicate Boolean values of true and false—1 indicates true and 0 indicates false. JavaScript converts the values true and false to the integers 1 and 0 when necessary. For example, when you attempt to use a Boolean variable of true in a mathematical operation, JavaScript converts the variable to an integer value of 1. The following shows a simple example of two variables that are assigned Boolean values, one true and the other false. Figure 2-5 shows the output in a Web browser:

```
var newCustomer = true;
var contractorRates = false;
document.write("<p>New customer: "
    + newCustomer + "</p>");
document.write("<p>Contractor rates: "
    + contractorRates + "</p>");
```

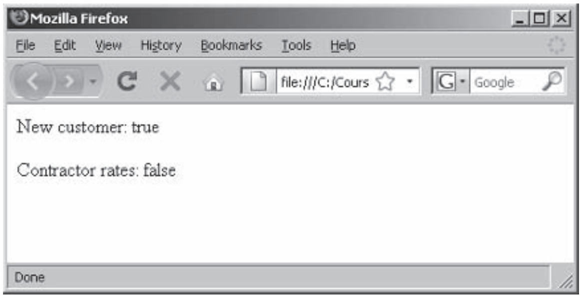



Figure 2-5 Boolean values

Next, you will add Boolean global variables to the index.html page of the CV Wedding Hall site. These variables will determine whether the wedding reception will include live music and flowers.

To add five Boolean global variables to the index.html page:

1. Return to the **index.html** file in your text editor.
2. Add to the script section the following global variables for the number of guests and limousines, the cost of live music, flowers, and the total estimate:

```
var guestsCost = 0;
var limousinesCost = 0;
var liveMusicCost = 0;
var flowersCost = 0;
var totalEstimate = 0;
```

3. Save the **index.html** file.

Working with Strings

As you learned in Chapter 1, a text string contains zero or more characters surrounded by double or single quotation marks. Examples of strings you may use in a script are company names, usernames, comments, and other types of text. You can use text strings as literal values or assign them to a variable.

Literal strings can also be assigned a zero-length string value called an **empty string**. For example, the following statement declares a variable named `customerName` and assigns it an empty string:

```
var customerName = "";
```

Empty strings are valid values for literal strings and are not considered to be `null` or `undefined`. Why would you want to assign an empty string to a literal string? Think for a moment about the `prompt()` method, which displays a dialog box with a message, a text box, an OK button, and a Cancel button. You can pass two string arguments to the `prompt()` method. The first argument displays an instruction to the user, while the second argument is the default text that appears in the prompt dialog box text box. If you do not include the second argument, then the value "undefined" appears as the default text of the prompt dialog box. To prevent "undefined" from displaying as the default text in the prompt dialog text box, you pass an empty string as the second argument of the `prompt()` method.

When you want to include a quoted string within a literal string surrounded by double quotation marks, you surround the quoted string with single quotation marks. When you want to include a quoted string within a literal string surrounded by single quotation marks, you surround the quoted string with double quotation marks. Whichever method you use, a string must begin and end with the same type of quotation marks. For example, you can use either `document.write("Alexander Rodriguez is called 'A-Rod'.")` or `document.write('Alexander Rodriguez is called "A-Rod".')`. Thus, `document.write("This is a text string.");` is valid, because it starts and ends with double quotation marks, whereas the statement `document.write("This is a text string.');` is invalid, because it starts with a double quotation mark and ends with a single quotation mark. In the second case, you would receive an error message because the Web browser cannot tell where the literal strings begin and end. The following code shows an example of a script that prints strings. Figure 2-6 shows the output.

```
document.write("<p>This is a literal ↵
    string.<br />");
document.write("This string contains a ↵
    'quoted' string.<br />");
document.write('This is another example of a ↵
    "quoted" string.<br />');
var firstString = "This literal string was ↵
    assigned to a variable.<br/>";
var secondString = 'This literal string was ↵
    also assigned to a variable.</p>';
document.write(firstString);
document.write(secondString);
```

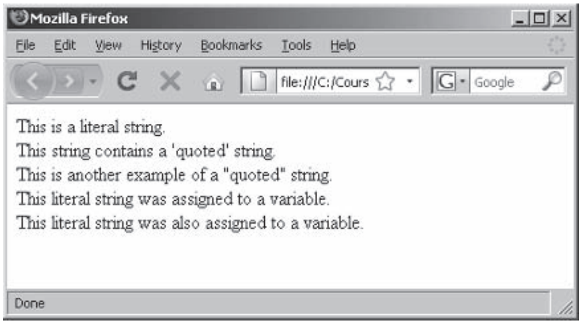


Figure 2-6 String examples in a Web browser

Unlike other programming languages, JavaScript includes no special data type for a single character, such as the `char` data type in the C, C++, and Java programming languages.

String Operators

JavaScript has two operators that can be used with strings: + and +=. When used with strings, the plus sign is known as the concatenation operator. The **concatenation operator** (+) is used to combine two strings. You have already learned how to use the concatenation operator. For example, the following code combines a string variable and a literal string, and assigns the new value to another variable:

```
var destination = "Honolulu";
var location = "Hawaii";
destination = destination + " is in " + location;
```

The combined value of the `location` variable and the string literal that is assigned to the destination variable is "Honolulu is in Hawaii."

You can also use the compound assignment operator (+=) to combine two strings. The following code combines the two text strings, but without using the `location` variable:

```
var destination = "Honolulu";
destination += " is in Hawaii";
```

Note that the same symbol—a plus sign—serves as the concatenation operator and the addition operator. When used with numbers or variables containing numbers, expressions using the concatenation operator return the sum of the two numbers. As you learned earlier in this chapter, if you use the concatenation operator with a string value and a number value, the string value and the number value are combined into a new string value, as in the following example:

```
var textString = "The legal voting age is ";
var votingAge = 18;
newString = textString + votingAge;
```

Escape Characters and Sequences

You need to use extra care when using single quotation marks with possessives and contractions in strings, because the JavaScript interpreter always looks for the first closing single or double quotation mark to match an opening single or double quotation mark. For example, consider the following statement:

```
document.write('<p>My city's zip code is 94558.</p>');
```

This statement causes an error. The JavaScript interpreter assumes that the literal string ends with the apostrophe following "city" and looks for the closing parentheses for the `document.write()` statement immediately following "city's". To get around this problem, you include an escape character before the apostrophe in "city's". An **escape character** tells the compiler or interpreter that the character that follows it has a special purpose. In JavaScript, the escape character is the backslash \. Placing a backslash in front of an apostrophe tells the JavaScript interpreter that the apostrophe is to be treated as a regular keyboard character, such as "a", "b", "1", or "2", and not as part of a single quotation mark pair that encloses a text string. The backslash in the following statement tells the JavaScript interpreter to print the apostrophe following the word "city" as an apostrophe.

```
document.write('<p>My city\'s zip code is 94558.</p>');
```

You can also use the escape character in combination with other characters to insert a special character into a string. When you combine the escape character with other characters, the combination is called an **escape sequence**. The backslash followed by an apostrophe `\'` and the backslash followed by a double quotation mark `\"` are both examples of escape sequences. Most escape sequences carry out special functions. For example, the escape sequence `\t` inserts a tab into a string. Table 2-3 describes the escape sequences that can be added to a string in JavaScript.

Escape sequence	Character
`\\`	Backslash
`\b`	Backspace
`\r`	Carriage return
`\"`	Double quotation mark
`\f`	Form feed
`\t`	Horizontal tab
`\n`	Newline

Table 2-3 JavaScript escape sequences *(continues)*

(continued)

Escape sequence	Character
\0	Null character
\'	Single quotation mark
\v	Vertical tab
XX	Latin-1 character specified by the *XX* characters, which represent two hexadecimal digits
XXXXX	Unicode character specified by the *XXXX* characters, which represent four hexadecimal digits

Table 2-3 JavaScript escape sequences

If you place a backslash before any character other than those listed in Table 2-3, the backslash is ignored.

Notice that one of the characters generated by an escape sequence is the backslash. Because the escape character itself is a backslash, you must use the escape sequence \\ to include a backslash as a character in a string. For example, to include the path “C:\JavaScript_Projects\Files\” in a string, you must include two backslashes for every single backslash you want to appear in the string, as in the following statement:

```
document.write("<p>My JavaScript files are located in ↵
C:\\JavaScript_Projects\\Files\\</p>");
```

The following code shows an example of a script containing strings with several escape sequences. Figure 2-7 shows the output.

```
<pre>
<script type="text/javascript">
/* <![CDATA[ */
document.write("<p>This line is printed \non ↵
    two lines.</p>"); // New line
document.write("<p>\tThis line includes a ↵
    horizontal tab.</p>"); // Horizontal tab
document.write("<p>My personal files are ↵
    in c:\\personal.</p>"); // Backslash
document.write(("<p>My cousin's nickname ↵
    is \"Bubba.\"</p>")); // Double quotation mark
document.write('<p>India\'s capital ↵
    is New Dehli.</p>'); // Single quotation mark
/* ]]> */
</script>
</pre>
```

> Several of the escape sequences, including the new line and horizontal tab escape sequences, are only recognized inside a container element such as the <pre> element.

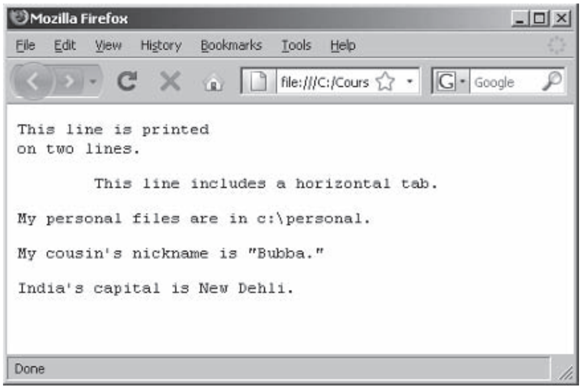


Figure 2-7 Output of script with strings containing escape sequences

The current version of the guest book page only allows you to add a single guest to the `<textarea>` element. In order to add multiple guests on individual lines, you need to add a carriage return escape sequence (\r) to the end of each line.

To modify the guest book page so you can add multiple guests:

1. Return to the **guestbook.html** file in your text editor.
2. Modify the statement in the `addGuest()` method that assigns the relationship argument to the `guestInfo` variable so that it also includes a carriage return escape sequence, as follows:

   ```
   guestInfo += relationship + "\r";
   ```

3. Modify the last statement in the button element's `onclick` event handler so that it adds the new guest string to the existing value in the `<textarea>` element, as follows:

   ```
   onclick="var newGuest=addGuest(
       document.newGuest.guestName.value,
       document.newGuest.relationship.value);
       document.newGuest.guests.value=
           document.newGuest.guests.value + newGuest"
   ```

4. Save the **guestbook.html** file, and then validate it with the W3C Markup Validation Service at **http://validator.w3.org/**. Once the file is valid, close it in your text editor. Open it again in your Web browser and test the script to ensure that you can add multiple guests.
5. Close your Web browser window.

Short Quiz 2

1. What is the difference between loosely typed and strongly typed programming languages?
2. Explain exponential notation.
3. What are Boolean values and how do you use them?
4. Explain how to use the concatenation and compound assignment operators with strings.
5. What are escape characters and escape sequences?

Using Operators to Build Expressions

In Chapter 1, you learned the basics of how to create expressions using basic operators, such as the addition operator (+) and multiplication operator (*). In this section, you will learn about additional types of operators you can use with JavaScript. Table 2-4 lists the operator types that you can use with JavaScript.

Operator type	Operators	Description
Arithmetic	addition (+) subtraction (–) multiplication (*) division (/) modulus (%) increment (++) decrement (––) negation (–)	Used for performing mathematical calculations
Assignment	assignment (=) compound addition assignment (+=) compound subtraction assignment (–=) compound multiplication assignment (*=)	Assigns values to variables

Table 2-4 JavaScript operator types *(continues)*

(continued)

Operator type	Operators	Description
	compound division assignment (/=)	
	compound modulus assignment (%=)	
Comparison	equal (==)	Compares operands and returns a Boolean value
	strict equal (===)	
	not equal (!=)	
	strict not equal (!==)	
	greater than (>)	
	less than (<)	
	greater than or equal (>=)	
	less than or equal (<=)	
Logical	and (&&)	Used for performing Boolean operations on Boolean operands
	or (||)	
	not (!)	
String	concatenation operator (+)	Performs operations on strings
	compound assignment operator (+=)	
Special	property access (`.`)	Used for various purposes and do not fit within other operator categories
	array index (`[]`)	
	function call (`()`)	
	comma (`,`)	
	conditional expression (`?:`)	
	delete (`delete`)	
	property exists (`in`)	
	object type (`instanceof`)	
	new object (`new`)	
	data type (`typeof`)	
	void (`void`)	

Table 2-4 JavaScript operator types

JavaScript operators are binary or unary. A **binary operator** requires an operand before and after the operator. The equal sign in the statement `myNumber = 100;` is an example of a binary operator. A **unary operator** requires a single operand either before or after the operator. For example, the increment operator (++), an arithmetic operator, is used for increasing an operand by a value of one. The statement `myNumber++;` changes the value of the `myNumber` variable to "101".

In the following sections, you will learn more about the different types of JavaScript operators.

> Another type of JavaScript operator, bitwise operators, operate on integer values; this is a fairly complex topic. Bitwise operators and other complex operators are beyond the scope of this book.

Arithmetic Operators

Arithmetic operators are used in JavaScript to perform mathematical calculations, such as addition, subtraction, multiplication, and division. You can also use an arithmetic operator to return the modulus of a calculation, which is the remainder left when you divide one number by another number.

Arithmetic Binary Operators

JavaScript binary arithmetic operators and their descriptions are listed in Table 2-5.

> The operand to the left of an operator is known as the left operand, and the operand to the right of an operator is known as the right operand.

Name	Operator	Description
Addition	+	Adds two operands
Subtraction	-	Subtracts one operand from another operand
Multiplication	*	Multiplies one operand by another operand
Division	/	Divides one operand by another operand
Modulus	%	Divides one operand by another operand and returns the remainder

Table 2-5 Arithmetic binary operators

The following code shows examples of expressions that include arithmetic binary operators. Figure 2-8 shows how the expressions appear in a Web browser:

```
var x = 0, y = 0, arithmeticValue = 0;
// ADDITION
x = 400;
y = 600;
arithmeticValue = x + y; // arithmeticValue changes to 1000
document.write("<p>arithmeticValue after addition expression: "
     + arithmeticValue + "</p>");
// SUBTRACTION
x = 14;
y = 6;
arithmeticValue = x - y; // arithmeticValue changes to 8
document.write("<p>arithmeticValue after subtraction expression: "
     + arithmeticValue + "</p>");
```

```
// MULTIPLICATION
x = 20;
y = 4;
arithmeticValue = x * y; // arithmeticValue changes to 80
document.write("<p>arithmeticValue after multiplication ↵
     expression: " + arithmeticValue + "</p>");
// DIVISION
x = 99;
y = 3;
arithmeticValue = x / y; // arithmeticValue changes to 33
document.write("<p>arithmeticValue after division ↵
     expression: " + arithmeticValue + "</p>");
// MODULUS
x = 5;
y = 3;
arithmeticValue = x % y; // arithmeticValue changes to 2
document.write("<p>arithmeticValue after modulus ↵
     expression: " + arithmeticValue + "</p>");
```

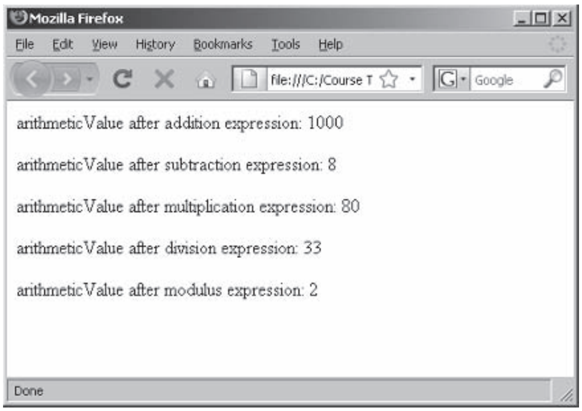


Figure 2-8 Results of arithmetic expressions

Notice in the preceding code that when JavaScript performs an arithmetic calculation, it performs the operation on the right side of the assignment operator, and then assigns the value to a variable on the left side of the assignment operator. For example, in the statement `arithmeticValue = x + y;`, the operands `x` and `y` are added, then the result is assigned to the `arithmeticValue` variable on the left side of the assignment operator.

You may be confused by the difference between the division (/) operator and the modulus (%) operator. The division operator performs a standard mathematical division operation. For example, dividing 15 by 6 results in a value of 2.5. By contrast, the modulus operator returns the remainder that results from the division of two integers. The following code, for instance, uses the division and modulus operators to return the result of dividing 15 by 6. The division of 15 by 6 results in a value of 2.5, because 6 goes into 15 exactly 2.5 times. But if you only allow for whole numbers, 6 goes into 15 only 2 times, with a remainder of 3 left over. Thus the modulus of 15 divided by 6 is 3, because 3 is the remainder left over following the division. Figure 2-9 shows the output.

```
var divisionResult = 15 / 6;
var modulusResult = 15 % 6;
document.write("<p>15 divided by 6 is "
     + divisionResult + ".</p>"); // prints '2.5'
document.write("<p>The whole number 6 goes into 15 twice, ↵
    with a remainder of "+ modulusResult + ".</p>"); // prints '3'
```

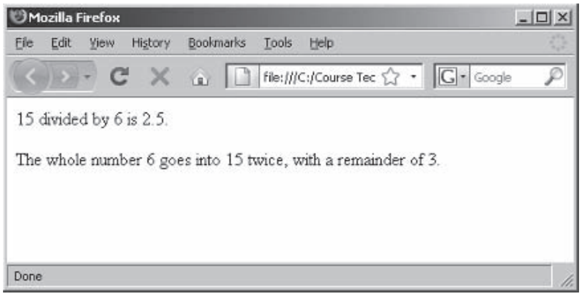


Figure 2-9 Division and modulus expressions

You can include a combination of variables and literal values on the right side of an assignment statement. For example, any of the following addition statements are correct:

```
arithmeticValue = 250 + y;
arithmeticValue = x + 425;
arithmeticValue = 250 + 425;
```

However, you cannot include a literal value as the left operand because the JavaScript interpreter must have a variable to which to assign the returned value. Therefore, the statement `362 = x + y;` causes an error.

When performing arithmetic operations on string values, the JavaScript interpreter attempts to convert the string values to numbers. The variables in the following example are assigned as string values instead of numbers because they are contained within quotation marks. Nevertheless, the JavaScript interpreter correctly performs the multiplication operation and returns a value of "20".

```
x = "4";
y = "5";
arithmeticValue = x * y; // the value returned is 20
```

The JavaScript interpreter does not convert strings to numbers when you use the addition operator. When you use the addition operator with strings, the strings are combined instead of being added together. In the following example, the operation returns a value of "54" because the x and y variables contain strings instead of numbers:

```
x = "5";
y = "4";
arithmeticValue = x + y; // a string value of 54 is returned
```

Arithmetic Unary Operators

Arithmetic operations can also be performed on a single variable using unary operators. Table 2-6 lists the arithmetic unary operators available in JavaScript.

Name	Operator	Description
Increment	++	Increases an operand by a value of one
Decrement	--	Decreases an operand by a value of one
Negation	-	Returns the opposite value (negative or positive) of an operand

Table 2-6 Arithmetic unary operators

The increment (++) and decrement (--) unary operators can be used as prefix or postfix operators. A **prefix operator** is placed before a variable. A **postfix operator** is placed after a variable. The statements `++count;` and `count++;` both increase the `count` variable by one. However, the two statements return different values. When you use the increment operator as a prefix operator, the value of the operand is returned *after* it is increased by a value of one. When you use the increment operator as a postfix operator, the value of the operand is returned *before* it is increased by a value of one. Similarly, when you use the decrement operator as a prefix operator, the value of the operand is returned *after* it is decreased by a value of one, and when you use the decrement operator as a postfix operator, the value of the operand is returned *before* it is decreased by a value of one. If you intend to assign the incremented or decremented value to another variable, then whether you use the prefix or postfix operator makes a difference.

You use arithmetic unary operators in any situation in which you want to use a more simplified expression for increasing or decreasing a value by 1. For example, the statement `count = count + 1;` is identical to the statement `++count;`. As you can see, if your goal is only to increase a variable by 1, then it is easier to use the unary increment operator. But remember that with the prefix operator, the value of the operand is returned *after* it is increased or decreased by a value of 1. By contrast, with the postfix operator, the value of the operand is returned *before* it is increased or decreased by a value of 1.

For an example of when you would use the prefix operator or the postfix operator, consider an integer variable named `studentID` that is used for assigning student IDs in a class registration script. One way of creating a new student ID number is to store the last assigned student ID in the `studentID` variable. When it's time to assign a new student ID, the script could retrieve the last value stored in the `studentID` variable and then increase its value by 1. In other words, the last value stored in the `studentID` variable will be the next number used for a student ID number. In this case, you would use the postfix operator to return the value of the expression *before* it is incremented by using a statement similar to `currentID = studentID++;`. If you are storing the last assigned student ID in the `studentID` variable, you would want to increment the value by 1 and use the result as the next student ID. In this scenario, you would use the prefix operator, which returns the value of the expression after it is incremented using a statement similar to `currentID = ++studentID;`.

Figure 2-10 shows a simple script that uses the prefix increment operator to assign three student IDs to a variable named `curStudentID`. The initial student ID is stored in the `studentID` variable and initialized to a starting value of "100". Figure 2-11 shows the output.

```
var studentID = 100;
var curStudentID;
curStudentID = ++studentID; // assigns '101'
document.write("<p>The first student ID is "
     + curStudentID + "</p>");
curStudentID = ++studentID; // assigns '102'
document.write("<p>The second student ID is "
     + curStudentID + "</p>");
curStudentID = ++studentID; // assigns '103'
document.write("<p>The third student ID is "
     + curStudenID + "</p>");
```

Prefix increment operator

Figure 2-10 Script that uses the prefix increment operator

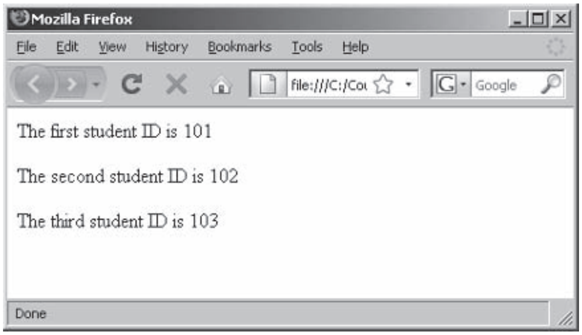


Figure 2-11 Output of the prefix version of the student ID script

The script in Figure 2-12 performs the same tasks, but using a postfix increment operator. Notice that the output in Figure 2-13 differs from the output in Figure 2-11. Because the first example of the script uses the prefix increment operator, which increments the `studentID` variable *before* it is assigned to `curStudentID`, the script does not use the starting value of "100". Rather, it first increments the `studentID` variable and uses "101" as the first student ID. By contrast, the second example of the script does use the initial value of "100" because the postfix increment operator increments the `studentID` variable *after* it is assigned to the `curStudentID` variable.

```
var studentID = 100 ;
var curStudentID;
curStudentID = studentID++; // assigns '100'
document.write("<p>The first student ID is "
     + curStudentID + "</p>");
curStudentID = studentID++; // assigns '101'
document.write("<p>The second student ID is "
     + curStudentID + "</p>");
curStudentID = studentID++; // assigns '102'
document.write("<p>The second student ID is "
     + curStudenID + "</p>");
```

Postfix increment operator

Figure 2-12 Script that uses a postfix increment operator

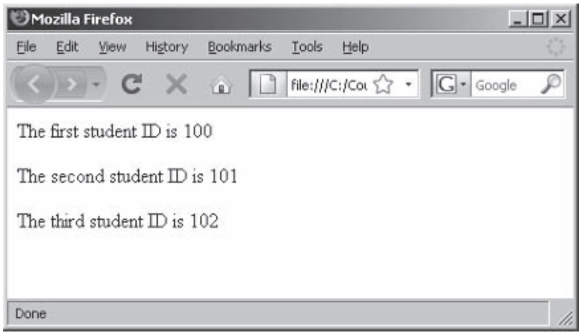


Figure 2-13 Output of the postfix version of the student ID script

Next, you will modify the index.html file of CV Wedding Hall site so that it calculates the cost of a wedding.

To modify the index.html file of CV Wedding Hall site so that it calculates the cost of a wedding:

1. Return to the **index.html file** in your text editor.
2. Locate the text **[Add details form here]** and replace it with the following form. This form allows users to enter the number of guests and limousines for a wedding. Notice that the `numGuests` and `numLimousines` text boxes use `onchange` events to call the `calcGuests()` and `calcLimousines()` functions, respectively. You will add these functions next.

```
<form action="" name="details">
<table>
    <tr>
        <td>
            <tr>
                <td>Guests<br />
                    ($65 each)</td>
                <td>
                    <input type="text"
                        name="numGuests" size="3"
                        onchange="calcGuests()" /></td>
            </tr>
            <tr>
                <td>Limousines<br />
                    ($125 each)</td>
                <td>
                    <input type="text"
                        name="numLimousines" size="3"
                   onchange="calcLimousines()" /></td>
            </tr>
</table>
</form>
```

3. Locate the text [**Add estimate form here**] and replace it with the following form. This form simply displays the calculated estimate.

```
<form action="" name="estimate">
<p>
    Estimated total cost:
    <input type="text" name="cost" size="5"
        style="border-style: none; border-color: ↵
        inherit; border-width: medium; ↵
        background-color: Transparent" text="0" /></p>
</form>
```

4. Add the following `calcGuests()` function to the end of the script section. The first statement subtracts the current guest cost from the `totalEstimate` variable. The second and third statements calculate the new guest cost and the fourth statement assigns the new estimate to the text box in the estimate form.

```
function calcGuests() {
    totalEstimate -= guestsCost;
    guestsCost = document.details.numGuests.value
        * 65;
    totalEstimate += guestsCost;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
```

5. Add the following `calcLimousines()` function to the end of the script section. This function contains the same statements as the `calcGuests()` function except that it calculates the limousine cost instead.

```
function calcLimousines() {
    totalEstimate -= limousinesCost;
    limousinesCost =
        document.details.numLimousines.value * 65;
    totalEstimate += limousinesCost;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
```

6. Save the **index.html** file and open it in your Web browser. Test the form by entering values in the Guests and Limousines text boxes. Figure 2-14 shows how the page appears after entering some values.

Figure 2-14 Wedding Planner page

7. Close your Web browser window.

Assignment Operators

Assignment operators are used for assigning a value to a variable. You have already used the most common assignment operator, the equal sign (=), to assign values to variables you declared using the `var` statement. The equal sign assigns an initial value to a new variable or assigns a new value to an existing variable. For example, the following code creates a variable named `favoriteBook`, uses the equal sign to assign it an initial value, then uses the equal sign again to assign it a new value:

```
var favoriteBook = "A Farewell to Arms";
favoriteBook = "The Kite Runner";
```

JavaScript includes other assignment operators in addition to the equal sign. These additional assignment operators, called **compound assignment operators**, perform mathematical calculations on variables and literal values in an expression, and then assign a new value to the left operand. Table 2-7 displays a list of the common JavaScript assignment operators.

Name	Operator	Description
Assignment	=	Assigns the value of the right operand to the left operand
Compound addition assignment	+=	Combines the value of the right operand with the value of the left operand, or adds the value of the right operand to the value of the left operand and assigns the new value to the left operand
Compound subtraction assignment	−=	Subtracts the value of the right operand from the value of the left operand and assigns the new value to the left operand
Compound multiplication assignment	*=	Multiplies the value of the right operand by the value of the left operand and assigns the new value to the left operand
Compound division assignment	/=	Divides the value of the left operand by the value of the right operand and assigns the new value to the left operand
Compound modulus assignment	%=	Divides the value of the left operand by the value of the right operand and assigns the remainder (the modulus) to the left operand

Table 2-7 Assignment operators

You can use the += compound addition assignment operator to combine two strings as well as to add numbers. In the case of strings, the string on the left side of the operator is combined with the string on the right side of the operator, and the new value is assigned to the left operator. Before combining operands, the JavaScript interpreter attempts to convert a nonnumeric operand, such as a string, to a number. If a nonnumeric operand cannot be converted to a number, you receive a value of "NaN". The value "NaN" stands for "Not a Number" and is returned when a mathematical operation does not result in a numerical value. The following code shows examples of the different assignment operators:

```
var x, y;
x = "Hello ";
x += "World"; // x changes to "Hello World"
document.write("<p>" + x + "<br />");
x = 100;
y = 200;
x += y;       // x changes to 300
document.write(x + "<br />");
x = 10;
y = 7;
x -= y;       // x changes to 3
document.write(x + "<br />");
x = 2;
y = 6;
x *= y;       // x changes to 12
```

```
document.write(x + "<br />");
x = 24;
y = 3;
x /= y;        // x changes to 8
document.write(x + "<br />");
x = 3;
y = 2;
x %= y;        // x changes to 1
document.write(x + "<br />");
x = "100";
y = 5;
x *= y;        // x changes to 500
document.write(x + "<br />");
x = "one hundred";
y = 5;
x *= y;        // x changes to NaN
document.write(x + "</p>");
```

Comparison and Conditional Operators

Comparison operators are used to compare two operands and determine if one numeric value is greater than another. A Boolean value of true or false is returned after two operands are compared. For example, the statement `5 < 3` would return a Boolean value of false, because 5 is not less than 3. Table 2-8 lists the JavaScript comparison operators.

Name	Operator	Description
Equal	==	Returns true if the operands are equal
Strict equal	===	Returns true if the operands are equal and of the same type
Not equal	!=	Returns true if the operands are not equal
Strict not equal	!==	Returns true if the operands are not equal or not of the same type
Greater than	>	Returns true if the left operand is greater than the right operand
Less than	<	Returns true if the left operand is less than the right operand
Greater than or equal	>=	Returns true if the left operand is greater than or equal to the right operand
Less than or equal	<=	Returns true if the left operand is less than or equal to the right operand

Table 2-8 Comparison operators

You can use number or string values as operands with comparison operators. When two numeric values are used as operands, the JavaScript interpreter compares them numerically. For example, the statement `arithmeticValue = 5 > 4;` results in true because the number 5 is numerically greater than the number 4. When

The comparison operator (==) consists of two equal signs and performs a different function than the one performed by the assignment operator that consists of a single equal sign =. The comparison operator *compares* values, whereas the assignment operator *assigns* values.

Comparison operators are often used with two kinds of special statements: conditional statements and looping statements. You'll learn how to use comparison operators in such statements in Chapter 3.

two nonnumeric values are used as operands, the JavaScript interpreter compares them in alphabetical order. The statement `arithmeticValue = "b" > "a";` returns true because the letter *b* is alphabetically greater than the letter *a*. When one operand is a number and the other is a string, the JavaScript interpreter attempts to convert the string value to a number. If the string value cannot be converted to a number, a value of false is returned. For example, the statement `arithmeticValue = 10 == "ten";` returns a value of false because the JavaScript interpreter cannot convert the string "ten" to a number.

The comparison operator is often used with another kind of operator, the conditional operator. The **conditional operator** executes one of two expressions, based on the results of a conditional expression. The syntax for the conditional operator is *`conditional expression ? expression1: expression2`*`;`. If the conditional expression evaluates to true, then `expression1` executes. If the conditional expression evaluates to false, then `expression2` executes.

The following code shows an example of the conditional operator. In the example, the conditional expression checks to see if the `intVariable` variable is greater than 100. If `intVariable` is greater than 100, then the text "intVariable is greater than 100" is assigned to the result variable. If `intVariable` is not greater than 100, then the text "intVariable is less than or equal to 100" is assigned to the `result` variable. Because `intVariable` is equal to 150, the conditional statement returns a value of true, the first expression executes, and "intVariable is greater than 100" prints to the screen.

```
var intVariable = 150;
var result;
(intVariable > 100) ? result =
     "intVariable is greater than 100" : result =
     "intVariable is less than or equal to 100";
document.write(result);
```

Next, you will add fields and code to the Wedding Planner form that allow users to select live music and flowers. Conditional operators in associated functions for each field will determine whether to add or subtract the cost of each item.

To add fields and code to the Wedding Planner form that allow users to select live music and flowers:

1. Return to the **index.html** file in your text editor.

2. Add the following elements and fields to the end of the table in the details form. Radio buttons allow users to select whether or not to include live music and flowers. The radio buttons use `onchange` event handlers to call associated functions for each of the radio buttons.

```
<tr>
    <td>Live music<br />
        ($500)</td>
    <td>
        <input type="radio" name="music"
            onchange="addMusic()" />Yes
        <input type="radio" name="music"
            checked="checked"
            onclick="removeMusic()" />No
    </td>
</tr>
<tr>
    <td>Flowers<br />
        ($400)</td>
    <td>
        <input type="radio" name="flowers"
            onchange="addFlowers()" />Yes
        <input type="radio" name="flowers"
            checked="checked"
            onchange="removeFlowers()"/>No </td>
</tr>
```

3. Add the following global variables above the `calcGuests()` function. These variables will be used to determine where the user has selected live music and flowers.

```
var liveMusic = false;
var flowers = false;
```

4. Add the following functions to the end of the script section. The `addMusic()` function uses a conditional operator to determine whether the `liveMusic` variable is set to false. If it is, then the `liveMusicCost` variable is assigned a value of 500. If not, then it is assigned a value of 0. The `liveMusicCost` variable is then assigned to the `totalEstimate` variable with an addition assignment operator. The last two statements assign the `liveMusic` variable a value of true and the value of the `totalEstimate` variable to the text box in the estimate form. The `removeMusic()` function uses the exact same syntax as the `addMusic()` function, except that it assigns a value of -500 to the `liveMusicCost` variable, which causes the addition assignment expression to subtract the value from the `totalEstimate` variable.

```
function addMusic() {
    (liveMusic == false) ? liveMusicCost = 500
        : liveMusicCost = 0;
    totalEstimate += liveMusicCost;
    liveMusic = true;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
function removeMusic() {
    (liveMusic == true) ? liveMusicCost = -500
        : liveMusicCost = 0;
    totalEstimate += liveMusicCost;
    liveMusic = false;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
```

5. Add the following `addFlowers()` and `removeFlowers()` functions to the end of the script section. These functions are identical to the `addMusic()` and `removeMusic()` functions, except they update the total estimate to include flower costs instead of the music cost.

```
function addFlowers() {
    (flowers == false) ? flowersCost = 400
        : flowersCost = 0;
    totalEstimate += flowersCost;
    flowers = true;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
function removeFlowers() {
    (flowers == true) ? flowersCost = -400
        : flowersCost = 0;
    totalEstimate += flowersCost;
    flowers = false;
    document.estimate.cost.value = "$"
        + totalEstimate;
}
```

6. Save the **index.html** file, and then validate it with the W3C Markup Validation Service at **http://validator.w3.org/**. Once the file is valid, close it in your text editor and open it in your Web browser. Test the functionality of the Live music and Flowers fields. Figure 2-15 shows how the page appears after adding the Live music and Flowers fields

Figure 2-15 Wedding Planner page after adding the Live music and Flowers fields

7. Close your Web browser window and text editor.

Logical Operators

Logical operators are used for comparing two Boolean operands for equality. For example, a script for an automobile insurance company may need to determine whether a customer is male *and* under 21 in order to determine the correct insurance quote. As with comparison operators, a Boolean value of true or false is returned after two operands are compared. Table 2-9 lists the JavaScript logical operators.

Name	Operator	Description
And	&&	Returns true if both the left operand and right operand return a value of true; otherwise, it returns a value of false
Or	||	Returns true if either the left operand or right operand returns a value of true; if neither operand returns a value of true, then the expression containing the Or || operator returns a value of false
Not	!	Returns true if an expression is false, and returns false if an expression is true

Table 2-9 Logical operators

The Or (||) and the And (&&) operators are binary operators (requiring two operands), whereas the Not (!) operator is a unary operator (requiring a single operand). Logical operators are often used with comparison operators to evaluate expressions, allowing you to combine the results of several expressions into a single statement. For example, the And (&&) operator is used for determining whether two operands return an equivalent value. The operands themselves are often expressions. The following code uses the And operator to compare two separate expressions:

```
var gender = "male";
var age = 17;
var riskFactor = gender=="male" && age<=21; // returns true
```

In the preceding example, the `gender` variable expression evaluates to true because it is equal to "male", and the `age` variable expression evaluates to true because its value is less than or equal to 21. Because both expressions are true, `riskFactor` is assigned a value of true. The statement containing the And (&&) operator essentially says, "if variable `gender` is equal to "male" *and* variable `age` is less than or equal to 21, then assign a value of true to `riskFactor`. Otherwise, assign a value of false to `riskFactor`." In the following code, however, `riskFactor` is assigned a value of false, because the `age` variable expression does not evaluate to true:

```
var gender = "male";
var age = 28;
var riskFactor = gender=="male" && age<=21; // returns false
```

The logical Or (||) operator checks to see if either expression evaluates to true. For example, the statement in the following code says, "if the variable `speedingTicket` is greater than 0 *or* variable `age` is less than or equal to 21, then assign a value of true to `riskFactor`. Otherwise, assign a value of false to `riskFactor`."

```
var speedingTicket = 2;
var age = 28;
var riskFactor = speedingTicket>0 || age<=21; // returns
true
```

Logical operators are often used within conditional and looping statements such as the `if...else`, `for`, and `while` statements. You will learn about conditional and looping statements in Chapter 3.

The `riskFactor` variable in the above example is assigned a value of true, because the `speedingTicket` variable expression evaluates to true, even though the `age` variable expression evaluates to false. This result occurs because the Or (||) statement returns true if *either* the left *or* right operand evaluates to true.

The following code is an example of the Not (!) operator, which returns true if an operand evaluates to false and returns false if an operand evaluates to true. Notice that since the Not operator is unary, it requires only a single operand.

```
var trafficViolations = true;
var safeDriverDiscount
    = !trafficViolations; // returns false
```

Special Operators

JavaScript also includes the special operators that are listed in Table 2-10. These operators are used for various purposes and do not fit within any other category.

Name	Operator	Description
Property access	`.`	Appends an object, method, or property to another object
Array index	`[]`	Accesses an element of an array
Function call	`()`	Calls up functions or changes the order in which individual operations in an expression are evaluated
Comma	`,`	Allows you to include multiple expressions in the same statement
Conditional expression	`?:`	Executes one of two expressions based on the results of a conditional expression
Delete	`delete`	Deletes array elements, variables created without the `var` keyword, and properties of custom objects
Property exists	`in`	Returns a value of true if a specified property is contained within an object
Object type	`instanceof`	Returns true if an object is of a specified object type
New object	`new`	Creates a new instance of a user-defined object type or a predefined JavaScript object type
Data type	`typeof`	Determines the data type of a variable
Void	`void`	Evaluates an expression without returning a result

Table 2-10 Special operators

You will be introduced to the special JavaScript operators as necessary throughout this book. One special operator that you will use in this section is the `typeof` operator. This operator is useful because the data type of variables can change during the course of program execution. This can cause problems if you attempt to perform an arithmetic operation and one of the variables is a string or the null value. To avoid such problems, you can use the `typeof` operator to determine the data type of a variable. The syntax for the `typeof` operator is `typeof(`*`variablename`*`);`. You should use the `typeof` operator whenever you need to be sure that a variable is the correct data type. The values that can be returned by the `typeof` operator are listed in Table 2-11.

Return value	Returned for
Number	Integers and floating-point numbers
String	Text strings
Boolean	True or false
Object	Objects, arrays, and null variables
Function	Functions
Undefined	Undefined variables

Table 2-11 Values returned by typeof operator

Short Quiz 3

1. What is the difference between the division (/) operator and the modulus (%) operator?
2. How do you use prefix and postfix operators?
3. Explain how to use the += compound addition assignment operator.
4. Explain how the JavaScript interpreter compares nonnumeric values.
5. Explain how to use logical operators.

Understanding Operator Precedence

When using operators to create expressions in JavaScript, you need to be aware of the precedence of an operator. The term **operator precedence** refers to the order in which operations in an expression are evaluated. Table 2-12 shows the order of precedence for JavaScript operators. Operators in the same grouping in Table 2-12 have the same order of precedence. When performing operations with operators in the same precedence group, the order of precedence is determined by the operator's **associativity**—that is, the order in which operators of equal precedence execute. Associativity is evaluated from left-to-right or right-to-left, depending on the operators involved, as explained shortly.

Operators	Description	Associativity
`.`	Objects—highest precedence	Left to right
`[]`	Array elements—highest precedence	Left to right
`()`	Functions/evaluation—highest precedence	Left to right
`new`	New object—highest precedence	Right to left
`++`	Increment	Right to left
`--`	Decrement	Right to left
`-`	Unary negation	Right to left
`+`	Unary positive	Right to left
`!`	Not	Right to left
`typeof`	Data type	Right to left
`void`	Void	Right to left
`delete`	Delete object	Right to left
`* / %`	Multiplication/division/modulus	Left to right
`+ -`	Addition/concatenation and subtraction	Left to right
`< <= > >=`	Comparison	Left to right
`instanceof`	Object type	Left to right
`in`	Object property	Left to right
`== != === !==`	Equality	Left to right
`&&`	Logical and	Left to right
`||`	Logical or	Left to right
`?:`	Conditional	Right to left
`=`	Assignment	Right to left
`= += -= *= /= %=`	Compound assignment	Right to left
`,`	Comma—lowest precedence	Left to right

Table 2-12 Operator precedence

Operators in a higher grouping have precedence over operators in a lower grouping. For example, the multiplication operator (*) has a higher precedence than the addition operator (+). Therefore, the expression `5 + 2 * 8` evaluates as follows: the numbers 2 and 8 are multiplied first for a total of 16, then the number 5 is added, resulting in a total of 21. If the addition operator had a higher precedence than the multiplication operator, then the statement would evaluate to 56, because 5 would be added to 2 for a total of 7, which would then be multiplied by 8.

The preceding list does not include bitwise operators. As explained earlier, bitwise operators are beyond the scope of this book.

As an example of how associativity is evaluated, consider the multiplication and division operators. These operators have an associativity of left to right. Thus the expression 30 / 5 * 2 results in a value of 12. Although the multiplication and division operators have equal precedence, the division operation executes first due to the left to right associativity of both operators. Figure 2-16 conceptually illustrates the left to right associativity of the 30 / 5 * 2 expression.

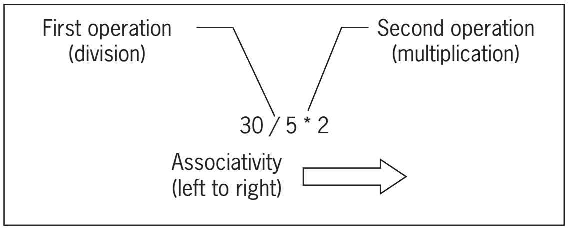


Figure 2-16 Conceptual illustration of left to right associativity

If the multiplication operator had higher precedence than the division operator, then the statement 30 / 5 * 2 would result in a value of 3 because the multiplication operation (5 * 2) would execute first. By contrast, the assignment operator and compound assignment operators—such as the compound multiplication assignment operator (*=)—have an associativity of right to left. Therefore, in the following code, the assignment operations take place from right to left. The variable *x* is incremented by one *before* it is assigned to the *y* variable using the compound multiplication assignment operator (*=). Then, the value of variable y is assigned to variable x. The result assigned to both the *x* and *y* variables is 8. Figure 2-17 conceptually illustrates the right to left associativity of the x = y *= ++x statement.

```
var x = 3;
var y = 2;
x = y *= ++x;
```

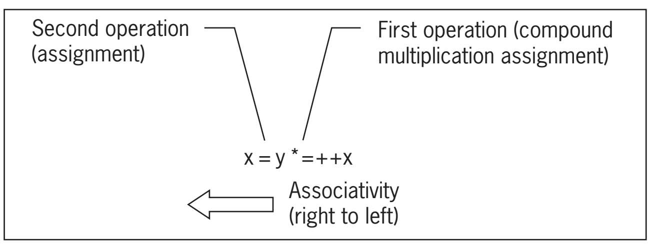


Figure 2-17 Conceptual illustration of right to left associativity

As you can see from the list, parentheses have the highest precedence. Parentheses are used with expressions to change the associativity with which individual operations in an expression are evaluated. For example, the expression 5 + 2 * 8, which evaluates to 21, can be rewritten to (5 + 2) * 8, which evaluates to 56. The parentheses tell the JavaScript interpreter to add the numbers 5 and 2 before multiplying by the number 8. Using parentheses forces the statement to evaluate to 56 instead of 21.

Short Quiz 4

1. What is associativity and how does it affect operator precedence?
2. Which operator has the highest level of associativity?
3. Which operators have the lowest level of associativity?

Summing Up

- Functions refer to a related group of JavaScript statements that are executed as a single unit.
- The term “variable scope” refers to where in your program a declared variable can be used. A global variable is one that is declared outside a function and is available to all parts of your program. A local variable is declared inside a function and is only available within the function in which it is declared.
- The values a program stores in computer memory are commonly called variables.
- The name you assign to a variable is called an identifier.
- Reserved words, which are also called keywords, are special words that are part of the JavaScript language syntax.
- A data type is the specific category of information that a variable contains.
- JavaScript is a loosely typed programming language.
- An integer is a positive or negative number with no decimal places.
- A floating-point number is a number that contains decimal places or that is written in exponential notation.

- A Boolean value is a logical value of true or false.
- An escape character tells the compiler or interpreter that the character that follows it has a special purpose.
- An expression is a single literal value or variable or a combination of literal values, variables, operators, and other expressions that can be evaluated by the JavaScript interpreter to produce a result.
- Operands are variables and literals contained in an expression. A literal is a value, such as a literal string or a number.
- Operators are symbols used in expressions to manipulate operands, such as the addition operator (+) and multiplication operator (*).
- A binary operator requires an operand before and after the operator.
- A unary operator requires a single operand either before or after the operator.
- Arithmetic operators are used in JavaScript to perform mathematical calculations, such as addition, subtraction, multiplication, and division.
- Assignment operators are used for assigning a value to a variable.
- Comparison operators are used to compare two operands and determine if one numeric value is greater than another.
- The conditional operator executes one of two expressions, based on the results of a conditional expression.
- Logical operators are used for comparing two Boolean operands for equality.
- Operator precedence is the order in which operations in an expression are evaluated.

Comprehension Check

1. A(n) _______________ allows you to treat a related group of statements as a single unit.
   a. statement
   b. variable
   c. function
   d. event

2. Functions must contain parameters. True or false?

3. Explain how to use a return statement to return a value to a statement that calls a function.

4. A variable that is declared outside a function in a code declaration block is called _______________ variable.

   a. local

   b. class

   c. program

   d. global

5. When a program contains a global variable and a local variable with the same name, the local variable takes precedence when its function is called. True or false?

6. How can you declare a global variable? (Choose all that apply.)

   a. By declaring the variable outside of a function

   b. By declaring the variable anywhere in your script section with the `global` keyword

   c. By declaring the variable inside of a function without the `var` keyword

   d. By declaring the variable in a function named `global`

7. Explain the concept of data types.

8. JavaScript is a strongly typed programming language. True or false?

9. Explain the purpose of the `null` data type.

10. Which of the following values are integers? (Choose all that apply.)

    a. 1

    b. 1.1

    c. 4e12

    d. –10

11. Which of the following values are floating-point numbers? (Choose all that apply.)

    a. 3.0e5

    b. .78

    c. 1,385,456,200

    d. –976,345

12. Which of following values can be assigned to a Boolean variable? (Choose all that apply.)

    a. 0

    b. 1

    c. true

    d. false

13. If you attempt to use a Boolean variable of false in a mathematical operation, JavaScript converts the variable to an integer value of 0. True or false?

14. The concatenation operator (+) is used for ________________. (Choose all that apply.)

    a. adding numbers

    b. combining text strings

    c. combining variables

    d. incrementing numeric variables

15. Which of the following is the correct syntax for including double quotation and single marks within a string that is already surrounded by double quotation marks?

    a. `"Shaquille \"Shaq\" O\'Neal is a basketball player."`

    b. `"Shaquille "Shaq" O\'Neal is a basketball player."`

    c. `"Shaquille /"Shaq/" O/'Neal is a basketball player."`

    d. `"Shaquille ""Shaq"" O''Neal is a basketball player."`

16. Explain the difference between unary and binary operators.

17. Explain how to use the conditional operator.

18. Which of the following characters separates expressions in the conditional expression used with a conditional operator?

    a. ?

    b. :

    c. ;

    d. &&

19. The Or (||) operator returns true if ________________. (Choose all that apply.)

    a. the left operand and right operand both return a value of true

    b. the left operand returns a value of true

    c. the left operand and right operand both return a value of false

    d. the right operand returns a value of true

20. Which of the following expressions returns a value of 56?

    a. 7 * (3 + 5)

    b. (7 * 3) + 5

    c. (7 * 3 + 5)

    d. 3 + 5 * 7

Reinforcement Exercises

Exercise 2-1

In this exercise, you will create a script that contains two functions.

1. Open your text editor and create a new document.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and “Two Functions” as the content of the <title> element. Include a <link> element that links to the js_styles.css style

sheet in your Chapter folder. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Two Functions</title>
<meta http-equiv="content-type" content="text/html;
     charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the first function to the script section as follows. This function writes a message to the screen using an argument that will ultimately be passed to it from the calling statement:

```
function printMessage(first_message) {
     document.write("<p>" + first_message + "</p>");
}
```

5. Add the second function, which displays a second message, to the end of the script section. In this case, the message ("This message was returned from a function.") is defined within the function itself. The only purpose of this function is to return the literal string "This message was returned from a function." to the calling statement.

```
function return_message() {
     return "<p>This message was returned from ↵
        a function.</p>";
}
```

6. Add the following script section and function to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

7. Type the following three statements, which call the functions in the document head. The first statement sends the text string "This message was printed by a function." This statement does not receive a return value. The second statement assigns the

function call to a variable named `return_value` but does not send any arguments to the function. The third statement writes the value of the `return_value` variable to the screen.

```
printMessage("This message was printed ↵
    by a function.");
var return_value = return_message();
document.write(return_value);
```

8. Save the document as **TwoFunctions.html** in the Exercises folder for Chapter 2, and then validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html** and fix any errors that it contains. Once the document is valid, close it in your text editor.

9. Open the **TwoFunctions.html** document in your Web browser. Figure 2-18 shows how the TwoFunctions.html document looks in a Web browser.

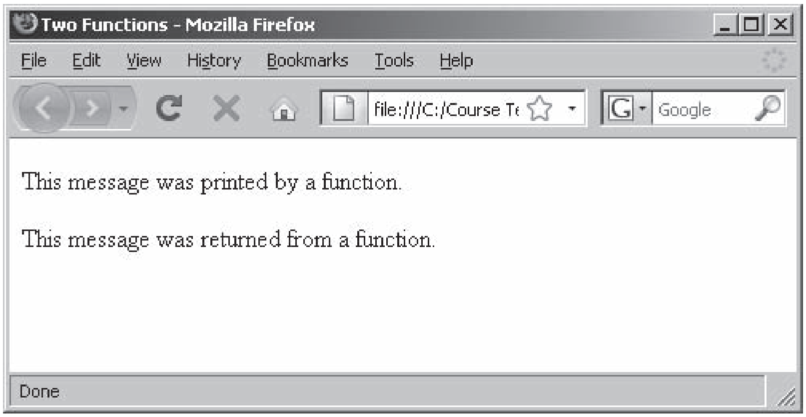


Figure 2-18 TwoFunctions.html in a Web browser

10. Close your Web browser window.

Exercise 2-2

In this exercise, you will create a Web page that uses variables to display information about the five largest islands in the world.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Largest Islands" as the content of the `<title>` element.

2. Add the following <h1> element to the document body:

```
<h1>Largest Islands</h1>
```

3. Add the following script section to the end of the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. In the script section, type the following statements, which declare variables containing the names and sizes of the world's five largest islands:

```
var island1Name = "Greenland";
var island2Name = "New Guinea";
var island3Name = "Borneo";
var island4Name = "Madagascar";
var island5Name = "Baffin";
var island1Size = 2175600;
var island2Size = 790000;
var island3Size = 737000;
var island4Size = 587000;
var island5Size = 507000;
```

5. Next, add the following statements to the end of the script section that print the values stored in each of the variables you declared and initialized in the last step:

```
document.write("<p>The largest island ↵
    in the world is " + island1Name
    + " with " + island1Size + " miles.</p>");
document.write("<p>The second largest island ↵
    in the world is " + island2Name
    + " with " + island2Size + " miles.</p>");
document.write("<p>The third largest island ↵
    in the world is " + island3Name
    + " with " + island3Size + " miles.</p>");
document.write("<p>The fourth largest island ↵
    in the world is " + island4Name
    + " with " + island4Size + " miles.</p>");
document.write("<p>The fifth largest island ↵
    in the world is " + island5Name
    + " with " + island5Size + " miles.</p>");
```

6. Save the document as **LargestIslands.html** in the Exercises folder for Chapter 2, and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window, but leave the LargestIslands.html document open in your text editor.

Exercise 2-3

In this exercise, you will create a script that uses assignment operators.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and "Assignment Operators" as the content of the <title> element.

3. Add the following <h1> element to the document body:

```
<h1>Assignment Operators</h1>
```

4. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Type the following statements in the script section. These statements perform several compound assignment operations on a variable named dataVar. After each assignment operation, the result is printed.

```
var dataVar = "Don ";
dataVar += "Gosselin";
document.writeln("<p>Variable after addition assignment = "
     + dataVar + "<br />");
dataVar = 70;
dataVar += 30;
document.writeln("Variable after addition assignment = "
     + dataVar + "<br />");
dataVar -= 50;
document.writeln("Variable after subtraction assignment = "
     + dataVar + "<br />");
dataVar /= 10;
document.writeln("Variable after division assignment = "
     + dataVar + "<br />");
dataVar *= 9;
document.writeln("Variable after multiplication assignment = "
     + dataVar + "<br />");
dataVar %= 200;
document.writeln("Variable after modulus assignment = "
     + dataVar + "</p>");
```

6. Save the document as **AssignmentOperators.html** in the Exercises folder for Chapter 2.

7. Use the W3C Markup Validation Service to validate the **AssignmentOperators.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

8. Close your Web browser window.

Exercise 2-4

In this exercise, you will create a script that uses comparison operators.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and "Comparison Operators" as the content of the <title> element.

3. Add the following <h1> element to the document body:

```
<h1>Comparison Operators</h1>
```

4. Add the following script section and paragraph elements to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following statements to the script section that perform various comparison operations on two variables. Notice that the first comparison is performed using the conditional operator.

```
var conditionalValue;
var value1 = "Don";
var value2 = "Dave";
value1 == value2 ? document.write(
    "<p>value1 equal to value2: true<br />")
    : document.write(
    "<p>value1 equal to value2: false<br />");
value1 = 37;
value2 = 26;
conditionalValue = value1 == value2;
document.write("value1 equal to value2: "
     + conditionalValue + "<br />");
conditionalValue = value1 != value2;
document.write("value1 not equal to value2: "
```

```
     + conditionalValue + "<br />");
conditionalValue = value1 > value2;
document.write("value1 greater than value2: "
     + conditionalValue + "<br />");
conditionalValue = value1 < value2;
document.write("value1 less than value2: "
     + conditionalValue + "<br />");
conditionalValue = value1 >= value2;
document.write("value1 greater than or equal to value2: "
     + conditionalValue + "<br />");
conditionalValue = value1 <= value2;
document.write("value1 less than or equal to value2: "
     + conditionalValue + "<br />");
value1 = 21;
value2 = 21;
conditionalValue = value1 === value2;
document.write(
     "value1 equal to value2 AND the same data type: "
     + conditionalValue + "<br />");
conditionalValue = value1 !== value2;
document.write(
     "value1 not equal to value2 AND not the same data type: "
     + conditionalValue + "</p>");
```

6. Save the document as **ComparisonOperators.html** in the Exercises folder for Chapter 2.

7. Use the W3C Markup Validation Service to validate the **ComparisonOperators.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

8. Close your Web browser window.

Exercise 2-5

In this exercise, you will create a script that uses logical operators.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Order Fulfillment" as the content of the <title> element.

3. Add the following <h1> element to the document body:

```
<h1>Order Fulfillment</h1>
```

4. Add the following script section and paragraph elements to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following statements to the script section that use logical operators on two variables:

```
var orderPlaced = true;
var orderFilled = false;
document.write("<p>Order has been placed: "
     + orderPlaced + "<br />");
document.write("Order has been filled: "
     + orderFilled + "<br />");
var orderComplete = orderPlaced && orderFilled;
document.write("Order has been placed and filled: "
     + orderComplete + "</p>");
```

6. Save the document as **OrderFulfillment.html** in the Exercises folder for Chapter 2.

7. Use the W3C Markup Validation Service to validate the **OrderFulfillment.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

8. Close your Web browser window.

Exercise 2-6

In this exercise, you will create a script that displays a portion of a review for a production of the opera *Pagliacci*, performed by an opera company called Pine Knoll Productions. The review will be rendered using `document.write()` statements that combine text strings with escape characters. Note that you can create the same document more easily using only XHTML elements. The purpose of this exercise is to demonstrate how text strings can be combined with escape characters.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Pine Knoll Productions" as the content of the `<title>` element.

3. Add the following style section to the document head:

```
<style type="text/css">
body { font-family: 'Trebuchet MS', Arial,
Helvetica, sans-serif }
</style>
```

4. Add the following script section and paragraph elements to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add to the script section the following `document.write()` statements, which contain combinations of text, elements, and escape characters:

```
document.write("<p>Pine Knoll Productions ↵
     presents </p>");
document.write("<h1>Pagliacci</h1>");
document.write("<p><strong>by Ruggero
     Leoncavallo</strong></p><hr />");
document.write("<p>The Pine Knoll Press calls ↵
     the company\'s production ");
document.write("of Leoncavallo\'s <em>Pagliacci</em> ↵
     a \"spectacular event\" ");
document.write("that will \"astound you\".");
```

Be sure to type the text strings in the code to the left on the same line. They contain line breaks here due to space limitations.

6. Save the document as **Pagliacci.html** in the Exercises folder for Chapter 2.

7. Use the W3C Markup Validation Service to validate the **Pagliacci.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

8. Close your Web browser window.

Exercise 2-7

Next, you will create a script that assigns different data types to a variable and prints the variable's data type. You will use the `typeof` operator to determine the data type of each variable.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the strict DTD

and “Changing Data Types” as the content of the `<title>` element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Declare a variable in the script section named `changingType`:

```
var changingType;
```

5. At the end of the script section, type the following line, which prints the data type contained in the `changingType` variable. The data type is currently “undefined,” because `changingType` has not yet been assigned a value.

```
document.write("<p>The changingType variable is "
     + typeof(changingType) + "<br />");
```

6. To the end of the script section, add the following two lines, which assign a string to the `changingType` variable and repeat the statement that prints the data type.

```
changingType = "It's a jungle out there.";
document.writeln("The changingType variable is "
     + typeof(changingType) + "<br />");
```

7. To the end of the script section, add the following lines, which change the `changingType` variable to the integer, floating-point, Boolean, and null data types. The statement that prints each data type repeats each time the variable’s data type changes.

```
changingType = 250;
document.writeln("The changingType variable is "
     + typeof(changingType) + "<br />");
changingType = 87.346;
document.writeln("The changingType variable is "
     + typeof(changingType) + "<br />");
changingType = true;
document.writeln("The changingType variable is "
     + typeof(changingType) + "<br />");
changingType = null;
document.writeln("The changingType variable is "
     + typeof(changingType) + "</p>");
```

8. Save the document as **ChangingTypes.html** in the Exercises folder for Chapter 2.

9. Use the W3C Markup Validation Service to validate the **ChangingTypes.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

10. Close your Web browser window.

Exercise 2-8

Next, you will create a script that contains the formula for converting Fahrenheit temperatures to Celsius. You will need to modify the formula so it uses the correct order of precedence to convert the temperature.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Convert to Celsius" as the content of the `<title>` element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add to the script section the following declaration for a variable named `fTemp` that represents a Fahrenheit temperature. The variable is assigned a value of 86 degrees.

```
var fTemp = 86;
```

5. Add the following two statements to the end of the script section. The first statement declares a variable named `cTemp` that will store the converted temperature. The right operand includes the formula for converting from Fahrenheit to Celsius. (Remember that the formula as given below is incorrect; later in this exercise you will correct the order of precedence in the formula.) The last statement prints the value assigned to the `cTemp` variable.

```
var cTemp = fTemp - 32 * 5 / 9;
document.write("<p>" + fTemp
    + " Fahrenheit is equal to " + cTemp
    + " degrees Celsius.</p>");
```

6. Save the document as **ConvertToCelsius.html** in the Exercises folder for Chapter 2, and then open it in your Web browser. 86 degrees Fahrenheit is actually equivalent to 30 degrees Celsius. However, the formula incorrectly calculates that 86 degrees Fahrenheit is equivalent to 68.22222222222223 Celsius.

7. Close your Web browser window and return to the **ConvertToCelsius.html** document in your text editor.

8. Modify the order of precedence in the Fahrenheit-to-Celsius formula by adding parentheses as follows so that it correctly calculates a value of 30 degrees Celsius for 86 degrees Fahrenheit:

```
var cTemp = (fTemp - 32) * (5 / 9);
```

9. Save the **ConvertToCelsius.html** document, close it in your text editor, and then open it in your Web browser. The temperature should be calculated correctly as 30 degrees Celsius.

10. Close your Web browser window.

Discovery Projects

Save your Discovery Projects document in the Projects folder for Chapter 2. Create the documents so they are well formed according to the transitional DTD. Be sure to validate each document with the W3C Markup Validation Service.

Project 2-1

Create a Web page with five text boxes. Assign to each text box's value attribute a value of zero. Add to each of the text boxes an `onchange` event handler that calls a function named `calcAvg()` and passes to the function the value of that text box by referencing its document object, form name, and `name` and `value` attributes. Within the `calcAvg()` function, pass the five parameters to another function, named `performCalc()`, and assign the return value to a variable named `calcResult`, then place the returned value to another text box with a name attribute of `averageResult`. In the `performCalc()` function, calculate the average of the five numbers (by adding the five values and dividing by five), then return the result to the `calcAvg()` function. When you perform the calculation, use the `parseInt()` function to ensure that the passed values are calculated as numbers. Save the document as **CalcAverage.html**.

Project 2-2

Many companies normally charge a shipping and handling fee for purchases. Create a Web page that allows a user to enter a purchase price into a text box; include a JavaScript function that calculates shipping and handling. Add functionality to the script that adds a minimum shipping and handling fee of $1.50 for any purchase that is less than or equal to $25.00. For any orders over $25.00, add 10% to the total purchase price for shipping and handling, but do not include the $1.50 minimum shipping and handling fee. The formula for calculating a percentage is *price* * *percent* / 100. For example, the formula for calculating 10% of a $50.00 purchase price is 50 * 10 / 100, which results in a shipping and handling fee of $5.00. After you determine the total cost of the order (purchase plus shipping and handling), display it in an alert dialog box. Save the document as **CalcShipping.html**.

Project 2-3

The formula for calculating body mass index (BMI) is $weight * 703 / height^2$. For example, if you weigh 200 pounds and are 72 inches tall, then you can calculate your body mass index with this expression: *(200 * 703) / (72 * 72)*. Create a Web page that contains three text boxes: one for your weight in pounds, one for your height in inches, and one that will contain the BMI result. Create a script with a function named `calcBMI()` that performs the calculation using the values in the weight and height text boxes and assign the result to the BMI text box. Convert the value to an integer by using the `parseInt()` function. Reference the text boxes from within the function by using the document object, form name, and `name` and `value` attributes of each text box (in other words, don't use function arguments). Perform the calculation by calling the function from an `onclick` event in a button element. Save the document as **BMI.html**.

Project 2-4

One built-in JavaScript function that you saw in this chapter is the `eval()` function, which evaluates expressions contained within strings. You can include a string literal or string variable as the argument for the `eval()` function. If the string literal or string variable you pass to the `eval()` function does not contain an expression that can be evaluated, you will receive an error. The statement `var returnValue = eval("5 + 3");` returns the value

8 and assigns it to the `returnValue` variable. The statement `var returnValue = eval("10");` also evaluates correctly and returns a value of 10, even though the string within the `eval()` function did not contain operators. The `eval()` function has one restriction: you cannot send it a text string that does not contain operators or numbers. If you send the `eval()` function a text string that does not contain operators or numbers, an empty value is returned. For example, the statement `var returnValue = eval("this is a text string");` assigns an empty value to the `returnValue` variable because it does not contain numbers or operators. However, the statement

```
var returnValue = eval("'this is a text string' +
' and this is another text string'");
```

evaluates correctly, because the string sent to the `eval()` function contains the concatenation operator. Use the `eval()` function to create a calculator program that includes push buttons and `onclick` event handlers. Use a variable named `inputString` to contain the operands and operators of a calculation. After a calculation is added to the `inputString` variable, perform the calculation using the `eval()` function. Use a single function named `updateString()` that accepts a single value representing a number or operator. Then, add the value to the `inputString` variable using the += assignment operator. After the `inputString` variable is updated, assign it as the value of a text box in a form. Save the document as **Calculator.html**.

CHAPTER 3

Building Arrays and Control Structures

In this chapter, you will:

- Store data in arrays
- Use `if` statements, `if...else` statements, and `switch` statements to make decisions
- Nest one `if` statement in another
- Use `while` statements, `do...while` statements, and `for` statements to repeatedly execute code
- Use `continue` statements to restart a looping statement

The code you have written so far has been linear in nature. In other words, your programs start at the beginning and end when the last statement in the program executes. Decision-making and flow-control statements allow you to determine the order in which statements execute in a program. Controlling the flow of code and making decisions during program execution are two of the most fundamental skills required in programming. In this chapter, you will learn about both decision-making statements and flow-control statements. Before learning how to use decision-making statements and flow-control statements, you will first learn about a data type that is often used with these types of statements: arrays.

Storing Data in Arrays

An **array** contains a set of data represented by a single variable name. You can think of an array as a collection of variables contained within a single variable. You use arrays when you want to store groups or lists of related information in a single, easily managed location. Lists of names, courses, test scores, and prices are typically stored in arrays. For example, Figure 3-1 shows that you can manage cell phone makes and models using a single array named `cellPhones`. What makes an array like this especially useful is that you can use it to refer to the individual phones without having to retype each make and model. You will learn how to refer to an individual item in an array later in this chapter.

The identifiers you use for an array name must follow the same rules as identifiers for variables. They must begin with an uppercase or lowercase ASCII letter, dollar sign ($), or underscore (_), can include numbers (but not as the first character), cannot include spaces, and cannot be reserved words.

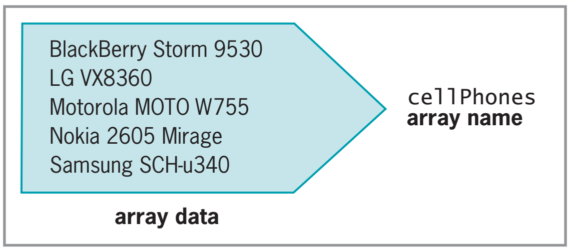


Figure 3-1 Conceptual example of an array

Declaring and Initializing Arrays

Arrays are represented in JavaScript by the `Array` object. The `Array` object contains a special constructor named `Array()` which is used for creating an array. A **constructor** is a special type of function that is used as the basis for creating reference variables (that is, variables whose data type is the reference data type). You create new arrays by using the keyword `new` and the `Array()` constructor with the following syntax:

```
var arrayName = new Array(number of elements);
```

Within the parentheses of the `Array()` construction, you include an integer that represents the number of elements to be contained in the array. Each piece of data contained in an array is called an **element**. The following code creates an array named `cellPhones` that has 10 elements:

```
var cellPhones = new Array(10);
```

An **index** is an element's numeric position within the array. The numbering of elements within an array starts with an index number of zero (0). (This numbering scheme can be very confusing for beginners.) You refer to a specific element by enclosing its index number in brackets at the end of the array name. For example, the first element in the `cellPhones` array is `cellPhones[0]`, the second element is `cellPhones[1]`, the third element is `cellPhones[2]`, and so on. This also means that if you have an array consisting of ten elements, then the 10th element in the array would be referred to using an index of 9. You assign values to individual array elements in the same fashion as you assign values to a standard variable, except that you include the index for an individual element of the array. The following code assigns values to the first three elements within the `cellPhones` array:

```
cellPhones[0] = "BlackBerry Storm 9530";   // first element
cellPhones[1] = "LG VX8360";    // second element
cellPhones[2] = "Motorola MOTO W755";   // third element
```

When you create a new array with the `Array()` constructor, declaring the number of array elements is optional. You can create the array without any elements and add new elements to the array as necessary. The size of an array can change dynamically. If you assign a value to an element that has not yet been created, the element is created automatically, along with any elements that might precede it. For example, the first statement in the following code creates the `cellPhones` array without any elements. The second statement then assigns "BlackBerry Storm 9530" to the third element, which also creates the first two elements (`cellPhones[0]` and `cellPhones[1]`) in the process. However, note that until you assign values to them, `cellPhones[0]` and `cellPhones[1]` will both contain `undefined` values.

```
cellPhones = new Array();
cellPhones[2] = "BlackBerry Storm 9530";
```

You can also assign values to array elements when you first create the array. The following code assigns some values to the `cellPhones` array when it is created, then prints each of the values, using the array element numbers:

```
cellPhones = new Array("BlackBerry Storm 9530",
    "LG VX8360", "Motorola MOTO W755");
```

Should you declare the number of array elements when you first create a new array or allow the size of the array to change dynamically? The basic rule of thumb is you should only declare the number of array elements if you know the exact number of elements that the array will store. Your program will perform faster if it does not need to continuously add new elements to an array at runtime. However, if you don't know how many elements your array will require, you could receive a runtime error if your script attempts to access an array element that does not exist or has not been assigned a value. So if you don't know how many elements your array will require, it's better to allow the script to size the array dynamically.

Most programming languages require that all of the elements in an array be of the exact same data type. However, in JavaScript the values assigned to array elements can be of different data types. For example, the following code creates an array and stores values with different data types in the array elements:

You will study advanced array techniques in Chapter 7.

```
var hotelReservation = new Array(4);
hotelReservation[0]
    = "Don Gosselin"; // guest name (string)
hotelReservation[1]
    = 5; // # of nights (integer)
hotelReservation[2]
    = 97.36; // price per night (floating point)
hotelReservation[3] = true; // non-smoking room (Boolean)
```

Accessing Element Information

You access an element's value just as you access the value of any other variable, except that you include brackets and the element index. For example, the following code prints the values contained in the first three elements of the `cellPhones` array:

```
document.writeln(
    cellPhones[0]); // prints "BlackBerry Storm 9530"
document.writeln(
    cellPhones[1]); // prints "LG VX8360"
document.writeln(
    cellPhones[2]); // prints "Motorola MOTO W755"
```

Modifying Elements

You modify values in existing array elements in the same fashion as you modify values in a standard variable, except you include brackets and the element index. The following code assigns values to the first three elements in the `cellPhones` array:

```
cellPhones[0] = "BlackBerry Storm 9530";   // first element
cellPhones[1] = "LG VX8360";   // second element
cellPhones[2] = "Motorola MOTO W755";   // third element
```

After you have assigned a value to an array element, you can change it later, just as you can change other variables in a script. To change the first array element in the `cellPhones` array from "BlackBerry Storm 9530" to "BlackBerry 8830 World Edition," you use the following statement:

```
cellPhones[0] = "BlackBerry 8830 World Edition";
```

Determining the Number of Elements in an Array

The `Array` class contains a single property, the **`length` property**, which returns the number of elements in an array. You append the `length` property to the name of the array whose length you want to retrieve using the following syntax: `*array_name*.length;`. Remember that, unlike method names, property names are not followed by parentheses. The following statements illustrate how to use the `length` property to return the number of elements in the `cellPhones[]` array:

```
cellPhones = new Array();
cellPhones[0] = "BlackBerry Storm 9530"; // first element
cellPhones[1] = "LG VX8360"; // second element
cellPhones[2] = "Motorola MOTO W755"; // third element
document.write("<p>The cell phone array has "
    + cellPhones.length + " elements.</p>");
```

Short Quiz 1

1. How do you declare and initialize an array?
2. How do you access and modify the individual elements in an array?
3. How do you determine the number of elements in an array?

Making Decisions

When you write a computer program, regardless of the programming language, you often need to execute different sets of statements depending on some predetermined criteria. For example, you might create a program that needs to execute one set of code in the morning and another set of code at night. Or you might create a program that must execute one set of code when it's running in Windows Explorer and another when it runs in Firefox. Additionally, you might create a program that depends on user input to determine exactly what code to run. For instance, suppose you create a Web page through which users place online orders. If a user clicks the Add to Shopping Cart button, a set of statements that builds a list of items to be purchased must execute. However, if the user clicks the Checkout button, an entirely different set of statements, which completes the transaction, must execute. The process of determining the order in which statements execute in a program is called **decision making** or **flow control**. The special types of JavaScript statements used for making decisions are called decision-making statements or decision-making structures. The most common type of decision-making statement is the `if` statement, which you will study first.

`if` Statements

The **`if` statement** is used to execute specific programming code if the evaluation of a conditional expression returns a value of true. The syntax for a simple `if` statement is as follows:

```
if (conditional expression)
     statement;
```

The `if` statement contains three parts: the keyword `if`, a conditional expression enclosed within parentheses, and executable statements. Note that the conditional expression must be enclosed within parentheses.

If the condition being evaluated returns a value of true, then the statement immediately following the conditional expression executes. After the `if` statement executes, any subsequent code executes normally. Consider the following code. Here, the `if` statement uses the equal (==) comparison operator to determine whether the variable `exampleVar` is equal to 5. (You learned about operators in Chapter 2.) Because the condition returns a value of true, two alert dialog boxes appear. The first alert dialog box is generated by the `if` statement when the condition returns a value of true, and the second alert dialog box executes after the `if` statement is completed.

```
var exampleVar = 5;
if (exampleVar == 5)     // CONDITION EVALUATES TO 'TRUE'
     window.alert("<p>The variable is equal to '5'.</p>");
window.alert("<p>This dialog box is generated after ↵
    the if statement.</p>");
```

In contrast, the following code displays only the second alert dialog box. The condition evaluates to false, because `exampleVar` is assigned the value 4 instead of 5.

```
var exampleVar = 4;
if (exampleVar == 5)     // CONDITION EVALUATES TO 'FALSE'
     window.alert("<p>This dialog box will not appear.</p>");
window.alert("<p>This is the only dialog box that ↵
     appears.</p>");
```

You can use a command block to construct a decision-making structure using multiple `if` statements. A **command block** is a set of statements contained within a set of braces, similar to the way function statements are contained within a set of braces. Each command block must have an opening brace (`{`) and a closing brace (`}`). If a command block is missing either the opening or closing brace, an error occurs. The following code shows a script that runs a command block if the conditional expression within the `if` statement evaluates to true.

```
var exampleVar = 5;
if (exampleVar == 5) {    // CONDITION EVALUATES TO 'TRUE'
    document.write("<p>The condition evaluates to ↵
        true.</p>");
    document.write("<p><code>exampleVar</code> is ↵
        equal to 5.</p>");
    document.write("<p>Each of these lines will be ↵
        printed.</p>");
}
document.write("<p>This statement always executes ↵
    after the if statement.</p>");
```

When an `if` statement contains a command block, the statements in the command block execute when the `if` statement condition evaluates to true. After the command block executes, the code after the command block executes normally. When the condition evaluates to false, the command block is skipped, and the statements after it executes. If the conditional expression within the `if` statement in the preceding code evaluates to false, then only the `write()` statement following the command block executes.

Next, you will start working on a physics quiz for a company named Gosselin Laboratories. You can find the physics quiz files in a folder

The statement immediately following the `if` statement can be written on the same line as the `if` statement itself. However, using a line break and indentation makes the code easier for the programmer to read.

named PhysicsQuiz in your Chapter folder for Chapter 3. The script will be set up so that users select answer alternatives by means of radio buttons created with the `<input>` tag within a form. In this first quiz, each question will be scored immediately. You will create the form containing the radio buttons, then use a series of `if` statements to score each question.

To create the physics quiz program and its form section:

1. Open the **PhysicsQuiz.html** file, located in a folder named PhysicsQuiz in your Chapter folder for Chapter 3, in your text editor.

2. Locate the text **[Add quiz here]** and replace it with the following form:

```
<form action="" name="quiz">
</form>
```

3. Add the following lines for the first question to the `<form>` element. The four radio buttons represent the answers. Because each button within a radio button group requires the same `Name` attribute, these four radio buttons have the same name of "question1". Each radio button is also assigned a value corresponding to its answer letter: a, b, c, or d. For each radio button group, the `onclick` event sends the button value to an individual function that scores the answer. Notice that the value for each button is sent to the function as a parameter.

```
<p><strong>1. How many natural elements are
there?</strong></p><p>
<input type="radio" name="question1" value="a"
    onclick="scoreQuestion1('a')" />92<br />
<!-- correct answer -->
<input type="radio" name="question1" value="b"
    onclick="scoreQuestion1('b')" />113<br />
<input type="radio" name="question1" value="c"
    onclick="scoreQuestion1('c')" />103<br />
<input type="radio" name="question1" value="d"
    onclick="scoreQuestion1('d')" />88</p>
```

You can build the program quickly by copying the input button code for the first question, pasting it into a new document, and then editing it to create questions two through five. If do you use copy and paste to create the input buttons in the following steps, make sure that you change the question number for each input button name and the function it calls.

4. Add the lines for the second question. If you prefer, copy and paste the code you typed earlier, taking care to make the necessary edits.

```
<p><strong>2. If one kg of air is compressed from 1 m3
    to 0.5 m3, which of the following statements is
    true?</strong></p><p>
<input type="radio" name="question2" value="a"
    onclick="scoreQuestion2('a')" />
    The density is halved.<br />
<input type="radio" name="question2" value="b"
    onclick="scoreQuestion2('b')" />
    The mass is halved.<br />
<input type="radio" name="question2" value="c"
    onclick="scoreQuestion2('c')" />
    The density is doubled.<br /> <!-- correct
    answer -->
<input type="radio" name="question2" value="d"
    onclick="scoreQuestion2('d')" />The mass is
    doubled.</p>
```

5. Add the lines for the third question, using copy and paste if you prefer.

```
<p><strong>3. What is the acceleration due to
gravity?</strong></p><p>
<input type="radio" name="question3" value="a"
    onclick="scoreQuestion3('a')" />
    980 m/s2<br />
<input type="radio" name="question3" value="b"
    onclick="scoreQuestion3('b')" />
    9.8 m/s2<br /> <!-- correct answer -->
<input type="radio" name="question3" value="c"
    onclick="scoreQuestion3('c')" />
    98 m/s2<br />
<input type="radio" name="question3" value="d"
    onclick="scoreQuestion3('d')" />
    0.98 m/s2</p>
```

6. Add the following lines for the fourth question:

```
<p><strong>4. What is the SI unit of
density?</strong></p><p>
<input type="radio" name="question4" value="a"
    onclick="scoreQuestion4('a')" />
    cm3/g<br />
<input type="radio" name="question4" value="b"
    onclick="scoreQuestion4('b')" />
    m3/kg<br />
<input type="radio" name="question4" value="c"
    onclick="scoreQuestion4('c')" />
    kg/m3<br /> <!-- correct answer -->
<input type="radio" name="question4" value="d"
    onclick="scoreQuestion4('d')" />
    g/cm3</p>
```

7. Add the following lines for the fifth question:

```
<p><strong>5. Which of these has the highest
density?</strong></p><p>
<input type="radio" name="question5" value="a"
    onclick="scoreQuestion5('a')" />
    Lead<br />
<input type="radio" name="question5" value="b"
    onclick="scoreQuestion5('b')" />
    Water<br />
<input type="radio" name="question5" value="c"
    onclick="scoreQuestion5('c')" />
    Mercury<br />
<input type="radio" name="question5" value="d"
    onclick="scoreQuestion5('d')" />
    Tungsten</p> <!-- correct answer -->
```

8. Save the document as **PhysicsQuiz.html** in the Chapter folder for Chapter 3.

Next you will add the functions to score each of the questions. The functions contain `if` statements that evaluate each answer.

To add JavaScript code to score each of the questions:

1. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

2. Add to the script section the following function, which scores the first question. A response of “Correct Answer” appears if the user provides the correct answer. A response of “Incorrect Answer” appears if the user provides an incorrect answer.

```
function scoreQuestion1(answer) {
     if (answer == "a")
          window.alert("Correct Answer");
     if (answer == "b")
          window.alert("Incorrect Answer");
     if (answer == "c")
          window.alert("Incorrect Answer");
     if (answer == "d")
          window.alert("Incorrect Answer");
}
```

3. Add the following `scoreQuestion2()` function after the `scoreQuestion1()` function:

```
function scoreQuestion2(answer) {
     if (answer == "a")
          window.alert("Incorrect Answer");
     if (answer == "b")
          window.alert("Incorrect Answer");
     if (answer == "c")
          window.alert("Correct Answer");
     if (answer == "d")
          window.alert("Incorrect Answer");
}
```

4. Add the following `scoreQuestion3()` function after the `scoreQuestion2()` function:

```
function scoreQuestion3(answer) {
     if (answer == "a")
          window.alert("Incorrect Answer");
     if (answer == "b")
          window.alert("Correct Answer");
     if (answer == "c")
          window.alert("Incorrect Answer");
     if (answer == "d")
          window.alert("Incorrect Answer");
}
```

5. Add the following `scoreQuestion4()` function after the `scoreQuestion3()` function:

```
function scoreQuestion4(answer) {
     if (answer == "a")
          window.alert("Incorrect Answer");
     if (answer == "b")
          window.alert("Incorrect Answer");
     if (answer == "c")
          window.alert("Correct Answer");
     if (answer == "d")
          window.alert("Incorrect Answer");
}
```

6. Add the following `scoreQuestion5()` function after the `scoreQuestion4()` function:

```
function scoreQuestion5(answer) {
     if (answer == "a")
          window.alert("Incorrect Answer");
     if (answer == "b")
          window.alert("Incorrect Answer");
     if (answer == "c")
          window.alert("Incorrect Answer");
     if (answer == "d")
          window.alert("Correct Answer");
}
```

7. Save the **PhysicsQuiz.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

8. Open the **PhysicsQuiz.html** document in your Web browser. As you select a response for each question, you will immediately learn whether the answer is correct. Figure 3-2 shows the output that appears if you select a wrong answer for Question 1.

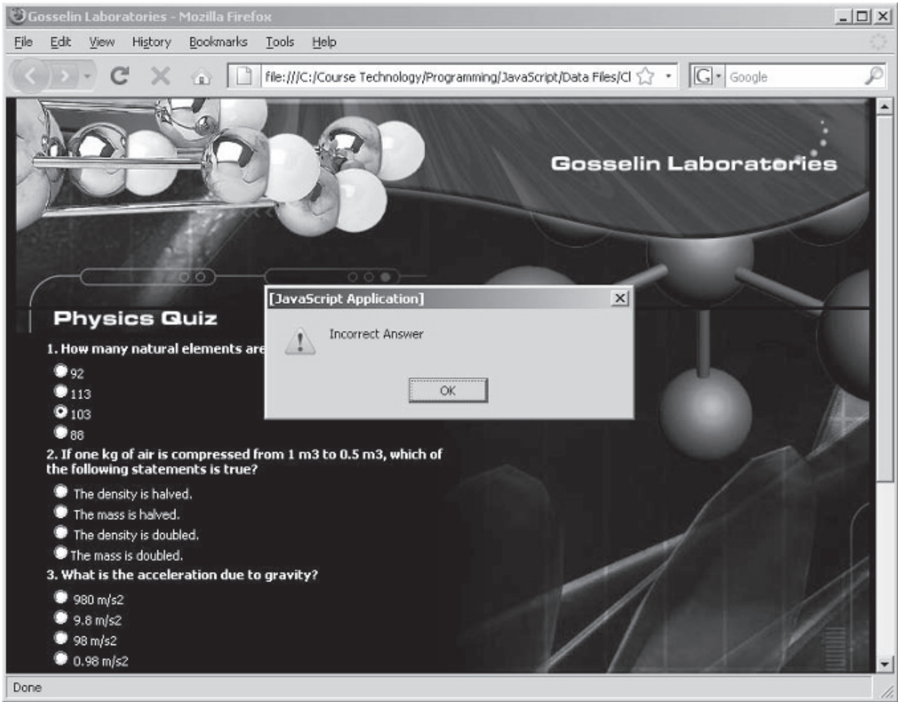


Figure 3-2 PhysicsQuiz.html in a Web browser

9. Close your Web browser window.

`if...else` Statements

So far you've learned how to use an `if` statement to execute a statement (or statements) if a condition evaluates to true. In some situations, however, you may want to execute one set of statements when the condition evaluates to true and another set of statements when the condition evaluates to false. In that case, you need to add an `else` clause to your `if` statement. For instance, suppose that you create a script that displays a confirmation dialog box that asks users to indicate whether they invest in the stock market by clicking an OK or Cancel radio button. An `if` statement in the script might contain a conditional expression that evaluates the user's input. If the condition evaluates to true (that is, if the user clicked the OK button), then the `if` statement would display a Web page on recommended stocks. If the condition evaluates to false (that is, if the user clicked the Cancel button), then the statements in an `else` clause would display a Web page on other types of investment opportunities.

The **`window.confirm()` method** displays a confirm dialog box that contains an OK button and a Cancel button. The syntax for the `window.confirm()` method is `window.confirm(`*`message`*`);`. When a user clicks the OK button in the confirm dialog box, a value of true is returned. When a user clicks the Cancel button, a value of false is returned. For example, the following statement displays the dialog box shown in Figure 3-3:

```
window.confirm("Would you like a cup of coffee?");
```

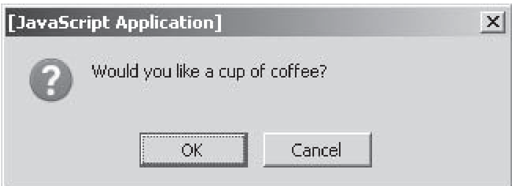


Figure 3-3 Confirm dialog box

An `if` statement that includes an else clause is called an **`if...else` statement**. You can think of an else clause as being a backup plan that is implemented when the condition returns a value of false. The syntax for an `if...else` statement is as follows:

```
if (conditional expression)
     statement;
else
     statement;
```

You can use command blocks to construct an `if...else` statement as follows:

```
if (conditional expression) {
     statements;
}
else {
     statements;
}
```

An `if` statement can be constructed without the `else` clause. However, the `else` clause can only be used with an `if` statement.

The following code shows an example of an `if...else` statement:

```
var today = "Tuesday"
if (today == "Monday")
     document.write("<p>Today is Monday</p>");
else
     document.write("<p>Today is not Monday</p>");
```

In the preceding code, the `today` variable is assigned a value of "Tuesday". If the condition `(today == "Monday")` evaluates to false, control of the program passes to the `else` clause, and the statement `document.write("<p>Today is not Monday</p>");` executes, causing the string "Today is not Monday" to print. If the `today` variable had been assigned a value of "Monday", the condition `(today == "Monday")` would have evaluated to true, and the statement `document.write("<p>Today is Monday</p>");` would have executed. Only one set of statements executes: either the statements following the `if` statement or the statements following the `else` clause. When either set of statements executes, any code following the `if...else` statements executes normally.

The JavaScript code for the PhysicsQuiz.html document you created earlier uses multiple `if` statements to evaluate the results of the quiz. Although the multiple `if` statements function properly, they can be simplified by using an `if...else` statement. Next, you will simplify the PhysicsQuiz.html program by replacing multiple `if` statements with one `if...else` statement.

Keep in mind that the correct answer for Question 2 is *c*, the correct answer for Question 3 is *b*, the correct answer for Question 4 is *c*, and the correct answer for Question 5 is *d*. You'll need to modify the preceding code accordingly for each question. Copy and paste code and then edit it to save on typing time.

To add `if...else` statements to PhysicsQuiz.html:

1. Return to the **PhysicsQuiz.html** document in your text editor and immediately save it as **PhysicsQuiz2.html**.
2. Because you only need the `if` statement to test for the correct answer, you can group all the incorrect answers in the `else` clause. Modify each of the functions that scores a question so that the multiple `if` statements are replaced with an `if...else` statement. The following code shows how the statements for the `scoreQuestion1()` function should look:

```
if (answer == 'a')
     window.alert("Correct Answer");
else
     window.alert("Incorrect Answer");
```

3. Save the **PhysicsQuiz2.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

4. Open the **PhysicsQuiz2.html** document in your Web browser. The program should function the same as when it contained only `if` statements.

5. Close your Web browser window.

Nested `if` and `if...else` Statements

As you have seen, you can use a control structure such as an `if` or `if...else` statement to allow a program to make decisions about which statements to execute. In some cases, however, you may want the statements executed by the control structure to make other decisions. For instance, you may have a program that uses an `if` statement to ask users if they like sports. If users answer yes, you may want to run another `if` statement that asks users whether they like team sports or individual sports. You can include any code you like within the code block for an `if` statement or an `if...else` statement, and that includes other `if` or `if...else` statements.

When one decision-making statement is contained within another decision-making statement, they are referred to as **nested decision-making structures**. An `if` statement contained within an `if` statement or within an `if...else` statement is called a nested `if` statement. Similarly, an `if...else` statement contained within an `if` or `if...else` statement is called a nested `if...else` statement. You use nested `if` and `if...else` statements to perform conditional evaluations that must be executed after the original conditional evaluation. For example, the following code evaluates two conditional expressions before the `write()` statement executes:

```
var salesTotal = window.prompt("What is the sales total?", 0);
if (salesTotal > 50)
        if (salesTotal < 100)
             document.write("<p>The sales total is between ↵
                 50 and 100.</p>");
```

The `document.write()` statement in the preceding example only executes if the conditional expressions in both `if` statements evaluate to true.

The preceding code uses the **`window.prompt()` method**, which displays a prompt dialog box with a message, a text box, an OK button, and a Cancel button. Any text that is entered into a prompt dialog box by a user can be assigned to a variable. The syntax for the `window.prompt()` method is *`variable`* = `window.prompt(`*`message`*`,` *`default text`*`);`. For example, the following code displays the dialog box shown in Figure 3-4:

```
var yourAge = window.prompt("How old are you?",
    "Enter your age here.");
```

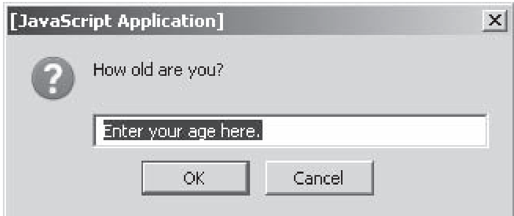


Figure 3-4 Prompt dialog box

The JavaScript code in the PhysicsQuiz2.html document is somewhat inefficient because it contains multiple functions that perform essentially the same task of scoring the quiz. A more efficient method of scoring the quiz is to include nested decision-making structures within a single function.

Next, you will modify the JavaScript code in the PhysicsQuiz2.html document so that it contains a single function that checks the correct answer for all the questions, using nested `if...else` statements.

To add nested `if...else` statements to the physics quiz program:

1. Return to the **PhysicsQuiz2.html** document in your text editor and immediately save it as **PhysicsQuiz3.html**.
2. Delete the five functions that score each question.
3. Add to the script section the first line for the single function that will check all the answers. The function will receive two arguments: the number argument, which represents the questions number, and the answer argument, which will score the answer selected by the user. Code within the body of the function uses the number argument to determine which question to store and the answer argument to determine the answer selected by the user.

```
function scoreQuestions(number, answer) {
```

4. Add the following code to score Question 1:

```
if (number == 1) {
     if (answer == "a")
          window.alert("Correct Answer");
     else
          window.alert("Incorrect Answer");
}
```

5. Add the following code to score Question 2:

```
else if (number == 2) {
     if (answer == "c")
          window.alert("Correct Answer");
     else
          window.alert("Incorrect Answer");
}
```

6. Add the following code to score Question 3:

```
else if (number == 3) {
     if (answer == "b")
          window.alert("Correct Answer");
     else
          window.alert("Incorrect Answer");
}
```

7. Add the following code to score Question 4:

```
else if (number == 4) {
     if (answer == "c")
          window.alert("Correct Answer");
     else
          window.alert("Incorrect Answer");
}
```

8. Add the following code to score Question 5:

```
else if (number == 5) {
     if (answer == "d")
          window.alert("Correct Answer");
     else
          window.alert("Incorrect Answer");
}
```

9. Add a closing brace (}) for the `scoreQuestions()` function. The completed function should appear in your document as follows:

```
function scoreQuestions(number, answer) {
    if (number == 1) {
        if (answer == "a")
            window.alert("Correct Answer");
        else
            window.alert("Incorrect Answer");
    }
    else if (number == 2) {
        if (answer == "c")
            window.alert("Correct Answer");
        else
            window.alert("Incorrect Answer");
    }
    else if (number == 3) {
        if (answer == "b")
            window.alert("Correct Answer");
```

```
        else
            window.alert("Incorrect Answer");
    }
    else if (number == 4) {
        if (answer == "c")
            window.alert("Correct Answer");
        else
            window.alert("Incorrect Answer");
    }
    else if (number == 5) {
        if (answer == "d")
            window.alert("Correct Answer");
        else
            window.alert("Incorrect Answer");
    }
}
```

10. Within each of the `<input>` elements, change the function called within the `onclick` event handler to `scoreQuestions(`*`number`*`, `*`answer`*`)`, changing the number argument to the appropriate question number and the answer argument to the appropriate answer. For example, the event handler for Question 1 should read: `scoreQuestions(1, 'a')`. The modified `<input>` elements in your document should appear as follows:

```
<p>
    <strong>1. How many natural elements are
        there?</strong></p>
<p>
    <input type="radio" name="question1" value="a"
        onclick="scoreQuestions(1, 'a')" />92<br />
        <!-- correct answer -->
    <input type="radio" name="question1" value="b"
        onclick="scoreQuestions(1, 'b')" />113<br />
    <input type="radio" name="question1" value="c"
        onclick="scoreQuestions(1, 'c')" />103<br />
    <input type="radio" name="question1" value="d"
        onclick="scoreQuestions(1, 'd')" />88</p>
<p>
    <strong>2. If one kg of air is compressed from ↵
        1 m3 to 0.5 m3, which of the following ↵
        statements is true?</strong></p>
<p>
    <input type="radio" name="question2" value="a"
        onclick="scoreQuestions(2, 'a')" />
        The density is halved.<br />
    <input type="radio" name="question2" value="b"
        onclick="scoreQuestions(2, 'b')" />
        The mass is halved.<br />
```

```
        <input type="radio" name="question2" value="c"
            onclick="scoreQuestions(2, 'c')" />
            The density is doubled.<br /><!-- correct
            answer -->
        <input type="radio" name="question2" value="d"
            onclick="scoreQuestions(2, 'd')" />
            The mass is doubled.</p>
    <p>
        <strong>3. What is the acceleration due to
            gravity?</strong></p>
    <p>
        <input type="radio" name="question3" value="a"
            onclick="scoreQuestions(3, 'a')" />
            980 m/s2<br />
        <input type="radio" name="question3" value="b"
            onclick="scoreQuestions(3, 'b')" />
            9.8 m/s2<br /><!-- correct answer -->
        <input type="radio" name="question3" value="c"
            onclick="scoreQuestions(3, 'c')" />
            98 m/s2<br />
        <input type="radio" name="question3" value="d"
            onclick="scoreQuestions(3, 'd')" />
            0.98 m/s2</p>
    <p>
        <strong>4. What is the SI unit of
            density?</strong></p>
    <p>
        <input type="radio" name="question4" value="a"
            onclick="scoreQuestions(4, 'a')" />
            cm3/g<br />
        <input type="radio" name="question4" value="b"
            onclick="scoreQuestions(4, 'b')" />
            m3/kg<br />
        <input type="radio" name="question4" value="c"
            onclick="scoreQuestions(4, 'c')" />
            kg/m3<br /><!-- correct answer -->
        <input type="radio" name="question4" value="d"
            onclick="scoreQuestions(4, 'd')" />
            g/cm3</p>
    <p>
        <strong>5. Which of these has the highest
            density?</strong></p>
    <p>
        <input type="radio" name="question5" value="a"
            onclick="scoreQuestions(5, 'a')" />
            Lead<br />
        <input type="radio" name="question5" value="b"
            onclick="scoreQuestions(5, 'b')" />
            Water<br />
        <input type="radio" name="question5" value="c"
            onclick="scoreQuestions(5, 'c')" />
            Mercury<br />
        <input type="radio" name="question5" value="d"
            onclick="scoreQuestions(5, 'd')" />
            Tungsten</p> <!-- correct answer -->
```

11. Save the **PhysicsQuiz3.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

12. Open the **PhysicsQuiz3.html** document in your Web browser. The program should function just as it did with the multiple `if` statements and the multiple functions.

13. Close your Web browser window.

`switch` Statements

Another JavaScript statement that is used for controlling program flow is the `switch` statement. The **`switch` statement** controls program flow by executing a specific set of statements, depending on the value of an expression. The `switch` statement compares the value of an expression to a value contained within a special statement called a `case` label. A **`case` label** in a `switch statement` represents a specific value and contains one or more statements that execute if the value of the `case` label matches the value of the `switch` statement's expression. For example, your script for an insurance company might include a variable named `customerAge`. A `switch` statement can evaluate the variable and compare it to a `case` label within the `switch` construct. The `switch` statement might contain several `case` labels for different age groups that calculate insurance rates based on a customer's age. If the `customerAge` variable is equal to 25, the statements that are part of the "25" `case` label execute and calculate insurance rates for customers who are 25 or older. Although you could accomplish the same task by using `if` or `if...else` statements, a `switch` statement makes it easier to organize the different branches of code that can be executed. The syntax for the `switch` statement is as follows:

```
switch (expression) {
     case label:
          statement(s);
     case label:
          statement(s);
     ...
     default:
          statement(s);
}
```

A `case` label consists of the keyword `case`, followed by a literal value or variable name, followed by a colon. JavaScript compares the value returned from the `switch` statement expression to the literal value or variable name following the `case` keyword. If a match is found, the `case` label statements execute. For example, the `case` label `case 3.17:` represents a floating-point integer value of 3.17. If the value of a `switch` statement expression equals 3.17, then the `case 3.17:` label statements execute. You can use a variety of data types as `case` labels within the same `switch` statement. The following code shows examples of four `case` labels:

```
case exampleVar:    // variable name
     statement(s)
case "text string": // string literal
     statement(s)
case 75:            // integer literal
     statement(s)
case -273.4:        // floating-point literal
     statement(s)
```

Another type of label used within `switch` statements is the `default` label. The **`default` label** contains statements that execute when the value returned by the `switch` statement expression does not match a `case` label. A `default` label consists of the keyword `default` followed by a colon.

When a `switch` statement executes, the value returned by the expression is compared to each `case` label in the order in which it is encountered. Once a matching label is found, its statements execute. Unlike the `if...else` statement, execution of a `switch` statement does not automatically stop after particular `case` label statements execute. Instead, the `switch` statement continues evaluating the rest of the `case` labels in the list. Once a matching `case` label is found, evaluation of additional `case` labels is unnecessary. If you are working with a large `switch` statement with many `case` labels, evaluation of additional `case` labels can potentially slow down your program.

To avoid slow performance, you need to give some thought to how and when to end a `switch` statement. A `switch` statement ends automatically after the JavaScript interpreter encounters its closing brace (}). You can, however, use a special kind of statement, called a `break` statement, to end a `switch` statement once it has performed its required task. A **`break` statement** is used to exit control statements, such as the `switch`, `while`, `do...while`, and `for` looping statements. To end a `switch` statement once it performs its required task, include a `break` statement within each `case` label.

The following code shows a `switch` statement contained within a function. When the function is called, it is passed an argument named `americanCity`. The `switch` statement compares the contents of the `americanCity` argument to the `case` labels. If a match is found, the city's state is returned and a `break` statement ends the `switch` statement. If a match is not found, the value "United States" is returned from the default label.

A single statement or multiple statements can follow a `case` label. However, unlike `if` statements, multiple statements for a `case` label do not need to be enclosed within a command block.

Other programming languages, such as Java and C++, require all `case` labels within a `switch` statement to be of the same data type.

```
function city_location(americanCity) {
     switch (americanCity) {
          case "Boston":
               return "Massachusetts";
               break;
          case "Chicago":
               return "Illinois";
               break;
          case "Los Angeles":
               return "California";
               break;
          case "Miami":
               return "Florida";
               break;
          case "New York":
               return "New York";
               break;
          default:
               return "United States";
     }
}
document.write("<p>" + city_location("Boston")
    + "</p>");
```


Next, you will modify the physics quiz program so that the `scoreAnswers()` function contains a `switch` statement instead of nested `if...else` statements. Each `case` statement in the modified program will check for the question number that is passed from the function number argument. The `switch` statement makes better programming sense than the nested `if...else` statements, because it eliminates the need to check the question number multiple times.

To add a `switch` statement to the physics quiz program:

1. Return to the **PhysicsQuiz3.html** document, and immediately save it as **PhysicsQuiz4.html**.
2. Change the `if...else` statements within the `scoreQuestions()` function to the following `switch` statement:

```
switch (number) {
     case 1:
          if (answer == 'a')
               window.alert("Correct Answer");
          else
               window.alert("Incorrect Answer");
          break;
     case 2:
          if (answer == 'c')
               window.alert("Correct Answer");
          else
               window.alert("Incorrect Answer");
          break;
```

```
        case 3:
              if (answer == 'b')
                    window.alert("Correct Answer");
              else
                    window.alert("Incorrect Answer");
              break;
        case 4:
              if (answer == 'c')
                    window.alert("Correct Answer");
              else
                    window.alert("Incorrect Answer");
              break;
        case 5:
              if (answer == 'd')
                    window.alert("Correct Answer");
              else
                    window.alert("Incorrect Answer");
              break;
   }
```

3. Save the **PhysicsQuiz4.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.
4. Open **PhysicsQuiz4.html** document in your Web browser. The program should function just as it did with the nested `if...else` statements.
5. Close your Web browser window.

Short Quiz 2

1. When will an `if` statement execute?
2. Why would you use a command block with a decision-making statement?
3. Why would you nest decision-making statements?
4. What type of label represents a specific value and contains one or more statements that execute if its value matches the value of the `switch` statement's expression?
5. Describe how the statements in a `switch` statement execute. When does a `switch` statement end?

Repeating Code

The statements you have worked with so far execute one after the other in a linear fashion. The `if`, `if...else`, and `switch` statements select only a single branch of code to execute, then continue to the statement that follows. But what if you want to repeat the same statement, function, or code section five times, 10 times, or 100 times? For example, you might want to perform the same calculation until a specific number is found. In that case, you would need to use a **loop statement**, a control structure that repeatedly executes a statement or a series of statements while a specific condition is true or until a specific condition becomes true. In this chapter, you'll learn about three types of loop statements: `while` statements, `do...while` statements, and `for` statements.

`while` Statements

One of the simplest types of loop statements is the **`while` statement**, which repeats a statement or series of statements as long as a given conditional expression evaluates to true. The syntax for the `while` statement is as follows:

```
while (conditional expression) {
     statement(s);
}
```

Many programmers often name counter variables `count`, `counter`, or something similar. The letters *i*, *j*, *k*, *l*, *x*, *y*, *z* are also commonly used as counter names. Using a name such as `count`, the letter *i* (for increment), or a higher letter, helps you remember (and lets other programmers know) that the variable is being used as a counter.

The conditional expression in the `while` statement is enclosed within parentheses following the keyword `while`. As long as the conditional expression evaluates to true, the statement or command block that follows executes repeatedly. Each repetition of a looping statement is called an **iteration**. When the conditional expression evaluates to false, the loop ends and the next statement following the `while` statement executes.

A `while` statement keeps repeating until its conditional expression evaluates to false. To ensure that the `while` statement ends after the desired tasks have been performed, you must include code that tracks the progress of the loop and changes the value produced by the conditional expression. You track the progress of a `while` statement, or any other loop, with a counter. A **counter** is a variable that is incremented or decremented with each iteration of a loop statement.

The following code shows a simple script that includes a `while` statement. The script declares a variable named `count` and assigns it an initial value of one. The `count` variable is then used in the `while` statement conditional expression (`count <= 5`). As long as the `count` variable is less than or equal to five, the `while` statement loops.

Within the body of the `while` statement, the `document.write()` statement prints the value of the `count` variable, then the `count` variable increments by a value of one. The `while` statement loops until the `count` variable increments to a value of six.

```
var count = 1;
while (count <= 5) {
     document.write(count + "<br />");
     ++count;
}
document.write("<p>You have printed 5 numbers.</p>");
```

The preceding code prints the numbers 1 to 5, with each number representing one iteration of the loop. When the counter reaches 6, the message "You have printed 5 numbers." prints, thus demonstrating that the loop has ended. Figure 3-5 shows the output of this simple script.

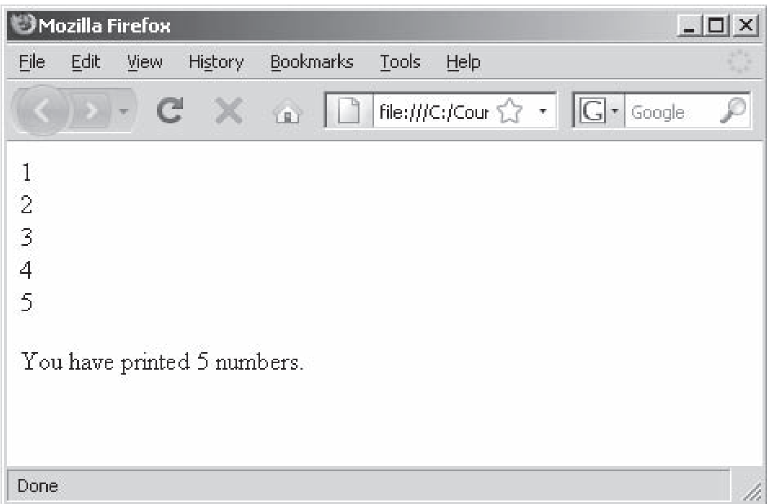


Figure 3-5 Output of a `while` statement using an increment operator

You can also control the repetitions in a `while` loop by decrementing (decreasing the value of) counter variables. Consider the following script:

```
var count = 10;
while (count > 0) {
     document.write(count + "<br />");
     --count;
}
document.write("<p>We have liftoff.</p>");
```

In this example, the initial value of the `count` variable is 10, and the decrement operator (`--`) is used to decrease `count` by one. When the `count` variable is greater than zero, the statement within the `while` loop prints the value of the `count` variable. When the value of `count` is equal to zero, the `while` loop ends, and the statement immediately following it prints. Figure 3-6 shows the script output.

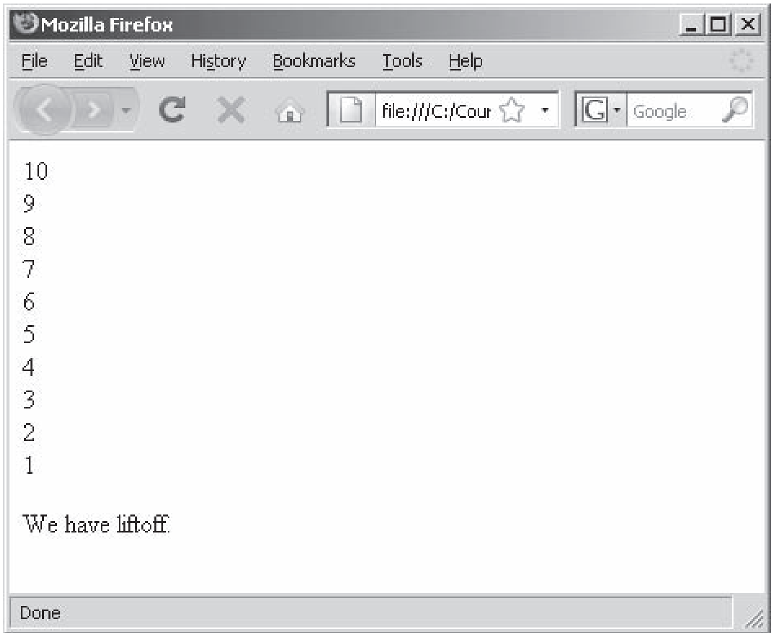


Figure 3-6 Output of a `while` statement using a decrement operator

There are many ways to change the value of a counter variable and to use a counter variable to control the repetitions of a `while` loop. The following example uses the `*=` assignment operator to multiply the value of the `count` variable by two. When the `count` variable reaches a value of 128, the `while` statement ends. Figure 3-7 shows the script output.

```
var count = 1;
while (count <= 100) {
     document.write(count + "<br />");
     count *= 2;
}
```

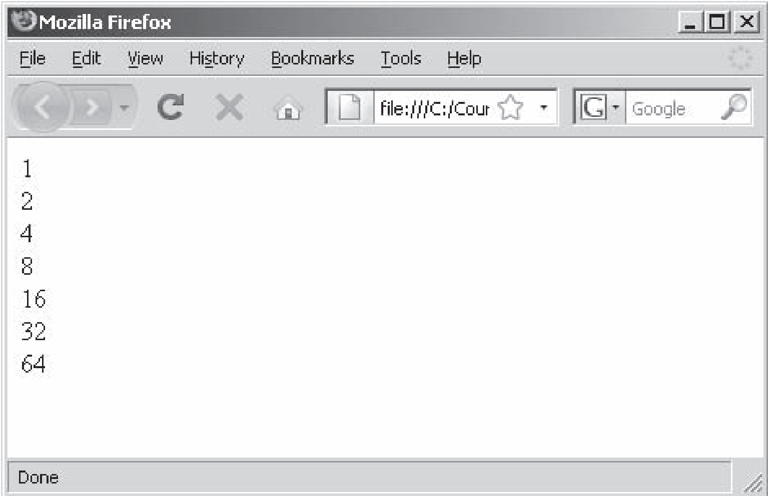


Figure 3-7 Output of a `while` statement using the *= assignment operator

To ensure that the `while` statement will eventually end, you must include code within the body of the `while` statement that changes the value of the conditional expression. For example, suppose that you have a `while` statement that prints odd numbers between 0 and 100. You need to include code within the body of the `while` statement that ends the loop after the last odd number (99) prints. If you do not include code that changes the value used by the conditional expression, your program will be caught in an infinite loop. In an **infinite loop**, a loop statement never ends because its conditional expression is never false. Consider the following `while` statement:

```
var count = 1;
while (count <= 10) {
     window.alert("The number is " + count + ".");
}
```

Although the `while` statement in the preceding example includes a conditional expression that checks the value of a `count` variable, there is no code within the `while` statement body that changes the `count` variable value. The `count` variable will continue to have a value of 1 through each iteration of the loop. That means an alert dialog box containing the text string "The number is 1." will appear over and over again, no matter how many times the user clicks the OK button.

Next, you will create a new version of the physics quiz program that is to be scored by a single `while` statement containing a nested `if` statement. Although this `while` statement is somewhat more complicated than the `if`, `if...else`, and `switch` statements you created previously, it requires many fewer lines of code. You will also include

In most cases, you must force a Web browser that is caught in an infinite loop to close. The method for forcing an application to close varies from one operating system to another. For Windows operating systems, press Ctrl+Alt+Delete, click Task Manager (or Start Task Manager in Vista) to open the Windows Task Manager, click the Applications tab, click the task containing your browser name, and then click End Task.

a Score button that grades the entire quiz after a user is finished. (Remember that the earlier version of the program graded the quiz answer by answer.)

To create a version of the physics quiz program that is scored by a `while` statement:

1. Return to the **PhysicsQuiz4.html** document and immediately save it as **PhysicsQuiz5.html**.

2. Delete the entire `scoreQuestions()` function from the `<head>` section, and then add the following lines to create two arrays, named `answers[]` and `correctAnswers[]`. The `answers[]` array will hold the answers selected each time the quiz runs, and the `correctAnswers[]` array will hold the correct response for each of the questions. The code also assigns the correct responses to each element of the `correctAnswers[]` array.

```
var answers = new Array(5);
var correctAnswers = new Array(5);
correctAnswers[0] = "a";
correctAnswers[1] = "c";
correctAnswers[2] = "b";
correctAnswers[3] = "c";
correctAnswers[4] = "d";
```

3. Add the following function, which assigns the response from each question to the appropriate element in the `answers[]` array. The program sends the actual question number (1–5) to the function by using the `onclick` event of each radio button. To assign question responses to the correct element, 1 must be subtracted from the question variable, because the elements in an array start with 0.

```
function recordAnswer(question, answer) {
     answers[question-1] = answer;
}
```

4. Type the following definition for a function that will score the quiz. You will call this function from a new Score button.

```
function scoreQuiz() {
}
```

5. Add to the `scoreQuiz()` function the following statement, which declares a new variable, and assigns to it an initial value of 0. The `totalCorrect` variable holds the number of correct answers.

```
var totalCorrect = 0;
```

6. Add the following variable declaration and `while` statement at the end of the `scoreQuiz()` function. In this code, a counter named `count` is declared and initialized to a value of 0, because 0 is the starting index of an array. The conditional expression within the `while` statement checks to see if `count` is less than the length of the array, which is one number higher than the largest element in the `answers[]` array. With each iteration of the loop, the statement in the `while` loop increments the `count` variable by one.

```
var count = 0;
while (count < correctAnswers.length) {
   ++count;
}
```

7. Add the following `if` statement to the beginning of the `while` loop, above the statement that increments the `count` variable. This `if` statement compares each element within the `answers[]` array to each corresponding element within the `correctAnswers[]` array. If the elements match, then the `totalCorrect` variable increments by one.

```
if (answers[count] == correctAnswers[count])
     ++totalCorrect;
```

8. Using alert dialog boxes too frequently is considered poor Web design practice. For this reason, this version of the physics quiz will write the quiz score to a text box named `score` in the form named "quiz". After the `while` loop in the `scoreQuiz()` function, add the following code that prints how many questions were answered correctly in the `quiz` text box, which you will create shortly

```
document.quiz.score.value = "You scored "
    + totalCorrect + " out of 5 answers correctly!";
```

The following code shows how your script section should appear:

```
<script type="text/javascript">
/* <![CDATA[ */
var answers = new Array(5);
var correctAnswers = new Array(5);
correctAnswers[0] = "a";
correctAnswers[1] = "c";
correctAnswers[2] = "b";
correctAnswers[3] = "c";
correctAnswers[4] = "d";
function recordAnswer(question, answer) {
     answers[question-1] = answer;
}
```

```
function scoreQuiz() {
     var totalCorrect = 0;
     var count = 0;
     while (count < correctAnswers.length) {
          if (answers[count] == correctAnswers[count])
               ++totalCorrect;
          ++count;
     }
     document.quiz.score.value = "You scored "
          + totalCorrect
          + " out of 5 answers correctly!";
}
/* ]]> */
</script>
```

9. In the `onclick` event handlers for each radio button, change the name of the called function from `scoreQuestions()` to `recordAnswer()`, but use the same arguments that you used for the `scoreQuestions()` function. For example, the `onclick` event handlers for the Question 1 radio buttons should now read `onclick="recordAnswer(1, 'a')"`.

10. Finally, add the following `<input>` elements immediately above the closing `</form>` tag. The button `<input>` element creates a command button whose `onclick` event handler calls the `scoreQuiz()` function. The text `<input>` element will contain the quiz score.

```
<p>
    <input type="button" value="Score"
onclick="scoreQuiz();" />
    <input type="text" name="score" size="40"
        style="color: white; border-style: none; ↵
        border-color: inherit; border-width: medium; ↵
        background-color: Transparent" text="0" />
</p>
```

11. Save the **PhysicsQuiz5.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

12. Open the **PhysicsQuiz5.html** document in your Web browser. Test the program by answering all five questions and clicking the **Score** button. Figure 3-8 shows how the program appears in a Web browser.

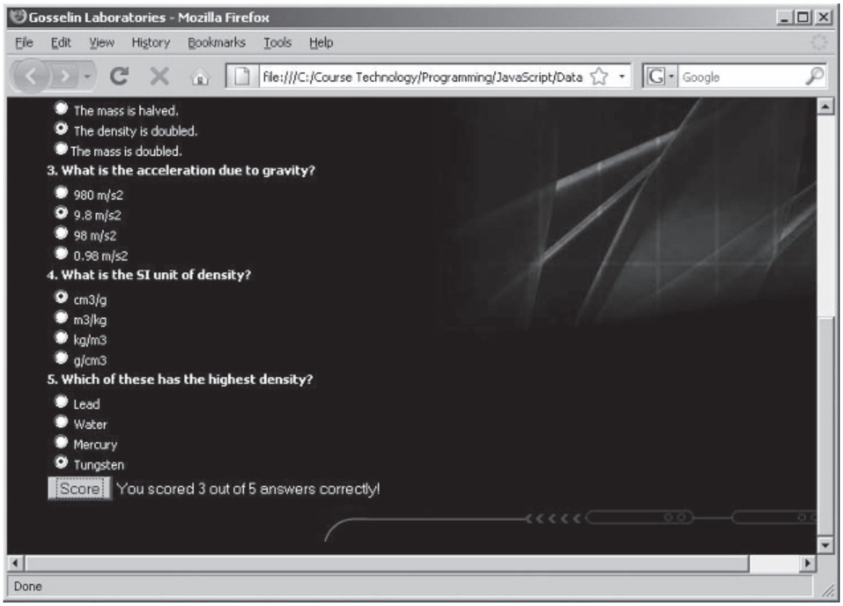


Figure 3-8 PhysicsQuiz5.html in a Web browser

13. Close your Web browser window.

`do...while` Statements

Another JavaScript looping statement, similar to the `while` statement, is the `do...while` statement. The **`do...while` statement** executes a statement or statements once, then repeats the execution as long as a given conditional expression evaluates to true. The syntax for the `do...while` statement is as follows:

```
do {
    statement(s);
} while (conditional expression);
```

As you can see in the syntax description, the statements execute before a conditional expression is evaluated. Unlike the simpler `while` statement, the statements in a `do...while` statement always execute once, before a conditional expression is evaluated.

The following `do...while` statement executes once before the conditional expression evaluates the `count` variable. Therefore, a single line that reads "The count is equal to 2." prints. After the conditional expression (`count < 2`) executes, the count variable is equal to 2. This causes the conditional expression to return a value of false, and the `do...while` statement ends.

```
var count = 2;
do {
    document.write("<p>The count is equal to "
        + count + ".</p>");
    ++count;
} while (count < 2);
```


Note that this `do...while` example includes a counter within the body of the `do...while` statement. As with the `while` statement, you need to include code that changes the conditional expression in order to prevent an infinite loop.

In the following example, the `while` statement never executes, because the `count` variable does not fall within the range of the conditional expression:

```
var count = 2;
while (count > 2) {
    document.write("<p>The count is equal to "
        + count + "</p>");
    ++count;
}
```

The following script shows an example of a `do...while` statement that prints the days of the week, using an array:

```
var daysOfWeek = new Array();
daysOfWeek[0] = "Monday"; daysOfWeek[1] = "Tuesday";
daysOfWeek[2] = "Wednesday"; daysOfWeek[3] = "Thursday";
daysOfWeek[4] = "Friday"; daysOfWeek[5] = "Saturday";
daysOfWeek[6] = "Sunday";
var count = 0;
do {
      document.write(daysOfWeek[count] + "<br />");
      ++count;
} while (count < daysOfWeek.length);
```

In the preceding example, an array is created containing the days of the week. A variable named `count` is declared and initialized to zero. (Remember, the first subscript or index in an array is zero.) Therefore, in the example, the statement `daysOfWeek[0];` refers to Monday. The first iteration of the `do...while` statement prints "Monday" and then increments the `count` variable by one. The conditional expression in the `while` statement then checks to determine when the last element of the array has been printed. As long as the count is less than then length of the array (which is one number higher than the largest element in the `daysOfWeek[] array`), the loop continues. Figure 3-9 shows the output of the script in a Web browser.

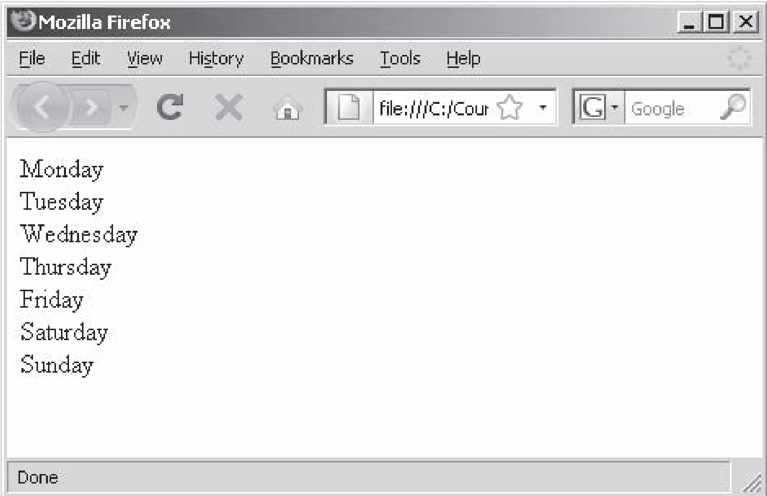


Figure 3-9 Days of Week script in a Web browser

Next, you will replace the `while` statement in the physics quiz program with a `do...while` statement.

To replace the `while` statement in the physics quiz program with a `do...while` statement:

1. Return to the **PhysicsQuiz5.html** document, and immediately save it as **PhysicsQuiz6.html**.

2. Change the `while` statement within the `scoreQuiz()` function to the following `do...while` statement:

```
do {
    if (answers[count] == correctAnswers[count])
          ++totalCorrect;
    ++count;
} while (count < 5);
```

3. Save the **PhysicsQuiz6.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

4. Open the **PhysicsQuiz6.html** document in your Web browser. The program should function just as it did with the nested `while` statement.

5. Close your Web browser window.

`for` Statements

So far you have learned how to use the `while` and the `do...while` statements to repeat, or loop through, code. You can also use the `for` statement to loop through code. The **`for` statement** is used to repeat a statement or series of statements as long as a given conditional expression evaluates to true. The `for` statement performs essentially the same function as the `while` statement: If a conditional expression within the `for` statement evaluates to true, then the `for` statement executes and will continue to execute repeatedly until the conditional expression evaluates to false.

One of the primary differences between the `while` statement and the `for` statement is that, in addition to a conditional expression, the `for` statement can also include code that initializes a counter and changes its value with each iteration. This is useful because it provides a specific place for you to declare and initialize a counter, and to update its value, which helps prevent infinite loops. The syntax of the `for` statement is as follows:

```
for (counter declaration and initialization; condition;
      update statement) {
      statement(s);
   }
```

When the JavaScript interpreter encounters a `for` loop, the following steps occur:

1. The counter variable is declared and initialized. For example, if the initialization expression in a `for` loop is `var count = 1;`, then a variable named `count` is declared and assigned an initial value of 1. The initialization expression is only started once, when the `for` loop is first encountered.
2. The `for` loop condition is evaluated.
3. If the condition evaluation in Step 2 returns a value of true, then the `for` loop statements execute, Step 4 occurs, and the process starts over again with Step 2. If the condition evaluation in Step 2 returns a value of false, then the `for` statement ends and the next statement following the `for` statement executes.
4. The update statement in the `for` statement is executed. For example, the `count` variable may be incremented by one.

> You can omit any of the three parts of the `for` statement, but you must include the semicolons that separate each section. If you omit a section, be sure that you include code within the body that will end the `for` statement or your program may get caught in an infinite loop.

The following script shows a `for` statement that prints the contents of an array:

```
var brightestStars = new Array();
brightestStars[0] = "Sirius";
brightestStars[1] = "Canopus";
brightestStars[2] = "Arcturus";
brightestStars[3] = "Rigel";
brightestStars[4] = "Vega";
for (var count = 0; count < brightestStars.length; ++count) {
     document.write(brightestStars[count] + "<br />");
}
```

As you can see in this example, the counter is initialized, evaluated, and incremented within the parentheses. You do not need to include a declaration for the count variable before the `for` statement, nor do you need to increment the `count` variable within the body of the `for` statement. Figure 3-10 shows the output.

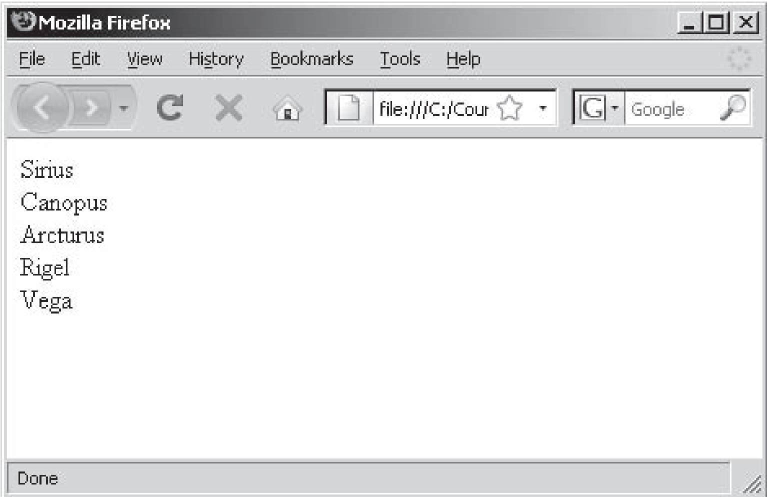


Figure 3-10 Output of brightest stars script

Using a `for` statement is more efficient than a `while` statement because you do not need as many lines of code. Consider the following `while` statement:

```
var count = 1;
while (count < brightestStars.length) {
     document.write(count + "<br />");
     ++count;
}
```

You could achieve the same flow control more efficiently by using a `for` statement as follows:

```
for (var count = 1; count < brightestStars.length; ++count) {
    document.write(count + "<br />");
}
```

There are times, however, when using a `while` statement is preferable to using a `for` statement, especially for looping statements that do need to declare, initialize, or update a counter variable. The following code relies on a Boolean value returned from a confirm dialog box, rather than a counter, for program control.

```
var i = true;
while (i == true)
    i = window.confirm("Do you want to redisplay ↵
        this dialog box?");
```


You could accomplish the same task in the preceding example by using a `for` statement, but in this case, the third part of the `for` statement, which updates the counter, would be unnecessary. This is because the counter is updated by the value returned from the `window.confirm()` method; a value of true would cause the loop to reiterate, while a value of false would cause the loop to exit. Therefore, this code is better written using a `while` statement. If you use a `for` statement instead of a `while` statement in the preceding example, you must not include the update section in the `for` statement. You must also remember to retain the semicolon that separates the conditional section from the update section. If you include the update section, you could create an infinite loop.

The following code shows an example of the Days of Week script you saw earlier. This time, however, the script includes a `for` statement instead of a `do...while` statement. Notice that the declaration of the `count` variable, the conditional expression, and the statement that increments the `count` variable are now all contained within the `for` statement. Using a `for` statement instead of a `do...while` statement simplifies the script somewhat, because you do not need as many lines of code.

```
var daysOfWeek = new Array();
daysOfWeek[0] = "Monday"; daysOfWeek[1] = "Tuesday";
daysOfWeek[2] = "Wednesday"; daysOfWeek[3] = "Thursday";
daysOfWeek[4] = "Friday"; daysOfWeek[5] = "Saturday";
daysOfWeek[6] = "Sunday";
for (var count = 0; count < daysOfWeek.length; ++count) {
     document.write(daysOfWeek[count] + "<br />");
}
```

Next, you will create a final version of the physics quiz program that is scored with a `for` statement instead of a `do...while` statement.

To replace the `do...while` statement in the physics quiz program with a `for` statement:

1. Return to the **PhysicsQuiz6.html** document, and immediately save it as **PhysicsQuiz7.html**.
2. Delete the declaration for the `count` variable within the `scoreQuiz()` function.

3. Change the `do...while` statement within the `scoreQuiz()` function to the following `for` statement.

```
for (var count = 0;
     count < correctAnswers.length; ++count) {
     if (answers[count] == correctAnswers[count])
          ++totalCorrect;
}
```

4. Save the **PhysicsQuiz7.html** document, validate it with the W3C Markup Validation Service at **validator.w3.org/file-upload.html**, and fix any errors that the document contains.

5. Open the **PhysicsQuiz7.html** document in your Web browser. The program should function just as it did with the nested `do...while` statement.

6. Close your Web browser window and text editor.

Using `CONTINUE` Statements to Restart Execution

When you studied `switch` statements, you learned how to use a `break` statement to exit `switch`, `while`, `do...while`, and `for` statements. A similar statement, used only with looping statements, is the **`continue` statement**, which restarts a loop with a new iteration. For example, suppose that you have a script that uses a `for` statement to loop through the elements of an array containing a list of stocks. For stocks worth more than $10, the script prints information such as purchase price and number of shares on the screen. However, for stocks worth less than $10, you use the `continue` statement to skip that stock and move on to a new iteration. For example, in the following code, when the `count` variable equals 3, the `continue` statement also stops the current iteration of the `for` loop, and the script skips printing the number 3. However, the loop continues to iterate until the conditional expression `count <= 5` is false. Figure 3-11 shows the output in a Web browser.

```
for (var count = 1; count <= 5; ++count) {
     if (count == 3)
          continue;
     document.write("<p>" + count + "</p>");
}
```

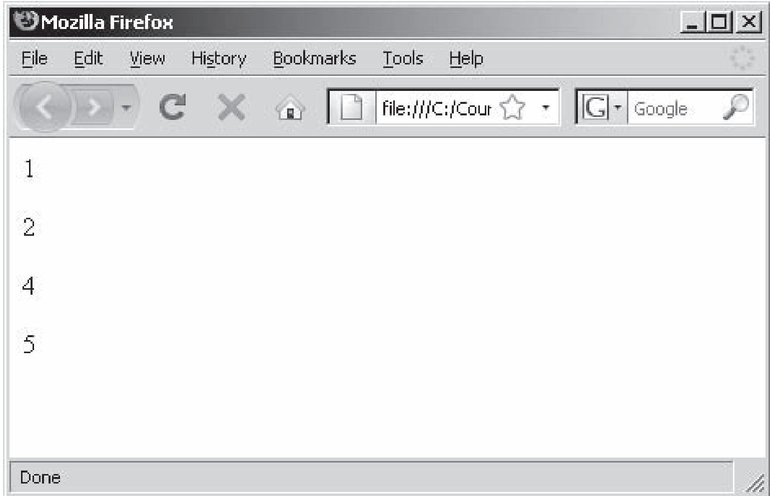


Figure 3-11 Output of a for `loop` with a `continue` statement

In comparison, consider the following code, which contains a `break` statement:

```
for (var count = 1; count <= 5; ++count) {
     if (count == 3)
          break;
     document.write("<p>" + count + "</p>");
}
```

The preceding code contains an `if` statement that checks if the current value of the `count` variable equals 3. When the `count` variable equals 3, the `break` statement immediately ends the `for` loop and displays the output shown in Figure 3-12.

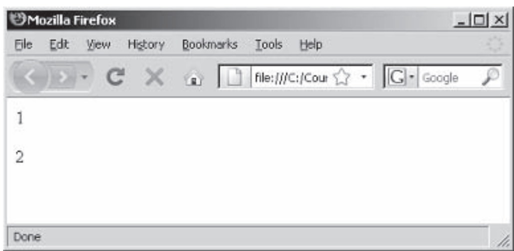


Figure 3-12 Output of a `for` loop with a `break` statement

Short Quiz 3

1. Why is a counter critical to repetition statements?
2. How do you break out of an infinite loop?
3. Which type of repetition statement always executes its statements once, even if the conditional expression returns a value of false?
4. What are the primary differences between the `while` statement and the `for` statement?
5. How do you restart a repetition statement?

Summing Up

- An array contains a set of data represented by a single variable name. You can think of an array as a collection of variables contained within a single variable.
- A constructor is a special type of function that is used as the basis for creating reference variables (that is, variables whose data type is the reference data type).
- Each piece of data contained in an array is called an element.
- An index is an element's numeric position within the array.
- The `Array` class contains a single property, the `length` property, which returns the number of elements in an array.
- The process of determining the order in which statements execute in a program is called decision making or flow control.
- The `if` statement is used to execute specific programming code if the evaluation of a conditional expression returns a value of true.
- A command block is a set of statements contained within a set of braces, similar to the way function statements are contained within a set of braces.
- An `if` statement that includes an `else` clause is called an `if...else` statement.

- When one decision-making statement is contained within another decision-making statement, they are referred to as nested decision-making structures.
- The `switch` statement controls program flow by executing a specific set of statements, depending on the value of an expression.
- A `break` statement is used to exit control statements, such as the `switch`, `while`, `do . . . while`, and `for` looping statements.
- A loop statement is a control structure that repeatedly executes a statement or a series of statements while a specific condition is true or until a specific condition becomes true.
- The `while` statement is used for repeating a statement or series of statements as long as a given conditional expression evaluates to true.
- Each repetition of a looping statement is called an iteration.
- An infinite loop is a situation in which a loop statement never ends because its conditional expression is never false.
- The `do . . . while` statement executes a statement or statements once, then repeats the execution as long as a given conditional expression evaluates to true.
- The `for` statement is used for repeating a statement or series of statements as long as a given conditional expression evaluates to true.
- The `continue` statement halts a looping statement and restarts the loop with a new iteration.

Comprehension Check

1. The identifiers you use for an array name must follow the same rules as identifiers for variables. True or false?

2. What is the correct syntax for creating an array named `taxRules` that contains five elements?

   a. `new Array(taxRules) = 5;`

   b. `Array(taxRules) + 5;`

   c. `var taxRules = Array(5);`

   d. `var taxRules = new Array(5);`

3. An error occurs if you attempt to assign a value to an element that has not yet been created. True or false?

4. Which of the following properties returns the number of elements in an array?

   a. `length`

   b. `size`

   c. `elements`

   d. `indexes`

5. Which characters are used to create a command block?

   a. ( )

   b. [ ]

   c. { }

   d. <>

6. Which of the following is the correct syntax for an `if` statement?

   a.
   ```
   if (singleIncome > 326450),
       window.alert("Your federal income tax ↵
          rate is 35%.");
   ```

   b.
   ```
   if (singleIncome > 326450);
       window.alert("Your federal income tax ↵
          rate is 35%.");
   ```

   c.
   ```
   if (singleIncome > 326450)
       window.alert("Your federal income tax ↵
          rate is 35%.");
   ```

   d.
   ```
   if singleIncome > 326450
       window.alert("Your federal income tax ↵
          rate is 35%.");
   ```

7. An `if` statement can include multiple statements provided that they _______________.

   a. execute after the `if` statement's closing semicolon

   b. are not contained within a command block

   c. do not include other `if` statements

   d. are contained within a command block

8. Which is the correct syntax for an `else` clause?

   a. `else "document.write('Your federal income ↵ tax rate is 28%.')";`

   b. `else; document.write("Your federal income ↵ tax rate is 28%.");`

   c. `else (document.write("Your federal income ↵ tax rate is 28%."));`

   d. `else document.write("Your federal income ↵ tax rate is 28%.");`

9. Decision-making structures cannot be nested. True or false?

10. The `switch` statement controls program flow by executing a specific set of statements, depending on ________________.

    a. whether an `if` statement executes from within a function

    b. the version of JavaScript being executed

    c. the value returned by a conditional expression

    d. the result of an `if...else` statement

11. When the value returned by a `switch` statement expression does not match a `case` label, then the statements within the ________________ label execute.

    a. `error`

    b. `else`

    c. `exception`

    d. `default`

12. You can exit a `switch` statement using a(n) ________________ statement.

    a. `complete`

    b. `end`

    c. `quit`

    d. `break`

13. Each repetition of a looping statement is called a(n) ________________.
    a. recurrence
    b. iteration
    c. cycle
    d. synchronization

14. Counter variables ________________. (Choose all that apply.)
    a. can only be incremented
    b. can only be decremented
    c. can be changed using any conditional expression
    d. do not change

15. Which of the following is the correct syntax for a `while` statement?

    a.
    ```
    while (i <= population.length) {
        document.write(population[i]);
        ++i;
    }
    ```
    b.
    ```
    while (i <= population.length, ++i) {
        document.write(population[i]);
    }
    ```
    c.
    ```
    while (i <= population.length);
        document.write(population[i]);
        ++i;
    ```
    d.
    ```
    while (i <= population.length; document.write(i)) {
        ++ population[i];
    }
    ```

16. Which of the following is the correct syntax for a `do...while` statement?

    a.
    ```
    do {
        document.write(counties[i]);
        while (i < counties.length)
    }
    ```
    b.
    ```
    do { while (i < counties.length)
        document.write(counties[i]);
    }
    ```

c.
```
do {
    document.write(counties[i]);
} while (i < counties.length);
```

d.
```
do while (i < counties.length) {
    document.write(counties[i]);
}
```

17. When is a `for` statement initialization expression executed?

    a. when the `for` statement begins executing

    b. with each repetition of the `for` statement

    c. when the counter variable is incremented

    d. when the `for` statement ends

18. Which of the following is the correct syntax for a `for` statement?

    a.
    ```
    for (var i = ; i < federalHoliday.length; ++i)
        document.write(federalHoliday[i]);
    ```

    b.
    ```
    for (var i = 0, i < holiday.length, ++i)
        document.write(federalHoliday[i]);
    ```

    c.
    ```
    for {
        document.write(federalHoliday[i]);
    } while (var i = 0; i < holiday.length; ++i)
    ```

    d.
    ```
    for (var i = 0; i < holiday.length);
        document.write(federalHoliday[i]);
        ++i;
    ```

19. Explain how an infinite loop is caused.

20. The ________________ statement halts a looping statement and restarts the loop with a new iteration.

    a. `restart`

    b. `continue`

    c. `break`

    d. `halt`

Reinforcement Exercises

Exercise 3-1

In this exercise, you will create a script for Walt's Lawn Service with a function that returns a string value.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the Strict DTD and "Walt's Lawn Service" as the content of the <title> element.

3. Create a script section in the document head that contains the following `favoriteLawnService()` function:

```
<script type="text/javascript">
/* <![CDATA[ */
function favoriteLawnService() {
     var companyName = "Walt's Lawn Service";
}
/* ]]> */
</script>
```

4. Modify the `favoriteLawnService()` function so that it returns the company name to another calling function.

5. Create another script section in the document body.

6. Add statements to the script section in the document body that call the `favoriteLawnService()` function and assign the return value to a variable named `bestLandscaper`.

7. Finally, write code that prints the contents of the `bestLandscaper` variable.

8. Save the document as **WaltsLawnService.html** in the Exercises folder for Chapter 3.

9. Use the W3C Markup Validation Service to validate the **WaltsLawnService.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

10. Close your Web browser window.

Exercise 3-2

In this exercise, you will create a script that uses a function to print information about financing options for a company named Cahill Cars. The script will include a global variable containing the name of the company and the function will contain global variables that store financing information.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the Strict DTD and "Cahill Cars" as the content of the <title> element.

3. Create a script section in the document head.

4. Add the following global variable to the script section in the document head:

```
var autoDealer = "Cahill Cars";
```

5. Add to the end of the script section a function named `printFinanceOptions()`. Within the `printFinanceOptions()` function, add the following `document.write()` methods to print the available financing options:

```
document.write("<h2>Financing Options</h2>");
document.write("<ul">");
document.write("<li>24 months: 6.75%</li>");
document.write("<li>48 months: 7.15%</li>");
document.write("<li>72 months: 7.50%</li>");
document.write("</ul">");
```

6. Add a script section to the document body that prints the global variable in an <h1> element and that calls the `printFinanceOptions()` function.

7. Save the document as **CahillCars.html** in the Exercises folder for Chapter 3.

8. Use the W3C Markup Validation Service to validate the **CahillCars.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

9. Close your Web browser window.

Exercise 3-3

In this exercise, you will correct errors in a simple JavaScript program that prints information for the Hotel Tennessee.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the Strict DTD and "Hotel Tennessee" as the content of the `<title>` element.

3. Create a script section in the document head that contains the following statement:

```
<script type="text/javascript">
/* <![CDATA[ */
document.write(hotelInfo());
/* ]]> */
</script>
```

4. Create a script section in the document body that contains the following `hotelInfo()` function:

```
<script type="text/javascript">
/* <![CDATA[ */
function hotelInfo() {
   return "<p>The Hotel Tennessee in Nashville ↵
      is within walking distance of the Country ↵
      Music Hall of Fame.</p>";
}
/* ]]> */
</script>
```

5. The code you typed in the preceding step should print a single statement that reads "The Hotel Tennessee in Nashville is within walking distance of the Country Music Hall of Fame." However, the code actually contains a design error that generates error messages when you attempt to open the program in a Web browser. Correct the error and make sure that the program runs successfully in a browser. (*Hint*: The problem has to do with where the script sections are placed in the document.)

6. Save the document as **HotelTennessee.html** in the Exercises folder for Chapter 3.

7. Use the W3C Markup Validation Service to validate the **HotelTennessee.html** document, and fix any errors that the

document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

8. Close your Web browser window.

Exercise 3-4

In this exercise, you will create a document that uses an `if...else` statement and confirm dialog boxes to verify that a passenger meets the eligibility requirements to sit in an airplane's exit row.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the Strict DTD and "Exit Row Requirements" as the content of the <title> element.

3. Create a script section in the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following `if...else` statements to the script section. These statements use confirm dialog boxes in the conditional expressions to determine whether a passenger meets the eligibility requirements to sit in an airplane's exit row.

```
if (window.confirm("Are you under 15 years old?"))
    document.write("<p>By federal law, children ↵
        under age 15 may not sit in emergency ↵
        exit rows.</p>");
else if (!window.confirm("Are you capable of ↵
    lifting 50 or more pounds?"))
    document.write("<p>You must be able to ↵
        lift 50 or more pounds to sit in an exit ↵
        row.</p>");
else if (!window.confirm("Are you willing ↵
    to assist the crew in the event of an ↵
    emergency?"))
    document.write("<p>To sit in an exit row, ↵
        you must be willing to assist the crew ↵
        in the event of an emergency.</p>");
else
    document.write("<p>You meet the criteria ↵
        for sitting in an exit row.</p>");
```

5. Save the document as **ExitRows.html** in the Exercises folder for Chapter 3.

6. Use the W3C Markup Validation Service to validate the **ExitRows.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window.

Exercise 3-5

In this exercise, you will write a `while` statement that prints all even numbers between 1 and 100 to the screen.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the Strict DTD and "Even Numbers" as the content of the `<title>` element.

3. Create a script section with a `while` statement that prints all even numbers between 1 and 100 to the screen.

4. Save the document as **EvenNumbers.html** in the Exercises folder for Chapter 3.

5. Use the W3C Markup Validation Service to validate the **EvenNumbers.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

6. Close your Web browser window.

Exercise 3-6

In this exercise, you will identify and fix the logic flaws in a `while` statement.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the Strict DTD and "While Logic" as the content of the `<title>` element.

3. Create a script section in the document head that includes the following code:

```
<script type="text/javascript">
/* <![CDATA[ */
var count = 0;
var numbers = new Array(100);
while (count > 100) {
     numbers[count] = count;
     ++count;
}
while (count > 100) {
     document.write(numbers[count]);
     ++count;
}
/* ]]> */
</script>
```


4. The code you typed in the preceding step should fill the array with the numbers 1 through 100, and then print them to the screen. However, the code contains several logic flaws that prevent it from running correctly. Identify and fix the logic flaws.

5. Save the document as **WhileLogic.html** in the Exercises folder for Chapter 3.

6. Use the W3C Markup Validation Service to validate the **WhileLogic.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window.

Exercise 3-7

Standard & Poor's issues a list of bond ratings that determines the investment quality of individual bonds. The bond ratings range from AAA to D, with AAA representing the highest-quality bonds. In this exercise, you will create a document with a simple form that displays the investment quality of each particular Standard & Poor's bond rating.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the Transitional DTD and "Bond Ratings" as the content of the <title> element.

3. Create a script section in the document head that includes the following `checkRating()` function and `switch` statement:

```
<script type="text/javascript">
/* <![CDATA[ */
function checkRating(rating) {
     switch (rating) {
          case "AAA":
               window.alert("Highest Quality");
          case "AA":
               window.alert("High Quality");
          case "A":
               window.alert("Upper Medium");
          case "BBB":
               window.alert("Medium");
          case "BB":
               window.alert("Speculative");
          case "B"
               window.alert("Highly Speculative");
          case "CCC":
               window.alert("Extremely Speculative");
          case "CC":
               window.alert("Probable Default");
          case "D":
               window.alert("Default");
     }
}
/* ]]> */
</script>
```

4. Add code to the `switch` statement you created in the previous step so that after the statements in a `case` label execute, the `switch` statement ends.

5. Modify the `switch` statement so that a default value of "You did not enter a valid bond rating." is displayed in an alert dialog box if none of the `case` labels match the `rating` variable.

6. Add the following form to the document body that includes an `onclick` event handler, which calls the `checkRating()` function. The value of the single text box is passed to the `checkRating()` function.

```
<form name="bondRating" action="">
<input type="text" name="rating" />
<input type="button" value="Check Bond Rating"
onclick="checkRating(document.bondRating.
rating.value);" />
</form>
```

7. Save the document as **BondRatings.html** in the Exercises folder for Chapter 3.

8. Use the W3C Markup Validation Service to validate the **BondRatings.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

9. Close your Web browser window.

Exercise 3-8

In this exercise, you will modify a nested `if` statement so that it uses a compound conditional expression instead. Use logical operators, such as the `||` (OR) and `&&` (AND) operators, to execute a conditional or looping statement based on multiple criteria.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the Strict DTD and "Oil Prices" as the content of the `<title>` element.

3. Create a script section in the document head that includes the following variable declaration and nested `if` statement:

```
<script type="text/javascript">
/* <![CDATA[ */
var oilPrice = 52.85;
if (oilPrice > 50) {
    if (oilPrice < 60)
        document.write("<p>Oil prices are between ↵
            $50.00 and $60.00 a barrel.</p>");
}
/* ]]> */
</script>
```

4. Modify the nested `if` statement you created in the previous step so that it uses a single `if` statement with a compound conditional expression to determine whether oil prices are between $50.00 and $60.00 a barrel. You will need to use the `&&` (AND) logical operator.

5. Save the document as **OilPrices.html** in the Exercises folder for Chapter 3.

6. Use the W3C Markup Validation Service to validate the **OilPrices.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser and examine how the elements are rendered.

7. Close your Web browser window.

Discovery Projects

Save your Discovery Projects document in the Projects folder for Chapter 3. Create the documents so that they are well formed according to the strict DTD. Be sure to validate each document with the W3C Markup Validation Service.

Project 3-1

Many companies normally charge a shipping and handling fee for purchases. Create a Web page that allows a user to enter a purchase price into a text box; include a JavaScript function that calculates shipping and handling. Add functionality to the script that adds a minimum shipping and handling fee of $1.50 for any purchase that is less than or equal to $25.00. For any orders over $25.00, add 10% to the total purchase price for shipping and handling, but do not include the $1.50 minimum shipping and handling fee. The formula for calculating a percentage is *price* * *percent* / 100. For example, the formula for calculating 10% of a $50.00 purchase price is 50 * 10 / 100, which results in a shipping and handling fee of $5.00. After you determine the total cost of the order (purchase plus shipping and handling), display it in an alert dialog box. Save the document as **CalcShipping.html**.

Project 3-2

The American Heart Association recommends that when you exercise, you stay within 50 to 85 percent of your maximum heart rate. This range is called your target heart rate. One common formula for calculating maximum heart rate is to subtract your age from 220. Create a Web page that you can use to calculate your target heart rate. Use a form that contains a text box in which users can enter their age, and a command button that uses an `onclick` event handler to call a function named `calcHeartRate()`. Within the `calcHeartRate()`, include a statement that calculates the maximum heart rate and assigns the result to a variable. Use two other statements that calculate the minimum (50%) and maximum (85%) target heart rates. To calculate the minimum target heart rate, you use the formula *maximum_heart_rate* * .5, and to calculate the maximum target heart rate, you use the formula *maximum_heart_rate* * .85. After you calculate the minimum and maximum target heart rates, display the result in another text box in the form. For example, for someone 35 years old, the target heart rate text box should display "92 to 157 beats per minute". Save the document as **TargetHeartRate.html**.

Project 3-3

Create a Web page that you can use to calculate miles per gallon. Add a form to the Web page that contains four text `<input>` elements: starting mileage, ending mileage, gallons used, and miles per gallon. Assign initial starting values of 0 to each of the `<input>` element's value attribute. Add `onchange` event handlers to the starting mileage, ending mileage, and gallons used text boxes that call a JavaScript function named `calcMPG()`. Create the `calcMPG()` function in a script section in the document head. Within the `calcMPG()` function, declare three variables, `startMiles`, `endMiles`, and `gallons`, and initialize each variable with the value assigned to the starting mileage, ending mileage, and gallons. Create an `if...else` statement that uses the `isNaN()` function within a compound conditional expression to determine whether the `startMiles`, `endMiles`, and `gallons` variables contain numeric values. If the variables do not contain numeric variables, display an alert dialog box informing the user that he or she must enter numeric values. If the variables do contain numeric values, the `else` clause should perform the miles-per-gallon calculation and assign the result to the Miles per Gallon text box in the form. The formula for calculating miles per gallon is (*ending_mileage - starting_mileage*) / *gallons*. The formula includes parentheses to force the order of precedence to calculate the subtraction operation before the division operation. (Recall from Chapter 2 that a division operation has higher precedence than a subtraction operation.) One problem with performing the calculation is that if you attempt to divide by zero, you will receive an error. For this reason, you need to use a nested `if` statement within the `else` clause to verify that the `gallons` variable contains a numeric value greater than zero. If the variable does not contain a value greater than zero, the statements within the `if` statement should not execute. Save the document as **GasMileage.html**.

Project 3-4

You can determine whether a year is a leap year by testing if it is divisible by 4. However, years that are also divisible by 100 are not leap years, unless they are also divisible by 400; in which case they are leap years. Write a script that allows a user to enter a year and then determines if the year entered is a leap year. Include a form with a single text box where the user can enter a year. Display an alert dialog box to the user stating whether the year entered is a standard year or a leap year. Save the document as **LeapYear.html**.

Project 3-5

A prime number is a number than can only be divided by itself or by one. Examples of prime numbers include 1, 3, 5, 13, and 17. Write a script that prints the prime numbers between 1 and 999 in a table that consists of 10 columns. You will need to use several looping and conditional statements to test all division possibilities. Use `document.write()` statements to create the table elements and a counter variable to create the table so that it consists of 10 columns. The counter variable should start with an initial value of 0 and be incremented by one each time your code identifies a prime number and prints it in a table cell. Once the counter variable reaches a value of 10 (meaning that 10 cells have been added to the current row), print `</tr><tr>` to start a new row and reset the variable to 0. Save the document as **PrimeNumbers.html**.

CHAPTER 4

Manipulating the Browser Object Model

In this chapter, you will:

- Study the browser object model
- Work with the `Window` object
- Study the `History`, `Location`, and `Navigator` objects

In some situations, you may need to use JavaScript to control the Web browser. For example, you might want to change the Web page being displayed or write information to the Web browser's status bar. Or, you may want to control elements of the Web page itself. To control the Web browser window or the Web page, you use the browser object model. This chapter discusses the components of the browser object model.

Understanding the Browser Object Model

The **browser object model (BOM)** (or **client-side object model**) is a hierarchy of objects, each of which provides programmatic access to a different aspect of the Web browser window or the Web page. You can use the methods and properties of objects in the browser object model to manipulate the window and elements displayed in a Web browser. The most basic objects in the browser object model are illustrated in Figure 4-1.

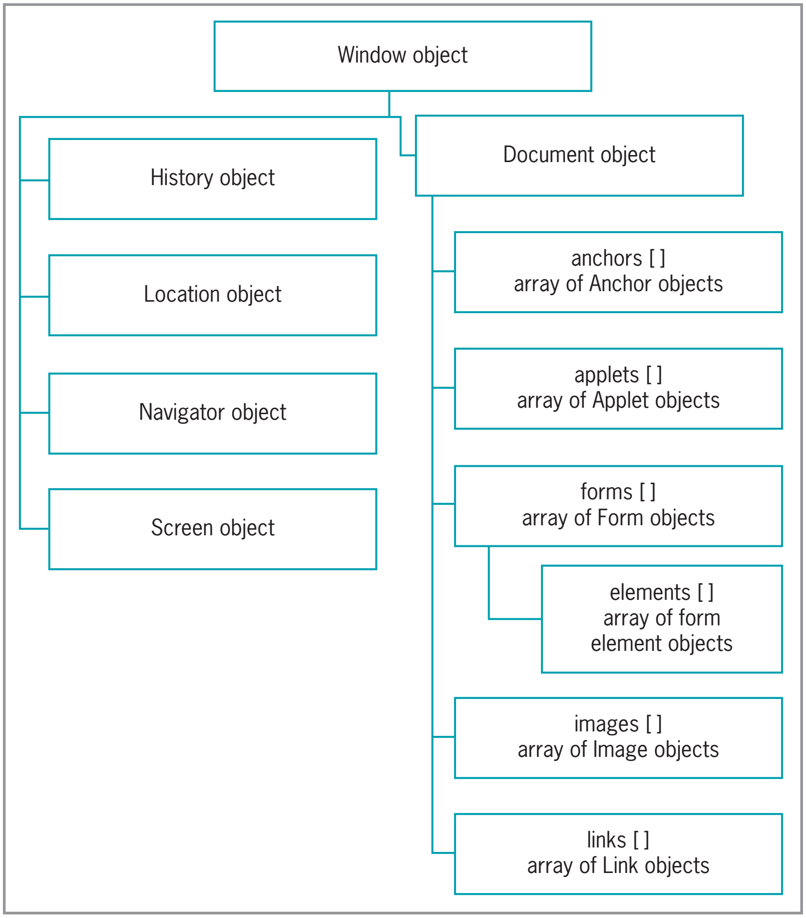


Figure 4-1 Browser object model

The browser object model is also called the JavaScript object model or the `Navigator` object model. However, other scripting technologies, such as VBScript, can also control aspects of the Web browser window or Web page. Therefore, the term "browser object model" or "client-side object model" is more accurate.

The concept of object models is fairly complex. You do not need to understand the details of working with object models in order to work with the browser object model in JavaScript. Instead, you should simply understand that object models define groups of interrelated objects.

You do not have to create any of the objects or arrays explicitly in the browser object model; they are created automatically when a Web browser opens a Web page. The top-level object in the browser object model is the **`Window` object**, which represents a Web browser window. The Web browser automatically creates the `Window` object for you. The `Window` object is called the **global object** because all other objects in the browser object model are contained within it. For example, the `Window` object contains the `Document` object, just as a Web browser window contains a Web page document. You use the methods and properties of the `Window` object to control the Web browser window, while you use the methods and properties of the `Document` object to control the Web page. Figure 4-2 illustrates the concepts of the `Window` object and the `Document` object.

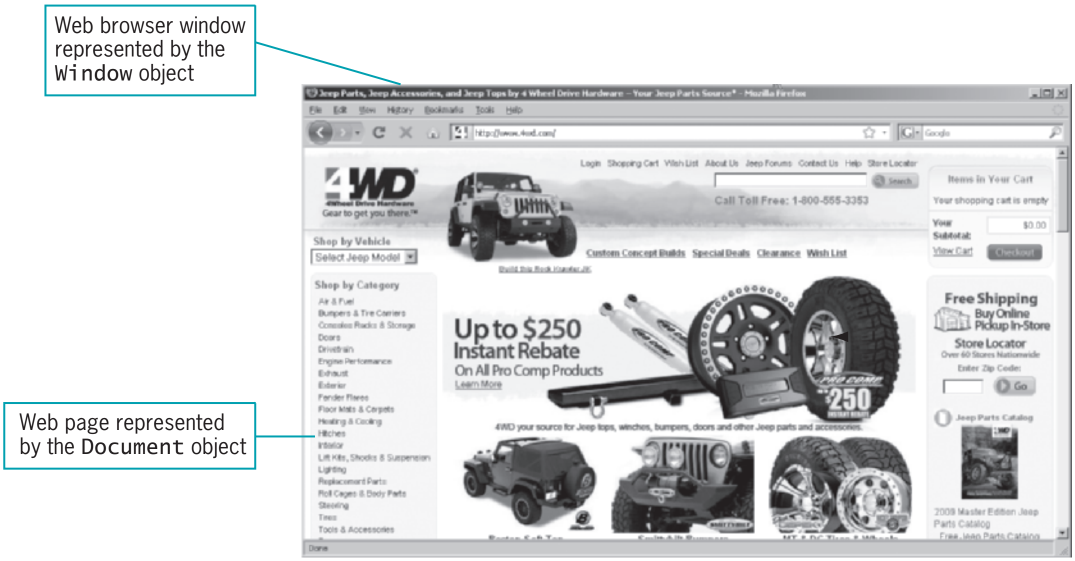


Figure 4-2 `Window` object and `Document` object

The Document Object

The `Document` object is arguably the most important object in the browser object model because it represents the Web page displayed in a browser. You are already familiar with the `write()` and `writeln()` methods, which refer to the `Document` object. The statement `document.write("Go Patriots!");` adds the text "Go Patriots!" to a Web page when it is rendered by a Web browser. All elements on a Web page are contained within the `Document` object, and each element is represented in JavaScript by its own object. This means that the `Document` object contains all of the elements you create on a Web page. For example, the `Form` object, which is used by JavaScript to represent forms created with the <form> element, is contained within the `Document` object, which is contained within the `Window` object. The `Radio` object, which is used by JavaScript to represent a radio button created with an <input> element, is contained within the `Form` object, which is contained within the `Document` object, which is contained within the `Window` object.

In this book, objects in the browser object model are referred to with an initial uppercase letter (`Document` object). However, when you use the object name in code, you must always use a lowercase letter. For example, the following statement refers to the `Document` object: `document.write("Go Patriots!");`. Note the use of the lowercase "d" in `document`.

The `Document` object branch of the browser object model is represented by its own object model called the Document Object Model, or DOM. You will learn more about the DOM in Chapter 10.

Referencing JavaScript Objects

Some of the objects in the browser object model represent arrays. In Figure 4-1, those objects that are arrays are followed by brackets, such as `forms[]` or `images[]`. The arrays contain objects created from the corresponding elements on a Web page. For example, the `images[]` array contains `Image` objects that represent all the <img> elements on a Web page. `Image` objects for each <img> element are assigned to the elements of the `images[]` array in the order that they appear on the Web page. The first `Image` object is represented by `images[0]`, the second `Image` object is represented by `images[1]`, and so on.

As you learned in Chapter 1, you can use JavaScript to reference any element on a Web page by using periods to append the element's name to the name of any elements in which it is nested, starting with the `Document` object. For elements that are represented by arrays, you can reference the object through the array instead of with the element name. Consider an `Image` object, which contains an `src` property that contains the URL assigned to an <img> element's `src` attribute. Assuming that the image is assigned a name of `companyLogo`, use the following code to display the image's URL in an alert dialog box:

```
<img src="company_logo.gif" name="companyLogo"
    height="100" width="200" onclick="window.alert( ↵
    'This image is located at the following URL: '
    + document.companyLogo.src);"
    alt="Image of a company logo." />
```

Instead of referencing the image by name, you can access it through the `images[]` array. The following <img> element includes an `onclick` event handler that uses the `Document` object to display the image's URL in an alert dialog box. The code assumes the image is the first image on the page by referencing the first element (0) in the `images[]` array.

```
<img src="company_logo.gif" height="100" width="200"
     onclick="window.alert(
     'This image is located at the following URL:'
     + document.images[0].src);"
     alt="Image of a company logo." />
```

Next, you start working on a simple Web site for an automotive manufacturer named Gosselin Motors. You will find these six prewritten Web pages in your Chapter folder for Chapter 4: index.html, DRG5000.html, DRGLX.html, DRG4000.html, DRGDX.html, and DRGSX.html. The index.html document is the home page; the rest of the pages display photos and information about different car models. You will modify these Web pages throughout the chapter.

In this exercise, you add an advertisement to the Gosselin Motors home page that changes when users click on the image. You will change the image using the `images[]` array.

To add an advertisement to the Gosselin Motors home page that changes when users click on the image:

1. Open your text editor, then open the **index.html** document located in your Chapter folder for Chapter 4.

2. Locate the <img> element that displays the banner1.gif image and add an `onclick` event handler, as follows. When the user clicks the image, an `onclick` event handler changes the image to another image named banner2.gif. Note that the banner image is the second image on the page, so the `images[]` array references element 1.

   ```
   <img src="images/banner1.gif" width="462"
       height="87" alt="Banner ads"
       onclick="document.images[1].src ↵
       ='images/banner2.gif';" />
   ```

3. Save the **index.html** document and open it in your Web browser. Figure 4-3 shows how the Web page appears. Click on the image to make sure that it changes to banner2.gif.

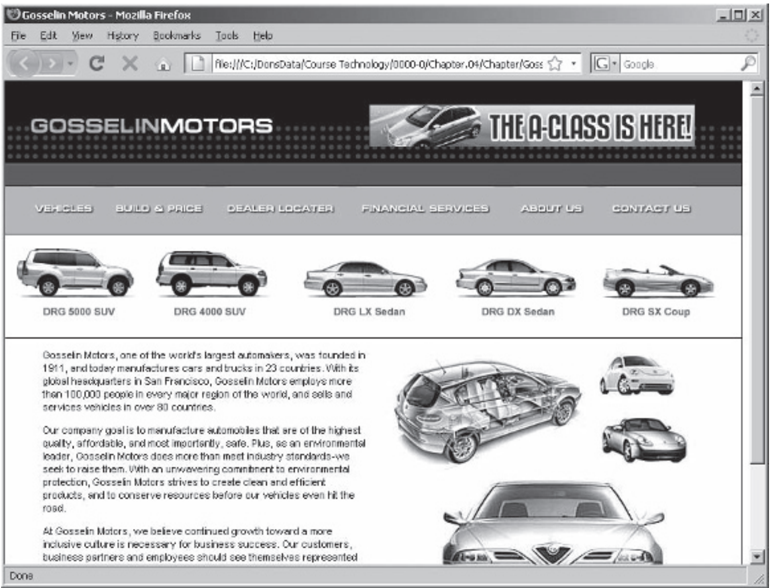


Figure 4-3 Gosselin Motors Web page with an advertisement

4. Close your Web browser window.

The code you entered in the preceding exercise refers to the second element (1) in the `images[]` array, which assumes that the image is the second image on the page. If other images are added to the Web page before the preceding statement, then referring to the second element in the `images[]` array would result in the wrong URL being displayed. When referring to the current object (in this case, the `Image` object for the preceding statement), you can simply use the `this` keyword instead of including the `Document` object and `images[]` array. The `this` keyword refers to the current object. The following code shows the example you saw before the last excercise, but this time written with the `this` keyword:

```
<img src="company_logo.gif" height="100" width="200"
    onclick="window.alert('This image is located at the ↵
    following URL: ' + this.src);"
    alt="Image of a company logo." />
```

Next, you will modify the `onclick` event handler in the index.html document so that it uses `this` references instead of referring to the `Document` object and `images[]` array.

To modify the event handlers in the index.html document so that they use `this` references instead of referring to the `Document` object and `images[]` array:

1. Return to the **index.html** file in your text editor.

2. Modify the `onclick` event handler in the banner image as follows:

```
<img src="images/banner1.gif" width="462"
    height="87" alt="Banner ads"
    onclick="this.src='images/banner2.gif';" />
```

3. Save the **index.html** document and open it in your Web browser. Figure 4-4 shows how the Web page appears after clicking the banner image.

Figure 4-4 Gosselin Motors Web page after adding a `this` reference

4. Close your Web browser window.

Short Quiz 1

1. Explain what the browser object model is and why it's so important to JavaScript.

2. What is the top-level object in the browser object model?

3. Explain how to reference arrays that are part of the browser object model.

Manipulating the Browser with the Window Object

The `Window` object includes several properties that contain information about the Web browser window. For instance, the `status` property contains information displayed in a Web browser's status bar. Also contained in the `Window` object are various methods that allow you to manipulate the Web browser window itself. You have already used some methods of the Window object, including the `window.alert()`, `window.confirm()`, and `window.prompt()` methods, which all display dialog boxes. Table 4-1 lists the `Window` object properties, and Table 4-2 lists the `Window` object methods.

Property	Description
`closed`	Returns a Boolean value that indicates whether a window has been closed
`defaultStatus`	Sets the default text that is written to the status bar
`document`	Returns a reference to the `Document` object
`history`	Returns a reference to the `History` object
`location`	Returns a reference to the `Location` object
`name`	Returns the name of the window
`opener`	Refers to the window that opened the current window
`parent`	Refers to a frame within the same frameset
`self`	Returns a self-reference to the `Window` object; identical to the `window` property
`status`	Specifies temporary text that is written to the status bar
`top`	Returns the topmost `Window` object
`window`	Returns a self-reference to the `Window` object; identical to the `self` property

Table 4-1 Window object properties

Method	Description
`alert()`	Displays a simple message dialog box with an OK button
`blur()`	Removes focus from a window
`clearInterval()`	Cancels an interval that was set with `setInterval()`
`clearTimeout()`	Cancels a timeout that was set with `setTimeout()`
`close()`	Closes a Web browser window
`confirm()`	Displays a confirmation dialog box with OK and Cancel buttons
`focus()`	Makes a `Window` object the active window
`moveBy()`	Moves the window relative to the current position

Table 4-2 Window object methods *(continues)*

(continued)

Method	Description
`moveTo()`	Moves the window to an absolute position
`open()`	Opens a new Web browser window
`print()`	Prints the document displayed in the current window
`prompt()`	Displays a dialog box prompting a user to enter information
`resizeBy()`	Resizes a window by a specified amount
`resizeTo()`	Resizes a window to a specified size
`scrollBy()`	Scrolls the window by a specified amount
`scrollTo()`	Scrolls the window to a specified position
`setInterval()`	Repeatedly executes a function after a specified number of milliseconds have elapsed
`setTimeout()`	Executes a function once after a specified number of milliseconds have elapsed

Table 4-2 Window object methods

> Some Web browsers, including Internet Explorer, have custom properties and methods for the `Window` object. This book describes only properties and methods that are common to browser objects in all current Web browsers.

Another way of referring to the `Window` object is by using the **`self` property**, which refers to the current `Window` object. Using the `self` property is identical to using the `window` property to refer to the `Window` object. For example, the following lines are identical:

```
window.alert("Your order has been received.");
self.alert("Your order has been received.");
```

Some JavaScript programmers prefer to use the `window` property, while other JavaScript programmers prefer to use the `self` property. The choice is yours. However, when attempting to decipher JavaScript code created by other programmers, be aware that both of these properties refer to the current `Window` object.

Because a Web browser assumes that you are referring to the global object, you do not need to refer explicitly to the `Window` object when using one of its properties or methods. For example, the `alert()` method is a method of the `Window` object. Throughout this text, you have used the full syntax of `window.alert(`*`text`*`);`, although the syntax `alert(`*`text`*`);` (without the `Window` object) works equally well. However, it's good practice to use the `window` or `self` references when referring to a property or method of the `Window` object in order to clearly identify them as belonging to the `Window` object. If you do not use the `window` or `self` reference, then you or another programmer might confuse a property or method of the `Window` object with JavaScript variables or functions.

Understanding Windows and Events

In Chapter 1, you learned how to use events with your Web pages. Events are particularly important when it comes to working with the browser object model because they allow you to execute the methods and change the properties of objects in the browser object model. In this section, you learn more about mouse events.

The `click` and `dblclick` Events

You have already extensively used the `click` event with form controls, such as radio buttons, to execute JavaScript code. However, keep in mind that the `click` event can be used with other types of elements. Earlier in this chapter, you used the `click` event to change the image displayed on the Gosselin Motors Web page. The `click` event is often used for the anchor element. In fact, the primary event associated with the anchor element is the `click` event. When a user clicks a link, the Web browser handles execution of the `onclick` event handler automatically, so you do not need to add an `onclick` event handler to your anchor elements.

There may be times, however, when you want to override an anchor element's automatic `onclick` event handler with your own code. For instance, you may want to warn the user about the content of a Web page that a particular link will open. In order to override the automatic `click` event with your own code, you add to the `<a>` element an `onclick` event handler that executes custom code. When you override an internal event handler with your own code, your code must return a value of true or false, using the `return` statement. With the `<a>` element, a value of true indicates that you want the Web browser to perform its default event handling operation of opening the URL referenced in the link. A value of false indicates that you do not want the `<a>` element to perform its default event handling operation. For example, the `<a>` element in the following code includes an `onclick` event handler. The `warnUser()` function that is called by the `onclick` event handler returns a value generated by the `window.confirm()` method. Recall that when a user clicks the OK button in a confirm dialog box, a value of true is returned. When a user clicks the Cancel button, a value of false is returned. Notice that there are two return statements in the following code. The return statement in the `warnUser()` function returns a value to the `onclick` event handler. The return statement in the `onclick` event handler returns the same value to the Web browser.

```
...
<script type="text/javascript">
/* <![CDATA[ */
function warnUser() {
    return window.confirm("This link is only for Red Sox fans. ↵
        Are you sure you want to continue?");
}
/* ]]> */
</script>
</head>
<body>
<p><a href="redsox.html"
onclick="return warnUser();">
Red Sox Fan Club</a></p>
</body>
</html>
```

The `dblclick` event works the same as the `click` event, except that users need to double-click the mouse instead of single-clicking it. The `dblclick` event is rarely used. They're not generally used with links, because as you know, links are driven by single mouse clicks, and they are rarely used in other situations because, from the user's point of view, single-clicks are much easier than double-clicks.

The `mouseover` and `mouseout` Events

You use the `mouseover` and `mouseout` events to create rollover effects. A **rollover** is an effect that occurs when your mouse moves over an element. The `mouseover` event occurs when the mouse passes over an element and the `mouseout` event occurs when the mouse moves off an element. These events are also commonly used to change an element's style, such as the formatting of a link when the mouse passes over it. To refer to a CSS style in JavaScript, you use the `this` reference and the `style` property in an event handler within the element itself. You use the **`style` property** to modify an element's CSS properties with JavaScript. In order to refer to a style with the `this` reference, you use a period to append the `style` property to it, followed by another period and a CSS property. CSS properties without hyphens are referred to in JavaScript with all lowercase letters. However, when you refer to a CSS property containing a hyphen in JavaScript code, you remove the hyphen, convert the first word to lowercase, and convert the first letter of subsequent words to uppercase. For example, the `text-decoration` property is referred to as `textDecoration`, `font-family` is referred to as `fontFamily`, `font-size` is referred to as `fontSize`, and so on. In the following code the `onmouseover` event underlines the link when the mouse passes over it, and the `onmouseout` event removes the link when the mouse passes off it:

```
<a href="redsox.html"
    onmouseover="this.style.textDecoration='underline';"
    onmouseout="this.style.textDecoration='none';">
    Red Sox Fan Club</a>
```

The `mouseover` and `mouseout` events are also commonly used to display an alternate image or explanatory text when the mouse passes over an element. The following table cell shows a more complex example of the `mouseover` and `mouseout` events. The cell contains five links representing different types of homes that a real estate agent is selling. When the user passes his or her mouse over a link, the link changes from blue to red and an image of the house is displayed. Moving the mouse off the link changes the link back to blue and displays an empty image. Figure 4-5 shows the page with the mouse over the Townhouse link.

```
<td>
    <p>
        <a href="cottage.html"
            onmouseover="document.images[9].src ↵
            ='cottage.jpg';this.style.color='Red'"
            onmouseout="document.images[9].src ↵
            ='noselection.jpg';this.style.color ↵
            ='Blue'">Cottage:<strong>
            $149,000</strong></a><br />
        <a href="ranch.html"
            onmouseover="document.images[9].src ↵
            ='ranch.jpg';this.style.color='Red'"
            onmouseout="document.images[9].src ↵
            ='noselection.jpg';this.style.color ↵
            ='Blue'">Ranch:<strong>
            $189,000</strong></a><br />
        <a href="townhouse.html"
            onmouseover="document.images[9].src ↵
            ='townhouse.jpg';this.style.color='Red'"
            onmouseout="document.images[9].src ↵
            ='noselection.jpg';this.style.color ↵
            ='Blue'">Townhouse:<strong>
            $319,000</strong></a><br />
        <a href="colonial.html"
            onmouseover="document.images[9].src ↵
            ='colonial.jpg';this.style.color='Red'"
            onmouseout="document.images[9].src ↵
            ='noselection.jpg';this.style.color ↵
            ='Blue'">Colonial:<strong>
            $389,000</strong></a><br />
        <a href="contemporary.html"
            onmouseover="document.images[9].src ↵
            ='contemporary.jpg';this.style.color='Red'"
            onmouseout="document.images[9].src ↵
            ='noselection.jpg';this.style.color ↵
            ='Blue'">Contemporary:<strong>
            $474,000</strong></a></p>
</td>
```

You can find a working copy of the real estate page in a folder named RealEstate in your Chapter folder for Chapter 4.

By default, Firefox does not allow scripts to change status bar text. To allow scripts to change status bar text, you must select the Tools menu, select Options, and then select Content in the Options dialog box. Select the Advanced button next to the Enable JavaScript button, and then select the Change status bar text box in the Advanced JavaScript Settings dialog box. Then, select OK twice to close the Advanced JavaScript Settings dialog box and the Options dialog box.

Figure 4-5 Real estate page with the mouse over the Townhouse link

The `defaultStatus` property specifies the default text that appears in the status bar whenever the mouse is not positioned over a link. The syntax for the `defaultStatus` property is `window.defaultStatus = "status bar text here";`. You will now add the `defaultStatus` property to the Gosselin Motors Web page so the text “Welcome to Gosselin Motors!” is displayed in the status bar by default. You will also add to each of the car model links `onmouseover` event handlers that display messages in an `<input>` box about clicking the link for more information along with `onmouseout` event handlers that remove the value assigned to the `<input>` box by changing its value to an empty string.

To add `defaultStatus` and `onmouseover` and `onmouseout` event handlers to the Gosselin Motors Web page:

1. Return to the **index.html** document in your text editor.
2. Add the following script section immediately above the closing `</head>` tag. The script contains a single statement that sets the Web page’s default status bar text to “Welcome to Gosselin Motors!”

```
<script type="text/javascript">
/* <![CDATA[ */
window.defaultStatus = "Welcome to Gosselin Motors!";
/* ]]> */
</script>
```

3. Locate `<!--[Add form here]-->` in the document body and replace it with the following form, which contains a single text box that will display messages when the mouse passes over a car model link:

```
<form action="" name="messageForm">
  <p><input type="text" name="carLink" size="40"
     style="color:Blue;font-weight:bold; ↵
     border-style:none; border-color: inherit; ↵
     border-width:medium;background-color: ↵
     Transparent" /></p>
</form>
```

4. Add `onmouseover` event handlers to each of the car model links as follows to modify the value assigned to the text box when the mouse pointer passes over the link, along with `onmouseout` event handlers that reset the text box to an empty string.

```
<a href="DRG5000.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG 5000 SUV.'"
    onmouseout="document.messageForm.carLink.value=''">
    <img src="images/drg5000.gif" width="154"
        height="108" alt="Formatting element"
        class="NoBorder"
/></a>
<a href="DRG4000.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG 4000 SUV.'"
    onmouseout="document.messageForm.carLink.value=''">
    <img src="images/drg4000.gif" width="154"
        height="108" alt="Formatting element"
        class=" NoBorder"
/></a>
<a href="DRGLX.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG LX Sedan.'"
    onmouseout="document.messageForm.carLink.value=''">
    <img src="images/drglx.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
<a href="DRGDX.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG DX Sedan.'"
    onmouseout="document.messageForm.carLink.value=''">
    <img src="images/drgdx.gif" width="154" height="108"
    alt="Formatting element" class="NoBorder" /></a>
<a href="DRGSX.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG SX Coup.'"
    onmouseout="document.messageForm.carLink.value=''">
    <img src="images/drgsx.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
```

5. Save the **index.html** document and open it in your Web browser. Figure 4-6 shows how the Web page appears when you hold your mouse pointer over the DRG 4000 SUV.

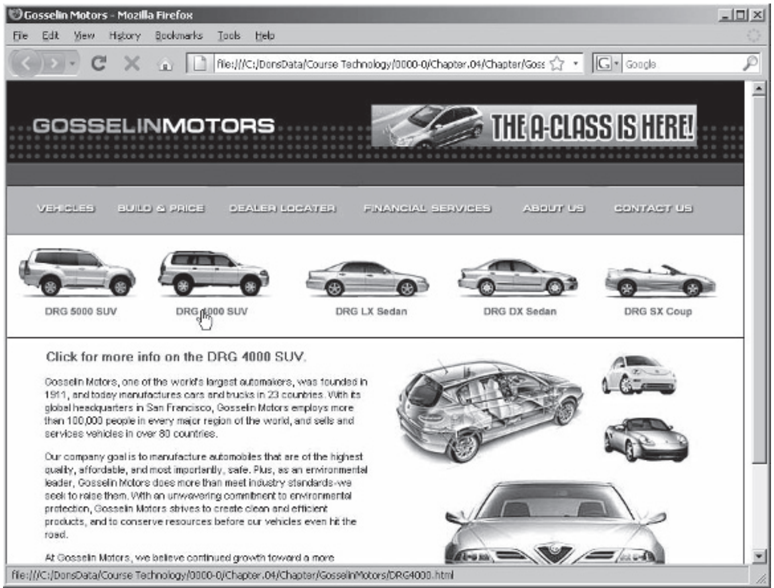


Figure 4-6 Gosselin Motors Web page after adding `defaultStatus` and `onmouseover` and `onmouseout` event handlers

6. Close your Web browser window.

One of the more common uses of rollovers is to replace (or swap) an image on a Web page with another image. Consider the following code. By default, the v500tec.gif file is displayed. The `onmouseover` event handler changes the image to showroom.gif, and the `onmouseout` event handler changes the image back to the v500tec.gif file. Figure 4-7 shows the Web page before the mouse is placed on the image. Once the mouse moves over the image, the image shown in Figure 4-8 is displayed.

```
<p><img src="v500tec.gif" height="90px" width="700px"
alt="Banner images" onmouseover="this.src='showroom.gif'"
onmouseout="this.src='v500tec.gif'" /></p>
```

Figure 4-7 Web page before the mouse passes over the image

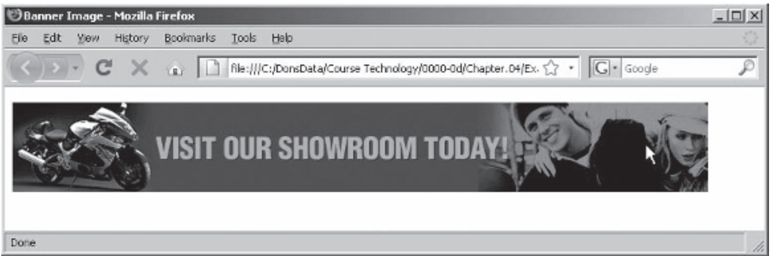


Figure 4-8 Web page with the mouse placed over the image

The *mousedown* and *mouseup* Events

The `mousedown` event occurs when you point to an element and hold the mouse button down; the `mouseup` event occurs when you release the mouse button. The following code shows the `<img>` element that displays the motorcycle and showroom images, this time using `mousedown` and `mouseup` events:

```
<p><img src="v500tec.gif" height="90px" width="700px"
alt="Banner images" onmousedown="this.src='showroom.gif'"
onmouseup="this.src='v500tec.gif'" /></p>
```

Next, you will modify the `<img>` element that displays the banner ads in the index.html document so the second image in the banner displays when you hold the mouse button down over the image.

To modify the `<img>` element that displays the banner ads in the index.html document so that the second image in the banner is displayed when you hold the mouse over it:

1. Return to the **index.html** document in your text editor.
2. Replace the `onclick` event handler in the banner-ad `<img>` element with `onmousedown` and `onmouseup` event handlers that swap the images.

```
<img src="images/banner1.gif" width="462"
height="87" alt="Banner ads"
onmousedown="this.src='images/banner2.gif'"
onmouseup="this.src='images/banner1.gif'" />
```


3. Save the **index.html** document and open it in your Web browser. Press and hold the mouse button over the banner image, then release it. You should see the images change when you press and release the mouse button.

4. Close your Web browser window.

Referring to Frames and Windows

When working with multiple frames and windows, you need to be able to refer to individual frames and windows in JavaScript code. When you create a new window, for instance, you may want to change the content displayed in that window. Or, if you have multiple frames in a window, you may need to change the content displayed in one frame, depending on which link is selected in another frame. Recall that the `frames[]` array contains all the frames in a window. The first frame in a window is referred to as `frames[0]`, the second frame is referred to as `frames[1]`, and so on. If a window contains no frames, then the `frames[]` array is empty. To refer to a frame within the same frameset, you use the **`parent` property** of the `Window` object combined with the frame's index number from the `frames[]` array. For example, if you have a Web page that creates four frames, the frames can be referred to as `parent.frames[0]`, `parent.frames[1]`, `parent.frames[2]`, and `parent.frames[3]`, respectively.

In addition to the `self` property, another property that is used to refer to a window is the `top` property of the `Window` object. The **`top` property** refers to the topmost window on a Web page. When working with frames, the top property refers to the window that constructed the frames. For example, if the code to create a parent frameset is located in a document named FramesExample.html, then the statement `top.location.href` would return the full URL for the FramesExample.html document, no matter which frame it was used in. When the `top` property is used on a Web page that does not contain frames, then it refers to the window itself.

Opening and Closing Windows

Most Web browsers allow you to open new Web browser windows in addition to the Web browser window or windows that may already be open. There are several reasons why you may need to open a new

Web browser window. You may want to launch a new Web page in a separate window, allowing users to continue viewing the current page in the current window. Or, you may want to use an additional window to display information such as a picture or an order form.

Whenever a new Web browser window is opened, a new `Window` object is created to represent the new window. You can have as many Web browser windows open as your system will support, each displaying a different Web page. For example, you can have one Web browser window display Microsoft's Web site, another Web browser window display Firefox's Web site, and so on.

You may be familiar with how to open a link in a new window by using the <a> element's `target` attribute. For example, the following link opens the Wikipedia home page in a new window, named `wikiWindow`:

```
<p><a href="http://www.wikipedia.org/"
target="wikiWindow">
Wikipedia home page</a>
```

Whenever the user clicks the preceding link, the Web browser looks for another Web browser window, named `wikiWindow`. If the window exists, then the link is opened in it. If the window does not exist, then a new window, named `wikiWindow`, is created where the link opens.

Right now, the links in the Gosselin Motors Web page open in the current window; they do not open in a new window. Next, you will modify the links so they use the <a> element's `target` attribute to open each URL in a separate window.

To modify the links in the Gosselin Motors Web page so that they use the <a> element's `target` attribute to open each URL in a separate window:

1. Return to the **index.html** document in your text editor.
2. Add the following attribute before the closing bracket for each of the five <a> elements that open the car model pages:

   ```
   target="carInfo"
   ```

3. Save the **index.html** document and open it in your Web browser. Click one of the links to see if the Web page opens in a new browser window. If you click other links on the Gosselin Motors Web page, you should notice that each Web page opens in the `carInfo` window (if it is currently open) instead of opening in a separate window. Figure 4-9 shows the `carInfo` window opened to the DRG SX Coup Web page.

Some Web browsers, including Firefox and Internet Explorer, can be configured to open new pages in either a new window or a tab in the current window. To configure Firefox to open pages in a new window, select the Tools menu, select Options, and then select Tabs in the Options dialog box. Select the radio button that opens pages in a new window and then click OK. To configure Internet Explorer to open pages in a new window, select the Tools menu, select Internet Options, and then select the General tab in the Internet Options dialog box. In the Tabs section, click the Settings button. In the Tabbed Browser Settings dialog box, select the radio button that opens links in a new window and then click OK twice to close the Tabbed Browser Settings and Internet Options dialog boxes.

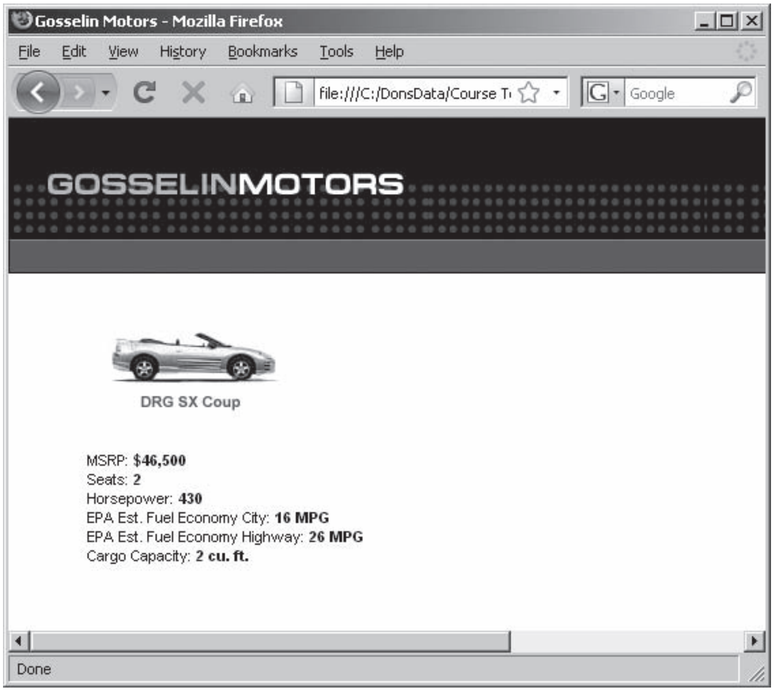


Figure 4-9 DRG SX Coup Web page opened in the `carInfo` window

4. Close your Web browser window.

Opening a Window

The problem with using the `target` attribute is that it's deprecated in XHTML; you can only use it in the transitional or frameset DTDs. In order to open new windows in the strict DTD, you must use the **`open()` method** of the `Window` object. The syntax for the `open()` method is as follows:

```
window.open(url, name, options, replace);
```

Table 4-3 lists the arguments of the `window.open()` method.

Argument	Description
`URL`	Represents the Web address or filename to be opened
`name`	Assigns a value to the `name` property of the new `Window` object
`options`	Represents a string that allows you to customize the new Web browser window's appearance
`replace`	A Boolean value that determines whether the URL should create a new entry in the Web browser's history list or replace the entry

Table 4-3 Arguments of the `Window` object's `open()` method

You can include all or none of the `window.open()` method arguments. The statement `window.open("http://www.wikipedia.org");` opens the Wikipedia home page in a new Web browser window, as shown in Figure 4-10. If you exclude the `URL` argument, then a blank Web page opens. For example, the statement `window.open();` opens the Web browser window displayed in Figure 4-11.

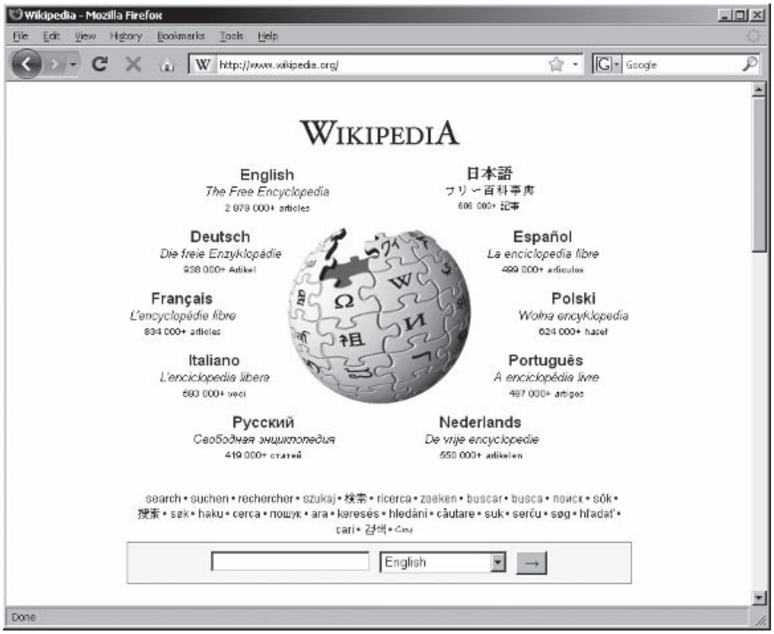


Figure 4-10 Web browser window opened with the URL argument of the `open()` method

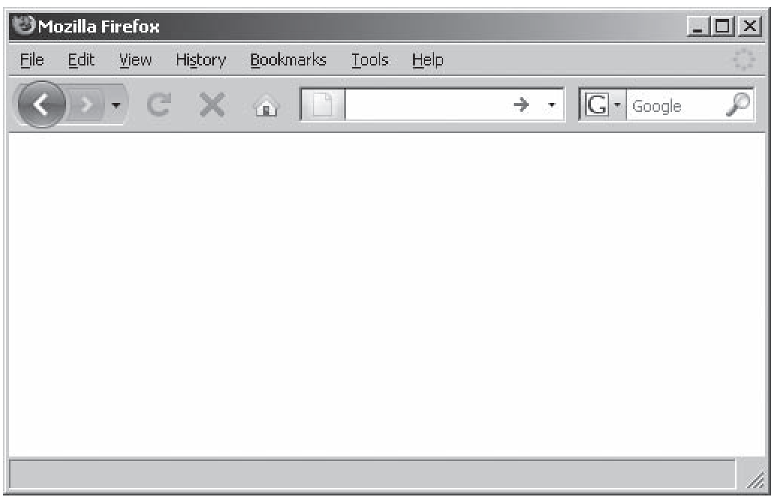


Figure 4-11 Blank Web browser window opened with the `window.open()` statement

If you are writing code that requires a user to click a link or a button, then you can use an event handler to call the `window.open()` method, and the window will open successfully. However, if you include JavaScript code that opens a new window without a request from the user, then the pop-up blocker feature that is available in most current Web browsers will prevent the window from opening.

When you open a new Web browser window, you can customize its appearance by using the `options` argument of the `window.open()` method. Table 4-4 lists some common options that you can use with the `window.open()` method.

Name	Description
`height`	Sets the window's height
`left`	Sets the horizontal coordinate of the left of the window, in pixels
`location`	Includes the URL Location text box
`menubar`	Includes the menu bar
`resizable`	Determines if the new window can be resized
`scrollbars`	Includes scroll bars
`status`	Includes the status bar
`toolbar`	Includes the Standard toolbar
`top`	Sets the vertical coordinate of the top of the window, in pixels
`width`	Sets the window's width

Table 4-4 Common options of the `Window` object's `open()` method

All the options listed in Table 4-4, with the exception of the `width` and `height` options, are set using values of "yes" or "no", or 1 for yes and 0 for no. To include the status bar, the options string should read "status=yes". You set the `width` and `height` options using integers representing pixels. For example, to create a new window that is 200 pixels high by 300 pixels wide, the string should read "height=200,width=300". When including multiple items in the options string, you must separate the items by commas. If you exclude the options string of the `window.open()` method, then all the standard options are included in the new Web browser window. However, if you include the options string, you must include all the components you want to create for the new window; that is, the new window is created with only the components you explicitly specify.

Figure 4-12 shows the Photo Gallery Web page from the Woodland Park Zoo, located in Seattle, Washington. If you select a link from one of the menus on the page, such as the Fennec Fox link that is highlighted in Figure 4-12, the Photo Gallery Slideshow Web page shown in Figure 4-13 opens.

Figure 4-12 Woodland Park Zoo Photo Gallery Web page

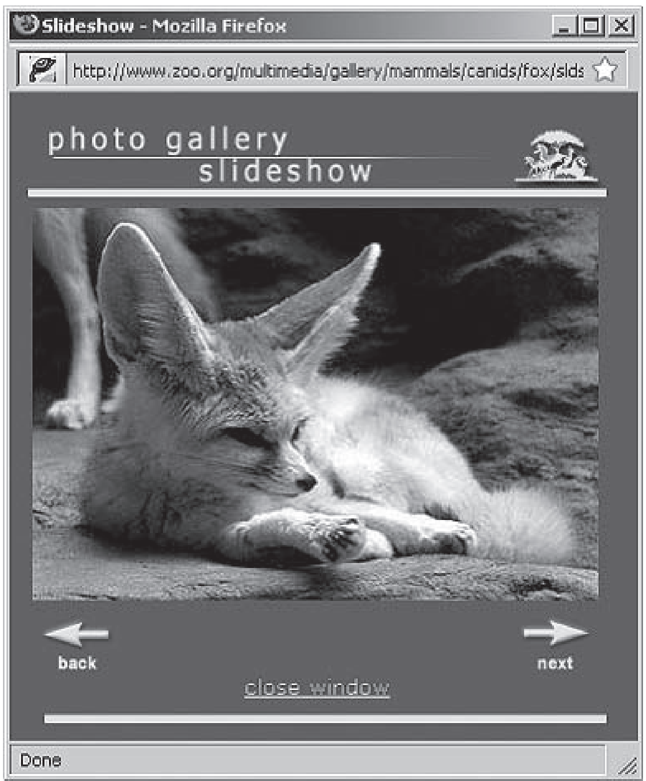


Figure 4-13 Woodland Park Zoo Photo Gallery Slideshow Web page displaying a fox

The menus shown in Figure 4-12 are created using DHTML, which you will study in Chapter 11.

Notice that the Photo Gallery Slideshow Web page does not display toolbars, the menu, the URL Location box, or the scrollbars. Also, keep in mind that it is sized to specific dimensions. If you were to attempt to resize the window, you would find that it couldn't be resized. The Photo Gallery Web page uses a JavaScript statement similar to the following to open the Photo Gallery Slideshow Web page when a user clicks the name of an animal:

```
var OpenWin = window.open(page, "CtrlWindow",
"toolbar=no,menubar=no,location=no,scrollbars=no, ↵
resizable=no,width=380,height=405");
```

The `name` argument of the `window.open()` method is essentially the same as the value assigned to the deprecated `target` attribute in that it specifies the name of the window where the URL should open. If the `name` argument is already in use by another Web browser window, then JavaScript changes focus to the existing Web browser window instead of creating a new window. For instance, the Photo Gallery Web page opens the Photo Gallery Slideshow Web page and assigns it a name of "CtrlWindow". If the `CtrlWindow` Web page already exists when you select another menu item from the Photo Gallery Web page, then the `CtrlWindow` Web page is reused; another window does not open. This is especially important with a Web page such as the Photo Gallery Web page, which allows you to view dozens of different Web pages for each of the animals listed in the menu. Imagine how crowded a user's screen would be if the program kept opening a new Photo Gallery Slideshow Web page window for each selected animal.

Next, you will modify the Gosselin Motors Web page so the links use the `window.open()` method instead of the `target` attribute to open the URLs in a separate page.

To modify the Gosselin Motors Web page so the links use the `window.open()` method instead of the `target` attribute to open the URLs in a separate page:

1. Return to the **index.html** document in your text editor.
2. Add the following global variable declaration and function to the end of the script section. The function will be called by `onclick` event handlers in each of the links.

```
var carWindow;
function showCar(linkTarget) {
  carWindow = window.open(linkTarget, "carInfo",
    "toolbar=no,menubar=no,location=no, ↵
    scrollbars=no,resizable=no,width=400, ↵
    height=375");
}
```

Be sure not to add a line break to the options string in the function to the right. The options string is broken here because of space limitations.

3. Next, replace the `target` attribute in each <a> element with an `onclick` event handler that calls the `showCar()` function, passing to it the URL of the target Web page. The `onclick` event handler should also return a value of "false" to prevent the index.html Web page from being replaced with the target Web page that you are opening in a separate window. The modified <a> elements should appear as follows:

```
<a href="DRG5000.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG 5000 SUV.'"
    onmouseout="document.messageForm.carLink.value=''"
    onclick="showCar('DRG5000.html');return false">
    <img src="images/drg5000.gif" width="154"
        height="108" alt="Formatting element"
        class="NoBorder" /></a>
<a href="DRG4000.html" onmouseover="document ↵
    .messageForm.carLink.value='Click for more ↵
    info on the DRG 4000 SUV.'"
    onmouseout="document.messageForm.carLink.value=''"
    onclick="showCar('DRG4000.html');return false">
    <img src="images/drg4000.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
<a href="DRGLX.html"
    onmouseover="document.messageForm.carLink.value ↵
        ='Click for more info on the DRG LX Sedan.'"
    onmouseout="document.messageForm.carLink.value=''"
    onclick="showCar('DRGLX.html');return false">
    <img src="images/drglx.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
<a href="DRGDX.html" onmouseover="document ↵
    .messageForm.carLink.value ↵
    ='Click for more info on the DRG DX Sedan.'"
    onmouseout="document.messageForm.carLink.value=''"
    onclick="showCar('DRGDX.html');return false">
    <img src="images/drgdx.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
<a href="DRGSX.html" onmouseover="document ↵
    .messageForm.carLink.value ↵
    ='Click for more info on the DRG SX Coup.'"
    onmouseout="document.messageForm.carLink.value=''"
    onclick="showCar('DRGSX.html');return false">
    <img src="images/drgsx.gif" width="154" height="108"
        alt="Formatting element" class="NoBorder" /></a>
```

4. Save the **index.html** document and open it in your Web browser. Click one of the links to see if the Web page opens in a new browser window. Figure 4-14 shows how the window appears with the DRGDX.html Web page displayed.

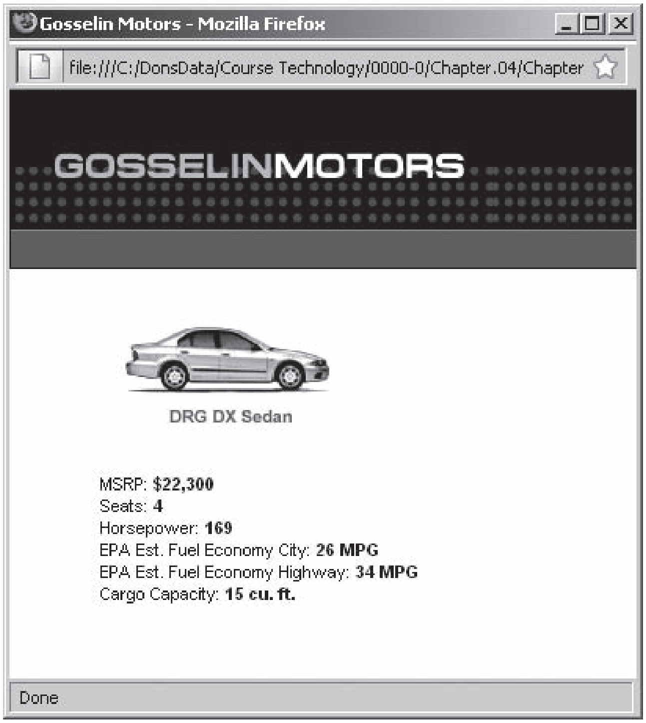


Figure 4-14 Window opened with the `open()` method

5. Close your Web browser windows.

A `Window` object's `name` property can be used only to specify a target window with a link and cannot be used in JavaScript code. If you want to control the new window by using JavaScript code located within the Web browser in which it was *created*, then you must assign the new `Window` object created with the `window.open()` method to a variable. The statement that opens the Photo Gallery Slideshow Web page assigns an object representing the new Web browser window to a variable named `OpenWin`. You can use any of the properties and methods of the `Window` object with a variable that represents a `Window` object.

One problem with Web pages such as the Gosselin Motors Web page is that windows that open in response to the user clicking a link can get hidden or "lost" behind other windows on the user's screen. For example, suppose that the user clicks the DRX 5000 SUV link on the Gosselin Motors Web page, thereby opening a new window. Then suppose that the user returns to the Gosselin Motors Web page (without closing the DRX 5000 SUV window) and clicks a different link. The window that displays the property is not automatically displayed as the active window on the screen. That is, it does not necessarily appear as the top window; it could instead be hidden behind other windows. The user may continuously click links, thinking that nothing is happening in response to his or her clicks, when in fact the code is actually working fine. The problem might be that the windows are open but not visible. In order to make a window the active window, you use the **focus() method** of the Window object. You append the focus() method to the variable that represents the window, not to the name argument of the window.open() method. For example, to make the Photo Gallery Slideshow window the active window, you use the following statement:

```
OpenWin.focus();
```

Next, you add a focus() method to the showCar() function in the Gosselin Motors Web page.

To add a focus() method to the showCar() function in the Gosselin Motors Web page:

1. Return to the **index.html** document in your text editor.
2. Add the following statement to the end of the showCar() function:

   ```
   carWindow.focus();
   ```

3. Save the **index.html** document and open it in your Web browser. Click one of the links to open the window that displays the property pages. Leave the Web page open, navigate back to the Gosselin Motors Web page, and click a different link. The window that displays the property pages should become the active window and display the URL for the Web page link you clicked.
4. Close your Web browser windows.

Closing a Window

The **close() method**, which closes a Web browser window, is the method you will probably use the most with variables representing other Window objects. To close the Web browser window represented by the OpenWin variable, you use the statement OpenWin.close();. To close the current window, you use the statement window.close() or self.close().

Next, you add links to each of the property Web pages that call the close() method, which will close the window.

It is not necessary to include the `Window` object or `self` property when using the `open()` and `close()` methods of the `Window` object. However, the `Document` object also contains methods named `open()` and `close()`, which are used for opening and closing Web pages. Therefore, the `Window` object is usually included with the `open()` and `close()` methods, in order to distinguish between the `Window` object and the `Document` object.

To add links to each of the property Web pages that call the `close()` method:

1. Return to your text editor and open the **DRG5000.html** document from the GosselinMotors folder in your Chapter folder for Chapter 4.
2. Locate the table cell that displays the image of the DRG 5000 auto along with the car's specifications. Add the following paragraph and anchor elements to the end of the table cell. The `onclick` event handler in the anchor element calls the `close()` method, which will close the window.

```
<p><a href="" onclick="self.close();">
Close Window</a></p>
```

3. Save and close the **DRG5000.html** document.
4. Repeat Steps 2 and 3 for the **DRG4000.html**, **DRGLX.html**, **DRGDX.html**, and **DRGSX.html** documents.
5. Open the **index.html** document in your Web browser and click one of the links. Figure 4-15 shows the new link (which closes the window) in the DRG LX Sedan Web page.

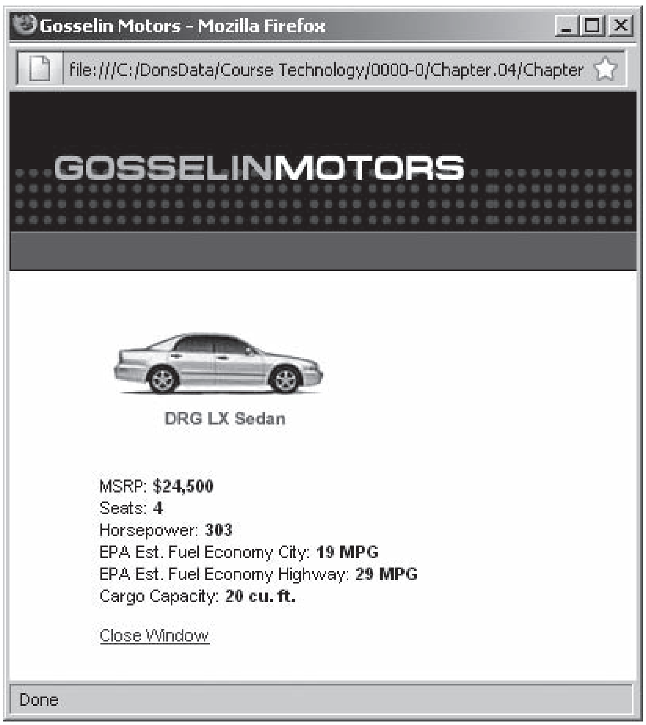


Figure 4-15 DRG LX Sedan Web page after adding a link with a `close()` method

6. Click the **Close Window** link to close the window you opened.
7. Close the Web browser window containing the Gosselin Motors Web page.

Working with Timeouts and Intervals

As you develop Web pages, you may need to have some JavaScript code execute repeatedly, without user intervention. Alternately, you may want to create animation or allow for some kind of repetitive task that executes automatically. For example, you may want to include an advertising image that changes automatically every few seconds. Or, you may want to use animation to change the ticking hands of an online analog clock (in which case each position of the clock hands would require a separate image).

You use the `Window` object's timeout and interval methods to create code that executes automatically. The **`setTimeout()` method** is used in JavaScript to execute code after a specific amount of time has elapsed. Code executed with the `setTimeout()` method executes only once. The syntax for the `setTimeout()` method is `var` *`variable`* `= setTimeout("`*`code`*`",` *`milliseconds`*`);`. This statement declares that the variable will refer to the `setTimeout()` method. The code argument must be enclosed in double or single quotation marks and can be a single JavaScript statement, a series of JavaScript statements, or a function call. The amount of time the Web browser should wait before executing the code argument of the `setTimeout()` method is expressed in milliseconds.

A millisecond is one thousandth of a second; there are 1,000 milliseconds in a second. For example, five seconds is equal to 5,000 milliseconds.

The **`clearTimeout()` method** is used to cancel a `setTimeout()` method before its code executes. The `clearTimeout()` method receives a single argument, which is the variable that represents a `setTimeout()` method call. The variable that represents a setTimeout() method call must be declared as a global variable. (Recall from Chapter 2 that a global variable is a variable declared outside of a function and is available to all parts of a JavaScript program.)

The script section in the following code contains a `setTimeout()` method and a `clearTimeout()` method call. The `setTimeout()` method is set to execute after 10,000 milliseconds (10 seconds) have elapsed. If a user clicks the OK button, the `buttonPressed()` function calls the `clearTimeout()` method.

```
...
<script type="text/javascript">
/* <![CDATA[ */
var buttonNotPressed = setTimeout(
     "window.alert('You must press the OK button to continue!')",
     10000);
function buttonPressed() {
     clearTimeout(buttonNotPressed);
     window.alert("The setTimeout() method was cancelled!");
}
/* ]]> */
</script>
</head>
<body>
<form action="">
<input type="button" value=" OK "
onclick="buttonPressed();" />
</form>
</body>
</html>
```

Two other JavaScript methods that create code and execute automatically are the `setInterval()` method and the `clearInterval()` method. The **`setInterval()` method** is similar to the `setTimeout()` method, except that it repeatedly executes the same code after being called only once. The **`clearInterval()` method** is used to clear a `setInterval()` method call in the same fashion that the `clearTimeout()` method clears a `setTimeout()` method call. The `setInterval()` and `clearInterval()` methods are most often used for starting animation code that executes repeatedly. The syntax for the `setInterval()` method is the same as the syntax for the `setTimeout()` method: `var` *`variable`* `= setInterval("`*`code`*`",` *`milliseconds`*`);`. As with the `clearTimeout()` method, the `clearInterval()` method receives a single argument, which is the global variable that represents a `setInterval()` method call.

By combining the `src` attribute of the `Image` object with the `setTimeout()` or `setInterval()` methods, you can create simple animation on a Web page. In this context, “animation” does not necessarily mean a complex cartoon character, but any situation in which a sequence of images changes automatically. However, Web animation can include the traditional type, involving cartoons and movement (like advertising with changing images or the ticking hands of the clock mentioned earlier). The following code uses the `setInterval()` method to automatically swap the motorcycle images you saw in Figures 4-7 and 4-8 every couple of seconds.

```
...
<script type="text/javascript">
/* <![CDATA[ */
var curBanner="cycle1";
function changeBanner() {
     if (curBanner == "cycle2") {
          document.images[0].src = "v500tec.gif";
          curBanner = "cycle1";
     }
     else {
          document.images[0].src = "showroom.gif";
          curBanner = "cycle2";
     }
}
/* ]]> */
</script>
</head>
<body onload="var begin=setInterval('changeBanner()', ↵
2000);">
<p><img src="v500tec.gif" height="90px" width="700px"
alt="Banner images" /></p>
</body>
</html>
```


Next, you will modify the Gosselin Motors Web page so that it uses the `setInterval()` method to change the banner image automatically.

To modify the Gosselin Motors Web page so that it uses the `setInterval()` method to change the banner image automatically:

1. Return to the **index.html** document in your text editor.
2. To the end of the script section, add the following global variable and `bannerAd()` function. The `bannerAd()` function will be called by a `setInterval()` method. As a result, the images will change automatically.

```
var curImage="banner1";
function bannerAd() {
    if (curImage == "banner2") {
        document.images[1].src = "images/banner1.gif";
        curImage = "banner1";
    }
    else {
        document.images[1].src = "images/banner2.gif";
        curImage = "banner2";
    }
}
```

3. Modify the opening `<body>` tag so it includes an `onload` event handler that calls the `setInterval()` method and `bannerAd()` function, as follows:

```
<body onload="var changeImages=setInterval
('bannerAd()',2000);">
```

4. Finally, remove the `onmousedown` and `onmouseup` event handlers from the `<img>` banner element.

```
<img src="images/banner1.gif" width="462"
    height="87" alt="Banner ads" />
```

5. Save the **index.html** document and then open it in your Web browser. The image should begin alternating automatically.
6. Close your Web browser window.

Short Quiz 2

1. What are the different ways that you can refer to the `Window` object?
2. Explain how to override an internal event handler with your own code.
3. How do you use JavaScript to modify an element's CSS properties?
4. How do you open and close a window, and customize its appearance?
5. Explain how to use timeouts and intervals to execute JavaScript code repeatedly.

Working with the `History`, `Location`, and `Navigator` Objects

In this section, you will learn how to work with the `History`, `Location`, and `Navigator` objects.

The `History` Object

The **`History` object** maintains an internal list (known as a history list) of all the documents that have been opened during the current Web browser session. Each Web browser window contains its own internal `History` object. You cannot view the URLs contained in the history list, but you can write a script that uses the history list to navigate to Web pages that have been opened during a Web browser session.

Two important security features are associated with the `History` object. First, the `History` object will not actually display the URLs contained in the history list. This is important because individual user information in a Web browser, such as the types of Web sites a user likes to visit, is private information. Preventing others from viewing the URLs in a `History` list is an essential security feature because it keeps people's likes and interests (as evidenced by the types of Web sites a person visits) confidential. This security feature is available in both Firefox and Internet Explorer.

A second important security feature of the `History` object is specific to Internet Explorer and has to do with the domain in which a Web page exists. As mentioned earlier, you can write a script that uses the history list to navigate to Web pages that have been opened during a Web browser session. In Internet Explorer, you can use JavaScript code to navigate through a history list. However, this is only possible if the currently displayed Web page exists within the same domain as the Web page containing the JavaScript code that is attempting to move through the list. For example, a user may open the home page for a company that sells office supplies. Suppose that the user then clicks on a link on the office supply company's home page that takes them to another Web page in the company's domain, such as an online ordering page. In this case, the office supply company's home page is added to the user's history list. JavaScript code on the online ordering page can use the `History` object to navigate back to the company's home page. If JavaScript code attempts to access the `History` object of a Web browser that contains a URL located in a different domain, the Web browser ignores the JavaScript code. This security feature helps prevent malicious programmers and unscrupulous Web sites from seizing control of your browser or even your computer. As a general rule, you should only use the `History` object to help visitors navigate through your particular Web site.

The `History` object includes three methods, listed in Table 4-5.

Method	Description
`back()`	Produces the same result as clicking a Web browser's Back button
`forward()`	Produces the same result as clicking a Web browser's Forward button
`go()`	Opens a specific document in the history list

Table 4-5 Methods of the `History` object

When you use a method or property of the `History` object, you must include a reference to the `History` object itself. For example, the back() and forward() methods allow a script to move backward or forward in a Web browser's history. To use the back() method, you must use the following: history.back().

The go() method is used for navigating to a specific Web page that has been previously visited. The argument of the go() method is an integer that indicates how many pages in the history list, forward or backward, you want to navigate. For example, history.go(-2); opens the Web page that is two pages back in the history list; the statement history.go(3); opens the Web page that is three pages forward in the history list. The statement history.go(-1); is equivalent to using the back() method, and the statement history.go(1); is equivalent to using the forward() method.

The History object contains a single property, the length property, which contains the specific number of documents that have been opened during the current browser session. To use the length property, you use the syntax history.length;. The length property does not contain the URLs of the documents themselves, only an integer representing how many documents have been opened. The following code uses an alert dialog box to display the number of Web pages that have been visited during a Web browser session:

```
window.alert("You have visited " + history.length
    + " Web pages.");
```

The History object is included in this chapter in order to introduce you to all of the major objects in the browser object model. However, you should avoid using the History object to navigate to Web pages that have been opened during a Web browser session. Instead, you should use the full URL with the href property of the Location object, as explained in the next section.

The Location Object

When you want to allow users to open one Web page from within another Web page, you usually create a hypertext link with the <a> element. You can also use JavaScript code and the Location object to open Web pages. The **Location object** allows you to change to a new Web page from within JavaScript code. One reason you may want to change Web pages with JavaScript code is to redirect your Web site visitors to a different or updated URL. The Location object contains several properties and methods for working with the URL of the document currently open in a Web browser window. When you use a method or property of the Location object, you must include a reference to the Location object itself. For example, to use the href property, you must write location.href = *URL*;. Table 4-6 lists the Location object's properties, and Table 4-7 lists the Location object's methods.

Properties	Description
hash	A URL's anchor
host	The host and domain name (or IP address) of a network host
hostname	A combination of the URL's host name and port sections
href	The full URL address
pathname	The URL's path
port	The URL's port
protocol	The URL's protocol
search	A URL's search or query portion

Table 4-6 Properties of the `Location` object

Method	Description
assign()	Loads a new Web page
reload()	Causes the page that currently appears in the Web browser to open again
replace()	Replaces the currently loaded URL with a different one

Table 4-7 Methods of the `Location` object

The properties of the `Location` object allow you to modify individual portions of a URL. When you modify any properties of the `Location` object, you generate a new URL, and the Web browser automatically attempts to open that new URL. Instead of modifying individual portions of a URL, it is usually easier to change the `href` property, which represents the entire URL. For example, the statement `location.href = "http://www.google.com";` opens the Google home page.

The `assign()` method of the `Location` object performs the same action as changing the `href` property: It loads a new Web page. The statement `location.assign ("http://www.google.com");` is equivalent to the statement `location.href = "http://www.google.com";`.

The `reload()` method of the `Location` object is equivalent to the Reload button in Firefox or the Refresh button in Internet Explorer. It causes the page that currently appears in the Web browser to open again. You can use the `reload()` button without any arguments, as in `location.reload();`, or you can include a Boolean argument of true or false. Including an argument of true forces the current Web page to reload from the server where it is located, even if no changes have been made to it. For example, the statement `location.reload(true);` forces the current page to reload. If you include an argument of false, or do not include any argument at all, then the Web page reloads only if it has changed.

You can use `this.location` to retrieve the URL of the current Web page.

The `replace()` method of the `Location` object is used to replace the currently loaded URL with a different one. This method works somewhat differently from loading a new document by changing the `href` property. The `replace()` method actually overwrites one document with another and replaces the old URL entry in the Web browser's history list. In contrast, the `href` property opens a different document and adds it to the history list.

The `Navigator` Object

The **`Navigator` object** is used to obtain information about the current Web browser. It gets its name from Netscape Navigator, but is also supported by Firefox, Internet Explorer, and other current browsers. Some Web browsers, including Internet Explorer, contain unique methods and properties of the `Navigator` object that cannot be used with other browsers. Table 4-8 lists properties of the `Navigator` object that are supported by most current Web browsers, including Firefox and Internet Explorer.

Properties	Description
`appCodeName`	The Web browser code name
`appName`	The Web browser name
`appVersion`	The Web browser version
`platform`	The operating system in use on the client computer
`userAgent`	The string stored in the HTTP user-agent request header, which contains information about the browser, the platform name, and compatibility

Table 4-8 Properties of the `Navigator` object

The `Navigator` object is most commonly used to determine which type of Web browser is running. Because of the incompatibilities between Firefox and Internet Explorer, it is important to be able to distinguish which browser is running in order to execute the correct code for a specific browser. (Cross-browser compatibility issues will be discussed in detail in Chapter 11.) The statement `browserType = navigator.appName;` returns the name of the Web browser in which the code is running to the `browserType` variable. You can then use the `browserType` variable to determine which code to run for the specific type of browser. The **`with` statement** eliminates the need to retype the name of an object when properties of the same object are being referenced in a series. To use the `with` statement, you create a structure similar to an `if` statement and pass the name of the object as a conditional expression. You can then refer to all of the object properties without referring to the object itself. The following `with` statement prints the five properties of the `Navigator` object for Firefox 3.0. Figure 4-16 shows the output.

```
with (navigator) {
      document.write("<p>Browser code name: "
         + appCodeName + "<br />");
      document.write("Web browser name: "
         + appName + "<br />");
      document.write("Web browser version: "
         + appVersion + "<br />");
      document.write("Operating platform: "
         + platform + "<br />");
      document.write("User agent: " + userAgent + "</p>");
}
```

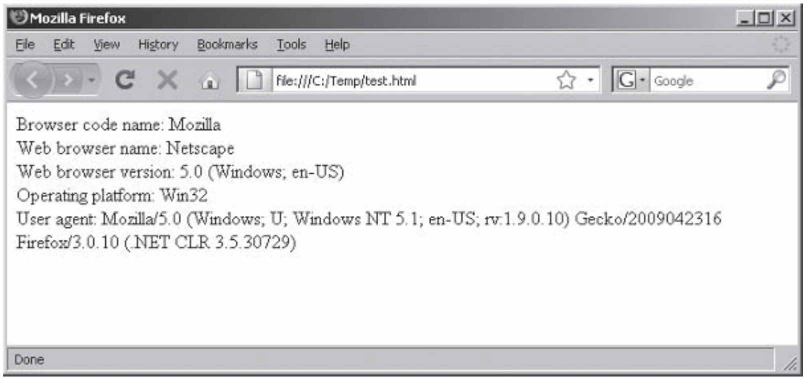


Figure 4-16 `Navigator` object properties in Firefox

The `Screen` Object

Computer displays can vary widely, depending on the type and size of the monitor, the type of installed graphics card, and the screen resolution and color depth selected by the user. For example, some notebook computers have small screens with limited resolution, while some desktop systems can have large monitors with very high resolution. The wide range of possible display settings makes it challenging to determine the size and positioning of windows generated by JavaScript. The **Screen object** is used to obtain information about the display screen's size, resolution, and color depth. Table 4-9 lists the properties of the `Screen` object that are supported by most current Web browsers, including Firefox and Internet Explorer.

Properties	Description
`availHeight`	Returns the height of the display screen, not including operating system features such as the Windows taskbar
`availWidth`	Returns the width of the display screen, not including operating system features such as the Windows taskbar
`colorDepth`	Returns the display screen's bit depth if a color palette is in use; if a color palette is not in use, returns the value of the `pixelDepth` property
`height`	Returns the height of the display screen
`pixelDepth`	Returns the display screen's color resolution in bits per pixel
`width`	Returns the width of the display screen

Table 4-9 Properties of the `Screen` object

The `colorDepth` and `pixelDepth` properties are most useful in determining the color resolution that the display supports. For example, if the `colorDepth` property returns a value of 32, which indicates high color resolution, then you can use JavaScript to display a high color image. However, if the `colorDepth` property returns a value of 16, which indicates medium color resolution, then you may want to use JavaScript to display a lower color image. The following code illustrates how to use the `colorDepth` property to determine which version of an image to display:

```
if (screen.colorDepth >= 32)
   document.write("<img href='companyLogo_highres.jpg' />");
else if (screen.colorDepth >= 16)
   document.write("<img href='companyLogo_mediumres.jpg' />");
else
   document.write("<img href='companyLogo_lowres.jpg' />");
```

The remaining `Screen` object properties determine the size of the display area. For example, on a computer with a screen resolution of 1280 by 768, the following statements print "Your screen resolution is 1280 by 768."

```
var screenWidth = screen.width;
var screenHeight = screen.height;
document.write("<p>Your screen resolution is " +
     screenWidth + " by " + screenHeight + ".</p>");
```

One of the more common uses of the `Screen` object properties is to center a Web browser window in the middle of the display area. For windows generated with the `window.open()` method, you can center a window when it first displays by assigning values to the `left` and `top` options of the `options` argument. To center a window horizontally, subtract the width of the window from the screen width, divide the remainder by two, and assign the result to the `left` option.

Similarly, to center a window vertically, subtract the height of the window from the screen height, divide the remainder by two, and assign the result to the `top` option. The following code demonstrates how to create a new window and center it in the middle of the display area:

```
var winWidth=300;
var winHeight=200;
var leftPosition = (screen.width-winWidth)/2;
var topPosition = (screen.height-winHeight)/2;
var optionString = "width=" + winWidth + ",height="
    + winHeight + ",left=" + leftPosition + ",top="
    + topPosition;
OpenWin = window.open("", "CtrlWindow", optionString);
```

Remember that the statements for opening a new window must be called from an event handler, or a Web browser's pop-up blocker will prevent the window from opening.

Next, you will modify the Gosselin Motors Web page so that the property window is centered in the middle of the display area.

To modify the Gosselin Motors Web page so that the property window is centered in the middle of the display area:

1. Return to the **index.html** document in your text editor.

2. Modify the `showCar()` function as follows so that it uses the `Screen` object to calculate the left and top positions of the property window:

```
function showCar(linkTarget) {
    var propertyWidth=400;
    var propertyHeight=375;
    var winLeft = (screen.width-propertyWidth)/2;
    var winTop = (screen.height-propertyHeight)/2;
    var winOptions = "toolbar=no,menubar=no, ↵
        location=no,scrollbars=no,resizable=no";
    winOptions += ",width=" + propertyWidth;
    winOptions += ",height=" + propertyHeight;
    winOptions += ",left=" + winLeft;
    winOptions += ",top=" + winTop;
    carWindow = window.open(linkTarget,
        "carInfo", winOptions);
    carWindow.focus();
}
```

3. Save the **index.html** document, and then validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and open it in your Web browser. Click one of the car links. The property window should open and be centered in the middle of your screen.

4. Close your Web browser windows.

Short Quiz 3

1. Explain the security features of the `History` object.
2. How do you use the `History` object to navigate backward or forward in a Web browser's history?
3. How do you use the `Location` object to change to a new Web page?
4. What is the `Navigator` object and how do you use it?

Summing Up

- The browser object model (BOM) or client-side object model is a hierarchy of objects, each of which provides programmatic access to a different aspect of the Web browser window or the Web page.
- The top-level object in the browser object model is the `Window` object, which represents a Web browser window.
- The `Document` object is arguably the most important object in the browser object model because it represents the Web page displayed in a browser.
- For elements that are represented by arrays, you can reference the object through the array instead of with the element name.
- Because the `Window` object is the global object, it is not necessary to include it in your statements.
- When you override an internal event handler with your own code, your code must return a value of true or false, using the return statement.
- A rollover is an effect that occurs when your mouse moves over an element.
- You use the `style` property to modify an element's CSS properties with JavaScript.
- Whenever a new Web browser window is opened, a new `Window` object is created to represent the new window.

- When you open a new Web browser window, you can customize its appearance by using the options argument of the `window.open()` method.
- A `Window` object's name property can be used only to specify a target window with a link and cannot be used in JavaScript code.
- To control the new window by using JavaScript code located within the Web browser in which it was created, you must assign the new `Window` object created with the `window.open()` method to a variable.
- The `setTimeout()` method is used in JavaScript to execute code after a specific amount of time has elapsed.
- The `clearTimeout()` method is used to cancel a `setTimeout()` method before its code executes.
- The `setInterval()` method repeatedly executes the same code after being called only once.
- The `clearInterval()` method is used to clear a `setInterval()` method call.
- The `History` object maintains an internal list (known as a history list) of all the documents that have been opened during the current Web browser session.
- The `Location` object allows you to change to a new Web page from within JavaScript code.
- The `Navigator` object is used to obtain information about the current Web browser.
- The `with` statement eliminates the need to retype the name of an object when properties of the same object are being referenced in a series.
- The `Screen` object is used to obtain information about the display screen's size, resolution, and color depth.

Comprehension Check

1. Which of the following objects is also referred to as the global object?
   a. `Document` object
   b. `Window` object
   c. `Browser` object
   d. `Screen` object

2. Which of the following elements in the browser object model is (are) referenced with arrays? (Choose all that apply.)
   a. images
   b. paragraphs
   c. forms
   d. links

3. Which of the following terms does not refer to the browser object model?
   a. Firefox object model
   b. JavaScript object model
   c. client-side object model
   d. Navigator object model

4. You must use the Window object or `self` property when referencing a property or method of the Window object. True or false?

5. Explain how to override an event with an event handler function.

6. Which of the following events is (are) used to create rollover effects? (Choose all that apply.)
   a. `onclick`
   b. `onload`
   c. `onmouseover`
   d. `onmouseout`

7. Explain how to open a blank window with the `window.open()` method.

8. You use the options string of the `window.open()` method to specify any elements that you do not want created for the new window. True or false?

9. Which of the following arguments of the options string of the `window.open()` method identifies the horizontal coordinate where the window will be positioned?

   a. `left`

   b. `leftPosition`

   c. `x-axis`

   d. `moveTo`

10. Explain why you should include the `Window` object or `self` property when using the `open()` and `close()` methods of the `Window` object.

11. How do you control a new window that you have created with JavaScript code?

    a. by using the appropriate element in the `windows[]` array of the Windows object

    b. by using the `name` argument of the `window.open()` method

    c. You cannot control a new window with JavaScript code.

    d. by assigning the new `Window` object created with the `window.open()` method to a variable

12. Explain the difference between the `setTimeout()` and `setInterval()` methods. Which method is most often used for starting animation code that executes repeatedly?

13. You can use JavaScript code to navigate through a history list, but only if the currently displayed Web page exists within the same domain as the Web page containing the JavaScript code that is attempting to move through the list. True or false?

14. The full URL of a Web page is located in the ________________ property of the `Location` object.

    a. `href`

    b. `hash`

    c. `src`

    d. `url`

15. Which property of the `Navigator` object returns the Web browser name?

    a. `browser`

    b. `browserName`

    c. `appName`

    d. `platform`

16. Explain how to use the `with` statement to reference an object's properties.

17. Which of the following properties of the `Screen` object returns the height of the display screen, not including operating system features such as the Windows taskbar?

    a. `displayHeight`

    b. `screenHeight`

    c. `availHeight`

    d. `height`

18. Explain how to center a window when it is created with the `window.open()` method.

19. To refer to a frame within the same frameset, you use the ________________ property of the `Window` object combined with the frame's index number from the `frames[]` array.

    a. `target`

    b. `parent`

    c. `base`

    d. `frame`

20. Which of the following properties of the `Window` object refers to the topmost window on a Web page?

    a. `main`

    b. `core`

    c. `top`

    d. `principal`

Reinforcement Exercises

Exercise 4-1

Most Windows applications include an About dialog box that displays copyright and other information about the program. In this exercise, you will create a script that opens a new window that is similar to an About dialog box.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the strict DTD and "About Dialog Box Example" as the content of the `<title>` element.

2. Add a form to the document body that includes a single command button that reads "About this JavaScript Program".

3. Add code to the Web page that opens a new browser window when a user clicks the command button. Make the new window 100 pixels high by 300 pixels wide, centered in the middle of the screen. Do not use any other display options. The new browser window should display a document named About.html (which you will create later in this exercise).

4. Save the document as **AboutExample.html** in the Exercises folder for Chapter 4.

5. Use the W3C Markup Validation Service to validate the **AboutExample.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

6. Create a Web page that conforms to the strict DTD that displays a single paragraph with the following text. Be sure to use your name in the paragraph.

```
<p>This program was created by your name. </p>
```

7. Add a button to the document body that closes the current window.

8. Save the document as **About.html** in the Exercises folder for Chapter 4.

9. Use the W3C Markup Validation Service to validate the **About.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

10. Open **AboutExample.html** in your Web browser and test the script's functionality. The About window should appear centered in the middle of your screen.

11. Close your Web browser window.

Exercise 4-2

In this exercise, you create a script that repeatedly flashes advertising messages in a text box for a company named Central Valley Florist.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the transitional DTD and "Central Valley Florist" as the content of the `<title>` element.

2. Add a script section to the document head, as follows:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Next, add the following heading elements and form to the document body, which will display the quote:

```
<h1>Central Valley Florist</h1>
<h2>Valentines Day Specials</h2>
<form name="advertising" action="">
<p><input type="text" name="message" size="60"
value="Place your Valentines Day orders today!" /></p>
</form>
```

4. Add to the script section the following code, which changes the portion of the warning that is displayed in a text box:

```
var curMessage="message1";
var changeMessage;
function adMessage(){
  if (curMessage == "message2"){
    document.advertising.message.value
      = "Place your Valentines Day orders today!";
    curMessage = "message1";
  }
  else {
    document.advertising.message.value
      = "All orders must be received by February 12th!";
    curMessage = "message2";
  }
}
```

5. Finally, add the following `onload` event handler to the opening <body> tag:

```
<body onload="var changeQuote=setInterval ↵
    ('adMessage()',2000);">
```

6. Save the document as **ValentinesDayOrders.html** in the Exercises folder for Chapter 4.

7. Use the W3C Markup Validation Service to validate the **ValentinesDayOrders.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser. The quote should change every few seconds.

8. Close your Web browser window.

Exercise 4-3

In this exercise, you will create a script that redirects users to a different Web page after 10 seconds, or allows them to click a hyperlink.

1. Create a new document in your text editor and type the <!DOCTYPE> declaration, `<html>` element, header information, and <body> element. Use the strict DTD and “New Web Address” as the content of the `<title>` element.

2. Add a script section to the document head, as follows:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Add to the script section the following global variable declaration and function to handle the task of redirecting the Web page:

```
var killRedirect;
function updatedURL() {
     location.href="UpdatedURL.html";
}
```

4. Add the following `onload` event handler to the opening <body> tag:

```
<body onload="killRedirect =
setTimeout('updatedURL()', 10000);">
```

5. Now add the following elements and text to the document body:

```
<h2>The URL for the Web page you are trying to
reach has changed!</h2>
<p><strong>You will be automatically redirected in
ten seconds. Click the link if JavaScript is
disabled in your browser.</strong></p>
<p>Be sure to update your bookmark!</p>
<p><a href="UpdatedURL.html">UpdatedURL.html</a></p>
```

6. Save the document as **Redirect.html** in the Exercises folder for Chapter 4.

7. Use the W3C Markup Validation Service to validate the **Redirect.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

8. Create a Web page that conforms to the strict DTD that displays a single paragraph with the following text:

```
<p>You have reached the updated Web page.</p>
```

9. Save the document as **UpdatedURL.html** in the Exercises folder for Chapter 4.

10. Use the W3C Markup Validation Service to validate the **UpdatedURL.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open the **Redirect.html** document in your Web browser. In 10 seconds, the UpdatedURL.html document should open automatically.

11. Close your Web browser window.

Exercise 4-4

In addition to specifying the size and position of a window when it first opens, you can also change the size and position of an open window, by using methods of the `Window` object. The `resizeTo()` method resizes a window to a specified size, and the `moveTo()` method moves a window to an absolute position. Using these methods, along with properties of the Screen object, you will create a script that resizes and repositions an open window so that it fills the screen.

1. Create a new document in your text editor and type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Maximize Browser Window" as the content of the <title> element.

2. Add a form to the document body that includes two command buttons: one that reads "Create New Window" and another that reads "Maximize New Window".

3. Add a script section to the document head, as follows:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following function for the Create New Window button. This function opens a document named MaxWindow.html (which you create shortly) in a new browser window, centered in the middle of the screen, when a user clicks the command button.

```
var maxWindow;
function createWindow() {
    var winWidth=300;
    var winHeight=100;
    var winLeft = (screen.width-winWidth)/2;
    var winTop = (screen.height-winHeight)/2;
    var winOptions = ",width=" + winWidth;
    winOptions += ",height=" + winHeight;
    winOptions += ",left=" + winLeft;
    winOptions += ",top=" + winTop;
    maxWindow = window.open("MaxWindow.html",
        "newWindow", winOptions);
    maxWindow.focus();
}
```

5. Add the following function for the Maximize New Window button. The first statement in the function uses the `moveTo()` method of the `Window` object to move the window named maxWindow (which is created by the `createWindow()` function) to position 0, 0, which represents the upper-left corner of the screen. The second statement uses the `resizeTo()` method of the `Window` object and the `availWidth` and `availHeight` properties of the `Screen` object to maximize the window. The final statement changes focus to the maximized window.

```
function maximizeWindow() {
    maxWindow.moveTo(0,0);
    maxWindow.resizeTo(screen.availWidth,
        screen.availHeight);
    maxWindow.focus();
}
```


6. Save the document as **MaximizeBrowser.html** in the Exercises folder for Chapter 4.

7. Use the W3C Markup Validation Service to validate the **MaximizeBrowser.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

8. Create a Web page that conforms to the strict DTD, and add the following text and elements to the document body:

```
<p><strong>Resizing and Repositioning
Example</strong></p>
<form action="">
<p><input type="button" value="Close Window"
     onclick="window.close();" /></p>
</form>
```

9. Save the document as **MaxWindow.html** in the Exercises folder for Chapter 4.

10. Use the W3C Markup Validation Service to validate the **MaxWindow.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

11. Open **MaximizeBrowser.html** in your Web browser, and click the **Create New Window** button. The new window should appear centered in the middle of your screen. Return to the **MaximizeBrowser.html** file in your Web browser, and click the Maximize New Window button. The new window should be resized and repositioned to fill the screen.

12. Close your Web browser windows.

Exercise 4-5

In this exercise, you will create a Web page for a greeting card company. The page will contain links that display images of greeting cards in a separate window. Your Exercises folder for Chapter 4 contains the following greeting card images that you can use for this project: birthday.jpg, halloween.jpg, mothersday.jpg, newyear.jpg, and valentine.jpg.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the strict DTD and "Gosselin Greeting Cards" as the content of the `<title>` element.

2. Add the following text and elements to the document body. The `onclick` events in the links call a function named `showCard()` that handles the process of displaying each greeting card in a separate window. You create the `showCard()` function next.

```
<h1>Gosselin Greeting Cards</h1>
<h2>All Occasions</h2>
<hr />
<p><a href="valentine.jpg"
onclick="showCard('valentine.jpg');return false">
Valentine's Day</a><br />
<a href="mothersday.jpg"
onclick="showCard('mothersday.jpg');return false">
Mother's Day</a><br />
<a href="halloween.jpg"
onclick="showCard('halloween.jpg');return false">
Halloween</a><br />
<a href="newyear.jpg"
onclick="showCard('newyear.jpg');return false">
New Year</a><br />
<a href="birthday.jpg"
onclick="showCard('birthday.jpg');return false">
Birthday</a></p>
```

3. Add a script section to the document head, as follows:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following global variable to the script section. This variable will represent the window that will display the greeting card images.

```
var cardWindow;
```

5. Add the following function to the end of the script section. The function opens a new window, centered in the middle of the screen, that displays the selected greeting card image.

```
function showCard(linkTarget) {
   var propertyWidth=400;
   var propertyHeight=350;
   var winLeft = (screen.width-propertyWidth)/2;
   var winTop = (screen.height-propertyHeight)/2;
   var winOptions = "toolbar=no,menubar=no,location=no, ↵
      scrollbars=yes,resizable=no";
   winOptions += ",width=" + propertyWidth;
   winOptions += ",height=" + propertyHeight;
   winOptions += ",left=" + winLeft;
   winOptions += ",top=" + winTop;
   cardWindow = window.open(linkTarget,
      "cardInfo", winOptions);
   cardWindow.focus();
}
```

6. Save the document as **GreetingCards.html** in the Exercises folder for Chapter 4.

7. Use the W3C Markup Validation Service to validate the **GreetingCards.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor, open it in your Web browser, and test the functionality.

8. Close your Web browser window.

Exercise 4-6

You have probably seen Web sites that invite you to add them to your browser's favorites list. With Internet Explorer, you can create a link that automatically adds the Web page to the favorites list by assigning a value of `javascript:window.external.AddFavorite(`*`url, site name`*`)` to the link's `href` property. Firefox does not contain similar functionality, so you need to use the Navigator object to determine the browser type. In this exercise, you will create a script that contains functionality for adding Course Technology's Web site to a browser's favorites list.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the strict DTD and

"Add to Favorites" as the content of the `<title>` element. Your document should appear as follows:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0
Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Add to Favorites</title>
<meta http-equiv="content-type" content="text/html;
     charset=iso-8859-1" />
</head>
<body>
</body>
</html>
```

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add to the script section the following statements. The first two statements retrieve the browser's name and version from the Navigator object. The remaining statements create text variables that will be used to create the bookmark link.

```
var browserName = navigator.appName;
var browserVer = parseInt(navigator.appVersion);
var linkText= "Add Course Technology ↵
    to your favorites!";
var url = "http://www.course.com";
var pageName = "Course Technology";
var favLink = "";
```

5. Add the following `if` statement to the end of the script section. The conditional expression determines whether the browser name is equal to "Microsoft Internet Explorer" and whether the browser version is greater than or equal to 4. If so, statements within the `if` statement build a link that automatically adds the Course Technology Web site to the favorites list in Internet Explorer.

```
if (browserName == "Microsoft Internet Explorer"
    && browserVer >= 4) {
    favLink = "<p><a href=\"javascript:window.external ↵
        .AddFavorite(url, pageName)\"";
    favLink += " onmouseover=\"window.status='";
    favLink += linkText + "'; return true\"";
    favLink += " onmouseout=\"window.status=";
    favLink += "''" + "; return true\"";
    favLink += ">" + linkText + "</a></p>";
    document.write(favLink);
}
```

6. Add the following else clause to the end of the script section to print “Add Course Technology to your favorites! (Ctrl+D)” for all other browsers:

```
else
    document.write("<p>Add Course Technology ↵
        to your favorites! (Ctrl+D)</p>");
```

7. Save the document as **AddToFavorites.html** in the Exercises folder for Chapter 4, and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and open it in Internet Explorer and test the functionality.

8. Close your Web browser window.

Discovery Projects

For the following projects, save the files you create in your Projects folder for Chapter 4. Be sure to validate each Web page with the W3C Markup Validation Service.

Project 4-1

Your Projects folder for Chapter 4 contains five advertising images for a concert series, concert1.gif through concert5.gif. Create a script that cycles through the images, displaying each image for five seconds. Save the document as **ConcertAds.html**.

Project 4-2

Create a Web page with a list of your favorite links. At the top of the page, include a check box with the text “Open link in a new window.” If a user clicks the check box, then the links on the page should open in a new window. Otherwise, the links should be loaded into the current window. Save the document as **LinkWindow.html**.

Project 4-3

A common use of the `onmouseover` and `onmouseout` event handlers is to change the button image displayed for a navigational link on a Web page. For example, holding your mouse over an image of a Home button (that jumps to the Web site’s home page) could replace the image with one that is more vivid in order to clearly identify the page that is the target of the link. Your Projects folder for Chapter 4 contains eight images, home1.gif, home2.gif, faq1.gif, faq2.gif, guestbook1.gif, guestbook2.gif, join1.gif, and join2.gif, which represent typical navigational buttons you will find on a Web site. The second version of each button is slightly more vivid than the first version. Create a Web page that displays the first version of each button as image links, using the `<a>` element. Holding your mouse over each image should display the more vivid version of the image, while moving your mouse off the image should display the less vivid version. Do not worry about actually creating a Web page as the target of each link; just assign an empty string to each `<a>` element's href attribute. Save the document as **Buttons.html**.

Project 4-4

Although frames are deprecated, some Web sites still use them to display someone else's Web page inside a frame at the originating Web site. In most cases you do not want your Web page displayed within someone else's frame, no matter what the circumstances. Think of a way you can prevent this from happening by using the `Location` object and the top property. Write a simple document named **Breakout.html** that displays the text "This document cannot be displayed in a frame." Include a JavaScript section in the document head that prevents the document from being displayed in a frame, then write a simple two-column frame document named **BreakoutCheck.html** to test your code. In the left column, display a Web page named BreakoutFrame.html that contains a link that attempts to open the **Breakout.html** document in the right frame column. If you are not familiar with how to create frames, refer to *http://www.w3schools.com/tags/tag_frame.asp*.

Project 4-5

You have probably come across Web sites that display an advertisement from a sponsor for a period of time before being redirected to the page you originally requested. Create a similar ad for a real estate company named Central Valley Realtors. Start by creating a Web page named **CVR1.html**. In the document body, create a table with two columns. In the left column, display the cvb1.gif image, located in your Projects folder for Chapter 4. The cvb1.gif file is an animated GIF file that displays an advertisement for a company named Central Valley Builders. In the right column, display three paragraphs. In the first paragraph, display the word "Advertisement". In the second paragraph, display the text "The Central Valley Realtors home page will be displayed in *n* seconds." Use a text field for the number of seconds, which means you will need to create a form to contain the text field. Set the default value of the text field to 15 seconds. In the third paragraph, include a link reading "Skip advertisement" that opens a Web page named CVR2.html (which is the "real" home page for Central Valley Realtors). Add to the CVR1.html page's opening `<body>` tag an `onload` event handler that calls a function named `startAdPage()`. Within the `startAdPage()` function, include two statements: one statement that uses a `setInterval()` method to call a function named `changeAd()` every five seconds, and another statement that uses a `setInterval()` method to call a function named `startCountdown()` every second. Create the `changeAd()` function so that every five seconds, it alternates the image in the document body with the three images that are located in your Projects folder for Chapter 4: cvb1.gif, cvb2,gif, and cvb3.gif. Create the `startCountdown()` function so that it changes the value assigned to the text field in the document body to the value of a variable named `count`, which is decreased by a value of one (from 15 to 1) each time the `startCountdown()` function executes. When the count reaches zero, clear both of the intervals and redirect the browser to the CVR2.html page. Create the **CVR2.html** page so that it contains an `<h1>` element that reads "Central Valley Realtors" and a paragraph element that reads "Welcome to our home page."

CHAPTER 5

Validating Form Data with JavaScript

In this chapter, you will:

- Learn about JavaScript and forms
- Use JavaScript to manipulate and validate form elements
- Learn how to manipulate selection lists with JavaScript
- Learn how to validate submitted data

Forms are one of the most common Web page elements used with JavaScript. Typical forms you may encounter on the Web include order forms, surveys, and applications. You use JavaScript to make sure that data was entered properly into the form fields and to perform other types of preprocessing before the data is sent to the server. Without JavaScript, the only action that a Web page can take on form data is to send it to a server for processing.

Understanding Forms

Many Web sites use **forms** to collect information from users and transmit that information to a server for processing. Typical forms you may encounter on the Web include order forms, surveys, and applications. Figure 5-1 shows part of a form that people can use to apply for an account on Twitter.

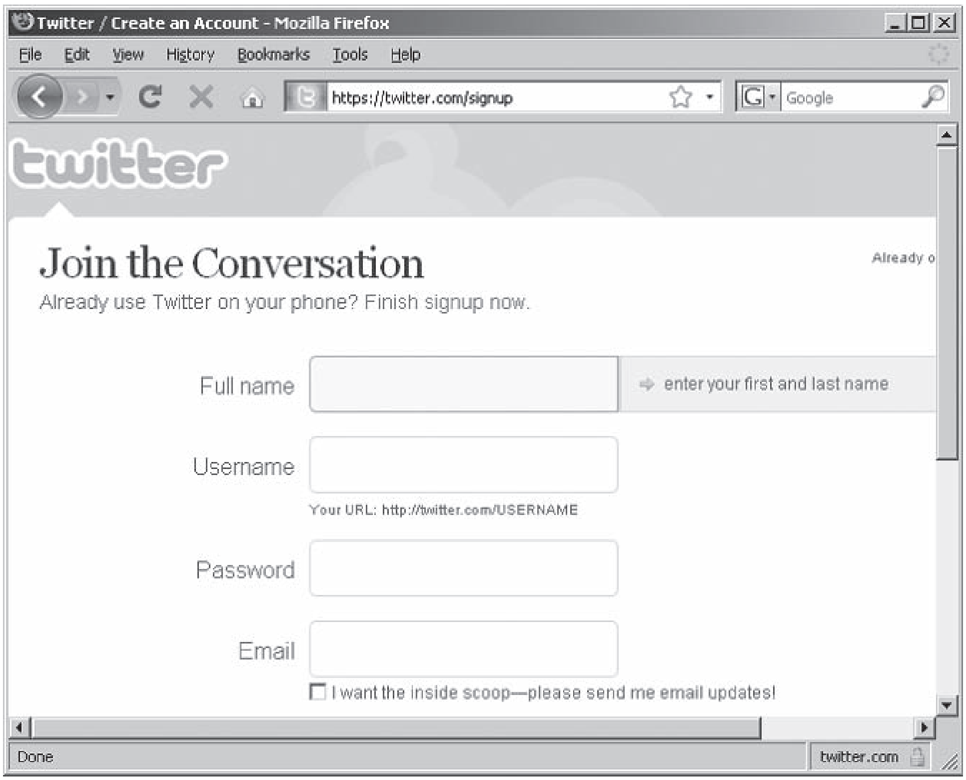


Figure 5-1 Twitter sign-up form

Another type of form frequently found on Web pages gathers search criteria from a user. After the user enters search criteria, the data is sent to a database on a Web server. The server then queries the database, using the data gathered in the search form, and returns the results to a Web browser. Figure 5-2 shows an example of the advanced search form from Google. If you enter “Don Gosselin” in the first field and “.edu” in the Search within a site or domain field, the Web server returns results similar to those shown in Figure 5-3.

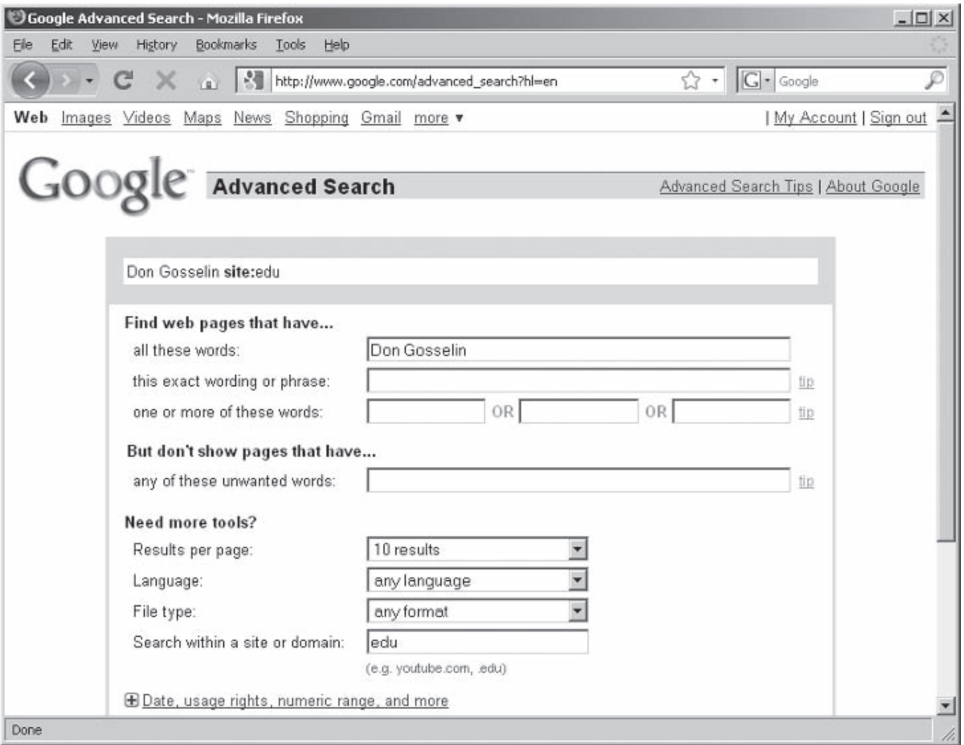


Figure 5-2 Google advanced search page

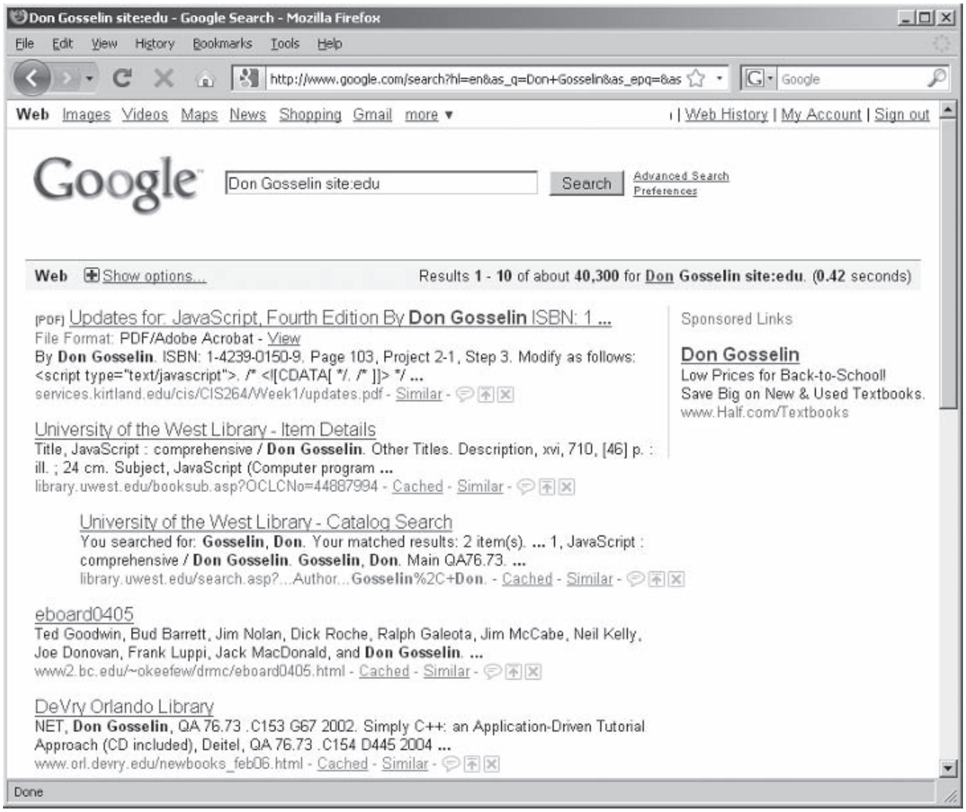


Figure 5-3 Google results page

Forms are usually set up so that the data collected is transmitted to a server-side scripting language program on a Web server. As you learned in Chapter 1, such programs execute on the Web server and not in a browser, as is the case with the JavaScript programs you have created in this book. Some of the more popular server-side scripting languages that are used to process form data include PHP, Common Gateway Interface (CGI), Active Server Pages (ASP), and JavaServer Pages (JSP).

In this chapter, you will work on a simple Web site for a technology company named Central Valley Technology. The goal of the chapter will be to submit a subscription form for the company's technology journal. Your Chapter folder for Chapter 5 contains a folder named CVTech that contains the files you will need for the project. Figure 5-4 shows the company's home page.

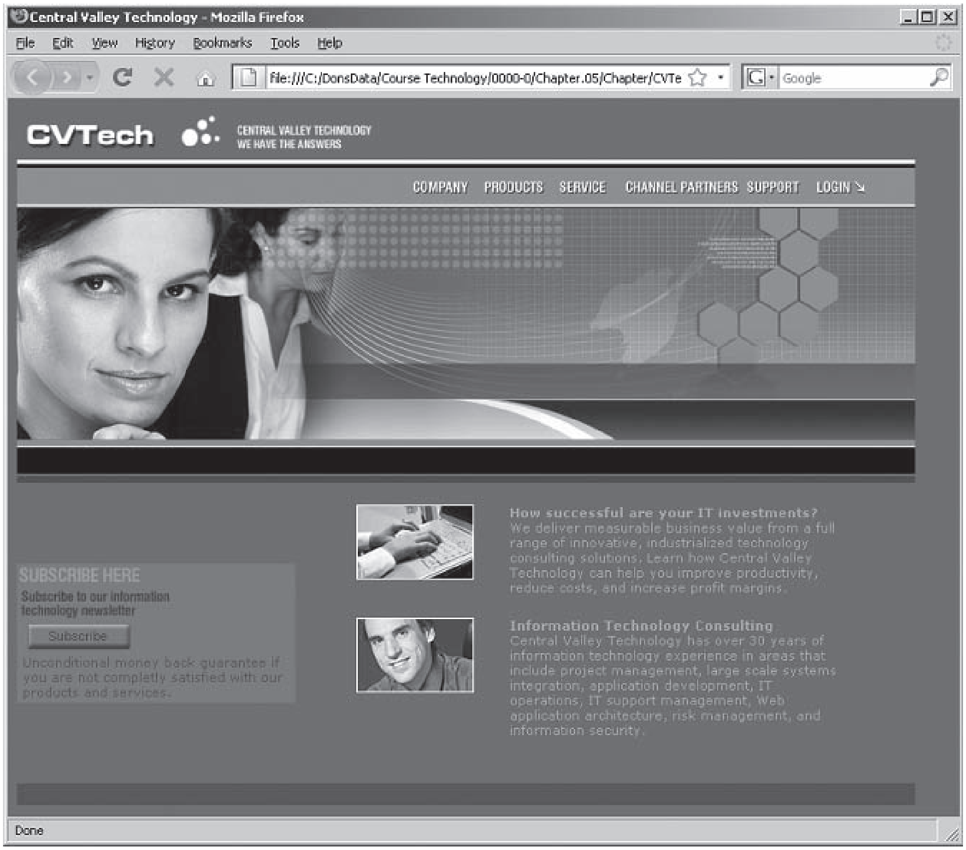


Figure 5-4 Central Valley Technology home page

If a form requires advanced or complex validation or processing, it is a good idea to have a server-side script do the work. Servers are usually much more powerful than a desktop computer or workstation.

Because the focus of this book is on client-side JavaScript, the scripts you write will submit the forms to a document named FormProcessor.html rather than to a Web server. The document FormProcessor.html, located in the CVTech folder, uses JavaScript code to display the values submitted from a form. The only purpose of the FormProcessor.html document is to display form data and provide a simple simulation of the response you would normally receive from a server-side scripting program.

Understanding the `<form>` Element

The **`<form>` element** designates a form within a Web page and contains all the text and elements that make up a form. You can include as many forms as you like on a Web page, although you cannot nest one form inside another form. Table 5-1 lists the attributes you can use with the `<form>` element.

Attribute	Description
`accept-charset`	Specifies a comma-separated list of possible character sets that the form supports.
`action`	Required attribute that specifies a URL to which form data is submitted. If this attribute is excluded, the data is sent to the URL that contains the form. Typically, you would specify an e-mail address or the URL of a program on a server.
`enctype`	Specifies the MIME type of the data being submitted. The default value is `application/x-www-form-urlencoded`.
`method`	Determines how form data is submitted. The two options for this attribute are "get" and "post". The default option, "get", appends form data as one long string to the URL specified by the `action` attribute. The "post" option sends form data as a transmission separate from the URL specified by the `action` attribute. Although "get" is the default, "post" is considered the preferred option, because it allows the server to receive the data separately from the URL.

Table 5-1 Attributes of the `<form>` element

To help ensure that your Web pages are well formed, you should always type the opening `<form>` tag and the closing `</form>` tag at the same time, and then go back and fill in the elements and content that you want to appear in the form.

The `enctype` attribute is important because a server-side scripting program can use its value to determine how to process the form data. The default MIME type of `application/x-www-form-urlencoded` specifies that form data should be encoded as one long string. The only other MIME types allowed with the `enctype` attribute are `multipart/form-data`, which encodes each field as a separate section, and `text/plain`, which is used to upload a document to a Web server or to submit form data to an e-mail address. With the exception of when you submit form data to an e-mail address, you should normally use the default MIME type of `application/x-www-form-urlencoded`.

Instead of submitting form data to a Web server, you can set up a form to send data to an e-mail address. Sending form data to an e-mail address is much simpler than creating and managing a script on a Web server. Instead of relying on a complex script on a Web server to process the data, you rely on the recipient of the e-mail message to process the data. For large organizations that deal with hundreds or thousands of orders a day, e-mailing form data is not an ideal solution. But for smaller companies or Web sites that do not have a high volume of orders, e-mailing form data is an option. To e-mail form data, you replace the Web server script's URL in the `<form>` element's `action` attribute with the `mailto` protocol, as follows: `action="mailto:`*`email_address`*`"`. Separate multiple recipients with commas. You can also use a question mark (?) to append the following options to the e-mail address in a mailto protocol: `to, cc, bcc, subject`, and `body`. (Using the `to` option is the equivalent of separate multiple recipients with commas.) Options appended to the *`mailto`* protocol are also separated by commas. For example, the `mailto` protocol assigned to the following `action` attribute sends the form data to two recipients, copies a third recipient, and specifies a subject line:

```
action = "mailto:reservations@skywardflyers.com,↵
    billing@skywardflyers.com? ↵
    cc = group_tours@skywardflyers.com, ↵
    subject = group reservations"
```

When you use the use the `mailto` protocol, be sure to use the `enctype` of "text/plain", which ensures that the data arrives at the e-mail address in a readable format.

MIME is a protocol that was originally developed to allow different document types to be transmitted as attachments to e-mail messages. Now MIME has become a standard method of exchanging files over the Internet. You specify MIME types with two-part codes separated by a forward slash (/). The first part specifies the MIME type, and the second part specifies the MIME subtype.

Working with Form Controls

There are four primary elements used within the `<form>` element to create form controls: `<input>, <button>, <select>`, and `<textarea>`. The `<input>` and `<button>` elements are used to create input fields with which users interact. The `<input>` element is the most commonly used form element and allows you to create the following types of form controls:

- Text boxes
- Password boxes
- Radio buttons
- Check boxes
- Push buttons
- File boxes
- Hidden form fields
- Submit buttons
- Image submit buttons
- Reset buttons

You can also use the `mailto` protocol with anchor (<a>) elements.

The `<select>` element displays choices in a drop-down menu or in a scrolling list known as a selection list. The `<textarea>` element is used to create a text field in which users can enter multiple lines of information. Any form element into which a user can enter data (such as a text box) or that a user can select or change (such as a radio button) is called a **field**.

You are not required to include a `value` attribute or enter a value into a field before the form data is submitted.

How form controls are rendered depends on the type of Web browser as well as the operating system. You may notice differences in how form controls appear between Windows and Macintosh operating systems and between different versions of the same operating system. For instance, there is a noticeable difference in the way that form controls are rendered in Windows XP compared to how they are rendered in Windows Vista. The figures in this chapter were generated using Firefox 3.0 running on Windows XP.

The `<input>, <textarea>`, and `<select>` elements can include `name` and `value` attributes. The `name` attribute defines a name for an element, and the `value` attribute defines a default value. When you submit a form to a Web server, the form data is submitted in name = value pairs, based on the `name` and `value` attributes of each element. For example, consider the following element, which creates a text `<input>` field:

```
<input type="text" name="company_info"
    value="Skyward Flyers" />
```

For the preceding element, a name = value pair of "company_info = Skyward Flyers" will be sent to a Web server (unless the user types something else into the field). If you intend to have your script submit forms to a Web server, you must include a `name` attribute for each `<input>, <textarea>`, and `<select>` element.

Using JavaScript with Forms

JavaScript is often used with forms to validate or process form data before the data is submitted to a server-side script. For example, customers may use an online order form to order merchandise from your Web site. When customers click the form's Submit button, you need to make sure that their information, such as the shipping address and credit card number, is entered correctly. To use JavaScript to access form controls and verify form information, you use the **Form object**, which represents a form on a Web page. The `Form` object is part of the browser object model, which you studied in Chapter 4, and contains properties, methods, and events that you can use to manipulate forms and form controls.

You can use JavaScript to access form controls created with any of the primary form elements: `<input>, <button>, <select>`, and `<textarea>`. This chapter focuses on how to use JavaScript with the `<input>` and `<select>` elements. However, you can also use many of the JavaScript techniques you learn in this chapter with the `<button>` and `<textarea>` elements.

Referencing Forms and Form Elements

Recall from Chapter 4 that some of the objects in the browser object model are arrays of other objects. For instance, the `Document` object includes a `forms[]` array that contains all the forms on a Web page. If a window does not contain any forms, then the `forms[]` array is empty. The first form in a document is referred to as `document.forms[0]`, the second form is referred to as `document.forms[1]`, and so on.

Prior to the development of XHTML, the most common way to refer to a form with JavaScript was to append the value assigned to the `<form>` element's `name` attribute to the `Document` object. For example, if you had a form with a `name` attribute that was assigned a value of "orderForm", you referred to the form in JavaScript as `document.orderForm`. However, the `<form>` element's `name` attribute is deprecated in XHTML. Although you can still use it with the transitional DTD, it is no longer available with the strict DTD. Therefore, if you want your Web pages to be well formed according to the strict DTD, you must avoid using the `name` attribute with your `<form>` elements. Referencing a form by its position in the `forms[]` array is usually not that difficult because most Web pages rarely include more than one form.

Just as the `Document` object has a `forms[]` array, the `Form` object has an `elements[]` array. You can use it to reference each element on a form. The **`elements[]` array** contains objects representing each of the controls in a form. Each element on a form is assigned to the `elements[]` array in the order in which it is encountered by the JavaScript interpreter. To refer to an element on a form, you reference the index number of the form in the `forms[]` array, followed by the appropriate element index number from the `elements[]` array. For example, if you want to refer to the first element in the first form on a Web page, use the statement `document.forms[0].elements[0];`. The third element in the second form is referenced using the statement `document.forms[1].elements[2];`. The following code shows an example of how each element on a form is assigned to the `elements[]` array:

```
<form action="post">
// The following element is assigned to elements[0]
Customer name: <input type="text" name="customer" /><br />
// The following element is assigned to elements[1]
E-mail address: <input type="text" name="email" /><br />
// The following element is assigned to elements[2]
Telephone: <input type="text" name="phone" /><br />
// The following element is assigned to elements[3]
Fax: <input type="text" name="fax" /><br />
</form>
```

Although the `name` attribute is deprecated in XHTML for the `<form>` element, it is still available for form control elements. In fact, if you plan to have your script submit a form to a server-side script, you must include a `name` attribute for each form element. This gives the server-side script a way to identify each piece of form data. Naming an element also gives you an alternative to referencing the element by its position in the `elements[]` array, which can be tedious if you have many fields on a form. For example, if you have an element named `quantity` in the first form on a Web page, you can refer to it using the statement `document.forms[0].quantity;`.

Working with the `Form` *Object*

Tables 5-2, 5-3, and 5-4 list the properties, events, and methods of the `Form` object.

Property	Description
`acceptCharset`	Returns a comma-separated list of possible character sets that the form supports
`action`	Returns the URL to which form data is submitted
`elements[]`	Returns an array of a form's elements
`enctype`	Sets or returns a string representing the MIME type of the data being submitted
`length`	Returns an integer representing the number of elements in the form
`method`	Sets or returns a string representing one of the two options for submitting form data: "get" or "post"
`name`	Sets or returns the value assigned to the form's `name` attribute
`target`	Sets or returns the target window where responses are displayed after submitting the form

Table 5-2 `Form` object properties

Event	Description
`reset`	Executes when a form's reset button is clicked
`submit`	Executes when a form's submit button is clicked

Table 5-3 `Form` object events

Method	Description
`reset()`	Resets a form without the use of a reset button
`submit()`	Submits a form without the use of a submit button

Table 5-4 `Form` object methods

Next, you start creating the technology journal subscription page for Central Valley Technology. The Web page will contain a subscription form that you will work on throughout this chapter.

To start creating the technology journal subscription page for Central Valley Technology:

1. Open your text editor, and then open the **subscription.html** document located in the CVTech folder in your Chapter folder for Chapter 5.
2. Locate `<!--[Add code here]-->` in the document body and replace it with the following heading elements:

```
<h1>Technology Journal Subscription Form</h1>
<h2>Customer Information</h2>
```

3. Add the following two tags after the `<h2>` element to create the form section. Throughout the rest of this chapter, you will add form elements between these tags. Notice that the form's `action` attribute submits the form data to the FormProcessor.html document, and the `method` attribute submits the form data using the `"get"` option in order to append the form data as one long string to the FormProcessor.html URL. This allows the JavaScript code within the FormProcessor.html document to display the data in the Web browser.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p><input type="submit" value="Subscribe" /> 
<input type="reset" /></p>
</form>
```

4. Save the document, but do not open it in a Web browser, because it does not yet contain any form elements.

Short Quiz 1

1. Explain how to use the Form object to use JavaScript to access form controls and verify form information.
2. How do you reference forms with the strict DTD?
3. How do you use the `elements[]` array to reference elements on a form?

Working with Input Fields

The empty `<input>` element is used to generate **input fields** that create different types of interface elements, such as text boxes, radio buttons, and so on. The input fields are used to gather information from the user. Table 5-5 lists the attributes of the `<input>` element.

Attribute	Description
accept	Determines the MIME type of a document that is uploaded via a file box
alt	Provides alternate text for an image submit button
checked	Determines whether or not a radio button or a check box is selected; a Boolean attribute
disabled	Disables a control
maxlength	Accepts an integer value that determines the number of characters that can be entered into a field
name	Designates a name for the element; part of the name = value pair that is used to submit data to a Web server
readonly	Prevents users from changing values in a control
size	Accepts an integer value that determines the width of a text box in characters
src	Specifies the URL of an image
type	Specifies the type of element to be rendered; type is a required attribute; valid values are text, password, radio, check box, reset, button, submit, image, file, and hidden
value	Sets an initial value in a field or a label for buttons; part of the name = value pair that is used to submit data to a Web server

Table 5-5 Attributes of the <input> element

Table 5-5 lists only attributes of the <input> element that are available in the strict DTD.

The checked attribute in Table 5-5, along with several other attributes you will encounter in HTML and XHTML, is a Boolean attribute, which means it specifies one of two values: true or false. In HTML, you can specify that the check box control is selected, or checked, by default by including the Boolean checked attribute within the <input> element, as follows:

```
<input type="checkbox" checked />
```

When a Boolean attribute is not assigned a value, as in the preceding code, the attribute is said to have a **minimized form**. However, recall from Chapter 1 that all attribute values must appear within quotation marks. This syntax also means that an attribute must be assigned a value. For this reason, minimized Boolean attributes are illegal in XHTML. You can still use Boolean attributes in XHTML provided you use their full form. You create the **full form** of a Boolean attribute by assigning the name of the attribute itself as the attribute's value. For example, to use the <input> element's checked Boolean attribute in XHTML, you use the full form of the attribute as follows:

```
<input type="checkbox" checked="checked" />
```

Remember that to specify a value of false for a Boolean attribute, you simply exclude the attribute from the element. If you do not want a check box control to be selected by default, for instance, you simply exclude the checked attribute from the <input> element as follows:

```
<input type="checkbox" />
```

One of the most important attributes of the `<input>` element is the `type` attribute, which determines the type of element to be rendered and is a required attribute. Valid values for the `type` attribute are text, password, radio, check box, reset, button, submit, image, file, and hidden. Each of these attributes creates a different element. You will study how to use JavaScript with the controls created with the text, password, button, radio, and check box values next. Later in this chapter, you will learn how to use JavaScript with controls created with the reset and submit values.

Input Field Objects

The `elements[]` array stores objects that represent each type of form control. Each of the different types of controls that can be created with an `<input>` element is represented by an object that is similar to the name of the control; a text box is represented by an `Input` object, a radio button list is represented by a `Radio` object, a check box is represented by a `Checkbox` object, and so on. Don't worry about the exact names of each type of input field object because you will never need to refer to them in your scripts. You do need to understand that each of these objects includes various properties and methods. The availability of each property or method depends on the type of form control. For example, the `Input` object includes a `checked` property that is only available to check boxes and radio buttons. Tables 5-6 and 5-7 list the properties and methods of the input field object, along with the form controls for which they are available.

Property	Description	Form controls
`accept`	Sets or returns a comma-separated list of MIME types that can be uploaded	File boxes
`accessKey`	Sets or returns a keyboard shortcut that users can press to jump to a control, or select and deselect a control	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`alt`	Sets or returns alternate text for an image	Image submit buttons
`checked`	Sets or returns the checked status of a check box or radio button	Check boxes, radio buttons
`defaultChecked`	Determines the control that is checked by default in a check box group or radio button group	Check boxes, radio buttons

Table 5-6 Input field object properties and their associated form controls *(continues)*

(continued)

Property	Description	Form controls
`defaultValue`	Sets or returns the default text that appears in a form control	Text boxes, password boxes, file boxes
`disabled`	Sets or returns a Boolean value that determines whether a control is disabled	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`form`	Returns a reference to the form that contains the control	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`maxLength`	Sets or returns the maximum number of characters that can be entered into a field	Text boxes, password boxes
`name`	Sets or returns the value assigned to the element's `name` attribute	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`readOnly`	Sets or returns a Boolean value that determines whether a control is read only	Text boxes, password boxes
`size`	Sets or returns a field's width (in characters)	Text boxes, password boxes
`src`	Sets or returns the URL of an image	Image submit buttons
`tabIndex`	Sets or returns a control's position in the tab order	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`type`	Returns the type of input element: button, check box, file, hidden, image, password, radio, reset, submit, or text	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes
`useMap`	Sets or returns the name of an image map	Image submit buttons
`value`	Sets or returns the value of form controls	Check boxes, radio buttons, reset buttons, submit buttons, image submit buttons, text boxes, password boxes, file boxes, hidden text boxes

Table 5-6 Input field object properties and their associated form controls

Method	Description	Form controls
`blur()`	Removes focus from a form control	Check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes
`click()`	Activates a form control's click event	Check boxes, radio buttons, reset buttons, submit buttons
`focus()`	Changes focus to a form control	Check boxes, radio buttons, reset buttons, submit buttons, text boxes, password boxes, file boxes
`select()`	Selects the text in a form control	Text boxes, password boxes, file boxes

Table 5-7 Input field object methods and their associated form controls

You will use several of the input field object properties and methods in this chapter. One property you have already used is the `value` property. Recall that in Chapter 3 you created a quiz using a form. The Web page included a script with the following statement that displayed the number of questions that were answered correctly:

```
document.quiz.score.value="You scored "
     + totalCorrect+ " out of 5 answers correctly!";
```

The preceding statement uses the `Document` object to set the `value` property in a control named `score` located in a form named `quiz`. The following code shows the same statement, but this time it uses the `forms[]` and `elements[]` arrays to set the value in the text box:

```
document.forms[0].elements[0].value="You scored "
     + totalCorrect+ " out of 5 answers correctly!";
```

Text Boxes

An `<input>` element with a type of "text" (`<input type="text" />`) creates a simple **text box** that accepts a single line of text. When used with a text box, the `value` attribute specifies text to be used as the default value at the moment a form first loads. The following code shows an example of some text boxes that include `name`, `value`, and `size` attributes. Figure 5-5 shows the form in a Web browser.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p>Name<br />
<input type="text" name="name" value="Office of the Mayor"
     size="50" /></p>
<p>Address<br />
```

```
<input type="text" name="address"
     value="City Hall"
     size="50" /></p>
<p>City, State, Zip<br />
<input type="text" name="city" value="New York" size="30" />
<input type="text" name="state" value="NY" size="2"
     maxlength="2" />
<input type="text" name="zip" value="38116" size="10"
     maxlength="10" /></p>
</form>
```

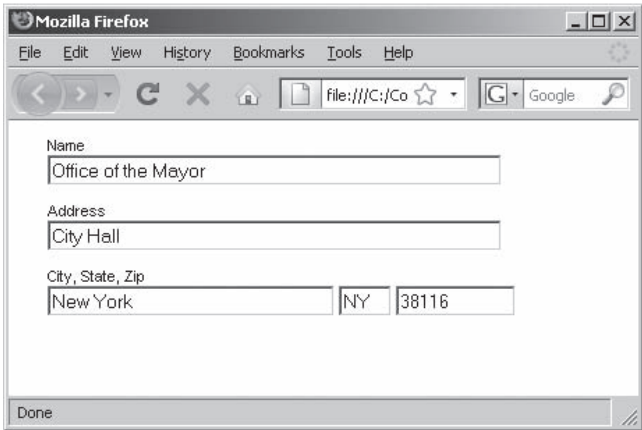


Figure 5-5: Form with several text `<input>` elements

Next, you add text `<input>` elements to the Subscription form to collect basic customer data.

To add text `<input>` elements to the Subscription form:

1. Return to the **subscription.html** document in your text editor.

2. Above the paragraph element containing the Submit and Reset buttons, add the following table to contain the billing and shipping information text boxes. The table will consist of a single row containing two cells.

```
<table border="0">
</table>
```

3. Within the table, add the following text `<input>` elements, which will be used to gather a customer's billing information and shipping information. The left cell contains the

billing information, and the right cell contains the shipping information.

```
<tr>
     <td valign="top">
          <h3>
               Billing Information</h3>
          <p>
               Name<br />
               <input type="text" name=
               "name_billing"
                    size="56" /></p>
          <p>
               Address<br />
               <input type="text" name=
               "address_billing"
                    size="56" /></p>
          <p>
               City, State, Zip<br />
               <input type="text" name=
               "city_billing" size="34" />
               <input type="text" name=
               "state_billing" size="2"
                    maxlength="2" />
               <input type="text" name=
               "zip_billing" size="10"
                    maxlength="10" /></p>
     </td>
     <td> </td>
     <td valign="top">
          <h3>
               Shipping Information</h3>
          <p>
               Name<br />
               <input type="text" name=
               "name_shipping"
                    size="56" /></p>
          <p>
               Address<br />
               <input type="text" name=
               "address_shipping"
                    size="56" /></p>
          <p>
               City, State, Zip<br />
               <input type="text" name=
               "city_shipping"
                    size="34" />
               <input type="text" name=
               "state_shipping"
                    size="2" maxlength="2" />
               <input type="text" name=
               "zip_shipping"
                    size="10" maxlength="5" /></p>
     </td>
</tr>
```

4. After the closing </table> tag, add the following elements for the telephone number:

```
<p>
     Telephone</p>
<p>
     (<input type="text" name="area"
         size="3" maxlength="3" />)
     <input type="text" name="exchange"
         size="3" maxlength="3" />
     <input type="text" name="phone"
         size="4" maxlength="4" /></p>
```

5. Save the **subscription.html** document and then open it in your Web browser. The text <input> elements you entered should appear as shown in Figure 5-6.

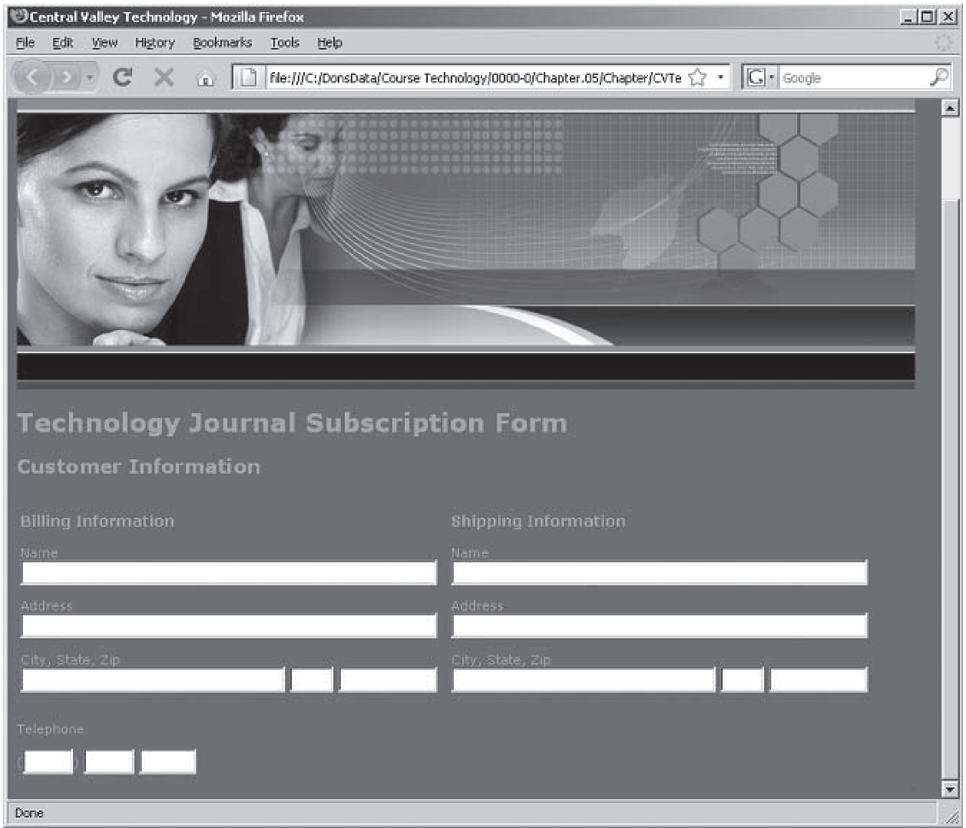


Figure 5-6 Subscription form after adding text <input> elements

6. Close your Web browser window.

Most form validation with JavaScript takes place when you submit the form. You will learn how to accomplish this kind of validation at the end of this chapter. However, there are some tricks you can use to ensure that users enter the correct information in the first place. For any fields that require numeric values, for instance, you can use JavaScript's built-in `isNaN()` function to determine whether the value entered by the user is a number. Recall from Chapter 3 that the `isNaN()` function determines whether a value is the special value NaN (not a number). The `isNaN()` function returns a value of true if the value passed to it is not a number and a value of false if the value passed to it is a number. The following function shows a statement that passes the value of a text box named "subtotal" in the first form on a Web page to the `isNaN()` function:

```
isNaN(document.forms[0].subtotal.value);
```

Next, you will add a function to the subscription.html document that uses the `isNaN()` function to check whether a value entered into the Zip code or telephone number fields in the subscription form is a number. The function will be called from the `change` event within each field. The `change` event is called when the value in a control changes. If the value entered is not a number, then the function returns a value of false, forcing the user to enter a numeric value into the field.

In Chapter 7, you will learn how to use regular expressions to more efficiently validate submitted data.

To add a function to the subscription.html document that checks whether a value entered into the Zip code or telephone number fields in the subscription form is a number:

1. Return to the **subscription.html** document in your text editor.

2. Add the following script section to the end of the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Add the following `checkForNumber()` function to the script section in the document head. The function checks whether the argument passed to it is a number. If it is not a number, an alert message is displayed and the function returns a value of false to prevent the `blur` event from occurring. Otherwise, the function returns a value of true, allowing the `blur` event to occur.

```
function checkForNumber(fieldValue) {
    var numberCheck = isNaN(fieldValue);
    if (numberCheck == true) {
        window.alert("You must enter a ↵
            numeric value!");
        return false;
    }
```

```
            else
                    return true;
    }
```

4. Next, add the following onblur event handler to the <input> elements for the two Zip code fields and the three telephone number fields. Notice that the function is passed a value of this.value, which uses the this reference to refer to the value property of the current form element.

```
onblur="return checkForNumber(this.value);"
```

5. Save the **subscription.html** document and then open it in your Web browser. Test the validation code by entering some nonnumeric numbers into the area code and telephone number fields.

6. Close your Web browser window.

Password Boxes

An <input> element with a type of "password" (<input type="password" />) creates a **password box** that is used for entering passwords or other types of sensitive data. Each character that a user types in a password box appears as an asterisk or bullet, depending on the operating system and Web browser, in order to hide the password from anyone who may be looking over the user's shoulder. The following code creates a password box with a maximum length of eight characters. Figure 5-7 shows how the password box appears in a Web browser after the user enters some characters.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p>Please enter a password of <br />
8 characters or less:<br />
<input type="password" name="password" maxlength="8" /></p>
</form>
```

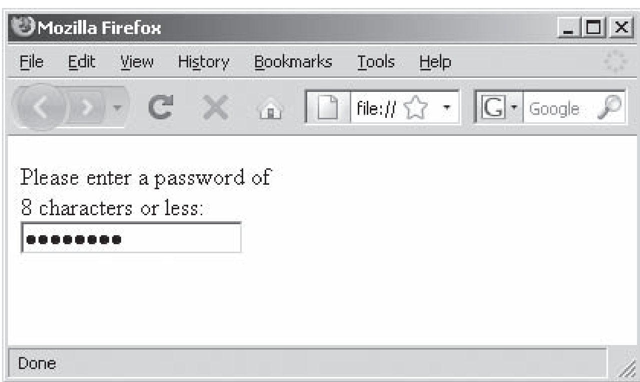


Figure 5-7 Password box in a Web browser

Next, you add a user name field and password <input> element to the subscription.html document that prompts users to enter a password required for managing subscriptions online.

To add a password <input> element to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.
2. Above the paragraph element containing the submit and reset buttons, add the following lines for the user name field and password <input> element, which prompts users for a password:

```
<p>User name<br />
<input type="text" name="userName" size="50" /></p>
<p>Password<br />
<input type="password" name="password"
    size="50" /></p>
```

3. Save the **subscription.html** document and then open it in your Web browser. Test the password field to see if the password you entered appears as asterisks or bullets. Figure 5-8 shows how the form appears after typing a password in Firefox running in Windows XP.

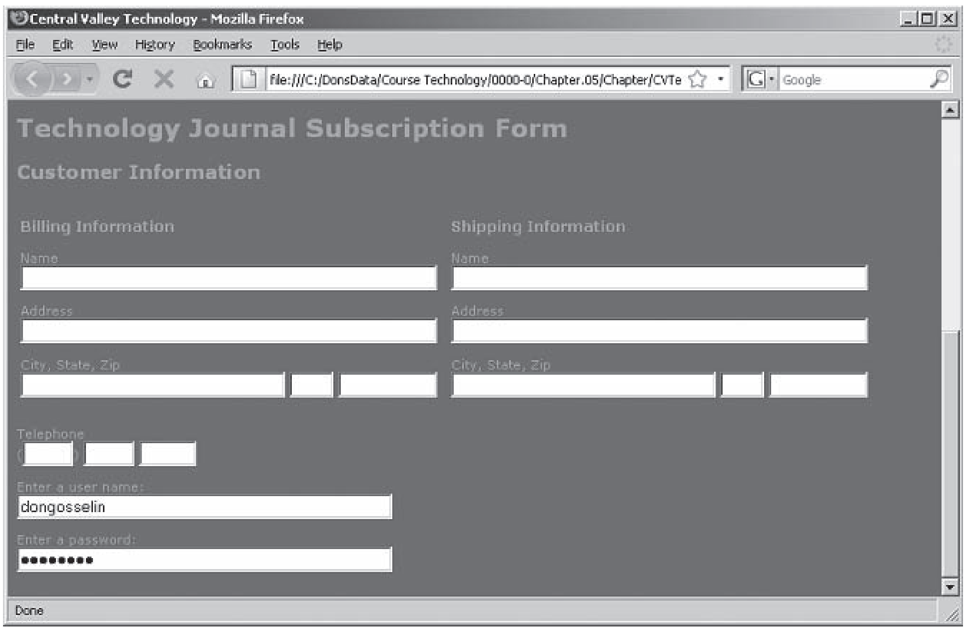


Figure 5-8 Subscription form after adding a password <input> element

4. Close your Web browser window.

You've probably had experience entering a password on a computer system and then being asked to enter the password again in a confirmation field to verify it. In JavaScript, you can check whether a user entered the same password in the password field and in the confirmation field by using an `if` statement to compare the values entered into the two fields. You will now add a password confirmation field to the subscription.html document.

To add a password confirmation field to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.
2. Above the paragraph element containing the Submit and Reset buttons at the end of the form, add the following lines for a password confirmation field. The `<input>` field includes an `onblur` event handler to call the `confirmPassword()` function.

```
<p>Confirm password<br />
<input type="password" name="password_confirm"
    size="50" onblur="confirmPassword();" /></p>
```

3. Add the following `confirmPassword()` function to the end of the script section. The function compares the values entered into both the password and password confirmation fields. If the values are not the same, then the function uses the `focus()` method to move the cursor back into the password field.

```
function confirmPassword() {
     if (document.forms[0].password_confirm.value
          !=document.forms[0].password.value) {
          window.alert("You did not enter ↵
              the same password!");
          document.forms[0].password.focus();
          }
}
```

4. Save the **subscription.html** document, and then open it in your Web browser. Test the password fields to ensure that they properly validate the entered passwords.
5. Close your Web browser window.

Push Buttons

An `<input>` element with a type of "button" (`<input type="button" />`) creates a **push button** that is similar to the OK and Cancel buttons you see in dialog boxes. You have already used push buttons in several projects in this book. Therefore, you may already understand that the primary purpose of push buttons is to execute JavaScript code that performs some type of function, such as a calculation.

Push buttons are also called “command buttons.”

You can use the `name` and `value` attributes with a push button `<input>` element. The text you assign to a push button’s `value` attribute is the text that appears on the button’s face. The width of a push button created with the `<input type="button">` element is based on the number of characters in its `value` attribute.

You are not required to include the `name` and `value` attributes, because a user cannot change the value of a push button. If you include the `name` and `value` attributes, then the default value set with the `value` attribute is transmitted to a Web server along with the rest of the form data. The following code creates a push button that uses JavaScript code to display a simple dialog box:

```
<p><input type="button" name="push_button"
    value="Click Here"
    onclick="window.alert('You clicked a push button.');" />
</p>
```

The code for the `<input>` element creates a button with a value of “Click Here” and a name of `push_button`. As shown in Figure 5-9, if you click the push button, you will see a dialog box containing the text “You clicked a push button.”

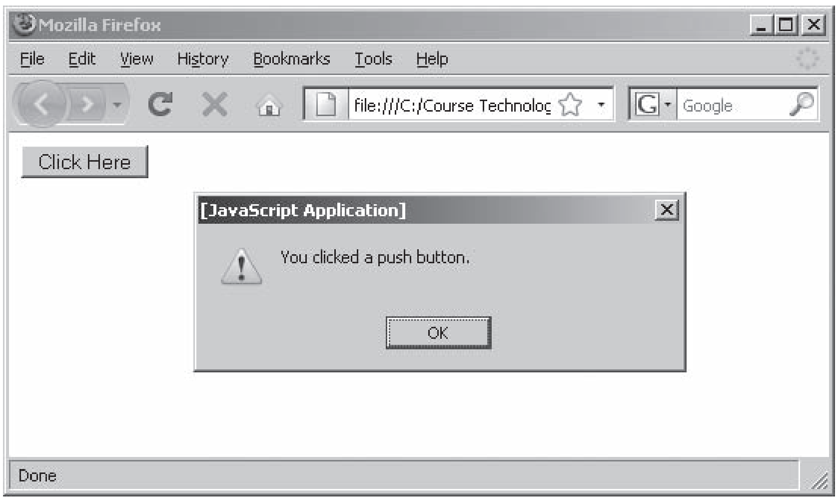


Figure 5-9 A push button in a Web browser

Radio Buttons

An `<input>` element with a type of `"radio"` (`<input type="radio" />`) is used to create a group of **radio buttons**, or **option buttons**, from which the user can select only one value. To create a group of radio buttons, all radio buttons in the group must have the same `name` attribute. Each radio button requires a `value` attribute that identifies the unique value associated with that button. Only the one selected radio button in a group creates a name=value pair when a form is submitted to a Web server. You can also include the `checked` attribute in a radio `<input>` element to set an initial value for a group of radio buttons. For example, you might have a group of radio buttons that lists the cost of journal subscriptions. One button lists the cost of a three-month subscription, another button lists the cost of a six-month subscription, and another lists the cost of a yearly subscription. In order to encourage subscribers to purchase the yearly subscription, you could include the `checked` attribute with the yearly subscription radio button. If the `checked` attribute is not included in any of the `<input type="radio">` elements in a radio button group, then none of the buttons in the group is selected when the form loads. The following code creates a group of five radio buttons. Because the married radio button includes the `checked` attribute, it is selected when the form first loads. Figure 5-10 shows how the radio buttons appear in a Web browser.

```
<form action="FormProcessor.html" method="get"
     enctype="application/x-www-form-urlencoded">
<p>What is your current marital status?<br />
<input type="radio" name="marital_status"
    value="single" />Single<br />
<input type="radio" name="marital_status"
    value="married" checked="checked" />Married<br />
<input type="radio" name="marital_status"
    value="divorced" />Divorced<br />
<input type="radio" name="marital_status"
    value="separated" />Separated<br />
<input type="radio" name="marital_status"
    value="widowed" />Widowed</p>
</form>
```

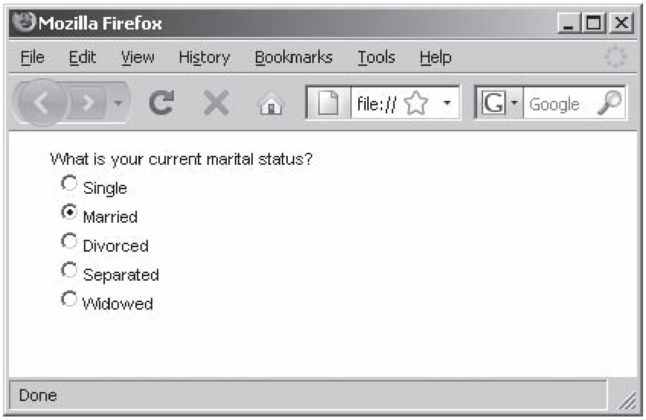


Figure 5-10 Form with radio buttons

Next, you add radio buttons to the subscription.html document that allow users to select their desired delivery option. The radio buttons you add are created within a table in order to make it easier to align the radio buttons on the page.

To add radio buttons to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.

2. Add the following `<h3>` element and opening `<table>` element and the table's header information to the end of the form but above the paragraph element containing the submit and reset buttons:

```
<h3>Delivery Rates</h3>
<table border="0">
<colgroup align="left" width="100" />
<colgroup span="4" align="center" width="100" />
<tr><th>6 issues</th>
<th>12 issues</th>
<th>18 issues</th>
<th>24 issues</th></tr>
```

3. Next, add the following table row elements for payment options by number of issues. Notice that each radio button's `name` attribute is assigned the same name of "delivery" so that the radio buttons are part of the same group.

```
<tr><td><input type="radio" name="delivery"
     value="17.50" />$17.50</td>
<td><input type="radio" name="delivery"
     value="26.95" />$26.95</td>
<td><input type="radio" name="delivery"
     value="32.90" />$32.90</td>
<td><input type="radio" name="delivery"
     value="46.00" />$46.00</td></tr>
```

4. Type the closing **</table>** tag.

5. Save the **subscription.html** document, and then open it in your Web browser. Test the radio buttons to verify that you can select only a single button at a time. Figure 5-11 shows how the radio buttons appear in a Web browser.

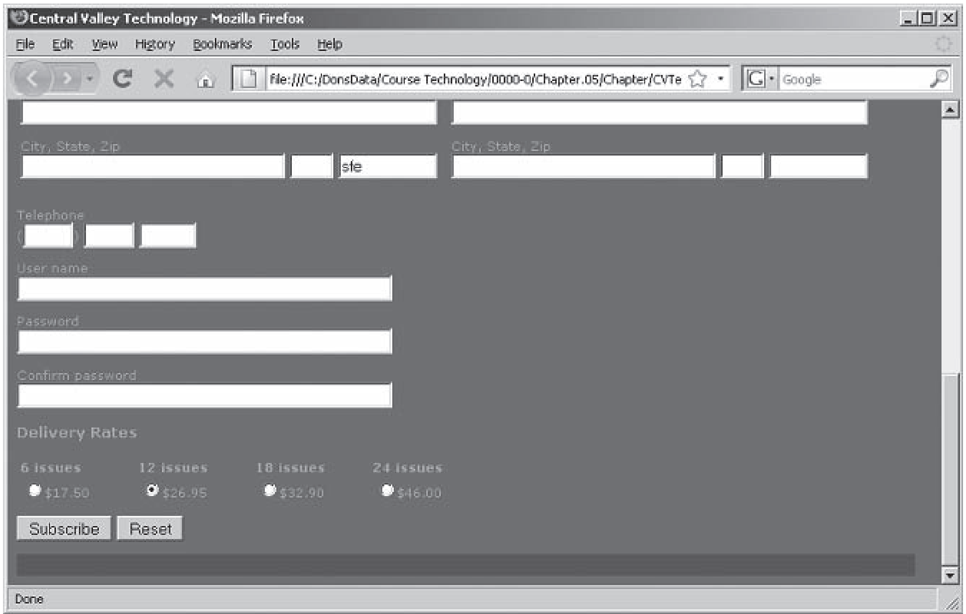


Figure 5-11 Subscription form after adding radio buttons

6. Close your Web browser window.

When multiple form elements share the same name, JavaScript creates an array out of the elements using the shared name. Radio buttons, for instance, share the same name so that a single name = value pair can be submitted to a server-side script. For example, assume that you have a group of radio buttons named `maritalStatus`. You can use the following statement to access the value of the second radio button in the group:

```
document.forms[0].maritalStatus[1].value;
```

When you have an array that is created from a group of buttons that shares the same name, you can use the `checked` property to determine which element in a group is selected. The `checked` property returns a value of true if a check box or radio button is selected, and a value of false if it is not. If you have a group of radio buttons named `maritalStatus`, then you can use a statement similar to the following to determine if the first radio button in the group is selected:

```
document.forms[0].maritalStatus[0].checked;
```

Next, you will add another group of radio buttons to the subscription form. The group contains two buttons, Monthly ($8.95) and Yearly ($19.95), which determine whether the customer wants to be automatically billed on a monthly or yearly basis, rather than pay for a specific number of issues. When the user selects a button, any selected radio button in the payment per number of issues group should be deselected. In order to deselect a radio button in a group, you need to loop through the array that represents the group and assign a value of false to the checked button.

To add monthly and yearly subscription radio buttons to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.

2. Add the following radio buttons for automatic renewal above the paragraphs containing the submit and reset buttons. The buttons call an `onclick` event handler named `billAutomatically()`, which you will create next.

```
<p>
     <strong>Automatic Renewal</strong>:
     <input type="radio" name="autoRenew"
     onclick="billAutomatically();" />
     Monthly ($8.95)
     <input type="radio" name="autoRenew"
     onclick="billAutomatically();" />
     Yearly ($19.95)
</p>
```

3. Add the following two functions to the end of the script section. The `billAutomatically()` function disables any selected radio button in the payment per number of issues group, and the `billByIssue()` function disables the selected radio button in the automatic renewal group.

```
function billAutomatically() {
    for (var i = 0; i < document.forms[0].delivery
        .length; ++i) {
        if (document.forms[0].delivery[i]
            .checked == true) {
            document.forms[0].delivery[i]
                .checked = false;
            break;
        }
    }
}
```

```
function billByIssue() {
    for (var i = 0; i < document.forms[0].autoRenew
        .length; ++i) {
        if (document.forms[0].autoRenew[i]
            .checked == true) {
            document.forms[0].autoRenew[i]
                .checked = false;
            break;
        }
    }
}
```


4. Add `onclick` event handlers to the radio buttons in the delivery rates group that call the `billByIssue()` function, as follows:

```
<td>
    <input type="radio" name="delivery"
        value="17.50"
        onclick="billByIssue();" />$17.50</td>
<td>
    <input type="radio" name="delivery"
        value="26.95"
        onclick="billByIssue();" />$26.95</td>
<td>
    <input type="radio" name="delivery"
        value="32.90"
        onclick="billByIssue();" />$32.90</td>
<td>
    <input type="radio" name="delivery"
        value="46.00"
        onclick="billByIssue();" />$46.00</td>
```

5. Save the **subscription.html** document, and then open it in your Web browser. Test the radio buttons to ensure that you can only select one button from either group.

6. Close your Web browser window.

Check Boxes

An `<input>` element with a type of "checkbox" (`<input type="checkbox" />`) creates a box that can be set to Yes (checked) or No (unchecked). You use **check boxes** when you want users to select whether or not to include a certain item or to allow users to select multiple values from a list of items. Include the `checked` attribute in a check box `<input>` element to set the initial value of the check box to Yes. If a check box is selected (checked) when a form is submitted, then the check box name=value pair is included in the form data. If a check box is not selected, a name=value pair is not included in the data submitted from the form.

The following code creates several check boxes. Note that the Fundraising check box is checked when the form first loads because it includes the checked attribute. Figure 5-12 shows how the check boxes appear in a Web browser.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<h3>Which committees would you like to serve on? </h3>
<p><input type="checkbox" name="committees"
     value="program_dev" />Program Development<br />
<input type="checkbox" name="committees"
     value="fundraising"
     checked="checked" />Fundraising<br />
<input type="checkbox" name="committees"
     value="pub_relations" />Public Relations <br />
<input type="checkbox" name="committees"
     value="education" />Education</p>
</form>
```

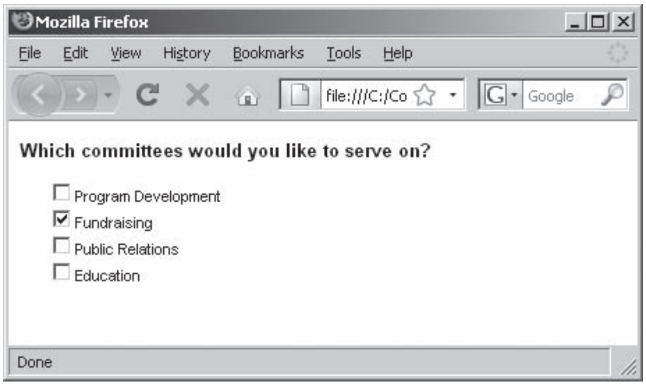


Figure 5-12 Form with check boxes

As with radio buttons, you can group check boxes by giving each check box the same name value, although each check box can have a different value. Unlike when using radio buttons, users can select as many check boxes in a group as they like. When multiple check boxes on a form share the same name, multiple name=value pairs, each using the same name, are submitted to a Web server. In the preceding example, if the Fundraising and Public Relations check boxes are selected, then two name=value pairs, committees=fundraising and committees=pub_relations, are submitted. Note that you are not required to group check boxes with the same name attribute. Although a common group name helps you to identify and manage groups of check boxes, it is often easier to keep track of individual values when each check box has a unique name attribute.

Next, you add check boxes to the subscription.html document to allow users to select the types of technology they are interested in.

To add check boxes to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.

2. Above the paragraph containing the submit and reset buttons, add the following check box elements:

```
<p>
    What technologies are you interested in?</p>
<p>
    <input type="checkbox" name="technologies"
        value="architecture" />Architecture <br />
    <input type="checkbox" name="technologies"
        value="hardware" />Hardware <br />
    <input type="checkbox" name="technologies"
        value="open_source" />Open source <br />
    <input type="checkbox" name="technologies"
        value="data" />Data management <br />
    <input type="checkbox" name="technologies"
        value="windows" />Windows<br />
    <input type="checkbox" name="technologies"
        value="mac" />Macintosh<br />
    <input type="checkbox" name="technologies"
        value="networking" />Networking
</p>
```

3. Save the **subscription.html** document, and then open it in your Web browser. Figure 5-13 shows how the check boxes appear.

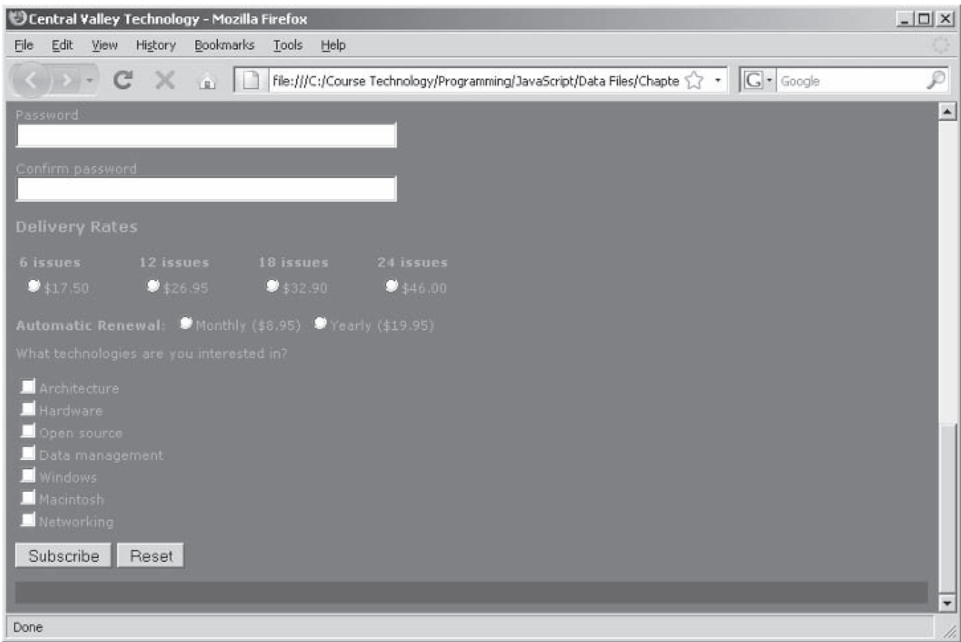


Figure 5-13 Subscription form after adding check boxes

4. Close your Web browser window.

You can use a check box element in Billing Information and Shipping Information at the top of the form in the subscription.html document. Because it is common to have the same billing and shipping address, you will add a check box element to the subscription form that copies the values of the billing information fields to the shipping information fields.

To add a check box element to the subscription form that copies the values of the billing information fields to the shipping information fields:

1. Return to the **subscription.html** document in your text editor.

2. Add the following `sameShippingInfo()` function to the end of the script section. The function uses an `if...else` statement to copy the values from the billing information fields to the shipping information fields when the check box is selected. When the check box is deselected, empty strings are assigned to the shipping information fields. Notice that the conditional expression in the `if` statement uses the `elements[]` array to refer to the check box control. You will not assign a name to the check box control because you do not want its value submitted to the Web server. Therefore, you must refer to it with the `elements[]` array.

```
function sameShippingInfo() {
     if (document.forms[0].elements[5].checked
          == true) {
          document.forms[0].name_shipping.value
               = document.forms[0].name_billing.value;
          document.forms[0].address_shipping.value
               = document.forms[0].address_billing
               .value;
          document.forms[0].city_shipping.value
               = document.forms[0].city_billing.value;
          document.forms[0].state_shipping.value
               = document.forms[0].state_billing
               .value;
          document.forms[0].zip_shipping.value
               = document.forms[0].zip_billing.value;
     }
     else {
          document.forms[0].name_shipping.value = "";
          document.forms[0].address_shipping
               .value = "";
          document.forms[0].city_shipping.value = "";
          document.forms[0].state_shipping
               .value = "";
          document.forms[0].zip_shipping.value = "";
     }
}
```

3. Now add the following check box element above the closing </td> tag for the table cell that contains the billing information fields:

```
<p><input type="checkbox"
    onclick="sameShippingInfo();" />
    Same shipping information</p>
```

4. Save the **subscription.html** document, and then open it in your Web browser. Enter some fields into the billing information fields and test the check box to see if it copies the values to the shipping information fields.

5. Close your Web browser window.

Short Quiz 2

1. What is the difference between minimized form and full form when referring to Boolean attributes in XHTML?

2. How do you use the `isNaN()` function to determine if the value entered by a user is a number?

3. What's the point of using a password box?

4. Why would you use the `name` and `value` attributes with a push button?

5. How do you create a group of radio buttons?

Creating Selection Lists

The **`<select>` element** creates a **selection list** that presents users with fixed lists of options from which to choose. The options displayed in a selection list are created with `<option>` elements, which you will study next. As with other form elements that create controls, the `<select>` element must appear within a block-level element such as the `<p>` element. The selection list can appear as an actual list of choices or as a drop-down menu. Depending on the number of options in the list, a selection list can also include a scroll bar. Table 5-8 lists the attributes of the `<select>` element.

Attribute	Description
`disabled`	Disables the selection list
`multiple`	Specifies whether a user can select more than one option from the list; a Boolean attribute
`name`	Designates a name for the selection list
`size`	Determines how many lines of the selection list appear

Table 5-8 Attributes of the `<select>` element

Like other form controls, the `<select>` element includes a `name` attribute that is submitted to a Web server. However, the value portion of a `<select>` element's name=value pair is the value assigned to an option that is created with the `<option>` element (which you study next). If a `<select>` element includes the Boolean `multiple` attribute, which specifies whether a user can select more than one option from the list, and a visitor selects more than one option in the list, then multiple name=value pairs for the `<select>` element are submitted with the form. Each instance of a `<select>` element's name=value pair includes a value assigned to one of the selected list options created with the `<option>` element.

The `size` attribute designates how many lines of the selection list appear when the form is rendered in a Web browser. If this attribute is excluded or set to 1, and the `<select>` element does not include the `multiple` attribute, then the selection list is a drop-down style menu. For drop-down style menus, the first option element is automatically selected.

Menu Options

You use **`<option>` elements** to specify the options that appear in a selection list. The content of an `<option>` element appears as a menu option in a selection list. Table 5-9 lists the attributes of the `<option>` element.

Attribute	Description
`disabled`	Disables the option
`label`	Designates alternate text to display in the selection list for an individual option
`selected`	Determines if an option is initially selected in the selection list when the form first loads; a Boolean attribute
`value`	Specifies the value submitted to a Web server

Table 5-9 Attributes of the `<option>` element

You specify a selection list's menu options using <option> elements placed within a <select> element. Each selection list must contain at least one <option> element. For example, the following code creates two selection lists. Figure 5-14 shows the code in a Web browser. Notice that because the first list's <select> element includes the multiple attribute, you can select multiple options, as shown in the figure. Also notice that "All" is the selected value in the first list and the "$2,000 to $2,999" option is the selected value in the second list.

```
<h1>Central Valley Appliances</h1>
<h2>Televisions</h2>
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<table border="0">
<tr><td style="background:white;border:0"><strong>
Brand</strong></td>
<td style="background:white;border:0"><strong>
Price Range</strong></td></tr>
<tr><td>
<select name="brand" multiple="multiple" size="6">
<option value="all" selected="selected">All</option>
<option value="hitachi">Hitachi</option>
<option value="magnovox">Magnovox</option>
<option value="panasonic">Panasonic</option>
<option value="samsung">Samsung</option>
<option value="sharp">Sharp</option>
<option value="sony">Sony</option>
</select></td>
<td>
<select name="price" size="6">
<option value="199">Under $200</option>
<option value="499">$200 to $499</option>
<option value="999">$500 to $999</option>
<option value="1999">$1,000 to
$1,999</option>
<option value="2999" selected="selected">$2,000 to
$2,999</option>
<option value="3000_plus">Over $3,000</option>
</select></td></tr></table></form>
```

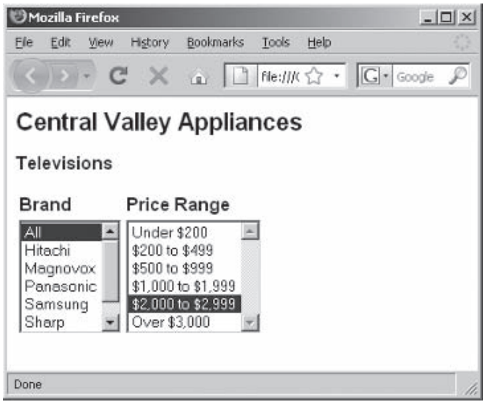


Figure 5-14 Two selection lists

Next, you add a selection list to the subscription.html document that a subscriber uses to select his or her job title.

To add a selection list to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.
2. Add the following selection list above the paragraph that contains the submit and reset buttons:

```
<p>What is your job title?</p>
<p><select name="jobTitle">
<option value="itStaff">IT staff</option>
<option value="consultant">Technical consultant
</option>
<option value="integrator">Systems integrator
</option>
<option value="manager">Manager</option>
<option value="director">Director</option>
<option value="vp">Vice President</option>
<option value="seniorManagement">CIO, CTO,
CSO, CEO, COO, Chairman, President</option>
<option value="other">Other</option>
</select></p>
```

3. Save the **subscription.html** document, and then open it in your Web browser. You should see the selection list at the bottom of the page. Because you did not include `size` and `multiple` attributes in the `<select>` element, the selection list appears as a drop-down menu.
4. Close your Web browser window.

The `Select` and `Option` Objects

The **`Select` object** represents a selection list in a form. The `Select` object includes an `options[]` array containing an `Option` object for each `<option>` element in the selection list. The **`Option` object** represents an option in a selection list. You use the `Select` and `Option` objects with JavaScript to manipulate the options displayed in a selection. The `Select` object contains the properties listed in Table 5-10 and the methods listed in Table 5-11.

Property	Description
`disabled`	Sets or returns a Boolean value that determines whether a control is disabled
`form`	Returns a reference to the form that contains the control
`length`	Returns the number of elements in the `options[]` array
`multiple`	Sets or returns a Boolean value that determines whether multiple options can be selected in a selection list
`name`	Sets or returns the value assigned to the element's name attribute
`options[]`	Returns an array of the options in a selection list
`selectedIndex`	Returns a number representing the element number in the `options[]` array of the first option selected in a selection list; returns -1 if No option is selected
`size`	Sets or returns the number of options to display
`tabIndex`	Sets or returns a control's position in the tab order
`type`	Returns the type of selection list; returns "select-one" if the `<select>` element does not include the `multiple` attribute, or it returns "select-multiple" if the `<select>` element does include the `multiple` attribute

Table 5-10 Properties of the `Select` object

Method	Description
`add(`*`element, before`*`)`	Adds a new option to a selection list
`blur()`	Removes focus from a form control
`focus()`	Changes focus to a form control
`remove(`*`index`*`)`	Removes an option from a selection list

Table 5-11 Methods of the `Select` object

You append the properties in Table 5-10 to the name representing the `<select>` element. For example, for the selection list you saw earlier with a `name` attribute of "brand", you use the following statement to assign the number of elements in the selection list to a variable named `numItems`:

```
var numItems = document.forms[0].brand.length;
```

Similarly, the following statement assigns the currently selected option in the selection list to a variable named `curSelection`:

```
var curSelection = document.forms[0].brand.selectedIndex;
```

If the `size` attribute is excluded or set to 1, and the `<select>` element does not include the `multiple` attribute, then the selection list is a drop-down style menu. For drop-down style menus, the first option element is automatically selected. However, for `<select>` elements that assign a value greater than 1 to the `size` attribute or that include the `multiple` attribute, to determine whether an option is selected in a selection list, you need to test whether the `selectedIndex` property contains a value of -1. If it does, then no option is selected. For example, the following code tests whether an option is selected in the `brand` selection list:

```
if (document.forms[0].brand.selectedIndex == -1)
     window.alert("No option is selected.");
else
     window.alert("An option is selected.");
```

The `Option` object contains the properties listed in Table 5-12.

Property	Description
`defaultSelected`	Returns a Boolean value that determines whether the `<option>` element representing the currently selected item includes the `selected` attribute
`disabled`	Sets or returns a Boolean value that determines whether a control is disabled
`form`	Returns a reference to the form that contains the control
`index`	Returns a number representing the element number within the `options[]` array
`label`	Sets or returns alternate text to display for the option in the selection list
`selected`	Sets or returns a Boolean value that determines whether an option is selected

Table 5-12 Properties of the `Option` object (*continues*)

(continued)

Property	Description
`text`	Sets or returns the text displayed for the option in the selection list
`value`	Sets or returns the text that is assigned to the `<option>` element's value attribute; this is the value that is submitted to the server

Table 5-12 Properties of the `Option` object

You append the properties in Table 5-12 to the `options[]` array. For example, the following code tests whether the first element in the `options[]` array for the `brand` selection list is selected:

The `Option` objects do not contain methods.

```
if (document.forms[0].brand.options[0].selected == true)
     window.alert("The first option is selected.");
else
     window.alert("The first option is not selected.");
```

Adding Options to a Selection List

Although the current ECMAScript recommendations suggest using the `add()` method of the `Select` object to add new options to a selection list, this method is not consistently implemented in current Web browsers. For instance, according to the ECMAScript recommendations, you should be able to add a new option to the end of a selection list by passing a value of null as the second parameter of the `add()` method. While this works in Firefox 2.0, it will not work in Internet Explorer 7.0 unless you eliminate the second parameter altogether from the function call. Similarly, you should be able to pass an integer as the second parameter to indicate which element the new element should be added before. Conversely, while this works in Internet Explorer 7.0, it does not appear to work in Firefox 2.0. Until this method is consistently available, you should avoid using it to add a new option to a selection list. Instead, to add a new option to a selection list after a Web page renders it, you must create a new option with the `Option()` constructor. Creating a new option with the `Option()` constructor is similar to creating an array with the `Array()` constructor. The syntax for the `Option()` constructor is as follows:

```
var variable_name = new Option(text, value,
     defaultSelected, selected);
```

Notice that the arguments passed to the `Option()` constructor match several of the properties of the `Option` object listed in Table 5-12.

The arguments allow you to set the properties of the new option in a single statement. For example, the following statement declares a new option and assigns values to each of the properties of the `Option` object:

```
var gardeningItem = new Option("mulch", "mulch",
     false, false);
```

The preceding statement creates a new `Option` object represented by the `gardeningItem` variable, and assigns values to the object's properties. You can also assign values to the properties after the new `Option` object is created. The following code performs the same tasks as the preceding statement:

```
var gardeningItem = new Option();
gardeningItem.text = "mulch";
gardeningItem.value = "mulch";
```

You do not have to assign values to all of the properties of a new `Option` object; you only need to assign values to the properties you need.

After you create a new `Option` object and assign values to its properties, you assign the object to an empty element in an `options[]` array. For example, to assign the `Option` object created in the preceding code to the third element in an `options[]` array in a selection list named `gardeningList`, you use the following statement:

```
document.forms[0].gardeningList.options[2] = gardeningItem;
```

Next, you add code to the subscription.html document that allows subscribers to build a selection of the technology journals to which they are currently subscribed.

To add code to the subscription.html document that allows subscribers to build a selection of the technology journals to which they are currently subscribed:

1. Return to the **subscription.html** document in your text editor.

2. Add the following elements above the paragraph that contains the submit and reset buttons. The first element is a text box where users can enter the name of a journal to which they subscribe. Note that the text box does not include a `name` argument; this prevents the field value from being submitted along with the rest of the form data. The Add Journal button includes an `onclick` event handler that calls a function named `addJournal()`, which you will add next. In order for the document to be well formed, the `<select>` element must include at least one `<option>` element. Therefore, you add a single `<option>` element that displays "Enter the technologies journals you subscribe to" in the selection list. In the next section, you will add code to the `addJournal()` function that deletes this unnecessary element when the subscriber adds a journal to the selection list.

```
<p>Journal <input type="text" size="68" /></p>
<p><input type="button" value="Add Journal"
onclick="addJournal();" style="width: 120px" /></p>
<p><select name="journals" multiple="multiple"
     size="10" style="width: 500px">
<option value="none">Enter the technologies
journals you subscribe to</option>
</select></p>
```


3. Add the following `addJournal()` function to the end of the script section. Notice that the code uses the `elements[]` array to refer to the text box where users enter the names of journals to which they subscribe; this is necessary because the text box does not include a `name` argument. (Again, the lack of the name argument prevents the contents of the text box from being submitted with the other form data.) Also notice how the function determines where to add the new item in the `options[]` array. The number of items in the `options[]` array is retrieved using the `Select` object's `length` property and assigned to a variable named `nextItem`. The value assigned to the `nextItem` variable represents the number of elements in the array. As you'll recall, the length of the array is one more than the number of elements in the array (because the array begins with an element of 0). That means you can use the value to identify the next available element.

```
function addJournal() {
     if (document.forms[0].elements[31].value == "")
          window.alert("You must enter a ↵
               journal name.");
     else {
          var journal = new Option();
          journal.text = document.forms[0]
               .elements[31].value;
          journal.value = document.forms[0]
               .elements[31].value;
          nextItem = document.forms[0].journals.length;
          document.forms[0].journals.options[nextItem]
               = journal;
          document.forms[0].elements[31].value = "";
     }
}
```

4. Save the **subscription.html** document, and then open it in your Web browser. Scroll to the end of the Web page and try adding some journals to the journal list. One problem you may notice is that the "Enter the journals you subscribe to" option remains in the selection list after the user adds journals. You will fix this in the next section.

5. Close your Web browser window.

Removing Options from a Selection List

To remove a single option from a selection list, you pass the option's index number in the `options[]` array to the `remove()` method of the `Select` object. For example, use the following statement to remove the first element in the `options[]` array of the `gardeningList` selection list.

```
document.forms[0].gardeningList.remove(0);
```

When you remove an element from the `options[]` array using a statement similar to the preceding statement, the remaining elements are reordered. In other words, all of the element numbers following the deleted element are decreased by a value of one.

You can remove all the options from an options array by appending the `Selection` object's `length` property to the `options[]` array without the brackets, and then by assigning the `length` property a value of 0. For example, to remove all the options in the `options[]` array of the `gardeningList` selection list, you use the following statement:

```
document.forms[0].gardeningList.options.length=0;
```

Next, you add code to the subscription.html document that deletes journal names from the selection list.

To add code to the subscription.html document that deletes journal names from the selection list:

1. Return to the **subscription.html** document in your text editor.

2. Add the following elements to the end of the <p> element that contains the Add Journal button. The Delete Journal button includes an `onclick` event handler, which calls a function named `deleteJournal()`. You will add this function next. To the `onclick` event handler in the Clear List button, you will assign a statement that deletes all the items in the list.

```
<input type="button" value="Delete Journal"
onclick="deleteJournal()" style="width: 120px" />
<input type="button" value="Clear List"
onclick="document.forms[0].journals ↵
     .options.length = 0;"
style="width: 120px" />
```

3. Add the following `deleteJournal()` function to the end of the script section. The function is very familiar to the `deleteItem()` function you saw in the shopping list form.

```
function deleteJournal() {
     var selectedItem =
         document.forms[0].journals.selectedIndex;
```

```
        if (selectedItem == -1)
             window.alert("You must select a ↵
                 journal name in the list.");
        else
             document.forms[0].journals
                 .remove(selectedItem);
   }
```

4. Finally, add the following `if` statement to the beginning of the `else` statement in the `addJournal()` function. This statement deletes the "Enter the technologies journals you subscribe to" option that is displayed by default in the selection list.

```
if (document.forms[0].journals.options[0]
     && document.forms[0].journals
     .options[0].value == "none")
     document.forms[0].journals.options[0] = null;
```

5. Save the **subscription.html** document, and then open it in your Web browser. Scroll to the end of the Web page and try adding some journals to the journal list. After you add the first journal, "Enter the technologies journals you subscribe to" should be removed from the list. Also, test the Delete Journal and Clear List buttons.

6. Close your Web browser window.

Changing Options in a Selection List

To change an option in a selection list, you simply assign new values to the option's `value` and `text` properties. For example, use the following statements to change the value of the first option in the `gardeningList` selection list from "Pruners" to "Mulch":

```
document.forms[0].gardeningList.options[0].value = "Mulch";
document.forms[0].gardeningList.options[0].text = "Mulch";
```

The following shows a completed example of the shopping list to which you can add new items. An Add Item button in the form calls a function named `addItem()`, which adds new items to the selection list. A new `Option` object named `gardeningItem` is created, and its text and value properties are assigned the value of the first text box in the form. A function named `deleteItem()`, which is called from the Delete Item button, handles deleting single items from the list. The `onclick` event handler in the Clear List button is assigned a statement that deletes all of the items in the list. A function named `changeItem()` changes the value of a selected item in the list to the value in the New Item text box. Figure 5-15 shows how the form appears in a Web browser.

```
<script type="text/javascript">
/* <![CDATA[ */
function addItem() {
     if (document.forms[0].elements[0].value == "")
          window.alert("You must enter an item.");
     else {
          var gardeningItem = new Option();
          gardeningItem.text = document.forms[0]
               .elements[0].value;
          gardeningItem.value = document.forms[0]
               .elements[0].value;
          nextItem = document.forms[0].gardeningList
               .length;
          document.forms[0].gardeningList
               .options[nextItem] = gardeningItem;
          document.forms[0].elements[0].value = "";
     }
}
function deleteItem() {
     var selectedItem
          = document.forms[0].gardeningList.selectedIndex;
     if (selectedItem == -1)
          window.alert("You must select an item ↵
               in the list.");
     else
          document.forms[0].gardeningList
               .options[selectedItem] = null;
}
function changeItem() {
     var selectedItem= document.forms[0].gardeningList
          .selectedIndex;
     if (selectedItem == -1)
          window.alert("You must select an item in ↵
               the list.");
     document.forms[0].gardeningList
          .options[selectedItem].value
          = document.forms[0].elements[0].value;
     document.forms[0].gardeningList
          .options[selectedItem].text
          = document.forms[0].elements[0].value;
}
/* ]]> */
</script>
</head>
<body>
<h1>Spring Planting</h1>
<h2>Gardening List</h2>
<form action="">
```

```
<p>New Item <input type="text" size="68"
name="elements[0]" /></p>
<p><input type="button" value="Add Item"
onclick="addItem()"
style="width: 120px" />
<input type="button" value="Delete Item"
onclick="deleteItem()"
style="width: 120px" />
<input type="button" value="Clear List"
onclick="document.forms[0].gardeningList.options ↵
     .length=0;"
style="width: 120px" />
<input type="button" value="Change Item"
onclick="changeItem()"
style="width: 120px" /></ p>
<p><select name="gardeningList" size="10"
style="width: 500px">
<option value="pruners">Pruners</option>
<option value="seeds">Seeds</option>
</select></p>
</form>
```

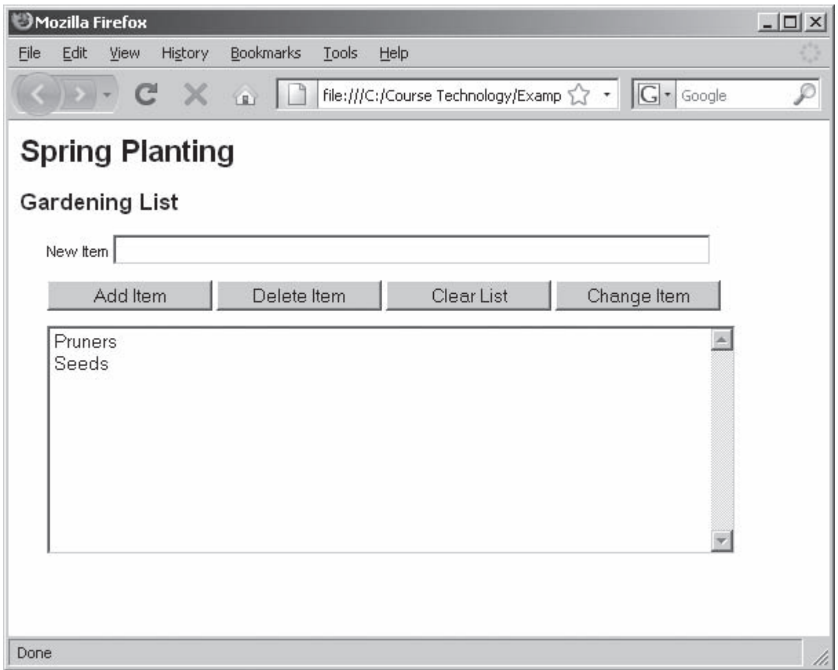



Figure 5-15 Shopping list form

Next, you add code to the subscription.html document that modifies journal names in the selection list.

To add code to the subscription.html document that modifies journal names in the selection list:

1. Return to the **subscription.html** document in your text editor.

2. Add the following elements to the end of the <p> element that contains the other buttons that build the list of journals. The Change Journal button includes an `onclick` event handler, which calls a function named `changeJournal()`. You will add this function next.

```
<input type="button" value="Change Journal"
onclick="changeJournal()" style="width: 120px" />
```

3. Add the following `changeJournal()` function to the end of the script section. The function is very similar to the `changeItem()` function you saw in the shopping list form.

```
function changeJournal() {
     var selectedItem =
          document.forms[0].journals.selectedIndex;
     if (selectedItem == -1)
          window.alert("You must select a journal↵
                 name in the list.");
     else {
               document.forms[0].journals
                    .options[selectedItem].value
                    = document.forms[0]
                    .elements[31].value;
               document.forms[0].journals
                    .options[selectedItem].text
                    = document.forms[0]
                    .elements[31].value;
     }
}
```

4. Save the **subscription.html** document and then open it in your Web browser. Scroll to the end of the Web page and try adding and changing some journals in the journal list. Figure 5-16 shows how the document appears.

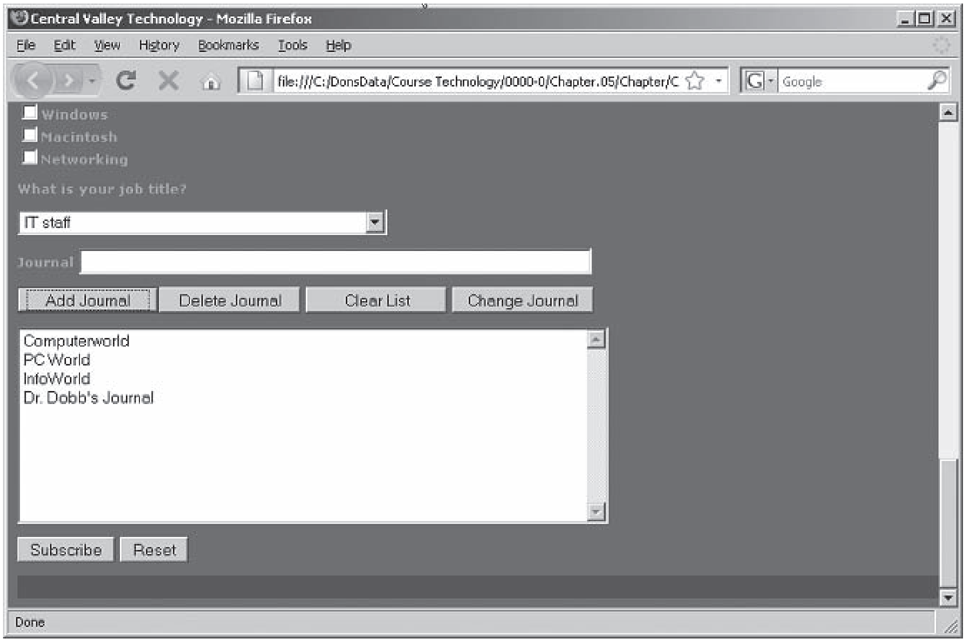


Figure 5-16 Subscription form with a selection list

5. Close your Web browser window.

Short Quiz 3

1. How do you create a selection list with the `<select>` element?
2. How do you use the Select object to manipulate selection lists with JavaScript?
3. How do you add options to a selection list with JavaScript?
4. How do you remove options in a selection list with JavaScript?
5. How do you change options in a selection with JavaScript?

Validating Submitted Data

In Chapter 3, you learned about many of the event handlers that can be used in JavaScript. Two additional event handlers, `onsubmit` and `onreset`, are available for use with the `<form>` element. The **`onsubmit` event handler** executes when a form is submitted to a server-side script (in other words, when a submit button is selected on a form). The `onsubmit` event handler is often used to verify or validate a form's data before it is sent to a server. The **`onreset` event handler** executes when a reset button is selected on a form. You use the `onreset` event handler to confirm that a user really wants to reset the contents of a form. Both the `onsubmit` and `onreset` event handlers are placed before the closing bracket of an opening `<form>` tag. The following code shows how a form tag with `onsubmit` and `onreset` event handlers is written:

```
<form action="FormProcessor.html" method="post"
     onsubmit="JavaScript statements;"
     onreset="JavaScript statements;">
```

The `onsubmit` and `onreset` event handlers must return a value of true or false, depending on whether the form should be submitted (true) or reset (false). For example, the `onsubmit` and `onreset` event handlers in the following code return values of true or false, depending on whether the user clicks the OK button or the Cancel button in the Confirm dialog box. If the user clicks the OK button, the Confirm dialog box returns a value of true, and the `onsubmit` or `onreset` event executes. If the user clicks the Cancel button, the Confirm dialog box returns a value of false, and the `onsubmit` or `onreset` event does not execute.

Remember that the Confirm dialog box returns a value of true if the user clicks the OK button and false if the user clicks the Cancel button.

```
<form action="FormProcessor.html" method="post"
     onsubmit="return window.confirm('Are you sure ↵
          you want to submit the form?');"
     onreset="return window.confirm('Are you sure ↵
          you want to reset the form?');">
```

Next, you will add `onsubmit` and `onreset` event handlers to the subscription.html document to confirm that the user really wants to submit or reset the form.

To add `onsubmit` and `onreset` event handlers to the subscription.html document:

1. Return to the **subscription.html** document in your text editor.
2. Add the following `confirmSubmit()` and `confirmReset()` function to the end of the script section:

```
function confirmSubmit() {
     var submitForm=window.confirm(
        "Are you sure you want to submit the form?");
     if (submitForm == true)
            return true;
     return false;
}
```

```
function confirmReset() {
     var resetForm = window.confirm(
         "Are you sure you want to reset the form?");
     if (resetForm == true)
            return true;
     return false;
}
```


3. Before the closing bracket of the opening `<form>` tag, add the following `onsubmit` and `onreset` event handlers, which call the `confirmSubmit()` and `confirmReset()` functions:

```
onsubmit="return confirmSubmit();"
onreset="return confirmReset();"
```

4. Save the **subscription.html** document, and then open it in your Web browser. Enter some data in the form's fields and click the **Reset** button to see if you receive the warning. Click the **Cancel** button and then click the **Subscribe** button to see if you receive the warning. Click the **OK** button in the Confirm dialog box. The data you entered should appear in the FormProcessor.html document.

5. Close your Web browser window.

Although the `onsubmit` event handler is useful for confirming that a user really wants to submit a form, its most important purpose is to validate form data. The validation of form data can mean many things, ranging from simply ensuring that a field is not empty to performing complex validation of credit card numbers. You have already seen several examples of validation at the form level when you wrote code that checked whether a value entered in the Zip code or telephone number fields in the subscription form was a number. You also wrote code that confirmed that the user entered the same value in the password and password confirmation boxes. In the next section you'll learn how to perform the final step in the validation of these types of fields: ensuring that they are not empty when the form is submitted.

Validating Text and Password Boxes

To verify that text and password boxes are not empty, you can use an `if` statement in the `onsubmit` event handler that checks whether the field's value property contains a value. For example, the following code (which could be called from an `onsubmit` event handler) uses an `if` statement to check whether two text fields (`firstName` and `lastName`) contain text. If they do contain text, a value of true is returned and the form is submitted. If they do not contain text, a value of false is returned and the form is not submitted. Notice that the conditional expression uses the || (Or) operator to confirm that both fields have been filled.

```
function submitForm() {
     if (document.forms[0].firstName.value == ""
          || document.forms[0].lastName.value == "") {
          window.alert("You must enter your first ↵
               and last names!");
          return false;
     }
     else
          return true;
}
```

Next, you add code to the confirmSubmit() function in the Subscription form that validates the text and password boxes.

To add code to the confirmSubmit() function in the Subscription form that validates the text and password boxes:

1. Return to the **subscription.html** document in your text editor.

2. Replace the statements within the confirmSubmit() function with the following statements, which validate the billing fields. The conditional statement uses multiple || (Or) operators to validate all of the billing fields in one expression.

```
if (document.forms[0].name_billing.value == ""
     || document.forms[0].address_billing.value == ""
     || document.forms[0].city_billing.value == ""
     || document.forms[0].state_billing.value == ""
     || document.forms[0].zip_billing.value == "") {
     window.alert("You must enter your ↵
          billing information.");
     return false;
}
```

3. Add the following statements to the end of the confirmSubmit() function to validate the shipping fields:

```
else if (document.forms[0].name_shipping.value == ""
     || document.forms[0].address_shipping.value == ""
     || document.forms[0].city_shipping.value == ""
     || document.forms[0].state_shipping.value == ""
     ||document.forms[0].zip_shipping.value == "") {
     window.alert("You must enter your ↵
          shipping information.");
     return false;
}
```

4. Add the following statements to the end of the confirmSubmit() function to validate the telephone fields:

```
else if (document.forms[0].area.value == ""
     || document.forms[0].exchange.value == ""
```

```
        || document.forms[0].phone.value == "") {
        window.alert("You must enter your ↵
            telephone number.");
        return false;
    }
```


5. Add the following statements to the end of the `confirmSubmit()` function to validate the user name:

```
else if (document.forms[0].userName.value == "") {
    window.alert("You must enter a user name.");
    return false;
}
```

6. Add the following statements to the end of the `confirmSubmit()` function to validate the password fields:

```
else if (document.forms[0].password.value == ""
    || document.forms[0].password_confirm.
    value == "") {
    window.alert("You must enter a password.");
    return false;
}
```

7. Finally, add the following return statement to the end of the `confirmSubmit()` function:

```
return true;
```

8. Save the **subscription.html** document, and then open it in your Web browser. Enter some data in the form's billing, shipping, telephone, and password fields, but leave some fields blank. Click the **Subscribe** button. Depending on which fields you left blank, you should see an alert message telling you which fields need to be filled in.

9. Click the **OK** button, fill in the fields you left blank, and then click the **Subscribe** button. The data you entered should appear in the FormProcessor.html document.

10. Close your Web browser window.

Validating Radio Buttons

Recall that when multiple form elements share the same name, JavaScript creates an array out of the elements using the shared name. Radio buttons, for instance, share the same name so that a single name=value pair can be submitted to a server-side script. When you have an array that is created from a group of buttons that share the same name, you can use the `checked` property to determine which element in a group is selected. The `checked` property returns a value of true if a check box or radio button is selected, and a value of false if it is not.

When you have an array that is created from a group of buttons that share the same name, you can use the `checked` property to determine which element in a group is selected. The `checked` property returns a value of true if a check box or radio button is selected, and a value of false if it is not. For example, if you have a group of radio buttons named `maritalStatus`, then you can use an `onsubmit` event handler similar to the following to determine if one of the radio buttons in the group is selected.


```
function submitForm() {
     var maritalStatusSelected = false;
     for (var i=0; i<5; ++i) {
          if (document.forms[0].maritalStatus[i].checked
               == true) {
               maritalStatusSelected = true;
               break;
          }
     }
     if (maritalStatusSelected == false) {
          window.alert("You must select your ↵
               marital status.");
          return false;
     }
     else
          return true;
}
```

Next, you add code to the `confirmSubmit()` function in the Subscription form that validates the Delivery Rates radio buttons.

To add code to the `confirmSubmit()` function in the Subscription form that validates the Delivery Rates radio buttons:

1. Return to the **subscription.html** document in your text editor.
2. The Delivery Rates radio buttons are contained within two groups: `delivery` and `autoRenew`. You need to ensure that a button is selected in one of the groups. First, add the following variable declaration and `for` statement above the `return true;` statement at the end of the `confirmSubmit()` function. The `for` statement checks whether a button is selected in the `delivery` group.

```
var deliverySelected = false;
for (var i=0; i<4; ++i) {
     if (document.forms[0].delivery[i].checked
          == true) {
          deliverySelected = true;
          break;
     }
}
```

3. Next, add the following `for` statement above the `return true;` statement at the end of the `confirmSubmit()` function to check whether a button is selected in the `autoRenew` group:

```
for (var j=0; j<2; ++j) {
     if (document.forms[0].autoRenew[j].checked
          == true) {
          deliverySelected = true;
          break;
     }
}
```

4. Finally, add the following code above the `return true;` statement at the end of the `confirmSubmit()` function to cancel the form submission if one of the Delivery Rates radio buttons is not selected:

```
if (deliverySelected != true) {
     window.alert("You must select a delivery ↵
          rate option.");
     return false;
}
```

5. Save the **subscription.html** document, and then open it in your Web browser. Enter some data in the form's billing, shipping, telephone, user name, and password fields, and then click the **Subscribe** button. You should see an alert message instructing you to select a delivery option. Click the **OK** button, select a delivery option, and then click the **Subscribe** button. The data you entered should appear in the FormProcessor.html document.

6. Close your Web browser window.

Validating Check Boxes

You can use the `checked` property to determine whether an individual check box has been selected. If check boxes are part of a group, then you can validate them using the same functionality as the validation code for radio buttons, because JavaScript creates an array out of elements with the same name. The following `onsubmit` event handler determines whether at least one check box in a group of check boxes named `committees` is selected:

```
function submitForm() {
     var committeesSelected = false;
     for (var i=0; i<4; ++i) {
          if (document.forms[0].committees[i].checked
               == true) {
               committeesSelected = true;
```

```
                    break;
               }
          }
          if (committeesSelected == false) {
               window.alert("You must select at least ↵
                    one committee.");
               return committeesSelected;
          }
          else
               return committeesSelected;
}
```

Because the subscription check boxes in the Subscription form are optional, you can skip adding validation code for them.

Validating Selection Lists

Validating selection lists is a little easier than validating radio buttons and check boxes because you only need to test whether the selection list's `selectedIndex` property contains a value of –1. If it does, then no option is selected.

Remember that if the `size` attribute is excluded or set to 1, and the `<select>` element does not include the `multiple` attribute, then the selection list is a drop-down style menu. For drop-down style menus, the first option element is automatically selected.

The following `onsubmit` event handler determines whether at least one option in a selection list named `brand` is selected:

```
function submitForm() {
     if (document.forms[0].brand.selectedIndex == -1) {
          window.alert("You must select at least ↵
               one brand.");
          return false;
     }
     else
          return true;
}
```

The selection list in the subscription form allows subscribers to build a list of journals to which they subscribe. However, one or more options (depending on whether the `<select>` element includes the `multiple` attribute) must be selected in the selection list in order to be submitted to a Web server with the rest of the form data. Because you cannot count on subscribers to select all of the journals they entered in the selection list before clicking the Subscribe button, you need to add code to the Subscription form that selects all of the journals when the form is submitted. You will do this by adding a looping statement to the `confirmSubmit()` event handler function that selects each option in the journal selection list, using the `selected` property of the `Option` object.

To add a looping statement to the `confirmSubmit()` event handler function that selects each option in the journal selection list:

1. Return to the **subscription.html** document in your text editor.
2. Locate the `return true;` statement at the end of the `confirmSubmit()` function. Above the `return true;` statement, add the following code to select all of the journals in the selection list when the form is submitted:

```
for (var k=0; k<document.forms[0].journals.length;
     ++k) {
     document.forms[0].journals.options[k].selected
          = true;
}
```

3. Save the **subscription.html** document, then validate it with the W3C Markup Validation Service and fix any errors that the document contains. Once the document is valid, open it in your Web browser. Enter some data in all of the form's fields, and be sure to enter some journal names. Click the **Subscribe** button. The data you entered, including the journal names, should appear in the FormProcessor.html document.
4. Close your Web browser window and text editor.

Short Quiz 4

1. How do you validate text and password boxes?
2. How do you validate radio buttons?
3. How do you validate check boxes?
4. How do you validate selection lists?

Summing Up

- Forms collect information from users and transmit that information to a server for processing.
- The `<form>` element designates a form within a Web page and contains all the text and elements that make up a form.

- Four primary elements are used within the `<form>` element to create form controls: `<input>`, `<button>`, `<select>`, and `<textarea>`.
- Any form element into which a user can enter data (such as a text box), or that a user can select or change (such as a radio button), is called a field.
- The `Form` object represents a form on a Web page, while the `Input` object represents a form control, such as a text box.
- The `Document` object includes a `forms[]` array that contains all of the forms on a Web page.
- The empty `<input>` element is used to generate input fields that create different types of interface elements, such as text boxes, radio buttons, and so on.
- The `<select>` element creates a selection list that presents users with fixed lists of items from which to choose.
- You use `<option>` elements to specify the options that appear in a selection list.
- The `Select` object represents a selection list in a form.
- The `Option` object represents an option in a selection list.
- An `<input>` element with a type of "submit" (`<input type="submit" />`) creates a submit button that transmits a form's data to a Web server.
- An `<input>` element with a type of reset (`<input type="reset" />`) creates a reset button that clears all form entries and resets each form element to the initial value specified by its `value` attribute.
- The `onsubmit` event handler executes when a form is submitted to a server-side script—that is, when a submit button is selected on a form using a submit `<input>` element or an image `<input>` element.
- The `onreset` event handler executes when a reset button is selected on a form.

Comprehension Check

1. Which of the following MIME types can you use with the `<form>` element's `enctype` attribute? (Choose all that apply.)
   a. `text/plain`
   b. `multipart/form-data`

c. `application/x-www-form-urlencoded`

d. `application/x-www-form-urlunencoded`

2. Why would you submit form data to an e-mail address instead of to a Web server? For what types of companies or Web sites is submitting form data to an e-mail address best suited?

3. Documents that reference a form's `name` attribute are well formed according to the strict DTD. True or false?

4. Objects representing each of the controls in a form are stored in the _______________ array.

   a. `forms[]`

   b. `controls[]`

   c. `inputs[]`

   d. `elements[]`

5. You can refer to a form control object with which of the following methods? (Choose all that apply.)

   a. the control's `name` attribute

   b. the `elements[]` array

   c. the `controls[]` array

   d. the `fields[]` array

6. Which of the following elements correctly uses the Boolean `selected` attribute in XHTML?

   a. `<option value="freshman" selected="1" />`

   b. `<option value="sophomore" selected="selected" />`

   c. `<option value="junior" selected />`

   d. `<option value="senior" selected="true" />`

7. Explain how to ensure that users enter a number into a text field.

8. Only one selected radio button in a group creates a name=value pair when a form is submitted to a Web server. True or false?

9. When multiple form elements share the same name, JavaScript creates an array out of the elements, using the shared name. True or false?

10. Which property sets and returns a Boolean value indicating whether multiple options can be selected in a selection list?

    a. `sizeable`

    b. `select`

    c. `multiple`

    d. `many`

11. Selection lists must include at least one `<option>` element. True or false?

12. What value does the `selectedIndex` property of the `Select` object return if no option is selected?

    a. –1

    b. 0

    c. 1

    d. false

13. How do you use the `Option()` constructor to add a new option after a Web page renders a selection list?

14. What is the correct syntax for removing the first element from an `options[]` array in a selection list named `customers`?

    a. `document.forms[0].customers.options[0] = null;`

    b. `document.forms[0].customers.remove(0);`

    c. `document.forms[0].customers.options[0] = 0;`

    d. `document.forms[0].customers.options[0] = -1;`

15. Where do you place the `onsubmit` event handler?

    a. in a submit `<input>` element

    b. in the closing `</form>` tag

    c. in the form control that calls the submit event

    d. in the opening `<form>` tag

16. Explain how to create a reset event handler function.

17. What must the `onsubmit` and `onreset` event handlers return?

18. Explain how to verify that text and password boxes are not empty.

19. Which of the following properties indicates whether a check box or radio button is selected?

    a. `selected`

    b. `checked`

    c. `active`

    d. `isSelected`

20. Explain how to validate selection lists.

Reinforcement Exercises

Exercise 5-1

In this exercise, you will create a script that automatically moves a user's cursor to the next field after a specified number of characters have been entered into the current field. The exercise will use a simple form that allows users to enter their 10-digit telephone number. The form will contain three text boxes for the area code, exchange, and number portions of the telephone number.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Auto Next Field" as the content of the `<title>` element.

3. Add the following form to the document body. The form contains three text boxes. The first two text boxes, for the area code and exchange, use the `onkeyup` event to call an event handler function named `nextField()`. Two arguments are passed to the `nextField()` function: a `this` reference, which passes the name of the current control, and the name of the destination control. Notice that each of the text boxes includes `maxlength` attributes.

```
<form action="FormProcessor.html"
method"get"
enctype="application/x-www-form-urlencoded">
<p><strong>Enter your 10-digit telephone number:
</strong>
<input type="text" name="area_code" size="4"
     onkeyup="nextField(this, document.forms[0] ↵
          .exchange)"
     maxlength="3" />
<input type="text" name="exchange" size="4"
     onkeyup="nextField(this, document.forms[0] ↵
          .number)"
     maxlength="3" />
<input type="text" name="number" size="5"
maxlength="4" /></p>
</form>
```

4. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add to the script section the following `nextField()` function, which is called from the `onkeyup` events in the `<input>` elements. Notice how the conditional expression compares length of the field to the `maxLength` property. The current value assigned to the field is retrieved with the `value` property. Then, a property named `length` is appended to the `value` property. The `length` property is a property of the `String` class, and it returns the number of characters in a string. (You will study the `String` class in Chapter 7.) If the length of the field is equal to the value assigned to the `maxLength` property, then the `focus()` statement moves the focus to the field identified by the `destField` parameter.

```
function nextField(startField, destField) {
     if (startField.value.length
          ==startField.maxLength)
     destField.focus();
}
```

6. Save the document as **AutoNextField.html** in the Exercises folder for Chapter 5.

7. Use the W3C Markup Validation Service to validate the **AutoNextField.html** document and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser.

8. Enter an area code into the first text box. After you enter the third number in the area code, focus transfers to the second text box. Enter an exchange into the second text box. After you enter the third number in the exchange, the focus is transferred to the third text box.

9. Close your Web browser window.

Exercise 5-2

When you first open a Web page with a form in a browser, none of the form controls has the focus. In this exercise, you create a Web page that sets the focus when the Web page first opens. The Web page you create will contain a simple inquiry form that might be sent to a real estate agent.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the strict DTD and "Realtor Inquiry" as the content of the `<title>` element.

2. Add the following heading element and form to the document body. The form contains several text boxes that gather details of the property that a customer is looking for along with a selection list that allows customers to select a specific type of property.

```
<h1>Real Estate Inquiry</h1>
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p>Name<br />
<input type="text" name="visitor_name"
size="50" /></p>
<p>E-mail address<br />
<input type="text" name="e-mail" size="50" /></p>
<p>Phone<br />
<input type="text" name="phone" size="50" /></p>
<p>Area of town<br />
<input type="text" name="area" size="50" /></p>
<p>Property <select name="property_type">
<option value="unselected">Select a Property Type
</option>
<option value="condo">Condos</option>
<option value="single">Single Family Homes</option>
<option value="multi">Multifamily Homes</option>
<option value="mobile">Mobile Homes</option>
<option value="land">Land</option>
</select>
```

```
Sq. feet <input type="text" name="feet" size="5" />
</p>
<p>Bedrooms <input type="text" name="bedrooms"
size="5" />
Maximum price <input type="text" name="price"
size="12" /></p>
<p>How should we contact you? <input type="radio"
name="contactHow" value="call_me" /> Call me
<input type="radio" name="contactHow"
value="e-mail_me" /> E-mail me</p>
<p><input type="submit" /></p>
</form>
```


3. Add a script section to the document head, as follows:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add to the script section the following `setFormFocus()` function, which uses the `focus()` method of the `Input` object to set the focus on the first control in the form, named `visitor_name`:

```
function setFormFocus() {
     document.forms[0].visitor_name.focus();
}
```

5. Add to the opening `<body>` tag the following `onload` event handler, which calls the `setFormFocus()` method when the page first loads:

```
onload="setFormFocus();"
```

6. Save the document as **RealEstateInquiry.html** in the Exercises folder for Chapter 5, and then open it in your Web browser. The first control on the form should receive the focus as soon as the form is rendered.

7. Close your Web browser window.

Exercise 5-3

In this exercise, you will add default values to the text boxes you created in the last exercise. You will also add `onfocus` event handlers to each text box to remove the default values when the text box receives the focus.

1. Return to the **RealEstateInquiry.html** document you created in the last exercise.

2. Add `value` attributes to each of the text `<input>` elements to create default values, as follows:

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p>Name<br />
<input type="text" name="visitor_name" size="50"
     value="Enter your name" /></p>
<p>E-mail address<br />
<input type="text" name="e-mail" size="50"
     value="Enter your e-mail address" /></p>
<p>Phone<br />
<input type="text" name="phone" size="50"
     value="Enter your phone number" /></p>
<p>Area of town<br />
<input type="text" name="area" size="50"
     value="What area of town are you ↵
          interested in?"/></p>
<p>Property <select name="property_type">
<option value="unselected">Select a Property Type</
option>
<option value="condo">Condos</option>
<option value="single">Single Family Homes</option>
<option value="multi">Multifamily Homes</option>
<option value="mobile">Mobile Homes</option>
<option value="land">Land</option>
</select>
Sq. feet <input type="text" name="feet" size="5"
     value="???" /> </p>
<p>Bedrooms <input type="text" name="bedrooms"
     size="5" value="???" />
Maximum price <input type="text" name="price"
     size="12" value="$$$" /></p>
<p>How should we contact you? <input type="radio"
     name="contactHow" value="call_me" /> Call me
<input type="radio" name="contactHow"
value="e-mail_me" /> E-mail me</p>
<p><input type="submit" /></p>
</form>
```

3. Add `onclick` event handlers to each `<input>` element to check whether the value of the control is equal to its default value. If so, then change the value to an empty string (""). For example, the `onclick` event handler for the `visitor_name` `<input>` element is as follows:

```
onclick="if (this.value=='Enter your name') ↵
     this.value='';")
```

4. Add validation code to the RealEstateInquiry.html document that verifies the text boxes are not empty and do not contain the default values when the form is submitted. For the square feet, number of bedrooms, and maximum price fields, include

validation code that verifies the user entered a numeric value. Also, add validation code that verifies whether users have selected values from the selection list and the radio button group.

5. Save the **RealEstateInquiry.html** document, validate it with the W3C Markup Validation Service, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser. Selecting each control should remove the default values.

6. Close your Web browser window.

Exercise 5-4

In this exercise, you will create a Web page that allows you to search the Web using several popular search engines listed in a selection list. The code you write will perform a search by appending the search item to the URL for the selected search engines. The URLs for different search engines such as Yahoo and Google require slightly different syntax for submitting a search. For example, with Yahoo! you append the search item to the URL `http://search.yahoo.com/search?p=` and for Google you append the search item to the URL `http://www.google.com/search?q=`. The required search syntax for each URL will be assigned to the `value` attribute of the option that represents the search engine in the selection list.

1. Create a new document in your text editor and type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the strict DTD and "Multiple Search Engines" as the content of the `<title>` element.

2. Add the following form to the document body. Notice that the value attribute of each option in the selection list is assigned the correct URL syntax for each search engine.

```
<form action="" name="searchForm">
<p>Search for <input type="text"
     name="searchTerm" />
     from <select name="engines">
     <option value="http://www.altavista.com/↵
        cgi-bin/query?kl=XX&amp;pgx=q&amp;
        Translate=on&amp;q=">
        Alta Vista</option>
     <option value="http://search.aol.com/↵
        dirsearch.adp?query=">
            AOL</option>
```

```
        <option value="http://www.google.com/search?q=">
           Google</option>
        <option value="http://search.lycos.com/ ↵
           default.asp?lpv=1&amp;loc=searchhp&amp; ↵
           tab=web&amp;query=">Lycos</option>
        <option value="http://search.yahoo.com/ ↵
           search?p="selected="selected">
           Yahoo!</option>
</select>
<input type="button" value="Search"
     onclick="doSearch()" /></p>
</form>
```


3. Add the following function to the script section. The first statement retrieves the selected index. The `if` statement first checks to see if a search engine is selected. If one is, then the `else` statement appends the search term to the search engine's URL and assigns the combined value to the `href` attribute of the `Location` object.

```
function doSearch() {
    var selectedItem = document.searchForm.engines
        .selectedIndex;
    if (selectedItem == -1)
        window.alert("You must select a ↵
            search engine.");
    else
        location.href = document.searchForm.engines
            .options[selectedItem].value
            + document.searchForm.searchTerm.value;
}
```

4. Save the document as **MultiSearchEngines.html** in the Exercises folder for Chapter 5, validate it via the W3C Markup Validation Service, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser. Test the form to ensure that you can search with each of the search engines in the selection list.

5. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 5. Be sure to validate each Web page with the W3C Markup Validation Service.

Project 5-1

Pick your favorite sport and search the Internet for the current roster of players for five teams. Create a Web page that contains two selection lists: one that displays a drop-down menu of team names and the other a multi-line selection list that displays player names. Write some JavaScript code that changes the list of players in the second selection list after you select a new team name from the first selection list. Save each team roster in its own variable, and use the techniques you learned in this chapter to dynamically add the player names to the selection list. Save the page as **TeamRosters.html**.

Project 5-2

Create a Web page for a takeout pizza restaurant. Use radio buttons to allow customers to select the type of pizza, such as vegetarian or meat lover's. Also include check boxes for extra toppings that can be added to a pizza such as extra cheese, mushrooms, or anchovies. Include a price for each pizza and each additional item and keep a running total in a text box. Save the page as **PizzaToGo.html**.

Project 5-3

Create a script that requires your visitors to accept your terms and conditions before proceeding, by selecting a check box. Save the page as **AcceptTerms.html**. Include two links, an Accept link and a Decline link. The Accept link should open a page named **AcceptPage.html** that displays the text "Thank you for accepting our terms." The Decline link should open a page named **DeclinePage.html** that displays the text "You did not accept our terms." In the AcceptTerms.html document, create a single event handler function named `confirmTerms()` that determines whether the check box is selected and returns a value of true if it is or false if it isn't. Call the `confirmTerms()` function from the Accept link. If the check box is selected, open the AcceptPage.html document. If the check box is not selected, display an alert dialog box informing the user that he or she must accept the terms. If the user clicks the Decline link, open the DeclinePage.html document.

Project 5-4

Create a Web page that contains a table with three columns. In the left and right columns, create two selection lists. Fill both selection lists with unique items, such as product names. In the middle column, add two buttons: one button should contain the characters ">>" and the other button should contain the characters "<<". Write a script that moves the selection list items between the two columns. For example, if the left column contains the name "iPod Nano", clicking the >> button should move the name to the right column. Save the script as **MoveMenuItems.html**.

Project 5-5

Create a registration form, similar to what you might encounter when registering for an online Web site. Include three sections: Personal Information, Security Information, and Preferences. In the Personal Information section, add name and e-mail address. Include default text in the name and e-mail text boxes, but write some code that removes the default text from each text box when a user clicks it. In the Security Information section, add password and password confirmation fields. Write code that ensures that the same value was entered into both fields. Also add a security challenge question selection list and a security answer text box that the Web site will use to help identify a user in the event that he or she loses his or her password. The security challenge selection list should contain questions such as "What is your mother's maiden name?", "What is the name of your pet?", and "What is your favorite color?". In the Preferences section, add radio buttons that confirm whether a user wants special offers sent to his or her e-mail address. Also, include check boxes with special interests the user may be interested in, such as entertainment, business, and shopping. Add Submit and Reset buttons that call `submit()` and `reset()` event handler functions when they are clicked. The `submit()` event handler function should ensure that the user has entered values into each text box, and that the values submitted are not the same as the default text. The `submit()` event handler function should also ensure that the user selects a security challenge question, selects a radio button to confirm whether he or she wants special offers sent to his or her e-mail address, and selects at least one interest check box. Submit the form to the FormProcessor.html script (there is a copy in your Projects folder for Chapter 5). Save the document as **Registration.html**.

CHAPTER 6

Using Object-Oriented JavaScript

In this chapter, you will:

- Study object-oriented programming
- Work with the `Date`, `Number`, and `Math` objects
- Define custom JavaScript objects

In this chapter, you will learn how to use object-oriented programming techniques in your JavaScript programs. Essentially, object-oriented programming allows you to use and create self-contained pieces of code and data, called objects, which can be reused in your programs. You already have some experience with object-oriented programming, after working with browser objects (including the `Window`, `Document`, and `Form` objects) in Chapters 4 and 5. The browser objects, however, are part of the Web browser itself. The objects you study in this chapter are part of the JavaScript programming language. Additionally, you will learn how to create your own custom JavaScript objects.

Introduction to Object-Oriented Programming

The JavaScript programs you have written so far have mostly been self-contained; most code, such as variables, statements, and functions, exists within a script section. For example, you may create a Web page for an online retailer that uses JavaScript to calculate the total for a sales order that includes state sales tax and shipping. However, the retailer may sell different types of products on different Web pages; one page may sell books, another page may sell sporting goods, and so on. If you want to reuse the JavaScript sales total code on multiple Web pages, you must copy all of the statements or recreate them from scratch for each Web page. Object-oriented programming takes a different approach. It allows you to reuse code without having to copy or recreate it.

Reusing Software Objects

Object-oriented programming (OOP) refers to the creation of reusable software objects that can be easily incorporated into multiple programs. The term **object** specifically refers to programming code and data that can be treated as an individual unit or component. (Objects are also called **components**.) The term **data** refers to information contained within variables or other types of storage structures. In Chapter 1, you learned that the procedures associated with an object are called methods, and the variables that are associated with an object are called properties or attributes.

Objects can range from simple controls such as a button, to entire programs such as a database application. In fact, some programs consist entirely of other objects. You'll often encounter objects that have been designed to perform a specific task. For example, in a retail sales program, you could refer to all of the code that calculates the sales total as a single object. You could then reuse that object over and over again in the same program just by typing the object name.

Popular object-oriented programming languages include C++, Java, and Visual Basic. Using any of these or other object-oriented languages, programmers can create objects themselves or use objects created by other programmers. For example, if you are creating an accounting program in Visual Basic, you can use an object named `Payroll` that was created in C++. The `Payroll` object may contain one method that calculates the amount of federal and state tax to deduct, another method that calculates the FICA amount to deduct, and so on. Properties of the `Payroll` object may include an employee's number of tax withholding allowances, federal and state tax percentages, and the cost of insurance premiums. You do not need to know how the `Payroll` object was created in C++, nor do you need to re-create it in Visual Basic. You only need to know how to access the methods and properties of the `Payroll` object from the Visual Basic program.

You have already used object-oriented programming techniques when you have included objects of the browser object model (BOM) in your scripts.

One way of understanding object-oriented programming is to compare it to how personal computers (PCs) are assembled. Many companies manufacturer PCs, but few build all of the components that go into a particular unit. Instead, computer manufacturers usually include components from other vendors. For example, there are many different brands of monitors, keyboards, mice, and so on. Even though different manufacturers build each of these hardware components, if they are designed for a PC, then they all share common ways of attaching to the main computer. Monitors plug into standard monitor ports, keyboards plug into standard keyboard ports, mice plug into mouse ports, and so on. In fact, most of today's hardware components can plug into a Universal Serial Bus (USB) port, which is a standard interface for connecting computer hardware. Just as all hardware components can plug into the same PC, the software components of an object-oriented program can all "plug into" one application.

An object-oriented accounting program is conceptually illustrated in Figure 6-1. In the figure, the accounting program is composed of four separate components that are plugged into the main accounting program: an `Accounts Receivable` object, an `Accounts Payable` object, an `Expense Reporting` object, and the `Payroll` object. The important thing to understand is that you do not need to rewrite these four objects for the accounting program; the accounting program only needs to call their methods and provide the correct data to their properties.

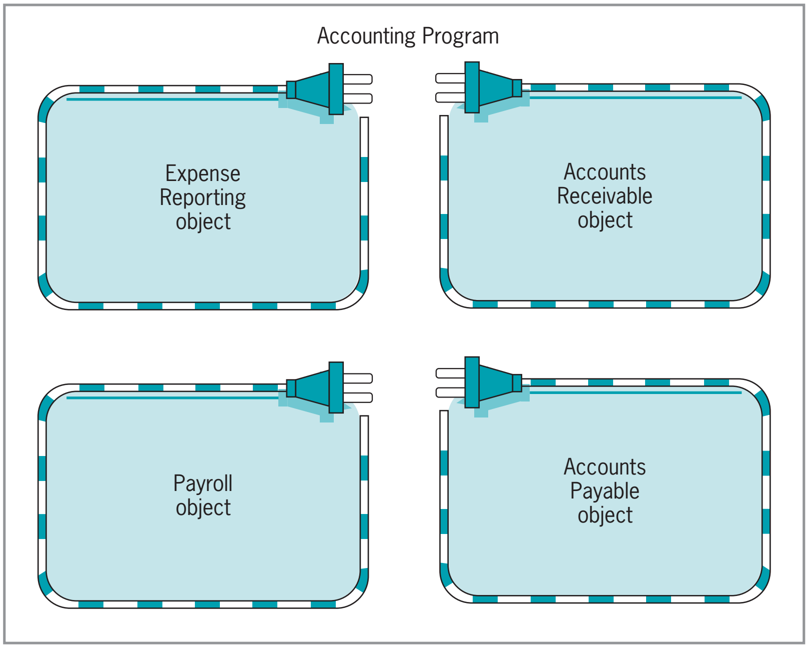


Figure 6-1 Conceptual illustration of an accounting program

What Is Encapsulation?

Objects are **encapsulated**, which means that all code and required data are contained within the object itself. In most cases, an encapsulated object consists of a single computer file that contains all code and required data. Encapsulation places code inside what programmers like to call a black box; when an object is encapsulated, you cannot see "inside" it—all internal workings are hidden. The code (methods and statements) and data (variables and constants) contained in an encapsulated object are accessed through an interface. The term **interface** refers to the programmatic elements required for a source program to communicate with an object. For example, interface elements required to access a `Payroll` object might be a method named `calcNetPay()`, which calculates an employee's net pay, and properties containing the employee's name and pay rate.

When you include encapsulated classes in your programs, users can see only the methods and properties of the object that you allow them to see. Essentially, the principle of **information hiding** states that any methods and properties that other programmers do not need to access or know about should be hidden. By removing the ability to see inside the black box, encapsulation reduces the complexity of the code, allowing programmers who use the code to concentrate on the task of integrating the code into their programs. Encapsulation also prevents other programmers from accidentally introducing a bug into a program, or from possibly even stealing the code and claiming it as their own.

You can compare a programming object and its interface to a hand-held calculator. The calculator represents an object, and you represent a program that wants to use the object. You establish an interface with the calculator object by entering numbers (the data required by the object) and then pressing calculation keys (which represent the methods of the object). You do not need to know about, nor can you see, the inner workings of the calculator object. As a programmer, you are concerned only with an object's methods and properties. To continue the analogy, you are only concerned with the result you expect the calculator object to return. Figure 6-2 illustrates the idea of the calculator interface.

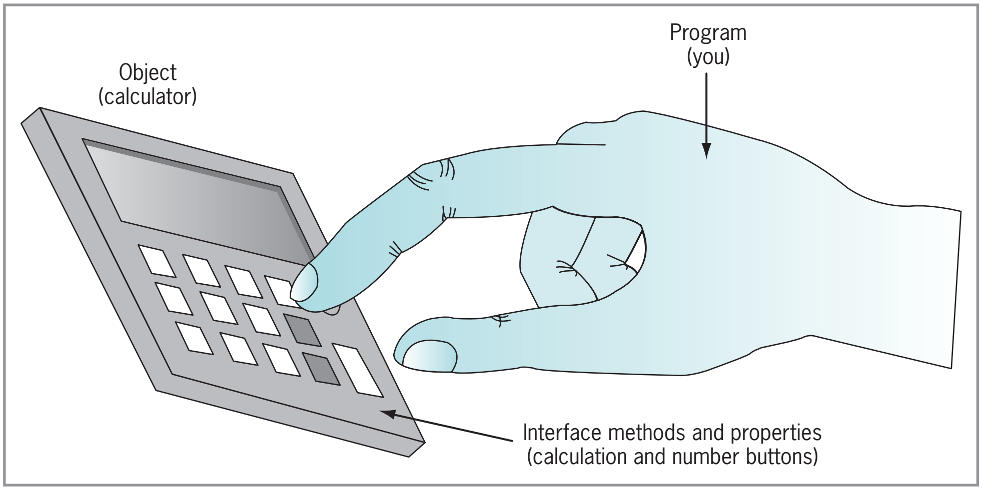


Figure 6-2 Calculator interface

In JavaScript, the `Document` object is encapsulated, making it a black box. The `write()` and `writeln()` methods are part of the interface that JavaScript can use to communicate with the `Document` object. Figure 6-3 illustrates the concept of a black box using JavaScript and the `Document` object.

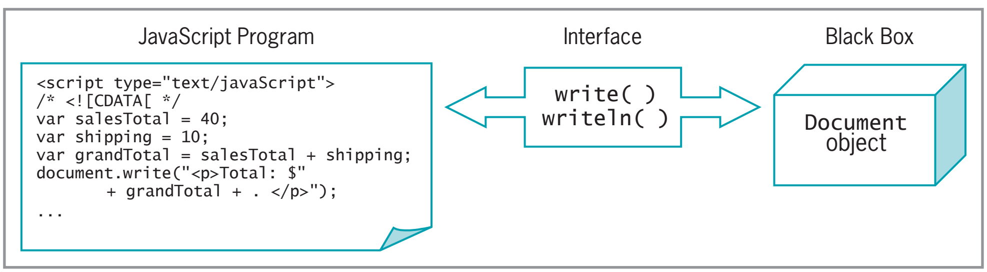


Figure 6-3 Conceptual example of the `Document` object black box

Another example of an object and its interface is Microsoft Word. Word itself is actually an object made up of numerous other objects. The program window (or user interface) is one object. The items you see in the interface, such as the buttons on the ribbon are used to execute methods. For example, the Bold button executes a bold method. The text of your document is the data you provide to the program. Microsoft Word is a helpful tool that you can use without knowing how the various methods work. You only need to know what each method does. To get full satisfaction out of Microsoft Word, you only need to provide the data (text) and execute the appropriate methods (such as the bold method), when necessary. In the same way, when using objects in your code, you only need to provide the necessary data (such as an employee's gross pay) and execute the appropriate method (such as the `calcNetPay()` method).

Understanding Classes

In object-oriented programming, the code, methods, attributes, and other information that make up an object are organized into **classes**. Essentially, a class is a template, or blueprint, that serves as the basis for new objects. When you use an object in your program, you actually create an instance of the class of the object. An **instance** is an object that has been created from an existing class. When you create an object from an existing class, you are said to be **instantiating** the object.

Later in this chapter, you will learn how to create, or instantiate, an object from built-in JavaScript classes and from custom classes that you write yourself. However, as a conceptual example, consider an object named `BankAccount` that contains methods and properties that you might use to record transactions associated with a checking or savings account. The `BankAccount` object is created from a `BankAccount` class. To use the `BankAccount` class, you create an instance of the class. A particular instance of an object **inherits** its methods and properties from a class—that is, it takes on the characteristics of the class on which it is based. The `BankAccount` object, for instance, would inherit all of the methods and properties of the `BankAccount` class. To give another example, when you create a new word-processing document, which is a type of object, it usually inherits the properties of a template on which it is based. The template is a type of class. The document inherits characteristics of the template such as font size, line spacing, and boilerplate text. In the same manner, programs that include instances of objects inherit the object's functionality.

Class names in traditional object-oriented programming usually begin with an uppercase letter. This convention is also followed in JavaScript.

Because objects in the browser object model are actually part of the Web browser, you do not need to instantiate them in order to use them in your programs. For example, you do not need to instantiate a `Document` object from the `Document` class in your JavaScript programs because the Web browser automatically instantiates one for you. However, you do need to instantiate some objects from the built-in JavaScript classes that you will study next.

Using Built-In JavaScript Classes

The JavaScript language includes the eleven built-in classes listed in Table 6-1. Each object contains various methods and properties for performing a particular type of task.

Class	Description
`Array`	Creates new array objects
`Boolean`	Creates new Boolean objects
`Date`	Retrieves and manipulates dates and times
`Error`	Returns run-time error information
`Function`	Creates new function objects
`Global`	Stores global variables and contains various built-in JavaScript functions
`Math`	Contains methods and properties for performing mathematical calculations
`Number`	Contains methods and properties for manipulating numbers
`Object`	Represents the base class for all built-in JavaScript classes; contains several of the built-in JavaScript functions
`RegExp`	Contains methods and properties for finding and replacing characters in text strings
`String`	Contains methods and properties for manipulating text strings

Table 6-1 Built-in JavaScript classes

You will study the `Date`, `Number`, `Math`, and `Object` classes in this chapter. You will study the `Array`, `String`, and `RegExp` classes in Chapter 7, and the `Error` object in Chapter 8.

Instantiating an Object

You can use some of the built-in JavaScript objects directly in your code, while other objects require you to instantiate a new object. The `Math` object is one that you can use directly in your programs without instantiating a new object. The following example shows how to use the `Math` object's `PI` (π) property in a script:

```
<script type="text/javascript">
// The following statement prints 3.141592653589793
document.write("The value of pi is " + Math.PI);
</script>
```

Unlike the `Math` object, an `Array` object requires you to instantiate a new object before you can use it. As you learned in Chapter 4, arrays are represented in JavaScript by the `Array` object, which contains a constructor named `Array()`. You create new arrays in your code using the `new` keyword and the `Array()` constructor. The following statement shows an example of how to instantiate an array named `deptHeads`:

```
var deptHeads = new Array();
```

You may be wondering why the preceding statement instantiates the new object using the `var` keyword. As you recall, the `var` keyword is used for declaring variables. The name you use for an instantiated object is really a variable just like an integer or string variable. In fact, programmers use the terms "variable" and "object" interchangeably. The difference is that the data the variable represents happens to be an object instead of a number or string. Recall from Chapter 1 that variables are the values a program stores in computer memory. Recall, too, that the JavaScript language also supports reference data types, which can contain multiple values or complex types of information, as opposed to the single values stored in primitive data types. In other words, in the same manner that you use a variable name to represent a primitive data type, such as an integer, in computer memory you also use a variable name to represent an object. Because the objects you declare in your JavaScript program are actually a certain type of variable, you can use the `var` keyword to identify them as variables. You are not required to use the `var` keyword when declaring any variables or objects in your programs; however, it is good practice always to do so.

The `Option` object is the only object in the W3C browser object model from which you can instantiate a new object. The Web browser creates all other objects in the browser object model automatically. (You studied the `Option` object in Chapter 5.)

Performing Garbage Collection

If you have worked with other object-oriented programming languages, then you may be familiar with the term **garbage collection**, which refers to cleaning up, or reclaiming, memory that is reserved by a program. When you declare a variable or instantiate a new object, you are actually reserving computer memory for the variable or object. With some programming languages, you must write code that deletes a variable or object after you are through with it in order to free the memory for use by other parts of your program or by other programs running on your computer. With JavaScript, you do not need to worry about reclaiming memory that is reserved for your variables or objects; JavaScript knows when your program no longer needs a variable or object and automatically cleans up the memory for you.

Short Quiz 1

1. Why do programmers refer to encapsulation as a black box?
2. What is instantiation as it relates to classes, objects, and object-oriented programming?
3. Explain how to conceptually instantiate an object from a class.

Using the `Date`, `Number`, and `Math` Classes

In this section, you will learn how to work with three of the most commonly used JavaScript classes: `Date`, `Number`, and `Math`. First, you will examine the `Date` class.

Manipulating the Date and Time with the `Date` Class

You can use dates in your programs to create a calendar, calculate how long it will take to do something, and so on. For instance, a Web page for a dry cleaning business may need to use the current date to calculate when a customer's dry cleaning order will be ready. The **`Date` class** contains methods and properties for manipulating the date and time. The `Date` class allows you to use the current date and time (or a specific date or time element, such as the current month) in your JavaScript programs. You create a `Date` object with one of the constructors listed in Table 6-2.

Constructor	Description
`Date()`	Creates a `Date` object that contains the current date and time from the local computer
`Date(`*`milliseconds`*`)`	Creates a `Date` object based on the number of milliseconds that have elapsed since midnight, January 1, 1970
`Date(`*`date_string`*`)`	Creates a `Date` object based on a string containing a date value
`Date(`*`year`*`, `*`month`*`[, `*`date`*`, `*`hours`*`, `*`minutes`*`, `*`seconds`*`, `*`milliseconds`*`])`	Creates a `Date` object with the date and time set according to the passed arguments; the year and month arguments are required

Table 6-2 `Date` class constructors

The following statement demonstrates how to create a `Date` object that contains the current date and time from the local computer:

```
var today = new Date();
```

The dates of the month and year in a `Date` object are stored using numbers that match the actual date and year. However, the days of the week and months of the year are stored in a `Date` object using numeric representations, starting with zero, similar to an array. The numbers 0 through 6 represent the days Sunday through Saturday, and the numbers 0 through 11 represent the months January through December. The following statement demonstrates how to specify a specific date with a `Date` constructor function. In this example, the date assigned to the `independenceDay` variable is July 4, 1776.

```
var independenceDay = new Date(1776, 6, 4);
```

After you create a new `Date` object, you can then manipulate the date and time in the variable, using the methods of the `Date` class. Note that the date and time in a `Date` object are not updated over time like a clock. Instead, a `Date` object contains the static (unchanging) date and time as of the moment the JavaScript code instantiates the object.

Table 6-3 lists commonly used methods of the `Date` class.

Method	Description
`getDate()`	Returns the date of a `Date` object
`getDay()`	Returns the day of a `Date` object
`getFullYear()`	Returns the year of a `Date` object in four-digit format
`getHours()`	Returns the hour of a `Date` object
`getMilliseconds()`	Returns the milliseconds of a `Date` object
`getMinutes()`	Returns the minutes of a `Date` object
`getMonth()`	Returns the month of a `Date` object
`getSeconds()`	Returns the seconds of a `Date` object
`getTime()`	Returns the time of a `Date` object
`setDate(`*`date`*`)`	Sets the date (1–31) of a `Date` object
`setFullYear(`*`year`*`[, `*`month`*`, `*`day`*`])`	Sets the four-digit year of a `Date` object; optionally allows you to set the month and the day
`setHours(`*`hours`*`[, `*`minutes`*`, `*`seconds`*`, `*`milliseconds`*`])`	Sets the hours (0–23) of a `Date` object; optionally allows you to set the minutes (0–59), seconds (0–59), and milliseconds (0–999)
`setMilliseconds(`*`milliseconds`*`)`	Sets the milliseconds (0–999) of a `Date` object

Table 6-3 Commonly used methods of the `Date` class *(continues)*

Method	Description
setMinutes(*minutes*[, *seconds*, *milliseconds*])	Sets the minutes (0–59) of a Date object; optionally allows you to set seconds (0–59) and milliseconds (0–999)
setMonth(*month*[, *date*])	Sets the month (0–11) of a Date object; optionally allows you to set the date (1–31)
setSeconds(*seconds*[, *milliseconds*])	Sets the seconds (0–59) of a Date object; optionally allows you to set milliseconds (0–999)
toLocaleString()	Converts a Date object to a string, set to the current time zone
toString()	Converts a Date object to a string
valueOf()	Converts a Date object to a millisecond format

Table 6-3 Commonly used methods of the Date class

Each portion of a Date object, such as the day, month, year, and so on, can be retrieved and modified using the Date object methods. For example, if you create a new Date object using the statement var curDate = new Date();, you can retrieve just the date portion stored in the curDate object by using the statement curDate.getDate();.

You can find a complete listing of Date class methods in the appendix.

The Date class does not contain any properties.

If you want to display the full text for days and months (for example, Wednesday, or January), then you can use a conditional statement to check the value returned by the getDay() or getMonth() method. For example, the following code uses an if...else construct to print the full text for the day of the week returned by the getDay() function. Figure 6-4 shows the output when the script is run on a Tuesday.

```
<script type="text/javascript">
var today = new Date();
var curDay = today.getDay();
if (curDay == 0)
    document.write("Today is Sunday.");
else if (curDay == 1)
    document.write("Today is Monday.");
else if (curDay == 2)
    document.write("Today is Tuesday.");
else if (curDay == 3)
    document.write("Today is Wednesday.");
else if (curDay == 4)
    document.write("Today is Thursday.");
else if (curDay == 5)
    document.write("Today is Friday.");
else if (curDay == 6)
    document.write("Today is Saturday.");
</script>
```

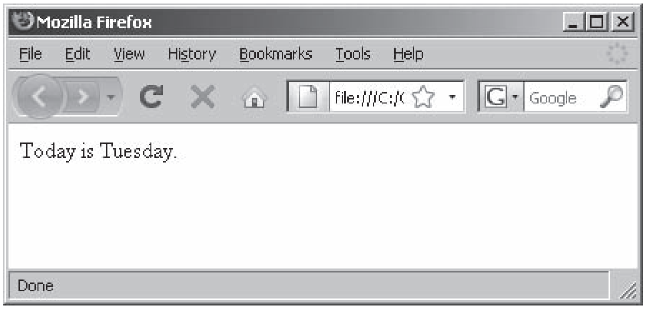


Figure 6-4 Output of a script with a `getDay()` method

If you need to return the full text of the day or month, you should assign the days of the week or the months of the year to an array. You can then combine the `getDay()` or `getMonth()` method with the array name to return the full text of the day or month. For example, the following code includes an array named `months` with 12 elements that are assigned the full text names of the months of the year:

```
<script type="text/javascript">
var today = new Date();
var months = new Array();
months[0] = "January"; months[1] = "February";
months[2] = "March"; months[3] = "April";
months[4] = "May"; months[5] = "June";
months[6] = "July"; months[7] = "August";
months[8] = "September"; months[9] = "October";
months[10] = "November"; months[11] = "December";
var curMonth = months[today.getMonth()];
document.write("<p>The current month is "
    + curMonth + ".</p>");
</script>
```

In the preceding code, the full text name of the month is assigned to the `curMonth` variable by using the statement `var curMonth = months[today.getMonth()];`. The value of the element is retrieved by placing the `today` object with the `getMonth()` method appended to it between the brackets of the `months` array name. Figure 6-5 shows the output.

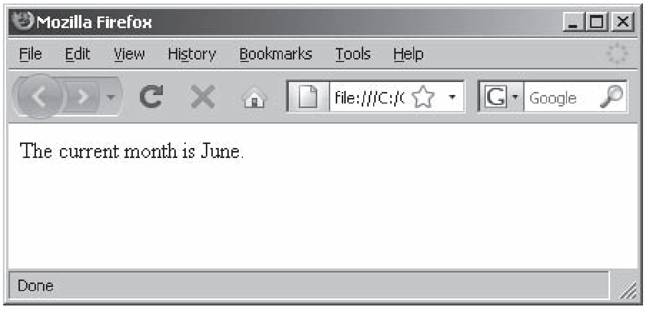


Figure 6-5 Output of a script with a `getMonth()` method

Next, you start working on a Web page for Coast City Windsurfing that visitors can use to create group reservations. The files you will need for this project are located in your Chapter folder for Chapter 6. You will use the `Date` object to generate a monthly calendar that visitors can use to select reservation dates. The script will submit the reservation information to a FormProcessor.html document that is similar to the one you used in Chapter 5. The FormProcessor.html document, located in your Chapter folder for Chapter 6, uses JavaScript code to display the values submitted from a form. The only purpose of the FormProcessor.html document is to display form data and provide a simple simulation of the response you would normally receive from a server-side scripting program.

To create a group reservations page for Coast City Windsurfing that uses the `Date` object to generate a monthly calendar:

1. Open your text editor, then open the **index.html** document from your Chapter folder for Chapter 6.

2. Locate `<!--[Add code here]-->` in the document body, and replace it with the following text and elements in the document body. The form submits the data to the FormProcessor.html document.

```
<form action="FormProcessor.html" method="get"
     enctype="application/x-www-form-urlencoded">
</form>
```

3. Add the following elements to the end of the form section:

```
<table border="0">

   <tr valign="top">
      <td>
         <h3>Windsurfing Date</h3>
         <p>
            <input type="text" name="reservationDate"
               onclick="displayCalendar()" /></p>
         <h3>Group Leader</h3>
```

```
                Last name<br />
                <input type="text" name="leaderLastName"
                   size="40" /><br />
                First name<br />
                <input type="text" name="leaderFirstName"
                   size="40" /><br />
                Telephone<br />
                <input type="text" name="leaderTelephone"
                   size="40" /><br />
                Address<br />
                <input type="text" name="leaderAddress"
                   size="40" /><br />
                City, State, Zip<br />
                <input type="text" name="leaderCity"
                size="23" />
                <input type="text" name="leaderState"
                   size="2" maxlength="2" />
                <input type="text" name="leaderZip" size="5"
                   maxlength="5" />
             <p><input type="submit"
                value="Submit Group Reservation" /></p>
             </td>
          </tr>
</table>
```

4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following statements to the script section, which declare a `Date` object at the global level, return the number representing the current month, and declare an array to contain the full text for the months of the year. The function creates a variable named `dateToday` and assigns it as the value of the Windsurfing Date field in the form.

```
var dateObject = new Date();
var month = dateObject.getMonth();
var monthArray = new Array("January","February",
   "March","April","May","June","July","August",
   "September","October","November","December");
function getTodayDate() {
   var dateToday = monthArray[month] + " "
      + dateObject.getDate() + ", "
      + dateObject.getFullYear();
   document.forms[0].reservationDate.value = dateToday;
}
```

6. Add an `onload` event handler to the opening <body> tag that calls the `getTodayDate()` function, as follows:

```
<body onload="getTodayDate()">
```

7. Save the document and open it in your Web browser. Figure 6-6 shows how the document appears in a Web browser. The current date should appear in the Windsurfing Date field.

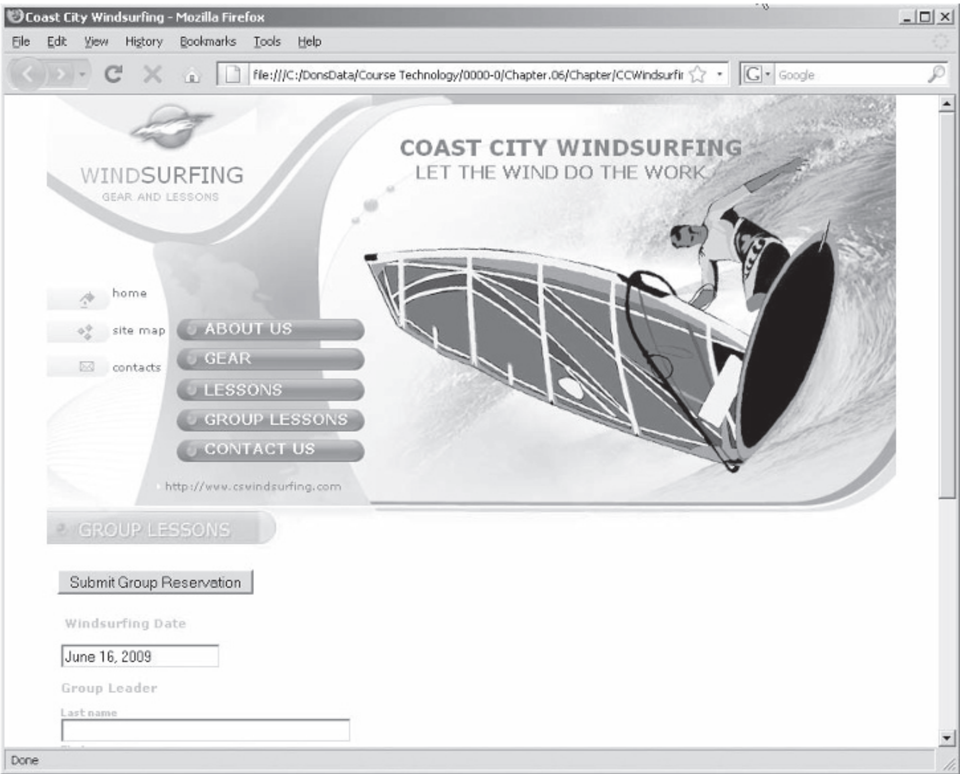


Figure 6-6 Coast City Windsurfing group reservations page

8. Close your Web browser window.

Next, you modify the Coast City Windsurfing page so that it includes functionality that allows users to select a date from a separate date picker window.

To add date picking functionality to the Coast City Windsurfing page:

1. Return to the **index.html** document in your text editor.
2. Add the following anchor element before the closing <p> tag in the paragraph element that contains the Windsurfing Date field. The anchor element contains an `onclick` event handler that calls a function named `displayCalendar()`, which you create next.

```
<a href=""
  onclick="displayCalendar();return false">
  Select Date</a>
```

3. Next, start building the following `displayCalendar()` function. The statements in the function use the `window.open()` method to create a new window that will display the calendar. Notice that the statements use the `calendarWin` variable (which represents the new window) with `document.write()` statements to create the new window. In order for the contents of the window to be well formed, the code includes `document.write()` statements that create the <!DOCTYPE> declaration, <html> element, and header information. The last statement begins creating the table that will display the calendar. Add the following function to the end of the script section:

```
function displayCalendar() {
   calendarWin = window.open("", "CalWindow",
   "status=no,resizable=yes,width=400,height=220, ↵
   left=200,top=200");
   calendarWin.focus();
   calendarWin.document.write("<!DOCTYPE html PUBLIC ↵
      '-//W3C//DTD XHTML 1.0 Strict//EN' ↵
      'http://www.w3.org/TR/xhtml1/DTD/ ↵
      xhtml1-strict.dtd'><html ↵
      xmlns='http://www.w3.org/1999/xhtml'> ↵
      <head><title>Coast City Windsurfing</title> ↵
      <meta http-equiv='content-type' ↵
      content='text/html;charset=iso-8859-1'/> ↵
      <link rel='stylesheet' href='js_styles.css' ↵
      type='text/css' /></head><body>");
   calendarWin.document.write("<table cellspacing='0' ↵
      border='1' width='100%'>");
}
```

Be sure to type the literal strings in this exercise on the same line. They are broken here because of space limitations.

4. Start building the table by adding the following statements to the end of the `displayCalendar()` function. Notice that the second statement uses the `monthArray` and the `month` variables to print the name of the current month and the `getFullYear()` method of the `dateObject` variable to print the year.

```
calendarWin.document.write("<colgroup span='7' ↵
   width='50' />");
calendarWin.document.write("<tr><td colspan='7' ↵
   align='center'><strong>" + monthArray[month]
   + " " + dateObject.getFullYear()
   + "</strong></td></td></tr>");
calendarWin.document.write("<tr align='center'> ↵
   <td>Sun</td><td>Mon</td><td>Tue</td> ↵
   <td>Wed</td><td>Thu</td><td>Fri</td> ↵
   <td>Sat</td></tr>");
calendarWin.document.write("<tr align='center'>");
```

5. Add the following statements to the end of the `displayCalendar()` function. The first statement uses the `setDate()` function to set the date of the `Date` object to the first day of the month. The second statement uses the `getDay()` function to determine which day of the week it is. For instance, if the `getDay()` function returns a value of 3, then the first day of the month starts on Wednesday. Any table cells for days in the first week that are part of the previous month are assigned a nonbreaking space character (` `) by the `for` statement.

```
dateObject.setDate(1);
var dayOfWeek = dateObject.getDay();
for (var i=0; i<dayOfWeek; ++i) {
   calendarWin.document.write("<td> </td>");
}
```

6. Add the following statements to the end of the `displayCalendar()` function. The first statement calculates the number of days in the first week that require date values. The second statement declares a variable named `dateCounter` that is used to keep track of the next date to write to the calendar. The `for` statement then finishes creating the first row in the table, which represents the first week of the month. Notice that the `for` statement creates anchor elements for each of the dates. When a user clicks on a date, an onclick event uses the `opener` property of the `self` object to assign the data value to the Windsurfing Date field in the form on the main Coast City Windsurfing Web page and then close the calendar window. (Recall that the `opener` property refers to the window that opened the current window.)

```
var daysWithDates = 7 - dayOfWeek;
var dateCounter = 1;
for(var i=0; i<daysWithDates; ++i) {
   var curDate = monthArray[month] + " "
      + dateCounter + ", "
      + dateObject.getFullYear();
   calendarWin.document.write(
      "<td><a href='' onclick='self.opener ↵
      .document.forms[0].reservationDate.value=\""
      + curDate + "\";self.close()'>"
      + dateCounter + "</a></td>");
   ++dateCounter;
}
```

7. Next, add the following variable declaration and `if...else` statement to determine the number of days in the `month` variable, which represents the `Date` object. You need the number of days in the current month in order to determine the number of days to display in the calendar. Add the statements to the end of the `displayCalendar()` function.

```
var numDays = 0;
// January, March, May, July, August, October,
December
if (month == 0 || month == 2 || month == 4
   || month == 6 || month == 7 || month == 9
   || month == 11)
      numDays = 31;
// February
else if (month == 1)
      numDays = 28;
// April, June, September, November
else if (month == 3 || month == 5 || month == 8
   || month == 10)
      numDays = 30;
```

8. Next, add the following `for` statement to the end of the `displayCalendar()` function. The calendar needs to consist of six body rows in order to display all of the dates for each month. You already added the first row in Steps 6 and 7. The following `for` statement adds the remaining five rows, starting and ending each row with `<tr align='center'>` and `</tr>`:

```
for (var rowCounter = 0; rowCounter < 5; ++rowCounter) {
   var weekDayCounter = 0;
   calendarWin.document.write("<tr align='center'>");
   calendarWin.document.write("</tr>");
}
```

9. Add the following code between the two `write()` statements in the `for` loop. This code adds the dates for each week. The `while` statement loops through the seven days in a week. While the `dateCounter` variable is less than or equal to the `numDays` variable (which represents the total number of days in the month), a table cell and the value of the `dateCounter` are created for each day. If the `dateCounter` variable is greater than the `numDays` variable, nonbreaking characters are added to each table cell for the remaining days in the week that are not part of the current month.

```
while (weekDayCounter < 7) {
   var curDate = monthArray[month] + " "
      + dateCounter + ", "
      + dateObject.getFullYear();
   if (dateCounter <= numDays)
      calendarWin.document.write("<td><a href='' ↵
         onclick='self.opener.document.forms[0] ↵
         .reservationDate.value=\"" + curDate
         + "\";self.close()'>" + dateCounter
         + "</a></td>");
   else
      calendarWin.document.write("<td> </td>");
      ++weekDayCounter;
      ++dateCounter;
}
```

10. Finally, add the following statements to the end of the `displayCalendar()` function. The first statement closes the `<table>`, `<body>`, and `<html>` elements. The second statement, which calls the `close()` method of the new window's `Document` object, notifies the Web browser window that you are finished writing to the window and the document should be displayed. (You learn more about the `Document` object's `close()` method in Chapter 10.)

```
calendarWin.document.write("</table></body></html>");
calendarWin.document.close();
```

11. Save the **index.html** document, open it in your Web browser, and then click the **Select Date** link to display the calendar window. Figure 6-7 shows how the calendar window appears. Click a date in the calendar window. The date should be added to the Windsurfing Date field on the Group Reservations page and the calendar window should close.

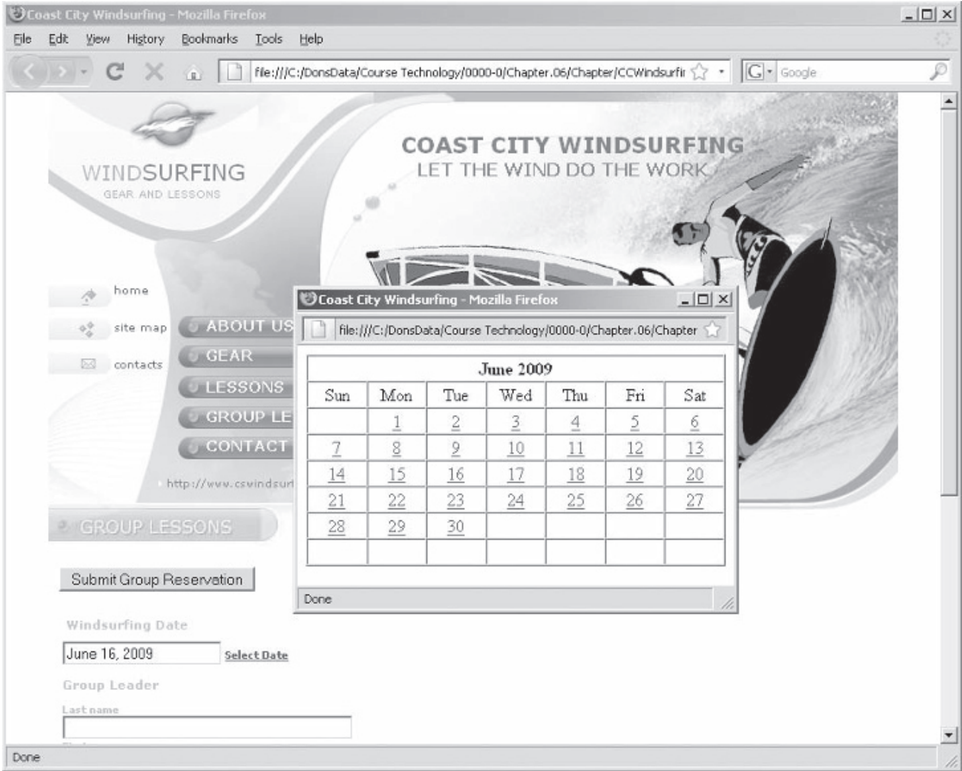


Figure 6-7 Calendar window that appears after clicking the Select Date link

12. Close your Web browser window.

Next, you complete the calendar functionality by modifying the script so it displays different months instead of just the current month.

To add functionality to the calendar script so it displays different months:

1. Return to the **index.html** document in your text editor.
2. Modify the first statement in the `displayCalendar()` function definition as follows so that it accepts a single parameter named `whichMonth`:

```
function displayCalendar(whichMonth) {
...
```

3. Locate the following statement in the `displayCalendar()` function:

```
calendarWin.document.write("<tr><td colspan='7'
align='center'><strong>" + monthArray[month] + " " +
dateObject.getFullYear() + "</strong></td></td></tr>");
```

4. Replace the preceding statement with the following statements. The `if` statement determines whether the value assigned to the `whichMonth` parameter is either –1 or 1. If the value is –1, then the `setMonth()` function sets the date assigned to the date object to one month earlier by subtracting a value of one from the value returned with the `getMonth()` function. If the value is 1, then the `setMonth()` function sets the date assigned to the date object to one month later by adding a value of one to the value returned with the `getMonth()` function. The variable declaration statement then uses another `getMonth()` function to assign the new month to the `month` variable. The `document.write()` statement builds the same header row at the beginning of the calendar that you saw in the last exercise, but this time it also creates Previous and Next links that rerun the `displayCalendar()` function when they are clicked.

```
if (whichMonth == -1)
   dateObject.setMonth(dateObject.getMonth()-1);
else if (whichMonth == 1)
   dateObject.setMonth(dateObject.getMonth()+1);
   var month = dateObject.getMonth();
   calendarWin.document.write("<tr><td colspan='2'> ↵
   <a href='' onclick='self.opener.displayCalendar(-1); ↵
   return false'>Previous</a></td><td colspan='3' ↵
   align='center'><strong>" + monthArray[month] + " "
   + dateObject.getFullYear() + "</strong></td> ↵
   <td colspan='2' align='right'><a href='' ↵
   onclick='self.opener.displayCalendar(1); ↵
   return false'>Next</a></td></tr>");
```

Be sure to type the text string that is printed with the `calendarWin.document.write()` statement on a single line.

5. Save the **index.html** document, open it in your Web browser, and then click the **Select Date** link to display the calendar window. The calendar window now includes Previous and Next links, as shown in Figure 6-8.

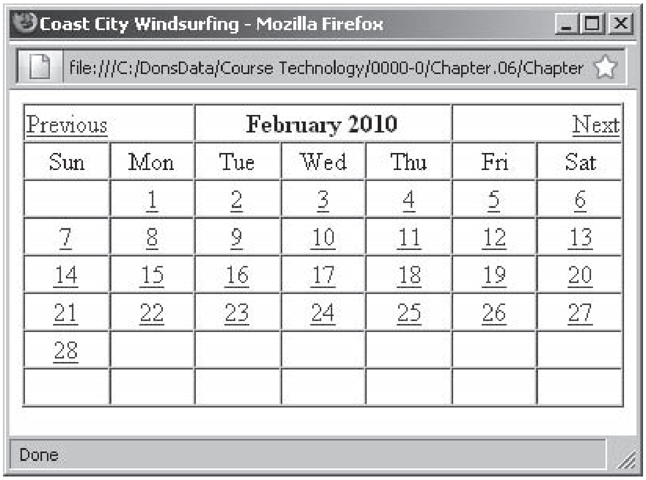


Figure 6-8 Calendar window with Previous and Next links

6. Test the **Previous** and **Next** links. The calendar window should update and display the correct dates for the selected month. Click a date in the calendar window to ensure that the date is still added to the Windsurfing Date field on the Group Reservations page and that the calendar window closes.

7. Close your Web browser window.

Manipulating Numbers with the `Number` Class

The **`Number` class** contains methods for manipulating numbers and properties that contain static values representing some of the numeric limitations in the JavaScript language (such as the largest positive number that can be used in JavaScript). While you can create a `Number` object using a statement similar to `var myNum = new Number();`, you are not required to. Instead, you can simply append the name of any `Number` class method or property to the name of an existing variable that contains a numeric value.

Using `Number` Class Methods

Table 6-4 lists the methods of the `Number` class.

Method	Description
`Number()`	`Number` object constructor
`toExponential(decimals)`	Converts a number to a string in exponential notation using a specified number of decimal places
`toFixed(decimals)`	Converts a number to a string with a specified number of decimal places
`toLocaleString()`	Converts a number to a string that is formatted with local numeric formatting conventions
`toPrecision(decimals)`	Converts a number to a string with a specific number of decimal places, in either exponential notation or in fixed notation
`toString(radix)`	Converts a number to a string using a specified radix
`valueOf()`	Returns the numeric value of a `Number` object

Table 6-4 `Number` class methods

The primary reason for using any of the "to" methods listed in Table 6-4 is to convert a number to a string value with a specific number of decimal places that will be displayed to a user. If you don't need to display the number for a user, there is no need to use any of the methods. The most useful `Number` class method is the `toFixed()` method, which you can use to display a numeric value with a specified number of decimal places. For example, you may have a number in your program that represents a dollar value. However, depending on the result of a calculation or a value entered by a user, the number may contain more than the two decimal places that are acceptable in a currency value. The following code shows a simple example of a numeric variable named `salesTotal` that is assigned a value of 49.95. If you apply a discount of 10% to the variable, the new number is equal to 44.955. Before displaying the value, the `write()` statement uses the `toFixed()` method to convert the value of the `salesTotal` variable to a string containing two decimal places.

```
var salesTotal = 49.95;
var discount = salesTotal * .1;
salesTotal -= discount; // new value is 44.955
document.write("$"
    + salesTotal.toFixed(2)); // displays $44.96
```

Another useful `Number` class method is the `toLocaleString()` method, which you can use to convert a number to a string that is formatted with local numeric formatting conventions. For example, with American numeric formatting conventions, you separate thousands with a comma. The following statements demonstrate how to convert the number 1210349 to the string $1,210,349:

Firefox displays the number in the code to the right without decimal places ($1,210,349), whereas Internet Explorer displays it with decimal places ($1,210,349.00).

```
var salesTotal = 1210349;
salesTotal = salesTotal.toLocaleString();
document.write("$"
    + salesTotal); // displays $1,210,349
```

By default, Internet Explorer displays two decimal places for numbers that are converted with the `toLocaleString()` method, whereas Firefox displays the number as a whole number. To convert a numeric value to a specified number of decimal places and to a local string is not intuitive in Firefox. First, you call the `toFixed()` method, which converts the number to a string with the specified number of decimals. Then, because it's a string, you need to convert it back to floating-point number with the `parseFloat()` function. Finally, you call the `toLocaleString()` method to convert the number to a string that is formatted with the local numeric formatting conventions. The following code converts the number 1210349.4567 to the string $1,210,349.46:

```
var salesTotal = 1210349.4567;
salesTotal = salesTotal.toFixed(2);
salesTotal = parseFloat(salesTotal);
salesTotal = salesTotal.toLocaleString();
document.write("$"
    + salesTotal); // displays $1,210,349.46
```

Although Internet Explorer will successfully display decimal places for numbers that are converted with the `toLocaleString()` method, you should use the `toFixed()` and `parseFloat()` methods to ensure that code that uses the `toLocaleString()` method is compatible with both Internet Explorer and Firefox.

Accessing `Number` Class Properties

Table 6-5 lists the properties of the `Number` class. Note that there is little reason for you to use these properties. However, they are listed here for the sake of completeness.

Property	Description
`MAX_VALUE`	The largest positive number that can be used in JavaScript
`MIN_VALUE`	The smallest positive number that can be used in JavaScript
`NaN`	The value NaN, which stands for "not a number"
`NEGATIVE_INFINITY`	The value of negative infinity
`POSITIVE_INFINITY`	The value of positive infinity

Table 6-5 `Number` class properties

Next, you add code to the Group Reservations page that calculates group discounts.

To add code to the Group Reservations page that calculates group discounts:

1. Return to the **index.html** document in your text editor.
2. Add the following text and elements just before the closing `</td>` tag in the table. The text and elements display group discounts and the first `<input>` element allows users to enter the number of windsurfers in their groups. The `onchange` event handler in the first `<input>` element then calls a function named `calcGroupDiscount()`, which will calculate the group discount according to the size of the group. Notice that an argument of `this.value` is passed to the function.

```
<h3>
   Group Discounts</h3>
<ul>
   <li>Daily Rate: $49</li>
   <li>5-10 windsurfers: 10% discount</li>
   <li>11-24 windsurfers: 20% discount</li>
   <li>25+ windsurfers: 25% discount</li>
</ul>
<p>
   How many windsurfers are in your group?
   <input type="text" size="5" value="0"
      onchange="calcGroupDiscount(this.value)" /></p>
<p>
   Your group rate is $<input type="text"
      name="discount" size="60" value="0"
      readonly="readonly"
      class="total" /></p>
```

3. Add the following `calcGroupDiscount()` function to the end of the script section. The `if...else` statements in the function calculate the group discount according to the value assigned to the `groupSize` parameter. The last statement in the function then assigns the discount rate to the discount field in the form.

```
function calcGroupDiscount(groupSize) {
   var dailyRate = 49;
   if (groupSize >= 5 && groupSize <= 10)
      dailyRate = 49 / 1.1;
   else if (groupSize > 10 && groupSize < 25)
      dailyRate = 49 / 1.2;
   else if (groupSize > 24)
      dailyRate = 49 / 1.25;
   var groupRate = groupSize * dailyRate;
   document.forms[0].discount.value = groupRate;
}
```

4. Save the **index.html** document and then open it in your Web browser. Enter a number in the group size field, then press the **Tab** key or click off the field so that the `calcGroupDiscount()` function is called by the `onchange` event handler. Notice that the group rate field displays all the digits in the calculated number. For example, Figure 6-9 shows a group rate of $356.3636363636363 after entering a value of 8 in the group size field.

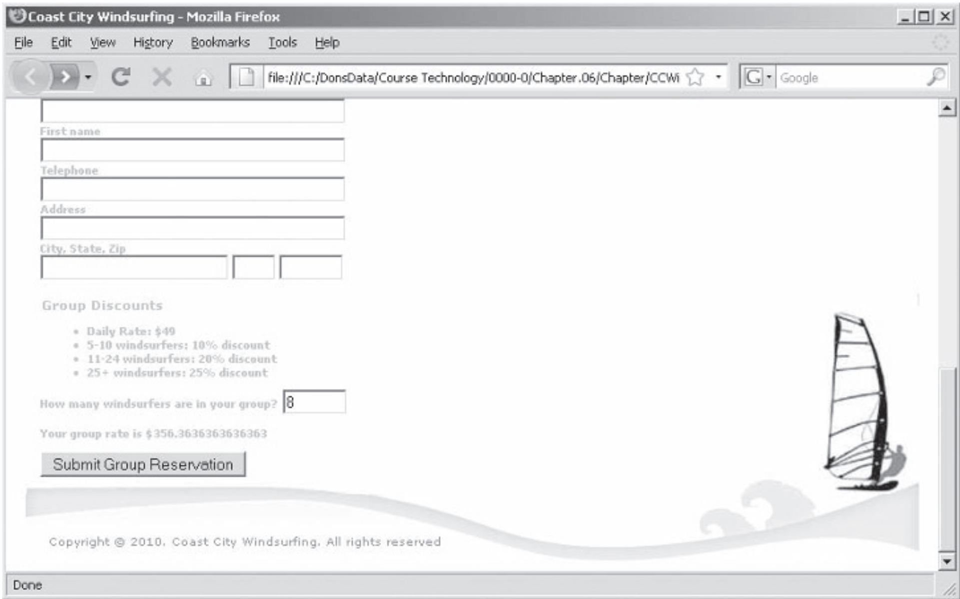


Figure 6-9 Group Reservations page after adding the Group Discounts section

5. Return to the **index.html** document in your text editor

6. Modify the last statement in the `calcGroupDiscount()` function as follows so that the `groupRate` includes the `toFixed()` method to convert the value of the `groupRate` variable to two decimal places.

```
document.forms[0].discount.value
    = groupRate.toFixed(2);
```

7. Save the **index.html** document and then reopen it in your Web browser. Enter a number in the group size field, then press the **Tab** key or click off the field so that the `calcGroupDiscount()` function is called by the `onchange` event handler. The group rate field should display the calculated number with two decimal places.

8. Close your Web browser window.

Performing Math Functions with the `Math` Class

The **`Math` class** contains methods and properties for performing mathematical calculations in your programs.

Using `Math` Class Methods

Table 6-6 lists the methods of the `Math` class.

Method	Description
`abs(`*x*`)`	Returns the absolute value of *x*
`acos(`*x*`)`	Returns the arc cosine of *x*
`asin(`*x*`)`	Returns the arc sine of *x*
`atan(`*x*`)`	Returns the arc tangent of *x*
`atan2(`*x*`,`*y*`)`	Returns the angle from the *x*-axis
`ceil(`*x*`)`	Returns the value of *x* rounded to the next highest integer
`cos(`*x*`)`	Returns the cosine of *x*
`exp(`*x*`)`	Returns the exponent of *x*
`floor(`*x*`)`	Returns the value of *x* rounded to the next lowest integer
`log(`*x*`)`	Returns the natural logarithm of *x*
`max(`*x*`,`*y*`)`	Returns the larger of two numbers
`min(`*x*`,`*y*`)`	Returns the smaller of two numbers
`pow(`*x*`,`*y*`)`	Returns the value of *x* raised to the *y* power
`random()`	Returns a random number
`round(`*x*`)`	Returns the value of *x* rounded to the nearest integer
`sin(`*x*`)`	Returns the sine of *x*
`sqrt(`*x*`)`	Returns the square root of *x*
`tan(`*x*`)`	Returns the tangent of *x*

Table 6-6 `Math` class methods

Unlike the `Array`, `Date`, and `Number` classes, the `Math` class does not contain a constructor. This means that you cannot instantiate a `Math` object using a statement such as `var mathCalc = new Math()`. Instead, you use the `Math` object and one of its methods or properties directly in your code. For example, the `sqrt()` method returns the square root of a number. The following code shows how to use the `sqrt()` method to determine the square root of 144:

```
var curNumber = 144;
squareRoot = Math.sqrt(curNumber); // returns '12'
document.write("The square root of " + curNumber
    + " is " + squareRoot);
```

Accessing `Math` Class Properties

Table 6-7 lists the properties of the `Math` class.

Property	Description
`E`	Euler's constant *e*, which is the base of a natural logarithm; this value is approximately 2.7182818284590452354
`LN10`	The natural logarithm of 10, which is approximately 2.302585092994046
`LN2`	The natural logarithm of 2, which is approximately 0.6931471805599453
`LOG10E`	The base-10 logarithm of *e*, the base of the natural logarithms; this value is approximately 0.4342944819032518
`LOG2E`	The base-2 logarithm of *e*, the base of the natural logarithms; this value is approximately 1.4426950408889634
`PI`	A constant representing the ratio of the circumference of a circle to its diameter, which is approximately 3.1415926535897932
`SQRT1_2`	The square root of 1/2, which is approximately 0.7071067811865476
`SQRT2`	The square root of 2, which is approximately 1.4142135623730951

Table 6-7 `Math` class properties

As an example of how to use the properties of the `Math` object, the following code shows how to use the `PI` property to calculate the area of a circle based on its radius. The code also uses the `round()` method to round the value returned to the nearest whole number.

```
var radius = 25;
var area = Math.round(Math.PI * radius
    * radius); // return 1963
document.write("A circle with a radius of " + radius
    + " has an area of " + area);
```

Next, you modify the `calcGroupDiscount()` function so that it uses the `round()` function of the `Math` object to round the group discount to the nearest integer instead of displaying decimal places. If you entered a large number in the last exercise when you tested the script, you may have noticed that although the group discount displayed only two decimal places, the number was not formatted with commas or whatever the formatting convention is for your locale. For example, if you entered a value of 38, the group rate is displayed as $1489.60. In American numeric formatting, the convention is to include commas to separate thousands. This means that the value $1489.60 should display as $1,489.60. To ensure that numbers are correctly displayed according to local numeric formatting conventions, you must use the `toLocaleString()` function, which you will also add to the `calcGroupDiscount()` function.

To modify the Group Reservations page so it uses the `round()` function of the `Math` object and the `toLocaleString()` function:

1. Return to the **index.html** document in your text editor.
2. Add the following statement immediately after the statement that declares the `groupRate` variable in the `calcGroupDiscount()` function; it declares and initializes the `groupRate` variable. This statement uses the `round()` function of the `Math` object to round the number to the nearest integer.

   ```
   groupRate = Math.round(groupRate);
   ```

3. Modify the last statement in the `calcGroupDiscount()` function so that it calls the `toLocaleString()` function instead of the `toFixed()` function, as follows:

   ```
   document.forms[0].discount.value
      = groupRate.toLocaleString();
   ```

4. Save the **index.html** document and then reopen it in your Web browser. Enter a number larger than 25 in the group size field, then press the **Tab** key or click off the field so that the `calcGroupDiscount()` function is called by the `onchange` event handler. The value in the group rate field should be displayed with a comma separator and no decimal places. Figure 6-10 shows how the page appears after entering a value of 35 in the group size field.

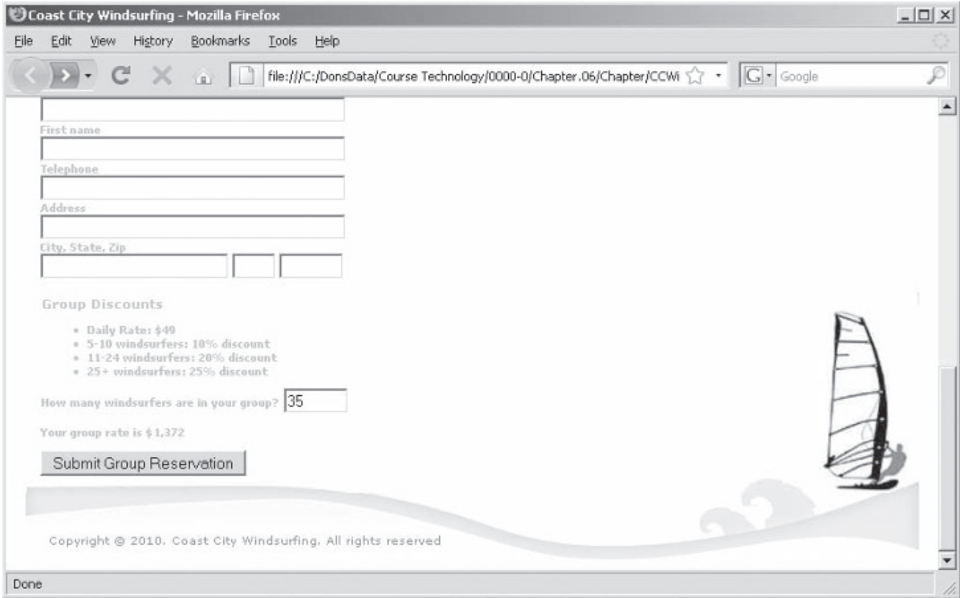


Figure 6-10 Group Reservations page after adding `Math.round()` and `toLocaleString()` functions

5. Close your Web browser window.

Short Quiz 2

1. How do you refer to the days of the week, dates of the month, and months of the year when working with the `Date` class?
2. What is the primary reason for using any of the "to" methods in the `Number` class?
3. How do you use the `Math` object and one of its methods or properties directly in your code?

Defining Custom JavaScript Objects

JavaScript is not a true object-oriented programming language. You can base objects in your programs on built-in JavaScript classes such as the `Array` and `Date` objects. However, you cannot create your own classes in JavaScript. For this reason, JavaScript is said to be an object-based programming language instead of an object-oriented programming language.

Nevertheless JavaScript does allow you to define your own custom objects. Unlike objects that are based on classes, custom objects in JavaScript are not encapsulated, which means that other programmers who use your custom object can see inside of the black box. Even though custom JavaScript objects cannot be encapsulated, you may find them useful, especially if you need to replicate the same functionality an unknown number of times in a script. For example, you may have a Web site that allows customers to place online orders for concert tickets. For each order, you may want to create a new object that uses properties to store information such as the customer's name, concert name, number of tickets, concert date, and so on. The object may also contain methods that calculate sales tax and sales total. Although you could use standard functions and variables to create the same functionality, the ability to treat each order as a self-contained object would make your job as a programmer a little easier.

The most recent implementation of the JavaScript language, ECMAScript Edition 3, includes support for true classes. However, at the time of this writing, no Web browsers support the new JavaScript class functionality.

Declaring Basic Custom Objects

Although JavaScript is not a true object-oriented programming language, you can create basic objects and properties by using the `Object` object. To declare a custom object with the `Object` object, you use the following statement:

```
var objectName = new Object();
```

You can also create a custom object by assigning a pair of empty braces to a variable name, as follows:

```
var objectName = {};
```

After you create a custom object, you can assign properties to the object by appending the property name to the object name with a period. For example, the following code creates a new object named `ConcertTickets` and assigns four properties to it: `customerName`, `concertName`, `ticketQuantity`, and `concertDate`. You can then access the values assigned to each property the same as you would for other types of objects, as demonstrated with the `document.write()` statements. Notice that the `concertDate` property is created as a `Date` object that stores the date and time of the concert. Figure 6-11 shows the output.

```
var ConcertTickets = new Object();
ConcertTickets.customerName = "Don Gosselin";
ConcertTickets.concertName = "Jimmy Buffett";
ConcertTickets.ticketQuantity = 2;
ConcertTickets.concertDate = new Date(2010, 6, 18, 20);
```

```
document.write("<h1>Ticket Order</h1>");
document.write("<p>Customer: " + ConcertTickets.customerName);
document.write("<br />Concert: " + ConcertTickets.concertName);
document.write("<br />Quantity: "
    + ConcertTickets.ticketQuantity);
document.write("<br />Date: "
    + ConcertTickets.concertDate.toLocaleString()
    +"</p>");
```

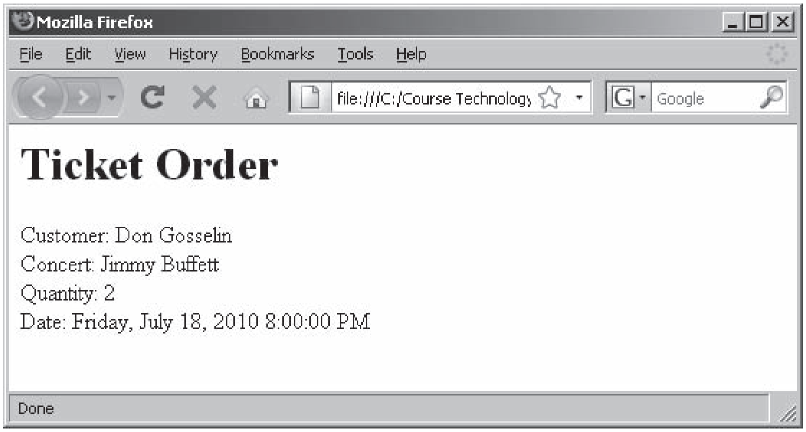


Figure 6-11 Output of custom object properties

Custom objects created as described in this section are limited to containing only properties. Although you may find it useful to create objects in this manner to organize complex data, in most cases you can use standard variables just as effectively. Objects are most useful when they contain both properties and methods. To create custom objects that contain methods, you must use constructor functions, which are described later in this chapter.

Next, you start adding a Group Members section to the Coast City Windsurfing page. This section allows you to enter information about each windsurfer in the group, including name, address, and phone number.

To add a Group Members form section to the Coast City Windsurfing page:

1. Return to the **index.html** document and delete the following text and elements:

```
<p>
   How many windsurfers are in your group?
   <input type="text" size="5" value="0"
      onchange="calcGroupDiscount(this.value)"></p>
```

2. Add the following code above the paragraph that displays the group rate:

```
</td>
<td>
<h3>Group Members</h3>
<p><input type="button" value="Add Windsurfer" />
<input type="button" value="Delete Windsurfer" />
<input type="button" value="Update Info" /></p>
<table border="0">
<tr>
  <td><select name="contacts" size="13"
      style="width: 150px">
      <option value="contacts">Group Members</option>
    </select></td>
  <td>Last name<br />
    <input type="text" name="lastname" size="50" /><br />
    First name<br />
    <input type="text" name="firstname" size="50" /><br />
    Telephone<br />
    <input type="text" name="telephone" size="50" /><br />
    Address<br />
    <input type="text" name="address" size="50" /><br />
    City, State, Zip<br />
    <input type="text" name="city" size="34" />
    <input type="text" name="state" size="2"
    maxlength="2" />
    <input type="text" name="zip" size="5"
    maxlength="5" /></td>
</tr>
</table>
```

3. Add the following object declaration to the end of the script section. The object properties will contain other objects that represent each windsurfer added to the Group Members list. Using one object to store other objects makes it easier to manage each group member as it is added to and deleted from the program.

```
var contactList = new Object();
```

4. Save the **index.html** document and open it in your Web browser. You still need to add functionality to the section before you can enter any windsurfers information. Figure 6-12 shows how the Web page appears after adding the Group Members section.

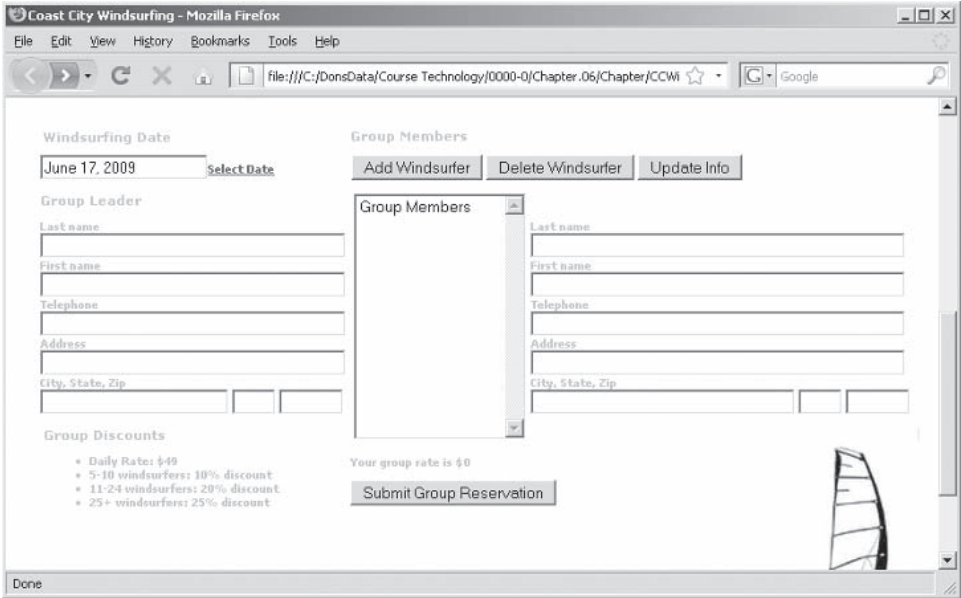


Figure 6-12 Group Reservations Web page after adding the Group Members section

5. Close your Web browser window.

Defining Constructor Functions

You can define your own custom objects by using a **constructor function**, which is a function that is used as the basis for a custom object. (Another term for constructor function is **object definition**.) As with traditional class-based objects, JavaScript objects inherit all the variables and statements of the constructor function on which they are based. Any JavaScript function can serve as a constructor. The following code defines a function named `ConcertTickets()` with four parameters that can serve as a constructor function:

```
function ConcertTickets(customer, concert,
    tickets, eventDate) {
...
}
```

Use a statement similar to the following to instantiate an instance of a `ConcertTickets` object:

```
var newOrder = new ConcertTickets();
```

Next, you add a constructor function to the Group Reservations page.

To add a constructor function to the Group Reservations page:

1. Return to the **index.html** document in your text editor.

2. Type the following constructor function above the `contactList` declaration statement in the script section:

   ```
   function Contact() {
   }
   ```

3. Save the **index.html** document.

Working with Object Properties

In this section, you will learn how to use properties with your custom JavaScript objects. First, you will learn how to add new properties.

Adding Properties

To add a property to a constructor function, you must add a statement to the function body that uses the `this` keyword with the following syntax: `this.`*`property_name`*` = `*`value`*;. In the case of a custom JavaScript object, the `this` keyword refers to the object that calls the constructor function. For example, the following constructor function includes four properties: `customerName`, `concertName`, `ticketQuantity`, and `concertDate`.

```
function ConcertTickets(customer, event, quantity, eventDate) {
    this.customerName = customer; // customer name
    this.concertName = event; // event name
    this.ticketQuantity = quantity; // number of tickets
    this.concertDate = eventDate; // concert date
}
```

The statements in the preceding constructor function use the `this` keyword to assign the values of the four arguments (`customer`, `event`, `quantity`, and `eventDate`) to the `customerName`, `concertName`, `ticketQuantity`, and `concertDate` properties of whichever object called the function. The use of the `this` reference is one of the primary differences between standard functions and constructor functions. Standard functions do not include a `this` reference, because they are not used as the basis of objects.

The following code declares a `ticketOrder` object based on the `ConcertTickets()` constructor function, assigns values to its four properties, and then prints the properties. The output is the same as that shown in Figure 6-11.

```
var ticketOrder = new ConcertTickets();
ticketOrder.customerName = "Don Gosselin";
ticketOrder.concertName = "Jimmy Buffett";
ticketOrder.ticketQuantity = 2;
ticketOrder.concertDate = new Date(2010, 6, 18, 20);
```

```
document.write("<h1>Ticket Order</h1>");
document.write("<p>Customer: " + ticketOrder.customerName);
document.write("<br />Concert: " + ticketOrder.concertName);
document.write("<br />Quantity: " + ticketOrder.ticketQuantity);
document.write("<br />Date: "
    + ticketOrder.concertDate.toLocaleString() + "</p>");
```


You can also assign values to the properties of an object when you first instantiate the object by using statements similar to the following:

```
var ticketOrder = new ConcertTickets("Don Gosselin",
    "Jimmy Buffett", 2, new Date(2010, 6, 18, 20));
document.write("<h1>Ticket Order</h1>");
document.write("<p>Customer: " + ticketOrder.customerName);
document.write("<br />Concert: " + ticketOrder.concertName);
document.write("<br />Quantity: " + ticketOrder.ticketQuantity);
document.write("<br />Date: "
    + ticketOrder.concertDate.toLocaleString()
    + "</p>");
```

Next, you will add properties to the `Contact` constructor function.

To add properties to the `Contact` constructor function, along with a function that copies the values from the Contacts form to the properties:

1. Return to the **index.html** document in your text editor.
2. Add the following properties to the `Contact` constructor function. Each property is initially assigned an empty string.

   ```
   this.lastName = "";
   this.firstName = "";
   this.telephone = "";
   this.address = "";
   this.city = "";
   this.state = "";
   this.zip = "";
   ```

3. Save the **index.html** document.

Enumerating Custom Object Properties

Some custom objects can contain dozens of properties. For example, a script may create new custom object properties that store sales prices for each item a customer wants to purchase. Suppose that you want to discount the individual sales prices by 10% of any items that cost more than $100. Because there is no way to determine in advance which items a customer will purchase, you have no way of knowing which properties have been added to the object for each individual customer. To execute the same statement or command block for all the properties within a custom object, you can use the

for...in statement, which is a looping statement similar to the `for` statement. The syntax of the `for...in` statement is as follows:

```
for (variable in object) {
    statement(s);
}
```

The variable name in the `for...in` statement constructor holds an individual object property. The object name in the constructor represents the name of an object that has been instantiated in a program. Unlike the other loop statements, the `for...in` statement does not require a counter or any other type of code to control how the loop functions. Instead, the `for...in` statement automatically assigns each property in an object to the variable name, performs the necessary statements on the property, then moves to the next property and starts over. The `for...in` statement ends automatically once it reaches the last property in an object. A typical use of the `for...in` statement is to retrieve the names of properties within an object, as shown in the following code:

```
var ConcertTickets = new Object();
ConcertTickets.customerName = "Don Gosselin";
ConcertTickets.concertName = "Jimmy Buffett";
ConcertTickets.ticketQuantity = 2;
ConcertTickets.concertDate = new Date(2010, 6, 18, 20);
for (prop in ConcertTickets) {
    document.write(prop + "<br />");
}
```

In the preceding code, the variable name `prop` holds the names of each property in the `ConcertTickets` object. The `document.write()` statement then writes the name of each property to the Web browser window, as shown in Figure 6-13.

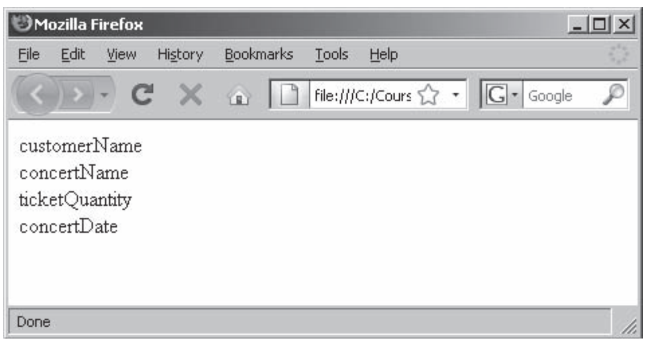


Figure 6-13 Property names printed with a `for...in` statement

The preceding example demonstrates how to use the `for...in` statement with objects instantiated from the `Object` object. Using the `for...in` statement with objects instantiated from constructor functions is very similar:

```
function ConcertTickets(customer, concert, tickets, eventDate) {
    this.customerName = customer;   // customer name
    this.concertName = concert; // concert name
    this.ticketQuantity = tickets; // number of tickets
    this.concertDate = eventDate; // concert date
}
var ticketOrder = new ConcertTickets("Don Gosselin",
    "Jimmy Buffett", 2, new Date(2010, 6, 18, 20));
for (prop in ticketOrder) {
    document.write(prop + "<br />");
}
```

One of the benefits of the `for...in` statement is that it **enumerates**, or assigns an index to, each property in an object, which is similar to the way elements in an array are indexed. You can use an enumerated object property to access the values contained within object properties. For example, in the following code, the `document.write()` statement within the body of the `for...in` statement refers to the `prop` variable as an index of the `ticketOrder` object:

```
for (prop in ticketOrder) {
    document.write(ticketOrder[prop] + "<br />");
}
```

Each iteration of the `for...in` statement in the preceding code now prints the contents of each property rather than just the property names. The code passes the `ticketOrder` object to the `document.write()` method, along with the `prop` variable enclosed in brackets (`ticketOrder[prop]`). You would use this same technique to print the contents of an array. Unlike the elements in an array, however, you cannot refer to the enumerated properties of an object outside of a `for...in` loop; doing so generates an error. The statement `document.writeln(ticketOrder[prop]);` causes an error outside of a `for...in` loop.

Next, you start adding a function named `addContact()`, which will add windsurfers to the contact list.

To start adding the `addContact()` function:

1. Return to the **index.html** document in your text editor.
2. Add the following `addContact()` function definition to the end of the script section:

```
function addContact() {
}
```

3. Add the following variable declaration to the `addContact()` function. This variable will store a number that will represent the new contact.

```
var newContact = 0;
```

4. Add the following `for...in` statement to the end of the `addContact()` function. This statement enumerates the properties in the `contactList` object and increments the `newContact` variable for each contact. The value assigned to the `newContact` variable will be used to represent each new contact that is added to the Group Members form.

```
for (contact in contactList) {
   ++newContact;
}
```

5. Save the **index.html** document.

Referring to Object Properties as Associative Arrays

JavaScript allows you to refer to object properties using associative array syntax. An **associative array** is an array whose elements are referred to with an alphanumeric key instead of an index number. For example, with associative arrays you can create a company's payroll information that uses each employee's last name instead of an index number to refer to an element in the array. To refer to an element in an associative array, you place an element's key in single or double quotation marks inside the array brackets. For example, the following statements create the elements in an array named `hotelReservation` using associative array syntax:

```
var hotelReservation = new Array(4);
hotelReservation["guest"] = "Don Gosselin";
hotelReservation["nights"] = 2;
hotelReservation["price"] = 89.95;
hotelReservation["nonsmoking"] = true;
document.write("<p>Guest: " + hotelReservation["guest"]);
document.write("<br />Nights: " + hotelReservation["nights"]);
document.write("<br />Price: " + hotelReservation["price"]);
document.write("<br />Non-smoking room: "
    + hotelReservation["nonsmoking"] + "</p>");
```

You can also use associative array syntax to refer to the properties of an object. The following example demonstrates how to refer to the `customerName` property of the `ConcertTickets` object using associative array syntax (`ConcertTickets["customerName"]`) instead of standard property syntax (`ConcertTickets.customerName`):

```
var ConcertTickets = new Object();
ConcertTickets.customerName = "Don Gosselin";
document.write("<p>Customer: " + ConcertTickets["customerName"]);
```

One of the benefits of using associative array syntax with object properties is that you can dynamically build property names at runtime. For example, the following statements use associative array syntax to create a property consisting of the word "employee" and an employee ID in an object named `employeeList`:

```
var employeeList = new Object();
var employeeID = 56725;
employeeList["employee" + employeeID] = "Don Gosselin";
```

You can print the contents of the property created with the preceding statements by using any of the following:

```
document.write(employeeList["employee" + employeeID]);
document.write(employeeList.employee56725);
document.write(employeeList["employee56725"]);
```

Next, you complete the `addContact()` function. The function will use associative array syntax to create the properties of each `Contact` object that is stored in properties of the `contactList` object.

To complete the addContact() function:

1. Return to the **index.html** document in your text editor.
2. Add the following statements to the end of the `addContact()` function. The `if` statement checks to see if the last name and first name fields have been filled in. If not, then an alert dialog box appears instructing users to enter the contact's first and last name. If both fields contain values, then an `else` statement instantiates a new `Contact` object and assigns it as a property of the `contactList` object. The remaining statements assign values to the `Contact` object property, create a new Option object, and assign the contents of the new `Contact` property to the new `Option` object. Notice that the statements use associative array syntax to build the name of the `Contact` objects that are assigned as properties of the `contactList` object.

```
if (document.forms[0].lastname.value == ""
   || document.forms[0].firstname.value == "")
   window.alert("You must enter the contact's ↵
      first and last names.");
else {
   contactList["contact" + newContact] = new Contact();
   contactList["contact" + newContact].lastName
      = document.forms[0].lastname.value;
   contactList["contact" + newContact].firstName
      = document.forms[0].firstname.value;
   contactList["contact" + newContact].telephone
      = document.forms[0].telephone.value;
```

```
contactList["contact" + newContact].address
  = document.forms[0].address.value;
contactList["contact" + newContact].city
= document.forms[0].city.value;
contactList["contact" + newContact].state
  = document.forms[0].state.value;
contactList["contact" + newContact].zip
= document.forms[0].zip.value;
var createContact = new Option();
createContact.value = contactList["contact"
  + newContact].lastName + "," + contactList["contact"
  + newContact].firstName;
createContact.text = contactList["contact"
  + newContact].lastName + ","
  + contactList["contact" + newContact].firstName;
document.forms[0].contacts.options[newContact]
  = createContact;
}
```

3. Add the following event handler to the Add Windsurfer element:

```
<input type = "button" value = "Add Windsurfer"
onclick = "addContact()" />
```

4. Save the **index.html** document, and open the document in your Web browser. Test the script by adding some contacts to the contact list.

5. Close your Web browser window.

Deleting Properties

You can use the `delete` operator to delete properties created with either the `Object` object or with a constructor function.

To delete a specific property in a custom object, you use the `delete` operator with the syntax `delete object.property`. For example, the following statement deletes the `concertDate` property of the `ConcertTickets` object:

```
delete ConcertTickets.concertDate;
```

Next, you add a `deleteContact()` function to the Group Reservations page that deletes selected windsurfers from the Group Members section.

To add a `deleteContact()` function:

1. Return to the **index.html** document in your text editor.

2. Add the following `deleteContact()` function definition to the end of the script section:

```
function deleteContact() {
}
```

3. Add the following statements to the `deleteContact()` function. These statements loop through each option in the selection list to determine which option is selected. Once the selected item is located, its index value is assigned to the `selectedContact` variable. The last statement deletes the item from the select list by assigning a value of null to the element in the `options[]` array.

```
var contactSelected = false;
var selectedContact = 0;
for (var i=0;i<document.forms[0].contacts
   .options.length;++i) {
   if (document.forms[0].contacts.options[i]
      .selected== true) {
      contactSelected = true;
      selectedContact = i;
      break;
   }
}
document.forms[0].contacts.options[i] = null;
```

4. Add the following statements to the end of the `deleteContact()` function. The `if...else` statement first checks the value assigned to the `contactSelected` variable. If the `contactSelected` variable contains a value of false, an alert dialog box informs the user that they must select a contact in the list. If the `contactSelected` variable contains a value of true, the `for...in` statement deletes all of the properties in the `contactList` object. Then, the `for` statement rebuilds the properties in the `contactList` object from the options that are displayed in the selection list.

```
if (contactSelected == true) {
   for (prop in contactList) {
      delete contactList[prop]
   }
   for (var i=0; i<document.forms[0].contacts.
   options.length;++i) {
      contactList["contact" + i] = new Contact();
      contactList["contact" + i].lastName
         = document.forms[0].lastname.value;
      contactList["contact" + i].firstName
         = document.forms[0].firstname.value;
      contactList["contact" + i].telephone
         = document.forms[0].telephone.value;
      contactList["contact" + i].address
         = document.forms[0].address.value;
      contactList["contact" + i].city
         = document.forms[0].city.value;
      contactList["contact" + i].state
         = document.forms[0].state.value;
```

```
        contactList["contact" + i].zip
           = document.forms[0].zip.value;
     }
  }
  else
  window.alert(
     "You must select a contact in the list.");
```


5. Add the following event handler to the Delete Windsurfer element:

```
<input type="button" value="Delete Windsurfer"
onclick="deleteContact()" />
```

6. Save the **index.html** document, and open the document in your Web browser. Test the script by adding and deleting some contacts to and from the contact list.

7. Close your Web browser window.

Creating Methods

You can create a function that will be used as an object method by referring to any object properties it contains with the `this` reference. For example, the following code defines a method that prints the `customerName`, `concertName`, `ticketQuantity`, and `concertDate` properties of the `ConcertTickets` constructor function:

```
function displayConcertTickets() {
    document.write("<p>Customer: " + this.customerName);
    document.write("<br />Concert: " + this.concertName);
    document.write("<br />Quantity: " + this.ticketQuantity);
    document.write("<br />Date: "
        + this.concertDate.toLocaleString() + "</p>");
}
```

After a method is created, it must be added to the constructor function, using the syntax `this.`*`methodname`*` = functionname`;. The *`methodname`* following the `this` reference is the name that is being assigned to the function within the object. Remember not to include the parentheses following the function name, as you would when calling a function in JavaScript. The statement `this.`*`methodname`*` = `*`functionname`*`()`; is incorrect, because it includes parentheses. To add the `displayConcertTickets()` function to the `ConcertTickets` function definition as a method named `showOrder()`, you include the statement `this.showOrder = displayConcertTickets`; within the function definition braces.

The following code shows the `ConcertTickets()` constructor function, the `displayConcertTickets()` function that creates the `showOrder()` method, and statements that instantiate two `ConcertTickets` objects and print the values of their properties. Figure 6-14 shows the output.

```
function ConcertTickets(customer, concert, tickets, eventDate) {
    this.customerName = customer;    // customer name
    this.concertName = concert; // concert name
    this.ticketQuantity = tickets; // number of tickets
    this.concertDate = eventDate; // concert date
    this.showOrder = displayConcertTickets;
}
function displayConcertTickets() {
    document.write("<p>Customer: " + this.customerName);
    document.write("<br />Concert: " + this.concertName);
    document.write("<br />Quantity: " + this.ticketQuantity);
    document.write("<br />Date: "
        + this.concertDate.toLocaleString() + "</p>");
}
var ticketOrder = new ConcertTickets("Don Gosselin",
    "Jimmy Buffett", 2, new Date(2010, 6, 18, 20));
ticketOrder.showOrder();
var ticketOrder = new ConcertTickets("Don Gosselin",
    "John Mayer", 2, new Date(2010, 8, 30, 20));
ticketOrder.showOrder();
```

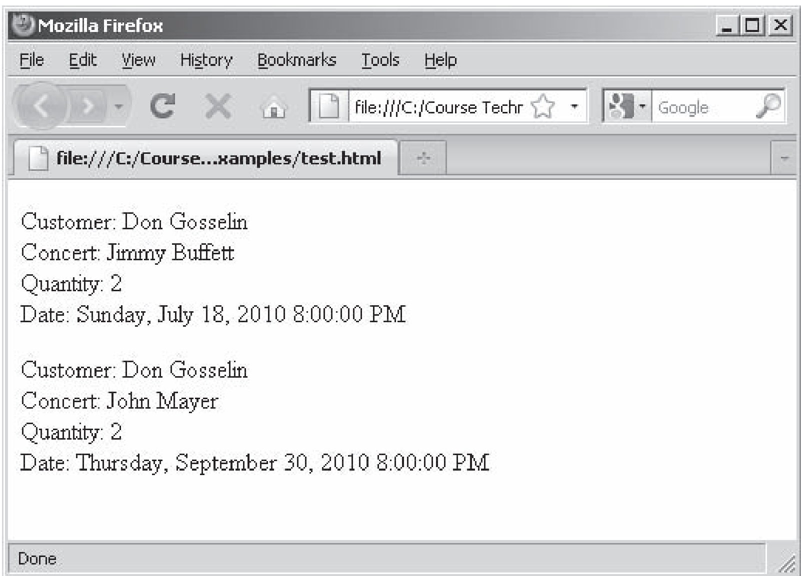


Figure 6-14 Output of a script with two instantiated custom objects

Now you will add methods to the `Contact` constructor function.

To add methods to the `Contact` constructor function:

1. Return to the **index.html** document in your text editor, and add the following function above the `contactList` declaration in the script section. The function updates the fields in the contacts form with the properties of the selected `Contact` object. An `onclick` event handler you will add to the `<select>` element later in these steps will call the function.

```
function getContactInfo() {
   document.forms[0].lastname.value = this.lastName;
   document.forms[0].firstname.value = this.firstName;
   document.forms[0].telephone.value = this.telephone;
   document.forms[0].address.value = this.address;
   document.forms[0].city.value = this.city;
   document.forms[0].state.value = this.state;
   document.forms[0].zip.value = this.zip;
}
```

2. Next, add the following function after the `getContactInfo()` function. This function updates the selected contact's information within the `Contact` object. You will pass the `curIndex` parameter from an `onclick` event handler that you will add to the Update Contact button.

```
function updateSelectedContact(curIndex) {
   this.lastName = document.forms[0].lastname.value;
   this.firstName = document.forms[0].firstname.value;
   this.telephone = document.forms[0].telephone.value;
   this.address = document.forms[0].address.value;
   this.city = document.forms[0].city.value;
   this.state = document.forms[0].state.value;
   this.zip = document.forms[0].zip.value;
   document.forms[0].contacts.options[curIndex].value
      = this.lastName + "," + this.firstName;
   document.forms[0].contacts.options[curIndex].text
      = this.lastName + "," + this.firstName;
   window.alert("Contact information updated.");
}
```

3. Add the following two statements to the end of the `Contact` constructor function, which declare `getContactInfo()` and `updateSelectedContact()` as methods of the `Contact` object:

```
this.getContacts = getContactInfo;
this.updateContact = updateSelectedContact;
```

4. Add an `onclick` event handler to the Update Info button, as follows. The event handler passes to the `updateContact()` function the `selectedIndex` property of the option that is selected in the selection list.

```
<input type="button" value="Update Info"
onclick="contactList['contact' + document.forms[0] ↵
   .contacts.selectedIndex].updateContact( ↵
   document.forms[0].contacts.selectedIndex);" />
```

5. Finally, add the following event handler to the `<select>` element. The event handler updates the data displayed in the contact information fields after a new option is clicked in the selection list.

```
onclick="contactList['contact'
   + this.selectedIndex].getContacts();"
```

6. Save the **index.html** document, and then open it in your Web browser. Test the script by adding some contacts to the contact list. Try clicking on a previously entered contact. The contact's information should be displayed in the contact information fields. Also, try updating a previously entered contact. Figure 6-15 shows how the form appears after adding several contacts.

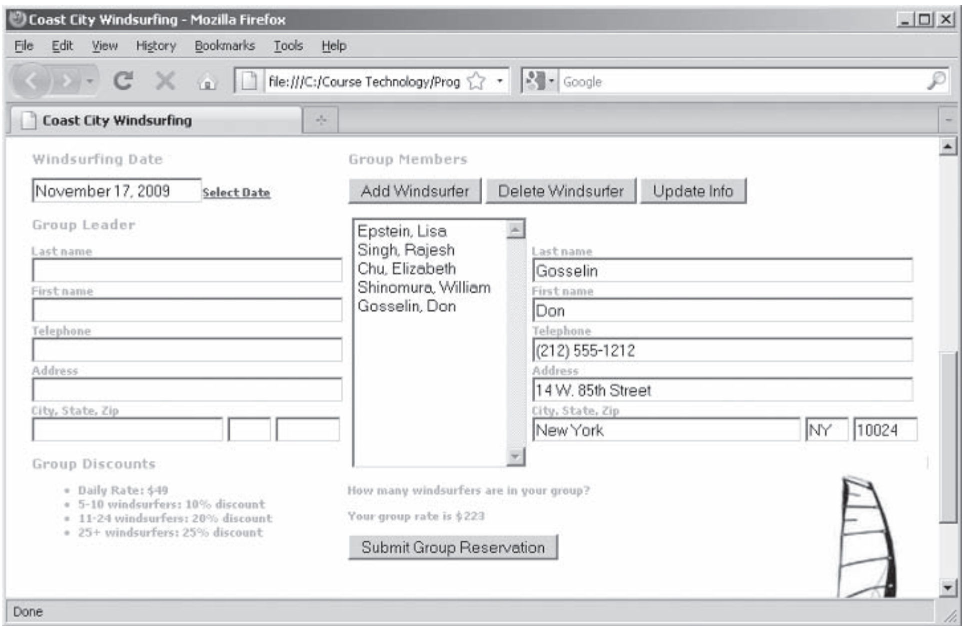


Figure 6-15 Contacts form after adding several contacts

7. Close your Web browser window.

Your final step is to modify the Group Reservations page so that the group discount is automatically calculated as individuals are added to and deleted from the Group Members list.

To modify the Group Reservations page so that it automatically calculates group discounts:

1. Return to the **index.html** document in your text editor, and add the following statement to the end of `else` clause in the `addContact()` function. This statement calls the `calcGroupDiscount()` function and passes to it the value of the `newContact` variable incremented by one.

   ```
   calcGroupDiscount(newContact + 1);
   ```

2. In the `deleteContact()` function, add the following statement to the end of the `if` statement that determines whether the `contactSelected` variable contains a value of true. This statement also calls the `calcGroupDiscount()` function, but it passes to it the `length` property of the `options[]` array, which indicates the number of items in the group members list.

   ```
   calcGroupDiscount(document.forms[0].
   contacts.options.length);
   ```

3. Save the **index.html** document, and then validate it with the W3C Markup Validation Service at validator.w3.org/file-upload.html. Once the document is valid, close it in your text editor.

4. Open the **index.html** document in your Web browser, and try adding and deleting some windsurfers. The group discount should be updated automatically.

Using the `prototype` Property

As explained earlier, objects inherit the properties and methods of the constructor functions from which they are instantiated. When you instantiate a new object named `ticketOrder`, based on the `ConcertTickets` constructor function, the new object includes the `customerName`, `eventName`, `numTickets`, and `concertDate` properties along with the `showOrder()` method. After instantiating a new object, you can assign additional properties to the object, using a period. The following code creates a new object based on the `ConcertTickets` constructor function, then assigns to the object a new property named `orderDate`. The statement uses the `Date()` constructor function without any arguments, which assigns the current date to the `orderDate` property.

```
var ticketOrder = new ConcertTickets("Don Gosselin",
    "Jimmy Buffett", 2, new Date(2010, 6, 18, 20));
ticketOrder.orderDate = new Date();
```


When you add a new property to an object that has been instantiated from a constructor function, the new property is only available to that specific object; the property is not available to the constructor function or to any other objects that were instantiated from the same constructor function. However, if you use the `prototype` property with the name of the constructor function, any new properties you create will also be available to the constructor function and any objects instantiated from it. The **prototype property** is a built-in property that specifies the constructor from which an object was instantiated. The following code uses the `prototype` property to add the `orderDate` property to the `ConcertTickets` constructor function. By using a `prototype` property, you ensure that all objects that extend the `ConcertTickets` constructor function also have access to the `orderDate` property.

```
var ticketOrder = new ConcertTickets("Don Gosselin",
    "Jimmy Buffett", 2, new Date(2010, 6, 18, 20));
ticketOrder.prototype.orderDate = new Date();
```

Object definitions can use the `prototype` property to extend other object definitions. That is to say, you can create a new object based on an existing object. The new object inherits the properties and methods of the original object. You can then add additional properties and methods to the new object that will not be available to the existing object. Consider an object definition named `Event` that contains generic properties and methods that might be used for planning an event. You may need to create additional object definitions that extend `Event` and that contain properties and methods specific to certain types of events. To extend one object definition (the derived object definition) from another object definition (the base object definition), append the `prototype` property to the derived object definition, followed by the `new` keyword and the name of the base object definition using the following syntax: `*derived_object*.prototype = new *base_object*();`. The following code shows an example of a `RetirementEvent` object definition that extends the `Event` object definition. The `Event` class definition contains some generic properties, `eventLocation`, `eventDate`, and `eventCost`, that apply to all types of events, along with a `calcEventCost()` method that calculates the cost of an event. The `RetirementEvent` class includes `guestOfHonor` and `company` properties along with a `showEventDetails()` method. Figure 6-16 shows the output.

```
<script type="text/javascript">
/* <![CDATA[ */
function Event(location, date) {
   this.eventLocation = location;
   this.eventDate = date;
   this.eventCost = 0;
   this.calcEventCost = calcCost;
}
function calcCost(guests) {
   this.eventCost = guests * 25; // $25 per head
}
function RetirementEvent(retiree, company) {
   this.guestOfHonor = retiree;
   this.companyName = company;
   this.showEventDetails = eventDetails;
}
function eventDetails() {
   document.write("<p>Guest of honor: " + this.guestOfHonor);
   document.write("<br />Company: " + this.companyName);
   document.write("<br />Event date: " + this.eventDate);
   document.write("<br />Event location: " + this.eventLocation);
   document.write("<br />Event cost: $"+
      this.eventCost.toLocaleString() + "</p>");
}
RetirementEvent.prototype = new Event();
var wertherRetirement = new RetirementEvent(
   "Jacob Werther", "Forestville Funding");
wertherRetirement.eventLocation = "Forestville, CA";
wertherRetirement.eventDate = "January 27, 2010";
wertherRetirement.calcEventCost(175);
wertherRetirement.showEventDetails();
/* ]]> */
</script>
```

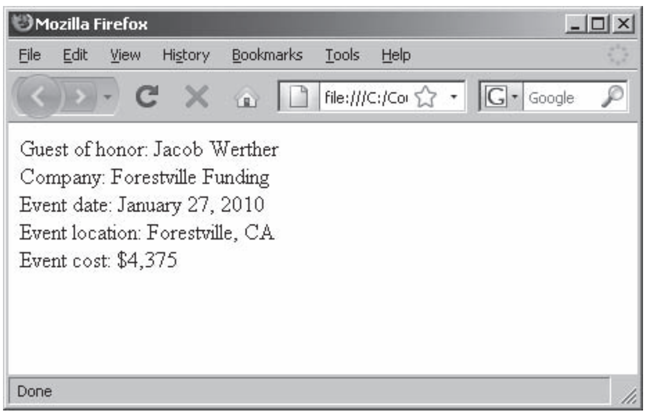


Figure 6-16 Output of a script with an extended object definition

Some object-oriented programming languages allow objects to inherit from more than one object definition. JavaScript, however, only allows objects to inherit from a single object definition.

Short Quiz 3

1. Why would you create a custom object with the `Object` object?
2. Explain how to create custom objects using a constructor function.
3. How do you add properties to a custom object?
4. How and why do you enumerate custom object properties?
5. How do you add methods to a custom object?

Summing Up

- The term object-oriented programming (or OOP) refers to the creation of reusable software objects that can be easily incorporated into another program.
- Reusable software objects are often referred to as components.
- In object-oriented programming, an object is programming code and data that can be treated as an individual unit or component. Data refers to information contained within variables or other types of storage structures.
- Objects are encapsulated, which means that all code and required data are contained within the object itself.
- An interface refers to the programmatic elements required for a source program to communicate with an object.
- The principle of information hiding states that any class members that other programmers do not need to access or know about should be hidden.
- In object-oriented programming, the code, methods, attributes, and other information that make up an object are organized using classes.
- An instance is an object that has been created from an existing class. When you create an object from an existing class, you are said to be instantiating the object.

- An object inherits, or takes on, the characteristics of the class on which it is based.
- The `Date` class contains methods and properties for manipulating the date and time.
- The `Number` class contains methods for manipulating numbers and properties that contain static values representing some of the numeric limitations in the JavaScript language (such as the largest positive number that can be used in JavaScript).
- The `Math` class contains methods and properties for performing mathematical calculations in your programs.
- You can define your own custom objects by using a constructor function (also known as an object definition), which is a function that is used as the basis for a custom object.
- The `this` keyword refers to the current object.
- The `prototype` property is a built-in property that specifies the constructor from which an object was extended.

Comprehension Check

1. Which of the following terms refer to programming code and data that can be treated as an individual unit or component? (Choose all that apply.)
   a. methods
   b. components
   c. objects
   d. properties

2. Explain the principle of information hiding. What does a "black box" refer to?

3. A(n) _______________ is an object that has been created from an existing class.
   a. constructor
   b. instance
   c. template
   d. structure

4. Explain why programmers use the terms "variable" and "object" interchangeably.

5. JavaScript automatically performs garbage collection. True or false?

6. Which of the following `Date` class constructors creates a `Date` object that contains the current date and time from the local computer?

   a. `Date()`

   b. `Date(milliseconds)`

   c. `Date(date_string)`

   d. `Date(year, month[, date, hours, minutes, seconds, milliseconds])`

7. Explain how to display the full text for days and months in a `Date` object.

8. Which of the following methods of the `Number` class converts a number to a string that is formatted with local numeric formatting conventions?

   a. `toString()`

   b. `toLocaleString()`

   c. `toFixed()`

   d. `valueOf()`

9. What is the primary reason for using most of the `Number` class methods?

10. What is the correct syntax for using the `sqrt()` method of the `Math` class?

    a. `firstNumber = Math.sqrt(secondNumber);`

    b. `var result = firstNumber.sqrt(secondNumber);`

    c. `var result = sqrt.Math(firstNumber, secondNumber);`

    d. `var result = Math.sqrt(firstNumber, secondNumber);`

11. A function that is used as the basis for an object is called an object definition or a(n) ______________.
    a. object variable
    b. class
    c. method
    d. constructor function
12. Explain why JavaScript is not a true object-oriented programming language.
13. In the case of a custom JavaScript object, the `this` keyword refers to ______________.
    a. the currently executing JavaScript statement
    b. the current object that called the constructor function
    c. the XHTML document
    d. the Web browser window
14. What is the correct syntax for creating an object named `currentSale` from a constructor function named `Transaction` that requires the two arguments `quantity` and `price`?
    a. `currentSale = new Transaction (2, 59.95);`
    b. `currentSale(2, 59.95) = new Transaction;`
    c. `new Transaction(2, 59.95) = currentSale;`
    d. `currentSale() = new Transaction 2, 59.95;`
15. Explain how to assign properties to a custom object created with the `Object` object.
16. The `Object` object can contain both properties and methods. True or false?
17. Which of the following statements is the correct syntax for assigning the value of a parameter named `priceQuote` to a property named `quote` in a constructor function?
    a. `quote = priceQuote;`
    b. `this.quote = priceQuote;`
    c. `this.quote = this.priceQuote;`
    d. `quote = this.priceQuote;`

18. What is the correct syntax for adding a new property named `squareFeet` to a constructor function named `RealEstate`?
    a. `RealEstate.prototype = squareFeet("");`
    b. `prototype.RealEstate.squareFeet = "";`
    c. `squareFeet.RealEstate.prototype = "";`
    d. `RealEstate.prototype.squareFeet = "";`
19. What is the correct syntax for adding an object method named `submitBid()` to a constructor function named `Auction`?
    a. `Auction = new submitBid();`
    b. `myMethod = this.submitBid;`
    c. `this.submitBid = myMethod();`
    d. `this.submitBid = submitBid;`
20. The built-in property that specifies the constructor from which an object was extended is called the ________________ property.
    a. `source`
    b. `origination`
    c. `default`
    d. `prototype`

Reinforcement Exercises

Exercise 6-1

One problem with the calendar in the Group Reservations Web page that you worked on in this chapter is that it does not display 29 days for the month of February during leap years. In Chapter 3, you created a simple form that tested for leap years. As you may recall, you can determine whether a year is a leap year by testing if it is divisible by 4. However, years that are also divisible by 100 are not leap years, unless they are also divisible by 400, in which case they are leap years (1900 was not a leap year; 2000 was). In this exercise, you will add code to the Group Reservations Web page that displays 29 days for the month of February during leap years.

1. Copy the **index.html** document from your Chapter folder for Chapter 6 to your Exercises folder for Chapter 6. Rename the document as **CVSGroupsLeapYear.html**.

2. In the `displayCalendar()` function, locate the following `else...if` statement that determines the number of days for the month of February:

```
else if (month == 1)
   numDays = 28;
```

3. Modify the `else...if` statement so that it includes the calculations for determining whether it is a leap year, as follows:

```
else if (month == 1) {
   var thisYear = dateObject.getYear();
   if (thisYear %4 ! = 0)
      numDays = 28;
   else if (thisYear % 400 == 0)
      numDays = 29;
   else if (thisYear % 100 == 0)
      numDays = 28;
   else
      numDays = 29;
}
```

4. Save the **CVSGroupsLeapYear.html** document.

5. Use the W3C Markup Validation Service to validate the **CVSGroupsLeapYear.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor.

6. Open the **CVSGroupsLeapYear.html** document in your Web browser, and click the **Select Date** link to display the calendar window. Click the **Next** or **Previous** link to navigate to the month of February in a leap year, such as 2012. The calendar should display 29 days.

7. Close your Web browser window.

Exercise 6-2

Another problem with the Group Reservations Web page is that if you submit the form, none of the windsurfers in the Group Members list are submitted unless their names are selected in the selection list. Even if you select the names in the list, only the last and first names are submitted. Furthermore, the values of the group member information fields (last name, first name, telephone, and so on) are submitted; these fields should not be submitted because their values are stored in the `Contact` objects that contain the information for each windsurfer. In this project, you will add an `onsubmit` event handler that selects all the options in the Group Members selection list and submits the properties in each `Contact` object along with each group member's name. You will also remove the `name` attributes from each of the group member information fields to prevent them from being submitted with the form. (Recall that only form fields with `name` attributes are submitted with a form.) Finally, you will modify the script so that it refers to each group member information field by its position in the `options[]` array instead of by its `name` attribute.

1. In your text editor, open the **CVSGroupsLeapYear.html** document from your Exercises folder for Chapter 6 and immediately save it as **CVSGroupsSubmission.html**.

2. Add to the opening `<form>` tag an `onsubmit` attribute that calls an event handler function named `submitReservation()`. (You create the event handler function in Step 3.)

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded"
onsubmit="return submitReservation();">
```

3. Add `multiple="multiple"` to the opening `<select>` tag of the Group Members selection list.

4. Type the following `submitReservation()` function at the end of the script section. The `for` loop iterates through the items in the Group Members selection list. For each item, it appends the properties of the associated object to the `value` property, using associative array syntax; this ensures that all information for each windsurfer is submitted with the form. The last statement in the `for` loop uses the `selected` property to select the item.

```
function submitReservation() {
   for (var k=0; k<document.forms[0].contacts
      .length; ++k) {
      document.forms[0].contacts.options[k].value += ", "
      + contactList["contact" + k].telephone + ", "
      + contactList["contact" + k].address + ", "
      + contactList["contact" + k].city + ", "
      + contactList["contact" + k].state + ", "
      + contactList["contact" + k].zip;
      document.forms[0].contacts.options[k]
         .selected = true;
   }
   return true;
}
```

5. Remove the `name` attributes from the `lastname`, `firstname`, `telephone`, `address`, `city`, `state`, and `zip` elements in the Group Members fields.

6. Finally, replace each of the references to the `name` properties in the script section of each of the Group Members fields with the element's associated index in the `elements[]` array. The indexes for the fields in the `elements[]` array are: `lastname=elements[12]`, `firstname=elements[13]`, `telephone=elements[14]`, `address=elements[15]`, `city=elements[16]`, `state=elements[17]`, and `zip=elements[18]`. For example, the statements in the `getContactInfo()` function should be modified as follows:

```
function getContactInfo() {
  document.forms[0].elements[12].value = this.lastName;
  document.forms[0].elements[13].value = this.firstName;
  document.forms[0].elements[14].value = this.telephone;
  document.forms[0].elements[15].value = this.address;
  document.forms[0].elements[16].value = this.city;
  document.forms[0].elements[17].value = this.state;
  document.forms[0].elements[18].value = this.zip;
}
```

Be sure to replace the `name` property references for the Group Members fields everywhere in the script section, not just in the `getContactInfo()` function.

7. Save the **CVSGroupsSubmission.html** document.

8. Use the W3C Markup Validation Service to validate the **CVSGroupsSubmission.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser. Add several entries to the Group Members list, and submit the form. The FormProcessor.html file should display the values for each of your entries, but it should not display the group member information fields.

9. Close your Web browser window.

Exercise 6-3

In this exercise, you will create a script that displays the current date and time and welcomes the user with "Good morning!", "Good afternoon!", or "Good evening!", depending on the time of day.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use strict DTD and "Welcome" as the content of the `<title>` element.

3. Add the following text and elements to the document body:

```
<h1>Welcome to My Web page</h1>
```

4. Add the following script section to the end of the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following variable declarations to the script section. The first variable instantiates a `Date` object. The second and third variables will be assigned text strings containing a greeting and the current time. The fourth and fifth variables are assigned the minute and hour values from the `Date` object.

```
var dateObject = new Date();
var greeting = " ";
var curTime = " ";
var minuteValue = dateObject.getMinutes();
var hourValue = dateObject.getHours();
```

6. Add the following code to the end of the script section. The first `if` statement evaluates the `minuteValue` variable and adds a 0 to the beginning of the value if it is less than 10. This forces the minutes to always display as two decimals. The `if...else` structure evaluates the `hourValue` variable and builds the strings that are assigned to the `greeting` and `curTime` variables.

```
if (minuteValue < 10)
   minuteValue = "0" + minuteValue;
if (hourValue < 12) {
   greeting = "<p>Good morning! "
   curTime = hourValue + ":" + minuteValue + " AM";
}
else if (hourValue == 12) {
   greeting = "<p>Good afternoon! ";
   curTime = hourValue + ":" + minuteValue + " PM";
}
else if (hourValue<17) {
   greeting = "<p>Good afternoon! "
   curTime = (hourValue-12) + ":" + minuteValue + " PM"
}
else {
   greeting = "<p>Good evening! "
   curTime = (hourValue-12) + ":" + minuteValue + " PM"
}
```

7. Add the following arrays to the end of the script section. These arrays contain the full text for days and months.

```
var dayArray = new Array("Sunday", "Monday", "Tuesday",
"Wednesday", "Thursday", "Friday", "Saturday");
var monthArray = new Array("January", "February",
"March", "April", "May", "June", "July", "August",
"September", "October", "November", "December");
```

8. Type the following statements at the end of the script section to retrieve the current day and month values from the dateObject variable:

```
var day = dateObject.getDay();
var month = dateObject.getMonth();
```

9. Finally, add the following statement to the end of the script section to display the current date and time and a welcome message:

```
document.write("<p>" + greeting + "It is" + curTime
   + "on" + dayArray[day] + "," + monthArray[month]
   + "" + dateObject.getDate() + ","
   + dateObject.getFullYear()
   + ".</p>");
```

10. Save the **WelcomeDateTime.html** document in your Exercises folder for Chapter 6.

11. Use the W3C Markup Validation Service to validate the **WelcomeDateTime.html** document, and fix any errors that the document contains. Once the document is valid, close it in your text editor and then open it in your Web browser. You should see the appropriate welcome message along with the time and date.

12. Close your Web browser window.

Exercise 6-4

In this exercise, you will create a tip calculator.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use strict DTD and “Tip Calculator” as the content of the <title> element.

3. Add the following heading and form to the document body. The form uses a table to format the display of the fields. The form is fairly straightforward. Several of the fields use an

onchange event handler to call a figureTip() method, which you will add in the next step.

```
<h2>Tip Calculator</h2>
<form action="">
<table border="0">
<tr><td>Bill:</td><td><input type="text" name="bill"
value="0"
onchange="figureTip();" /></td></tr>
<tr><td>Tip %:</td><td><input type="text"
name="tip_percent" value="0"
onchange="figureTip();" /> (enter as a whole
number)</td></tr>
<tr><td># of People:</td><td><input type="text"
name="num_people"
value="1" onchange="figureTip();" /> </td></tr>
<tr><td>Tip amount:</td><td><input type="text"
name="tip_amount" value="0"
readonly="readonly" /></td></tr>
<tr><td>Total:</td><td><input type="text"
name="total" value="0"
readonly="readonly" /></td></tr>
<tr><td>Total per Person:</td><td><input type="text"
name="total_person" value="0"
readonly="readonly" /></td></tr>
</table>
</form>
```

4. Next, add the following script section to the document head. The function uses the Document object to retrieve the values entered in the form fields. The calculated results use the Math.round() method to round the figures to whole numbers.

```
<script type="text/javascript">
/* <![CDATA[ */
function figureTip() {
   var bill = document.forms[0].bill.value;
   var tipPercent = document.forms[0].tip_percent.value;
   var numPeople = document.forms[0].num_people.value;
   var tipAmount = Math.round(bill * ("." + tipPercent));
   var total = Math.round(bill * (1 + "." + tipPercent));
   var totalPerPerson = Math.round(total / numPeople);
   document.forms[0].tip_amount.value
       = tipAmount.toLocaleString();
   document.forms[0].total.value
       = total.toLocaleString();
   document.forms[0].total_person.value
       = totalPerPerson.toLocaleString();
}
/* ]]> */
</script>
```

5. Save the document as **TipCalculator.html** in the Exercises folder for Chapter 6, and then validate it with the W3C Markup Validation Service at validator.w3.org/file-upload.html. Once the TipCalculator.html document is valid, close it in your text editor, and then open it in your Web browser. Test the calculator's functionality.
6. Close your Web browser window.

Discovery Projects

Save your Discovery Projects files in the Projects folder for Chapter 6. Be sure to validate the files you create with the W3C Markup Validation Service.

Project 6-1

Create a Web page that allows a coach to submit a roster for a baseball team. Use a custom JavaScript object similar to the one you created for the Group Reservations Web page. Include fields for the team's name and head coach's contact information. Create a Team Members section, similar to the Group Members section on the Group Reservations page, to allow the coach to enter information for each team member, including his or her contact information and the position played. Include functionality that allows the coach to add, delete, and modify player information. Also include a check box that the coach can select if permission has been received from the player's guardian. Write functionality that submits all of the team member's information (including the permission field) to the FormProcessor.html document (a copy is located in your Projects folder for Chapter 6), and create the form so that the team member information fields are not submitted. Save the document as **TeamRoster.html**.

Project 6-2

Use the Date object to create an age calculator. Create three selection lists that allow users to select the date, month, and year when they were born. For the year selection list, display the years 1950 to 2010. Include a push button that performs the calculation along with text boxes that display the following data: the user's age in years, months, and days, and how long a person has been living in months, days, hours, and minutes. Finally, include a text box that displays the number of days until the user's next birthday. Save the document as **AgeCalculator.html**.

Project 6-3

A popular use of the `Date` object is to create a digital clock. However, recall that the date and time in a `Date` object are not updated over time like a clock. Instead, a `Date` object contains the static date and time as of the moment the JavaScript code instantiates the object. You can simulate a digital clock that appears to "click" off each second by using a `setInterval()` method that continuously executes code to retrieve the current time. Use this technique to create a digital clock that displays a 12-hour clock in a form's text box. The clock should display hours, minutes, seconds, and either AM or PM. Format the displayed time so that any minutes or seconds that are less than 10 are preceded by a 0, such as 10:08:07 AM. Save the document as **DigitalClock.html**.

Project 6-4

Create a Web page for a digital photo development company. Include a form that allows clerks at the company to enter orders for each customer. The form should allow you to enter one item per order. Include radio buttons for different types of items that can be created with digital images, including hard-copy prints, posters, coffee mugs, and T-shirts. Use a `Date` object to calculate the date an item will be ready automatically, based on the current date. For example, hard-copy prints and posters should be ready one day from today, coffee mugs two days from today, T-shirts three days from today, and so on. Submit the form to the FormProcessor.html document (a copy is located in your Projects folder for Chapter 6). Save the document as **DigitalPhotos.html**.

CHAPTER 7

Manipulating Data in Strings and Arrays

In this chapter, you will:

- Manipulate strings
- Work with regular expressions
- Manipulate arrays
- Convert between strings and arrays

One of the most common uses of JavaScript is for processing form data submitted by users. Because form data is submitted as strings, a good JavaScript programmer must be adept at dealing with strings. Another critical skill for a JavaScript programmer is the ability to manipulate arrays. Earlier in this book, you learned basic skills for working with both strings and arrays. In this chapter, you learn how to use advanced techniques for both strings and arrays. You also learn how to employ regular expressions, which are used for matching and manipulating strings according to specified rules.

Manipulating Strings

As you learned in Chapter 1, a string is text contained within double or single quotation marks. You can use text strings as literal values or assign them to a variable. For example, the first statement in the following code prints a literal text string, whereas the second statement assigns a text string to a variable. The third statement then uses the `document.write()` statement to print the text string assigned to the variable.

```
document.write("2003-04 NBA All-Star Game MVP: ");
var basketballPlayer = "Shaquille O'Neal";
document.write("<p>" + basketballPlayer + "</p>");
```

Whether you use single or double quotation marks, a string must begin and end with the same type of quotation mark. For example, `document.write("<p>This is a text string.</p>");` is valid because the string starts and ends with double quotation marks. Likewise, `document.write('<p>This is a text string.</p>');` is valid because the string begins and ends with single quotation marks. By contrast, the statement `document.write("<p>This is a text string.</p>');` is invalid because the string starts with a double quotation mark and ends with a single quotation mark. In this case, you would receive an error message because the JavaScript interpreter cannot tell where the literal string begins and ends.

The preceding example demonstrates some of the basic techniques for creating and combining strings. You will often find it necessary to parse the text strings in your scripts. When applied to text strings, the term **parsing** refers to the act of extracting characters or substrings from a larger string. This is essentially the same concept as the parsing (rendering) that occurs in a Web browser when the Web browser extracts the necessary formatting information from a Web page before displaying it on the screen. In the case of a Web page, the document itself is one large text string from which formatting and other information needs to be extracted. However, when working on a programming level, parsing usually refers to the extraction of information from string literals and variables.

To parse the text strings in your scripts, you use the methods and `length` property of the `String` class. All literal strings and string variables in JavaScript are represented by a **`String` class**, which contains methods for manipulating text strings.

This chapter discusses only class methods that are part of ECMAScript.

In this chapter, you create a JavaScript program that validates e-mail information that is entered into a form on a Web page. The form information will be submitted to the FormProcessor.html document that you have used in the past two chapters, while the validation functionality will be achieved with an `onsubmit` event handler. Your Chapter folder for Chapter 7 includes a Web page named email.html that contains the form you will validate along with the FormProcessor.html document. Figure 7-1 shows how the email.html document appears in a Web browser.

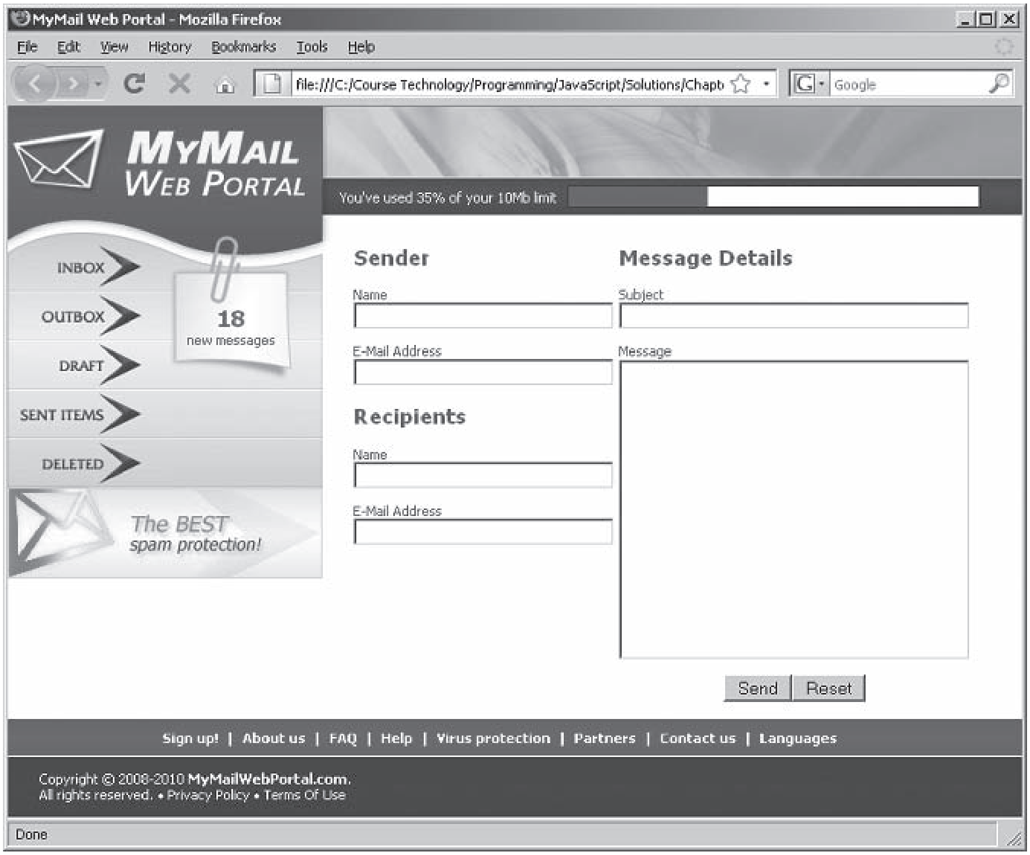


Figure 7-1 The email.html document in a Web browser

First, you will add an `onsubmit` event handler to the e-mail form.

To add an `onsubmit` event handler to the e-mail form:

1. Open, in your text editor, the **email.html** document, located in your Chapter folder for Chapter 7.
2. Add the following script section above the closing `</head>` tag:

   ```
   <script type="text/javascript">
   /* <![CDATA[ */
   /* ]]> */
   </script>
   ```

3. Add the following `validateSubmission()` function to the script section. You will modify the `validateSubmission()` function throughout this chapter.

   ```
   function validateSubmission() {
   }
   ```

4. Save the **email.html** document and then open it in your Web browser. Type some information into the form fields, and click the **Send** button. The data you entered should appear in the FormProcessor.html page.
5. Close your Web browser window.

Formatting Strings

This section describes how to use special characters and how to change the letter case of strings.

Using Special Characters

You learned in Chapter 2 that when you want to include basic types of special characters, such as quotation marks, within a literal string, you must use an escape sequence. The escape sequence for double quotation marks is `\"` and the escape sequence for single quotation marks is `\'`. For example, the text string assigned to the `basketballPlayer` variable includes escape sequences for both double and single quotation marks. Figure 7-2 shows the output in a Web browser.

```
var basketballPlayer = "Shaquille \"Shaq\" O\'Neal";
MVP = "2003-04 NBA All-Star Game MVP: "
    + basketballPlayer;
document.write("<p>" + MVP + "</p>");
```

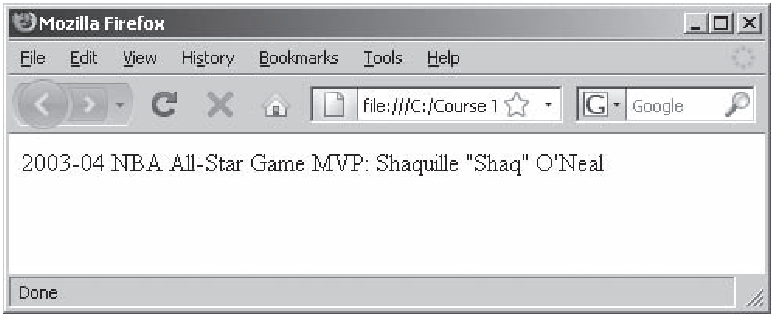


Figure 7-2 Output of a text string created with escape sequences and the concatenation operator

For other types of special characters, you need to use **Unicode**, which is a standardized set of characters from many of the world's languages. A number represents each character in the Unicode character set. For instance, the Unicode numbers for the uppercase letters A, B, and C, are 65, 66, and 67, respectively. In most cases, you can use XHTML numeric character references or character entities to represent Unicode characters in text strings. For example, the copyright symbol (©) can be represented in HTML by the numeric character reference © and the character entity is ©. To assign the text "© 1995-2006" to a variable named copyrightInfo in JavaScript, you can use either of the following statements:

```
copyrightInfo = "<p>&#169; 1995-2006</p>";
    // numeric character ref.
copyrightInfo = "<p>&copy; 1995-2006</p>";
    // character entity
```

Instead of using numeric character references or character entities within text strings, as shown in the preceding example, you can use the **fromCharCode() method,** which constructs a text string from Unicode character codes that are passed as arguments. The fromCharCode() method is called a static method because it is not used as a method of any string objects (which can be literal strings or variables) in your scripts. Instead, you must call fromCharCode() as a method of the String class with the following syntax String.fromCharCode(*char1*, *char2*, ...). The following statement uses the fromCharCode() method to print "JavaScript" with Unicode characters:

```
document.write("<p>" +
    String.fromCharCode(
    74,97,118,97,83,99,114,105,112,116)
    + "</p>");
```

The character set that is most commonly used today is American Standard Code for Information Interchange, or ASCII, which is a standardized set of numeric representations for English characters. The Unicode character set contains the ASCII character set as a subset. Unicode will eventually replace ASCII entirely because of ASCII's limitation to English characters.

The numeric characters in the preceding statement would be rendered in a Web browser as "JavaScript". The following statement uses the `fromCharCode()` method to print "© 1995-2006":

```
document.write("<p>" + String.fromCharCode(169)
    + " 1995-2006</p>");
```

Changing Case

To change the case of letters in a string, you use the `toLowerCase()` and `toUpperCase()` methods of the `String` class. The **`toLowerCase()` method** converts a text string to lowercase, whereas the **`toUpperCase()` method** converts a text string to uppercase. You append either method to a string or variable that contains the text for which you want to change letter case. For example, the following code uses the `toUpperCase()` method to print the contents of the `agency` variable ("fema") in uppercase letters ("FEMA"):

```
var agency = "fema";
document.write("<p>" + agency.toUpperCase()
    + "</p>");
```

Note that the `toUpperCase()` method in the preceding statement does not convert the contents of the `agency` variable to uppercase letters; it only prints the text in uppercase letters. If you want to change the contents of a variable to upper- or lowercase letters, you must assign the value returned from the `toLowerCase()` or `toUpperCase()` methods to that variable or to a different variable. The following statements demonstrate how to change the contents of the `agency` variable to uppercase letters:

```
var agency = "fema";
agency = agency.toUpperCase()
document.write("<p>" + agency + "</p>");
```

Because e-mail addresses are case insensitive, you will modify the e-mail form so that it converts the case of the e-mail addresses to lowercase letters.

To modify the e-mail form so that it converts the case of the e-mail addresses to lowercase letters:

1. Return to the **email.html** document in your text editor.
2. Add the following statements to the `validateSubmission()` function. The first statement declares a Boolean variable named `retValue`, which will be returned from the `validateSubmission()` function. Recall that the value returned from an `onsubmit` event handler (the `validateSubmission()` function) determines whether the JavaScript interpreter submits the form data. The second

statement passes to the `validateEmail()` function the form object that contains the sender's e-mail address, not just the value entered into the field. This allows the `validateEmail()` function to modify the form value directly. Notice that the value returned from the `validateEmail()` function is assigned to the `retValue` variable. If the `validateEmail()` function returns a value of false (meaning that the e-mail address did not pass validation), the `if` statement returns that value, which cancels the form submission.

```
var retValue = true;
retValue = validateEmail(
    document.forms[0].sender_email);
if (retValue == false)
    return retValue;
```

3. Add the following statements to the end of the `validateSubmission()` function. These statements pass the recipient's e-mail object to the `validateEmail()` function. If the `validateEmail()` function returns a value of false (meaning that the e-mail address did not pass validation), the `if` statement returns that value, which cancels the form submission.

```
retValue = validateEmail(
    document.forms[0].recipient_email);
if (retValue == false)
    return retValue;
```

4. Add the following `validateEmail()` function to the end of the script section. The function accepts a single argument containing a field that you want to make lowercase. The first statement in the function assigns the value of the field to a variable named `email`, while the second statement converts the contents of the `email` variable to lowercase and then assigns the converted value back to the field. The third statement returns a value of true.

```
function validateEmail(formObject) {
    var email = formObject.value;
    formObject.value = email.toLowerCase();
    return true;
}
```

5. Add to the opening `<form>` tag an `onsubmit` event handler that calls the `validateSubmission()` function, as follows:

```
<form action="FormProcessor.html" method="get"
onsubmit="return validateSubmission()">
```

6. Save the **email.html** document, and then open it in your Web browser. Enter some uppercase e-mail addresses into the

sender and recipient e-mail fields, and then click the **Send** button. The e-mail addresses you entered should appear in the FormProcessor.html page in lowercase letters.

7. Close your Web browser window.

Counting Characters in a String

You will often find it necessary to count characters and words in strings, particularly with strings from form submissions. For example, you might need to count the number of characters in a password to ensure that a user selects a password with a minimum number of characters. Or, you might have a Web page that allows users to submit classified ads that cannot exceed a maximum number of characters. The `String` class contains a single property, the **`length` property**, which returns the number of characters in a string. To return the total number of characters in a string, you append the `length` property of the `String` class to a literal string, variable, or object containing text. For example, the following code uses the `length` property to count the number of characters in a variable named `country`. The `document.write()` statement prints "The country name contains 18 characters."

The `length` property counts escape sequences such as `\n` as one character.

```
var country = "Kingdom of Morocco";
document.write("<p>The country name contains "
    + country.length + " characters.</p>");
```

The e-mail form includes a Subject field in which users can enter the subject of a message. Next, you modify the script so that it uses the `length` property to prevent users from entering a subject of more than 40 characters.

To modify the script so that it uses the `length` property to prevent users from entering a subject of more than 40 characters:

1. Return to the **email.html** document in your text editor.
2. Add the following `if...else` statement after the first statement in the `validateSubmission()` function that declares the `retValue` variable. Notice that the `length` property is appended to the `value` property of the `subject` object. If the length of the subject field is greater than 40 characters, a message is displayed to the user stating that she has exceeded the maximum number of characters and the `if` statement returns a value of false, preventing the form's submission. The `else` statement ensures that the `sender_email`, `recipient_email`, and `subject` fields are filled in.

```
if (document.forms[0].subject.value.length > 40) {
    window.alert("The subject must be 40 ↵
        characters or less!");
    return false;
}
else if (document.forms[0].sender_email.value == ""
    || document.forms[0].recipient_email.value == ""
    || document.forms[0].subject.value == "") {
    window.alert("You did not fill in one of the ↵
        following required fields: sender e-mail, ↵
        recipient e-mail, or subject.");
    return false;
}
```


3. Add the following statements after the closing brace of the `else` clause to check if the `retValue` variable was set to false:

```
if (retValue == false)
    return retValue;
```

4. Save the **email.html** document, and then open it in your Web browser. Omit the sender e-mail, recipient e-mail, and subject fields and click the **Send** button. You should see the message about filling in the required fields. Then, for the Subject field, enter more than 40 characters and click the **Send** button. You should see the message informing you that the subject contains more than 40 characters.

5. Close your Web browser window.

Finding and Extracting Characters and Substrings

In some situations, you will need to find and extract characters and substrings from a string. For example, if your script receives an e-mail address, you may need to extract the name portion of the e-mail address or domain name. To search for and extract characters and substrings in JavaScript, you use the methods listed in Table 7-1.

Method	Description
`charAt(`*`index`*`)`	Returns the character at the specified position in a text string; returns an empty string if the specified position is greater than the length of the string
`charCodeAt(`*`index`*`)`	Returns the Unicode character code at the specified position in a text string; returns `NaN` if the specified position is greater than the length of the string

Table 7-1 Search and extraction methods of the `String` class *(continues)*

(continued)

Method	Description
`indexOf(`*`text`*`[, `*`index`*`])`	Performs a case-sensitive search and returns the position number in a string of the first character in the *`text`* argument; if the *`index`* argument is included, then the `indexOf()` method starts searching at that position within the string; returns -1 if the character or string is not found
`lastIndexOf(`*`text`*`[, `*`index`*`])`	Performs a case-sensitive search and returns the position number in a string of the last instance of the first character in the *`text`* argument; if the *`index`* argument is included, then the `lastIndexOf()` method starts searching at that position within the string; returns -1 if the character or string is not found
`match(`*`pattern`*`)`	Performs a case-sensitive search and returns an array containing the results that match the *`pattern`* argument; returns `null` if the text is not found
`search(`*`pattern`*`)`	Performs a case-sensitive search and returns the position number in a string of the first instance of the first character in the *`pattern`* argument; returns -1 if the character or string is not found
`slice(`*`starting index`*`[, `*`ending index`*`])`	Extracts text from a string, starting with the position number in the string of the *`starting index`* argument and ending with the position number of the *`ending index`* argument; allows negative argument values
`substring(`*`starting index`*`[, `*`ending index`*`])`	Extracts text from a string starting with the position number in the string of the *`starting index`* argument and ending with the position number of the *`ending index`* argument; does not allow negative argument values

Table 7-1 Search and extraction methods of the `String` class

There are two types of string search methods: methods that return a numeric position in a text string and methods that return a character or substring. To use methods that return the numeric position in a text string, you need to understand that the position of characters in a text string begins with a value of 0, the same as with indexed array elements. For example, the `search()` method returns the position of the first instance of the first character of a text string that is passed as an argument. If the search string is not found, the `search()` method returns a value of -1. The following code uses the `search()` method to determine whether the `email` variable contains an @ character. Because the position of text strings begins with 0, the `document.write()` statement returns a value of 9, even though the @ character is the 10th character in the string.

```
var email = "president@whitehouse.gov";
document.write(email.search("@")); // returns 9
```

As another example, the `indexOf()` method returns the position of the first occurrence of one string in another string. The primary difference between the `search()` method and the `indexOf()` method is that you can pass to the `indexOf()` method a second optional argument that specifies the position in the string where you want to start searching. If the search string is not found, the `indexOf()` method returns a value of -1. The following code uses the `indexOf()` method to determine whether the `email` variable contains an @ character. Because the `indexOf()` method includes a value of 10 as the second optional argument, the `document.write()` statement returns a value of -1 (indicating that the search string was not found) because the method began searching in the string after the position of the @ character.

```
var email = "president@whitehouse.gov";
document.write(email.indexOf("@", 10));
    // returns -1
```

To extract characters from a string, you use the `substring()` or `slice()` methods. In both cases, you pass to the method the starting index and ending index of the characters you want to extract. Both methods return a substring containing the specified characters or an empty string if the specified starting index does not exist. For example, the second statement in the following code uses the `search()` method to identify the position of the `@` character in the `email` variable. The `substring()` method then returns the name portion of the e-mail address by using a starting index position of 0 (the first character in the string) and the value assigned to the `nameEnd` variable as the ending index position.

```
var email = "president@whitehouse.gov";
var nameEnd = email.search("@");
document.write("<p>The name portion of the e-mail ↵
    address is '" + email.substring(0, nameEnd)
    + "'.</p>");
```

To extract characters from the middle or end of a string, you need to identify the position of the character in the string where you want to start the extraction. One way to do this is by using the `search()`, `indexOf()`, or `lastIndexOf()` methods. The `lastIndexOf()` method works the same way as the `indexOf()` method except that it returns the position of the last occurrence of one string in another string instead of the first. The following code uses the `lastIndexOf()` method to return the position of the period within the e-mail address in the `email` variable. The `substring()` method then uses the index returned from the `lastIndexOf()` method to return the domain identifier of the e-mail address.

```
var email = "president@whitehouse.gov";
var startDomainID = email.lastIndexOf(".");
document.write("<p>The domain identifier of ↵
    the e-mail address is " +
    email.substring(startDomainID) + ".</p>");
```


The only difference between the `slice()` and `substring()` methods is that the `slice()` method allows you to specify negative argument values for the index arguments. If you specify a negative value for the starting index, the `slice()` method starts at the end of the text string; -1 represents the last character in the string, -2 represents the second to last character, and so on. If you specify a negative value for the ending index, the number of characters that the `slice()` method extracts also starts at the end of the text string. Note that the `slice()` method does not return the character represented by the ending index; it returns the character immediately before the ending index. For example, the first `slice()` method in the following statements uses a starting index of -6, which represents the letter "S" in the *JavaScript* text string, and an ending index of -3, which represents the letter "i" in the *JavaScript* text string. Remember that both positions are counted from the end of the text string. In comparison, the second `slice()` method uses a starting index of 2, which represents the letter "v" in the *JavaScript* text string, and an ending index is 4, which represents the letter "S" in the *JavaScript* text string. Because the index values are positive, they are counted from the beginning of the text string. Figure 7-3 shows how the following statements print in a Web browser.

```
var language = "JavaScript";
document.write("<p>" + language.slice(-6,-3)
    + "</p>");
document.write("<p>" + language.slice(2,5)
    + "</p >");
```

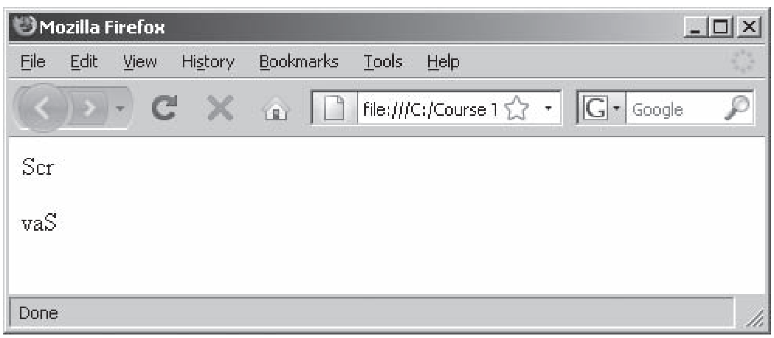


Figure 7-3 Examples of the `slice()` method with negative and positive index values

The following code uses the `slice()` method to return the domain identifier of the e-mail address in the `email` variable:

```
var email = "president@whitehouse.gov";
document.write("<p>The domain identifier of the ↵
    e-mail address is " + email.slice(-4)
    + ".</p>");
```

The following code contains another example of the `slice()` method. In this version, the code uses `search()` and `lastIndexOf()` methods to return the domain name of the e-mail address. Notice that the second statement increments the position returned from the `search()` method by one. This prevents the @ character from being included in the substring returned from the `slice()` method.

```
var email = "president@whitehouse.gov";
var domainBegin = email.search("@") + 1;
var domainEnd = email.lastIndexOf(".");
document.write("<p>The domain name portion of the ↵
    e-mail address is '" + email.slice(domainBegin,
    domainEnd) + "'.</p>");
```

Later in this chapter, you learn how to use regular expressions to validate strings, including e-mail addresses. For now, you use the `search()` and `lastIndexOf()` methods simply to check whether the e-mail addresses entered into the form contain an @ sign to separate the name and domain and a period to separate the domain and identifier.

To use the `search()` and `lastIndexOf()` methods to check whether the e-mail addresses entered into the form contain an @ sign and a period to separate the domain and identifier:

1. Return to the **email.html** document in your text editor.
2. Add the following bolded statements to the `validateEmail()` function. The function uses `search()` and `lastIndexOf()` methods to determine whether the string passed to it contains an @ sign and a period. If the string does contain both characters, a value of true is returned. If not, a value of false is returned.

```
function validateEmail(formObject) {
    var email = formObject.value;
    if (email.search("@") == -1
        || email.lastIndexOf(".") == -1) {
        window.alert("One or more of the e-mail ↵
            addresses you entered does not appear ↵
            to be valid.");
        return false;
    }
    formObject.value = email.toLowerCase();
    return true;
}
```

3. Save the **email.html** document, and then open it in your Web browser. Enter e-mail addresses in the sender and recipient e-mail fields that do not include @ signs or periods, and then click the **Send** button. You should see the message informing you that one or more of the e-mail addresses are invalid.
4. Close your Web browser window.

Replacing Characters and Substrings

The `replace()` method is case sensitive.

In addition to finding and extracting characters in a string, you might also need to replace them. The **`replace()` method** of the `String` class creates a new string with the first instance of a specified pattern replaced with the value of the text argument. The syntax for the `replace()` method is `string.replace(pattern, text)`. Essentially, the `replace()` method replaces the first matching pattern it finds in the string with the text.

When you pass a simple text string as the pattern argument of the `replace()` method, only the first instance of the pattern is replaced with the specified text. To replace all instances of a pattern, you must use a regular expression as the pattern argument and set the property of the `RegExp` object's `global` property. Regular expressions and the `RegExp` object are discussed later in this chapter.

The following example demonstrates how to use the `replace()` method to replace "president" in the `email` variable with "vice. president".

```
var email = "president@whitehouse.gov";
var newEmail = email.replace("president",
    "vice.president");
document.write("<p>" + newEmail + "</p>");
    // prints 'vice.president@whitehouse.gov'
```

Combining Characters and Substrings

So far, you have used the concatenation operator (+) and the compound assignment operator (+=) to combine text strings. The JavaScript `String` class also includes the **`concat()` method**, which creates a new string by combining strings that are passed as arguments. The syntax for the `concat()` method is `string.concat(value1, value2, ...)`. Note that the `concat()` method does not change the original string but returns a new string. The *`value`* arguments are appended to the string in the order in which they are passed to the `concat()` method. For example, the following statements demonstrate how to use the `concat()` method to build a string that is printed using a `document.write()` statement. Figure 7-4 shows the output in a Web browser.

```
var name = "Theodor Seuss Geisel";
var penName = "Dr. Seuss";
document.write("<p>" + penName.concat(
    " was the pen name of ", name)
    + ".</p>");
```

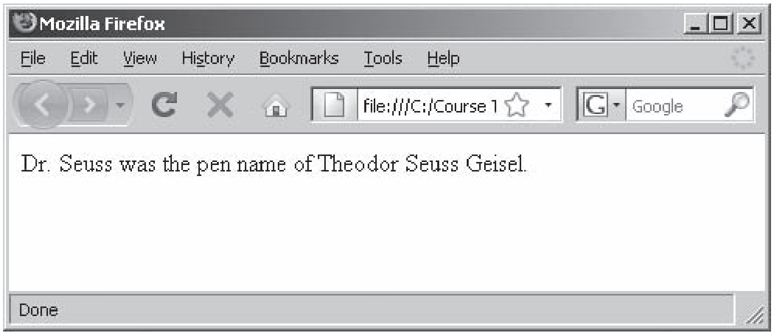


Figure 7-4 Output generated with the `concat()` method of the `String` class

In most cases, you do not need to use the `concat()` method. Instead, it is usually easier to use the concatenation operator and the compound assignment operator to combine text strings. The following code shows the same statements from the preceding example, but this time using concatenation operators:

```
var name = "Theodor Seuss Geisel";
var penName = "Dr. Seuss";
document.write("<p>" + penName
    + " was the pen name of "
    + name + ".</p>");
```

Comparing Strings

In Chapter 2, you studied various operators that you can use with JavaScript, including comparison operators. Although comparison operators are most often used with numbers, they can also be used with strings. The following statements use the comparison operator (==) to compare two variables containing text strings:

```
var florida = "Miami is in Florida.";
var cuba = "Havana is in Cuba.";
if (florida == cuba)
     document.write("<p>Same location.</p>");
else
     document.write("<p>Different locations.</p>");
```

Because the text strings are not the same, the `else` clause prints the text "Different locations." You can also use comparison operators to determine whether one letter is higher in the alphabet than another letter. In the following code, the first `document.write()` statement executes because the letter "B" is higher in the alphabet than the letter "A":

```
var firstLetter = "A";
var secondLetter = "B";
```

```
if (secondLetter > firstLetter)
    document.write("<p>The second letter is ↵
    higher in the alphabet than the first ↵
    letter.</p>");
else
    document.write("<p>The second letter is lower ↵
        in the alphabet than the first ↵
        letter.</p>");
```

The comparison operators actually compare individual characters according to their Unicode position. Lowercase letters are represented by the values 97 ("a") to 122 ("z"). Uppercase letters are represented by the values 65 ("A") to 90 ("Z"). Because lowercase letters have higher values than uppercase letters, the lowercase letters are evaluated as being "greater" than the uppercase letters. For example, an uppercase letter "A" is represented by Unicode value 65, whereas a lowercase letter "a" is represented by Unicode value 97. For this reason, the statement `"a" > "A"` returns a value of true because the uppercase letter "A" has a lower Unicode value than the lowercase letter "a."

In addition to using standard comparison operators, the `String` class includes a **`localeCompare()` method**, which compares strings according to the particular sort order of a language or country. The syntax for the `localeCompare()` method is *`sourceString`*`.localeCompare(`*`compareString`*`)`. If *`compareString`* is equivalent to *`sourceString`*, the method returns a value of 0; if *`compareString`* sorts before *`sourceString`*, the method returns a value greater than 0, usually 1; if *`compareString`* sorts after *`sourceString`*, the method returns a value less than 0, usually -1. For example, consider the following `localeCompare()` method, which compares the strings "Dan" and "Don". Because "Dan" sorts before "Don", the method returns a value of 1.

```
var sourceString = "Don";
var compareString = "Dan";
document.write(sourceString.localeCompare(
    compareString)); // returns 1
```

In comparison, the following statement, which switches the "Dan" and "Don" arguments, returns a value of -1:

```
var sourceString = "Dan";
var compareString = "Don";
document.write(sourceString.localeCompare(compareString));
    // returns -1
```

If both strings values are equal, the `localeCompare()` method returns a value of 0, as in the following example:

```
var sourceString = "Don";
var compareString = "Don";
document.write(sourceString.localeCompare(
    compareString)); // returns 0
```

Keep in mind that the `localeCompare()` method performs a case-sensitive comparison of two strings. The following statements return a value of 1 because the lowercase “d” in the comparison string sorts before the uppercase “D” in the source string:


```
var sourceString = "Don";
var compareString = "don";
document.write(sourceString.localeCompare(
    compareString )); // returns 1
```

To perform a case-insensitive comparison of two strings, you must first use the `toLowerCase()` or `toUpperCase()` methods to convert the strings to the same case. The `localeCompare()` statement in the following code returns a value of 0 because both the source string and comparison string are converted to lowercase before the comparison is performed:

```
var sourceString = "Don";
var compareString = "don";
sourceString = sourceString.toLowerCase();
compareString = compareString.toLowerCase();
document.write(sourceString.localeCompare(
    compareString )); // returns 0
```

Next, you add a function to the e-mail form that determines whether a user entered the same e-mail address for the sender and recipient.

To add a function to the e-mail form that determines whether a user entered the same e-mail address for the sender and recipient:

1. Return to the **email.html** document in your text editor.

2. Add the following statements to the end of the `validateSubmission()` function. The first statement calls a function named `compareAddresses()`, which you create next. Notice that parameters are passed to the `compareAddresses()` function: one for the sender e-mail object and one for the recipient e-mail object. The second statement returns the `retValue` variable from the `validateSubmission()` function.

   ```
   retValue = compareAddresses(
       document.forms[0].sender_email,
       document.forms[0].recipient_email);
   return retValue;
   ```

3. Add the following `compareAddresses()` function to the end of the script section. The function accepts two parameters for the sender and recipient e-mail objects, which it assigns

to two variables: `senderEmail` and `recipientEmail`. Both variables are converted to lowercase with the `toLowerCase()` method and then compared with the `localeCompare()` method. If both e-mail addresses are the same, a message is displayed to the user and the function returns a value of false.

```
function compareAddresses(senderObject,
    recipientObject) {
    var senderEmail = senderObject.value;
    var recipientEmail = recipientObject.value;
    senderEmail = senderEmail.toLowerCase();
    recipientEmail = recipientEmail.toLowerCase();
    if (senderEmail.localeCompare(recipientEmail)
        == 0) {
        window.alert("You entered the same e-mail ↵
            address for sender and recipient.");
        return false;
    }
    else
        return true;
    }
```

4. Save the **email.html** document, and then open it in your Web browser. Enter the same e-mail address in the sender and recipient e-mail fields, and click the **Send** button. You should see the message informing you that you entered the same e-mail address for both the sender and recipient.

5. Close your Web browser window.

Short Quiz 1

1. Why would you need to count the number of characters in a text string?

2. Explain how you include special characters within a text string.

3. Explain why you might need to find and extract characters and substrings from a string.

Working with Regular Expressions

One of the more complex methods of working with strings involves the use of **regular expressions**, which are patterns that are used for matching and manipulating strings according to specified rules. With scripting languages such as JavaScript, regular expressions are most commonly used for validating submitted form data. For example, you can use a regular expression to ensure that a user enters a date in a specific format, such as *mm/dd/yyyy*, or a telephone number in the format (###) ###-####. Most scripting languages support some form of regular expressions.

ECMAScript regular expressions are based on the regular expression functionality of the Perl 5 programming language.

Defining Regular Expressions in JavaScript

Regular expression patterns in JavaScript must begin and end with forward slashes. The following statement defines a regular expression pattern for determining whether a text string contains "https" and assigns it to a variable named `urlProtocol`. Notice that the regular expression pattern is not enclosed in quotation marks.

```
var urlProtocol = /https/;
```

You can use regular expressions with several of the `String` class methods, including the `search()` and `replace()` methods. The value you pass to either of these methods can be either a text string or a regular expression. The following statements pass the `urlProtocol` regular expression to the `search()` method, which then searches the text contained within the `url` variable for "https". Because the `url` variable contains a protocol of "http" instead of "https", the `search()` method returns a value of -1, indicating that the regular expression pattern was not found.

```
var urlProtocol = /https/;
var url = "http://www.dongosselin.com";
document.write("<p>" + url.search(urlProtocol)
    + "</p>"); // returns -1
```

In addition to assigning a regular expression to a variable, you can also pass the pattern directly to a method that accepts regular expressions. The following example demonstrates how to pass the `/https/` regular expression directly to the `search()` method. Again, notice that the regular expression is not enclosed within quotation marks.

```
var url = "http://www.dongosselin.com";
document.write("<p>" + url.search(/https/)
    + "</p>"); // returns -1
```

A final approach to creating a regular expression is to use the `RegExp()` constructor. The `RegExp()` constructor is part of the **RegExp object**, which contains methods and properties for working with regular expressions in JavaScript. The syntax for creating a regular expression with the `RegExp()` constructor is as follows:

```
var regExpName = new RegExp("pattern"[,
    attributes]);
```

Notice that the pattern in the preceding syntax is surrounded by quotation marks instead of forward slashes. The following example demonstrates how to use the `RegExp()` constructor with the "https" pattern:

```
var urlProtocol = new RegExp("https");
var url = "http://www.dongosselin.com";
document.write("<p>" + url.search(urlProtocol)
    + "</p>"); // returns -1
```

All three ways of defining regular expressions result in the same functionality, so which one you use makes little difference. Because the value passed to the `RegExp()` constructor is a text string, the JavaScript interpreter must convert it to a regular expression before it can be used as a regular expression. This added step can make `RegExp()` constructors slightly slower than assigning a regular expression to a text string or passing one as an argument. For this reason, some programmers prefer not to use `RegExp()` constructors to define regular expressions. However, you may find them helpful for keeping your scripts organized and easy to read.

Next, you modify the `search()` method in the `validateEmail()` function so that it searches for the @ sign in the e-mail addresses using a regular expression instead of the "@" text string.

You cannot use regular expressions with the `indexOf()` and `lastIndexOf()` methods.

To modify the `search()` method in the `validateEmail()` function so that it searches for the @ sign in the e-mail addresses using a regular expression instead of the "@" text string:

1. Return to the **email.html** document in your text editor.
2. Locate the `if` statement in the `validateEmail()` function and modify the conditional expression so that the value passed to the `search()` method is passed as a regular expression instead of a string, as shown in the following bolded code:

```
...
if (email.search(/@/)
    == -1 || email.lastIndexOf(".") == -1) {
...
```

3. Save the **email.html** document, and then open it in your Web browser. Enter e-mail addresses in the sender and recipient e-mail fields that do not include @ signs, and then click the **Send** button. You should see the message informing you that one or more of the e-mail addresses are invalid.
4. Close your Web browser window.

Using Regular Expression Methods

Although you can use regular expressions with several of the `String` class methods, the `RegExp` object includes two methods, `test()` and `exec()`, which are specifically designed for working with regular expressions. The `exec()` method is somewhat complex, so you will study only the `test()` method in this book. The `test()` method returns a value of true if a string contains text that matches a regular expression or false if it doesn't. The syntax for the `test()` method is as follows:

```
var pattern = test(string);
```

The following code demonstrates how to use the `test()` method to determine whether the `url` variable contains the text "dongosselin". Because the variable does contain the text, the `document.write()` statement prints "true".

```
var urlDomain = new RegExp("dongosselin");
var url = "http://www.dongosselin.com";
document.write("<p>" + urlDomain.test(url)
    + "</p>"); // returns true
```

The preceding examples simply demonstrate how to use the `test()` method. In fact, there is no point in using regular expression methods with such examples because you can more easily determine whether the two strings match by using the `search()` method or one of the other `String` class methods. The real power of regular expressions comes from the patterns you write, as you'll learn in the next section.

Writing Regular Expression Patterns

The hardest part of working with regular expressions is writing the patterns and rules that are used for matching and manipulating strings. As an example of a common, albeit complicated, regular expression, consider the following code:

```
emailPattern = /^[_a-zA-Z0-9\\-]+(\.[_a-zA-Z0-9\\-] ↵
    +)*@[a-zA-Z0-9\\-]+(\.[a-zA-Z0-9\\-]+)*(\.[a- ↵
    z]{2,3})$/;
email = "dongosselin@compuserve.com";
if (emailPattern.test(email))
    document.write("<p>You entered a valid ↵
        e-mail address.</p.");
else
    document.write("<p>You did not enter a valid ↵
        e-mail address.</p.");
```

The preceding code uses the `test()` method to determine whether the `email` variable contains a valid e-mail address. If the `test()` method returns a value of true, then a `document.write()` statement prints "You entered a valid e-mail address." As you can see, the logic is straightforward: If the e-mail address doesn't match the regular expression, then a `document.write()` statement prints "You did not enter a valid e-mail address." The complex part of the code is the pattern that is defined in the first statement.

You can find many types of prewritten regular expressions on the Regular Expression Library Web page at *http://www.regexlib.com/*.

Regular expression patterns consist of literal characters and **metacharacters**, which are special characters that define the pattern matching rules in a regular expression. Table 7-2 lists the metacharacters that you can use with JavaScript regular expressions.

Metacharacter	Description
.	Matches any single character
\	Identifies the next character as a literal value
^	Matches characters at the beginning of a string
$	Matches characters at the end of a string
()	Specifies required characters to include in a pattern match
[]	Specifies alternate characters allowed in a pattern match
[^]	Specifies characters to exclude in a pattern match
-	Identifies a possible range of characters to match
|	Specifies alternate sets of characters to include in a pattern match

Table 7-2 JavaScript regular expression metacharacters

Matching any Character

You use a period (`.`) to match any single character in a pattern. A period in a regular expression pattern really specifies that the pattern must contain a value where the period is located. For example, the following code specifies that the `zip` variable must contain five characters. Because the variable only contains three characters, the `test()` method returns a value of false.

```
var zipPattern = /...../;
var zip = "015";
document.write(zipPattern.test(zip));
    // returns false
```

By comparison, the following `test()` method returns a value of true because the `zip` variable contains five characters:

```
var zipPattern = /...../;
var zip = "01562";
document.write(zipPattern.test(zip));
    // returns true
```

Because the period only specifies that a character must be included in the designated location within the pattern, you can also include additional characters within the pattern. The following `test()` method returns a value of true because the `zip` variable contains the required five characters along with the ZIP+4 characters.

```
var zipPattern = /...../;
var zip = "01562-2607";
document.write(zipPattern.test(zip));
    // returns true
```

Matching Characters at the Beginning or End of a String

The ^ metacharacter matches characters at the beginning of a string, and the $ metacharacter matches characters at the end of a string. A pattern that matches the beginning or end of a line is called an **anchor**. To specify an anchor at the beginning of a line, the pattern must begin with the ^ metacharacter. The following example specifies that the `url` variable begin with "http". Because the variable does begin with "http", the `test()` method returns true.

```
var urlProtocol = /^http/;
var url = "http://www.dongosselin.com";
document.write(urlProtocol.test(url));
    // returns true
```

All literal characters following the ^ metacharacter in a pattern compose the anchor. This means that the following example returns false because the `url` variable does not begin with "https" (only "http" without the 's'), as is specified by the anchor in the pattern:

```
var urlProtocol = /^https/;
var url = "http://www.dongosselin.com";
document.write(urlProtocol.test(url));
    // returns false
```

To specify an anchor at the end of a line, the pattern must end with the $ metacharacter. The following demonstrates how to specify that a URL ends with "com":

```
var urlIdentifier = /com$/;
var url = "http://www.dongosselin.com";
document.write(urlIdentifier.test(url));
    // returns true
```

The preceding code returns true because the URL assigned to the `urlIdentifier` variable ends with "com". However, the following code returns false because the URL assigned to the `url` variable does not end with "gov".

```
var urlIdentifier = /gov$/;
var url = "http://www.dongosselin.com";
document.write(urlIdentifier.test(url));
    // returns false
```

Matching Special Characters

To match any metacharacters as literal values in a regular expression, you must precede the character with a backslash. For example, a period (`.`) metacharacter matches any single character in the pattern. If you want to ensure that a string contains an actual period and not any character, you need to escape it with a backslash. The domain identifier in the following code is appended to the domain name with a comma instead of a period. However, the regular expression returns true because the period in the expression is not escaped.

```
var urlIdentifier = /.com$/;
var url = "http://www.dongosselin,com";
document.write(urlIdentifier.test(url));
    // returns true
```

To correct the problem, you must escape the period as follows:

```
var urlIdentifier = /\.com$/;
var url = "http://www.dongosselin,com";
document.write(urlIdentifier.test(url));
    // returns false
```

Next, you modify the conditional expression in the `validateEmail()` function so it uses `test()` methods and determines whether a domain identifier is appended to the domain name with a period.

To add `test()` methods to the `validateEmail()` function:

1. Return to the **email.html** document in your text editor.
2. Locate the `if` statement in the `validateEmail()` function and modify the conditional expression so it uses the `test()` method to search for an @ sign in the e-mail address. Also, replace the `lastIndexOf()` method with a `test()` that determines whether a domain identifier is appended to the domain name with a period. The modified conditional expression should appear as follows:

```
...
if (/@/.test(email) == false
    || /\....$/.test(email) == false) {
...
```

3. Save the **email.html** document and then open it in your Web browser. Enter e-mail addresses in the sender and recipient e-mail fields that do not include @ signs or a domain identifier appended to the domain name with a period, and then click the **Send** button. You should see the message informing you that one or more of the e-mail addresses are invalid.
4. Close your Web browser window.

Specifying Quantity

Metacharacters that specify the quantity of a match are called **quantifiers**. Table 7-3 lists the quantifiers that you can use with JavaScript regular expressions.

Quantifier	Description
`?`	Specifies that the preceding character is optional
`+`	Specifies that one or more of the preceding characters must match
`*`	Specifies that zero or more of the preceding characters can match
`{n}`	Specifies that the preceding character repeat exactly *n* times
`{n,}`	Specifies that the preceding character repeat at least *n* times
`{n1, n2}`	Specifies that the preceding character repeat at least *n1* times but no more than *n2* times

Table 7-3 JavaScript regular expression quantifiers

The question mark quantifier specifies that the preceding character in the pattern is optional. The following code demonstrates how to use the question mark quantifier to specify that the protocol assigned to the beginning of the `url` variable can be either http or https:

```
var urlProtocol = /^https?/;
var url = "http://www.dongosselin.com";
document.write(urlProtocol.test(url));
    // returns true
```

The addition quantifier (+) specifies that one or more of the preceding characters match, while the asterisk quantifier (*) specifies that zero or more of the preceding characters match. As a simple example, the following code demonstrates how to ensure that a variable containing a string of name=value pairs contains at least one equal sign:

```
var stringPattern = /=+/;
var queryString = "sport=football";
document.write(stringPattern.test(queryString));
    // returns true
```

Similarly, for a string that consists of multiple name=value pairs separated by ampersands (&), the following code demonstrates how to check whether the `queryString` variable contains zero or more ampersands:

```
var stringPattern = /=+&*/;
var queryString = "sport=football&sport=baseball";
document.write(stringPattern.test(queryString));
    // returns true
```

The `{ }` quantifiers allow you to specify more precisely the number of times that a character must repeat. The following code shows a

You can validate a Zip code much more efficiently with character classes, which are covered later in this chapter.

simple example of how to use the `{ }` quantifiers to ensure that a Zip code consists of at least 5 characters:

```
var zipPattern = /.{5}/;
var zip = "01562";
document.write(zipPattern.test(zip));
    // returns true
```

Specifying Subexpressions

Notice that the preceding pattern includes the ^ and $ metacharacters to anchor both the beginning and end of the pattern. This ensures that a string exactly matches the pattern in a regular expression.

As you learned earlier, regular expression patterns can include literal values; any strings you validate against a regular expression must contain exact matches for the literal values contained in the pattern. You can also use parentheses metacharacters `( )` to specify the required characters to include in a pattern match. Characters contained in a set of parentheses within a regular expression are referred to as a **subexpression** or **subpattern**. Subexpressions allow you to determine the format and quantities of the enclosed characters as a group. As an example, consider the following pattern, which defines a regular expression for a telephone number:

```
/^(1-)?(\(.{3}\) )?(.{3})(\-.{4})$/
```

The first and second groups in the preceding pattern include the `?` quantifier. This allows a string to optionally include a 1 and the area code. If the string does include these groups, they must be in the exact format of `1-`*nnn* (where *nnn* represents the area code), including the space following the area code. Similarly, the telephone number itself must include two groups that require the number to be in the format of "555-1212". Because the 1 and area code are optional, each of the `test()` methods in the following code returns a value of true:

```
var phonePattern
    = /^(1 )?(\(.{3}\) )?(.{3})(\-.{4})$/;
document.write("<p>" + phonePattern.test(
    "555-1234") + "</p>"); // returns true
document.write("<p>" + phonePattern.test(
    "(707) 555-1234") + "</p>"); // returns true
document.write("<p>" + phonePattern.test(
    "1 (707) 555-1234") + "</p>"); // returns true
```

Defining Character Classes

You use **character classes** in regular expressions to treat multiple characters as a single item. You create a character class by enclosing the characters that make up the class within bracket `[]` metacharacters. Any characters included in a character class represent alternate characters that are allowed in a pattern match. As an example of a simple character class, consider the word "analyze", which the

British spell as “analyse”. Both of the following statements return true because the character class allows either spelling of the word:

```
var wordPattern = /analy[sz]e/;
document.write("<p>" + wordPattern.test("analyse")
    + "</p>"); // returns true
document.write("<p>" + wordPattern.test("analyze")
    + "</p>"); // returns true
```

In comparison, the following regular expression returns false because “analyce” is not an accepted spelling of the word:

```
document.write("<p>" + wordPattern.test("analyce")
    + "</p>"); // returns false
```

You use a hyphen metacharacter (-) to specify a range of values in a character class. You can include alphabetical or numerical ranges. You specify all lowercase letters as “[a-z]” and all uppercase letters as “[A-Z]”. The following statements demonstrate how to ensure that only the values A, B, C, D, or F are assigned to the `letterGrade` variable. The character class in the regular expression specifies a range of A-D or the character ‘F’ as valid values in the variable. Because the variable is assigned a value of “B”, the `test()` method returns true.

```
var gradeRange = /[A-DF]/;
var letterGrade = "B";
document.write("<p>" + gradeRange.test(letterGrade)
    + "</p>"); // returns true
```

In comparison, the following `test()` method returns false because “E” is not a valid value in the character class:

```
var gradeRange = /[A-DF]/;
var letterGrade = "E";
document.write("<p>" + gradeRange.test(letterGrade)
    + "</p>"); // returns false
```

To specify optional characters to exclude in a pattern match, include the ^ metacharacter immediately before the characters in a character class. The following examples demonstrate how to exclude the letters “E” and G-Z from an acceptable pattern in the `letterGrade` variable. The first `test()` method returns a value of true because the letter “A” is not excluded from the pattern match, while the second `test()` method returns a value of false because the letter “E” is excluded from the pattern match.

```
var gradeRange = /[^EG-Z]/;
var letterGrade = "A";
document.write("<p>" + gradeRange.test(letterGrade)
    + "</p>"); // returns true
letterGrade = "E";
document.write("<p>" + gradeRange.test(letterGrade)
    + "</p>"); // returns false
```

The following statements demonstrate how to include numeric characters in or exclude them from a pattern match. The first statement returns true because it allows any numeric character, while the second statement returns false because it excludes any numeric character.

```
document.write("<p>" + /[0-9]/.test("5")
    + "</p>"); // returns true
document.write("<p>" + /[^0-9]/.test("5")
    + "</p>"); // returns false
```

Note that you can combine ranges in a character class. The first of the following statements demonstrates how to include all alphanumeric characters, and the second demonstrates how to exclude all lowercase and uppercase letters:

```
document.write("<p>" + /[0-9a-zA-Z]/.test("7")
    + "</p>"); // returns true
document.write("<p>" + /[^a-zA-Z]/.test("Q")
    + "</p>"); // returns false
```

The following statements demonstrate how to use character classes to create a phone number regular expression pattern:

```
var phonePattern = /^(1 )?(\([0-9]{3}\) )? ↵
    ([1-9]{3})(\-[1-9]{4})$/;
document.write("<p>" + phonePattern.test(
    "1 (707) 555-1234") + "</p>");
```

As a more complex example of a character class, examine the following e-mail validation regular expression, which you saw earlier in the chapter. At this point, you should recognize how the regular expression pattern is constructed. The anchor at the beginning of the pattern specifies that the first part of the e-mail address must include one or more of the characters A–Z (upper- or lowercase), 0–9, or an underscore (_) or hyphen (-). The second portion of the pattern specifies that the e-mail address can optionally include a dot separator, as in “don.gosselin”. The pattern also requires the @ character. Following the literal @ character, the regular expression uses patterns that are similar to the patterns in the name portion of the e-mail address, to specify the required structure of the domain name. The last portion of the pattern specifies that the domain identifier must consist of at least two, but not more than three, alphabetic characters.

```
var emailPattern = /^[_a-zA-Z0-9\-]+(\.[_a-zA-Z0-9\-] ↵
    +)*@[a-zA-Z0-9\-]+(\.[a-zA-Z0-9\-]+)*(\.[a-z] ↵
    {2,3})$/;
```

JavaScript regular expressions include special escape characters that you can use in character classes to represent different types of data. For example, the "w" expression can be used instead of the "0-9a-zA-Z" pattern to allow any alphanumeric characters in a character class. Table 7-4 lists the JavaScript character class expressions.

Expression	Description
\w	Alphanumeric characters
\D	Alphabetic characters
\d	Numeric characters
\S	All printable characters
\s	Whitespace characters
\W	Any character that is not an alphanumeric character
\b	Backspace character

Table 7-4 JavaScript character class escape characters

Be sure to include the brackets that make up each escape character within the character class brackets.

The following statements demonstrate how to use the \d escape character to test for numeric characters:

```
document.write("<p>" + /[\d]/.test("5") + "</p>");
    // returns true
document.write("<p>" + /[\d]/.test("A") + "</p>");
    // returns false
```

As a more complex example, the following statement demonstrates how to compose the e-mail validation regular expression with class expressions:

```
var emailPattern = /^[_\w\-]+(\.[_\w\-]+)*@[\w\-] ↵
    +(\.[\w\-]+)*(\.[\D]{2,3})$/;
```

Next, you modify the `validateEmail()` function so it uses an e-mail regular expression to validate e-mail addresses.

To validate the e-mail addresses in the e-mail form with a regular expression:

1. Return to the **email.html** document in your text editor.
2. Add the following e-mail regular expression variable above the `if` statement in the `validateEmail()` function:

   ```
   var emailCheck = /^[_\w\-]+(\.[_\w\-]+)*@[\w\-] ↵
       +(\.[\w\-]+)*(\.[\D]{2,3})$/;
   ```

3. Modify the conditional expression in the `if` statement so it validates e-mail addresses with the `test()` method and the `emailCheck` regular expression, as follows:

```
...
if (emailCheck.test(email) == false) {
...
```

4. Save the **email.html** document, and then open it in your Web browser. Enter some invalid e-mail addresses in the sender and recipient e-mail fields and click the **Send** button. You should see the message informing you that one or more of the e-mail addresses are invalid.

5. Close your Web browser window.

Matching Multiple Pattern Choices

To allow a string to contain an alternate set of substrings, you separate the strings in a regular expression pattern with the | metacharacter. This is essentially the same as using the Or operator (||) to perform multiple evaluations in a conditional expression. For example, to allow a string to contain either "vegetarian" or "vegan", you include the pattern "vegetarian | vegan".

The following code demonstrates how to check whether a domain identifier at the end of a string contains a required value of either .com, .org, or .net. The first `document.write()` statement returns a value of false because the URL contains a domain identifier of .gov, while the second `document.write()` statement returns a value of true because the domain identifier contains a valid value of .com.

```
domainPattern = /\.(com|org|net)$/;
document.write("<p>" + domainPattern.test(
    "http://www.dongosselin.gov")
    + "</p>"); // returns false
document.write("<p>" + domainPattern.test(
    "http://www.dongosselin.com")
    + "</p>"); // returns true
```

Setting Regular Expression Properties

The RegExp object includes several properties that you can use to configure how JavaScript executes regular expressions. Table 7-5 lists the properties of the `RegExp` object. Note that several of the properties can be set with flags, which represent specific values that can be assigned to the property.

Property	Flag	Description
`global`	`g`	Determines whether to search for all possible matches within a string
`ignoreCase`	`i`	Determines whether to ignore letter case when executing a regular expression
`lastIndex`	–	Stores the index of the first character from the last match
`multiline`	`m`	Determines whether to search across multiple lines of text
`source`	–	Contains the regular expression pattern

Table 7-5 Properties of the `RegExp` object

The values of the `lastIndex` and `source` properties are automatically set by the JavaScript interpreter, although you can set the values of the `global`, `ignoreCase`, and `multiline` properties from within your scripts. You have two options for setting the values of these properties. First, you can assign a value of true or false to the property by creating a regular expression with the `RegExp()` constructor. For example, the first statement in the following code declares a `RegExp` object named `opecCountry` that searches for the pattern "saudi arabia". The second statement then assigns a value of true to the `ignoreCase` property of the `opecCountry` variable so that the case of the regular expression is ignored when it executes.

```
var opecCountry = new RegExp("saudi arabia");
opecCountry.ignoreCase = true;
```

A second option for setting the values of the `global`, `ignoreCase`, and `multiline` properties is to use the flags that are listed in Table 7-5. You can pass the flags as text strings as the second argument of the `RegExp()` constructor. For example, the following statement causes the regular expression to ignore case when it executes:

```
var opecCountry = new RegExp("saudi arabia", "i");
```

A third option for setting the values of the `global`, `ignoreCase`, and `multiline` properties is to use the flags that are listed in Table 7-5 when you assign a regular expression to a variable without using the `RegExp()` constructor. To use one of the property flags, you place it after the closing slash at the end of the regular expression. For example, the first statement in the following code declares the regular expression that searches for the pattern "saudi arabia", and sets the `ignoreCase` attribute to true by appending the *i* flag after the closing forward slash. The `test()` method then returns a value of true, even though the letter case of "Saudi Arabia" in the `OPEC` variable does not match the letter case of "saudi arabia" in the `opecCountry` regular expression variable.

```
var opecCountry = /saudi arabia/i;
var OPEC = "Algeria, Angola, Indonesia, Iran, ↵
    Iraq, Kuwait, Libya, Nigeria, Qatar, ↵
    Saudi Arabia, United Arab Emirates, Venezuela";
document.write("<p>" + opecCountry.test(OPEC)
    + "</p>"); // returns true
```


Recall that you can use regular expressions with several methods of the `String` class, including the `search()` and `replace()` methods. By default, the `replace()` method only replaces the first occurrence of a specified pattern in the target string. To replace all instances of a specified pattern with the `replace()` method, you set the value of the `RegExp` object's `global` property to true, either with the `RegExp()` constructor or by including the *g* flag in the regular expression pattern that is assigned to a variable. The following example demonstrates how to use the *g* flag to replace all instances of colon symbols in the `infoString` variable with equal signs:

```
var infoString =
"firstName:Don,lastName:Gosselin,occupation:writer";
infoString = infoString.replace(/:/g, "=");
```

Short Quiz 2

1. List three types of strings you would validate with regular expressions.
2. What objects and methods do you use to create a regular expression and to determine whether a particular string matches a regular expression pattern?
3. Describe the metacharacters you can use with regular expressions.
4. What does a period in a regular expression represent?
5. Explain how to define a character class with a regular expression.

Manipulating Arrays

To manipulate arrays in your scripts, you use the methods and `length` property of the **`Array` class**. You already know how to use the `new` keyword and the `Array()` constructor to create an array in your programs. When you create an array in your programs using the `Array()` constructor, you are really instantiating an object from the

`Array` class. The methods of the `Array` class are discussed throughout this section.

In the following steps, you modify the recipient section of the e-mail form in order to allow users to enter multiple recipients. You will use a selection list that users can use to add and delete recipient information dynamically. Later in this section, you will use methods of the `Array` class to modify the contents of the selection list.

To add a selection list to the recipient section to the e-mail form:

1. Return to the **email.html** document in your Web browser.
2. Add the following text and elements immediately after the paragraph tag that contains the `recipient_email` element. These elements create three command buttons: Add, Remove, and Update. Each of the buttons contains `onclick` event handlers that call functions, which you will work on for the rest of this chapter.

```
<p><input type="button" value="Add"
onclick="addRecipient()" /> 
<input type="button"
value="Remove" onclick="deleteRecipient()" /> 
<input type="button" value="Update"
onclick="updateSelectedRecipient()" /></p>
<select name="recipients" size="4"
style="width: 200px"
<option value="recipients">Recipients</option>
</select>
```

3. Add the following `addRecipient()` function to the end of the script section. This function executes when a user clicks the Add button. The `if` statement first determines whether the user entered a recipient's name and e-mail address. The `else` clause then uses the `validateEmail()` function to validate the e-mail address. If the e-mail address is valid, the remainder of the statements in the `else` clause remove the default "recipients" entry from the selection list and then add the recipient's name and e-mail address to the selection list. (You learned how to dynamically add new elements to a selection list in Chapter 5.)

```
function addRecipient() {
    if (document.forms[0].recipient_name.value
        == "" || document.forms[0].recipient_email
        .value == "")
        window.alert("You must enter the ↵
            recipient's name and e-mail address.");
    else {
        retValue = validateEmail(
            document.forms[0].recipient_email);
```

```
            if (retValue == false)
                return retValue;
            if (document.forms[0].recipients
                .options[0] && document.forms[0]
                .recipients.options[0].value
                == "recipients")
                document.forms[0].recipients
                    .options[0] = null;
                var nextRecipient = document.forms[0]
                    .recipients.options.length;
                var createRecipient = new Option(
                    document.forms[0]
                    .recipient_name.value + ", "
                    + document.forms[0]
                    .recipient_email.value);
                document.forms[0].recipients
                    .options[nextRecipient]
                    = createRecipient;
        }
    }
```

4. Add the following `deleteRecipient()` function to the end of the script section. This simple function includes two statements that delete a selected recipient from the selection list.

```
function deleteRecipient() {
    var selectedIndex = document.forms[0]
        .recipients.selectedIndex;
  document.forms[0].recipients.remove(selectedIndex);
}
```

5. It is possible that someone may want to send a message to him or herself, so delete the entire `compareAddresses()` function from the script section.

6. Delete the following statement from the `validateSubmission()` function that called the `compareAddresses()` function:

```
retValue = compareAddresses(
    document.forms[0].sender_email,
    document.forms[0].recipient_email);
return retValue;
```

7. Delete the following statements from the `validateSubmission()` function that validated the recipient e-mail; this functionality is now being handled by the `addRecipients()` function.

```
retValue = validateEmail(document.forms[0]
    .recipient_email);
if (retValue == false)
    return retValue;
```

8. Save the **email.html** document, and then open it in your Web browser. Test the selection list functionality by adding and deleting some e-mail addresses. Figure 7-5 shows the form in a Web browser.

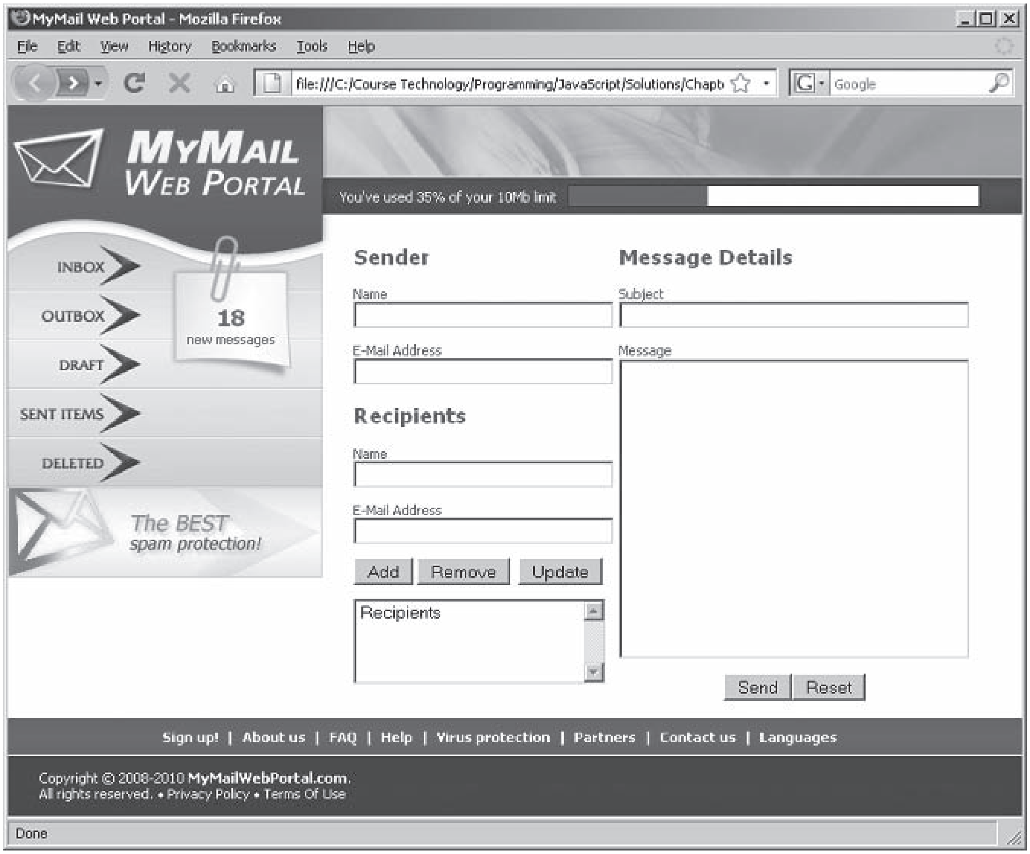


Figure 7-5 The email.html document after adding multiple recipient functionality

9. Close your Web browser window.

Finding and Extracting Elements and Values

This section discusses methods for finding and extracting elements and values in an array. The primary method for finding a value in an array is to use a looping statement to iterate through the array until you find a particular value. For example, the `for` statement in the following code loops through the `hospitalDepts[]` array to see if it contains "Neurology." If it does, a message prints and the `break` statement ends the `for` loop.

```
var hospitalDepts = new Array("Anesthesia",
    "Molecular Biology", "Neurology",
    "Pediatrics");
for (var i=0; i<hospitalDepts.length; ++i) {
    if (hospitalDepts[i] == "Neurology") {
        document.write("<p>The hospital has a ↵
            Neurology department.</p>");
            break;
    }
}
```

To extract elements and values from an array, you use the `slice()` method to return (copy) a portion of an array and assign it to another array. The syntax for the `slice()` method is `array_name.slice(start, end);`. The *`array_name`* argument indicates the name of the array from which you want to extract elements. The *`start`* argument indicates the start position within the array to begin extracting elements. The *`end`* argument is an integer value that indicates the number of elements to return from the array, starting with the element indicated by the *`start`* argument.

The following example demonstrates how to use the `slice()` method to return the first five elements in the `topGolfers[]` array. The elements are assigned to a new element named `topFiveGolfers[]`. Figure 7-6 shows the output.

```
var topGolfers = new Array("Tiger Woods",
    "Vijay Singh", "Ernie Els", "Phil Mickelson",
    "Retief Goosen", "Padraig Harrington",
    "David Toms", "Sergio Garcia",
    "Adam Scott", "Stewart Cink");
var topFiveGolfers = topGolfers.slice(0, 5);
document.write("<p>The top five golfers in the ↵
    world are:</p><p>");
for (var i=0; i<topFiveGolfers.length; ++i) {
    document.write(topFiveGolfers[i] + "<br />");
}
```

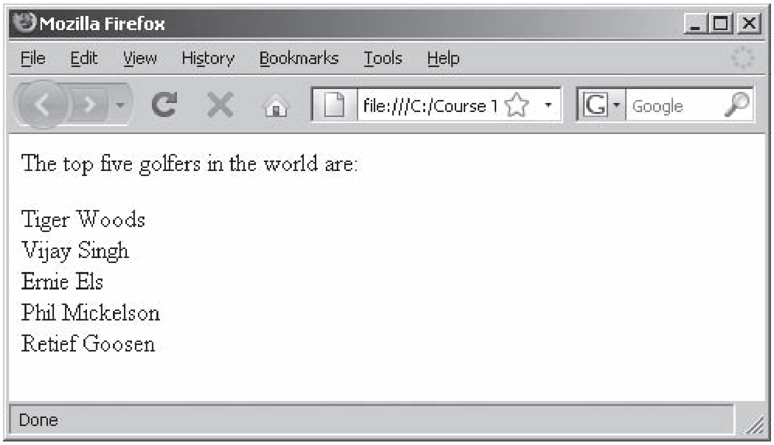


Figure 7-6 Output of an array returned with the `slice()` method

Manipulating Elements

As you use arrays in your scripts, you will undoubtedly need to add and remove elements. For example, suppose that you have a shopping cart program that uses an array to store the names of products that a customer plans to purchase. As the customer selects additional products to purchase, or changes her mind about an item, you will need to manipulate the elements in the array of products.

Adding and Removing Elements to and from the Beginning of an Array

To add or remove elements to or from the beginning of an array, you need to use the `shift()` and `unshift()` methods. The `shift()` method removes and returns the first element from the beginning of an array, whereas the `unshift()` method adds one or more elements to the beginning of an array. You append the `shift()` method to the name of the array whose first element you want to remove. You append the `unshift()` method to the name of an array and pass to the method a comma-separated list of values for each element you want to add. For example, the following code declares and initializes an array containing the names of the world's top-ranked golfers in 2005. The `shift()` method removes the first golfer, Ernie Els, from the top of the array and the `unshift()` method adds the two highest-ranked players, Tiger Woods and Vijay Singh, to the top of the array. Figure 7-7 shows the output.

```
var topGolfers = new Array(
     "Ernie Els",
     "Phil Mickelson",
     "Retief Goosen",
```

```
        "Padraig Harrington",
        "David Toms",
        "Sergio Garcia",
        "Adam Scott",
        "Stewart Cink");
topGolfers.shift();
topGolfers.unshift("Tiger Woods", "Vijay Singh");
for (var i=0; i<topGolfers.length; ++i) {
        document.write(topGolfers[i] + "<br />");
}
```

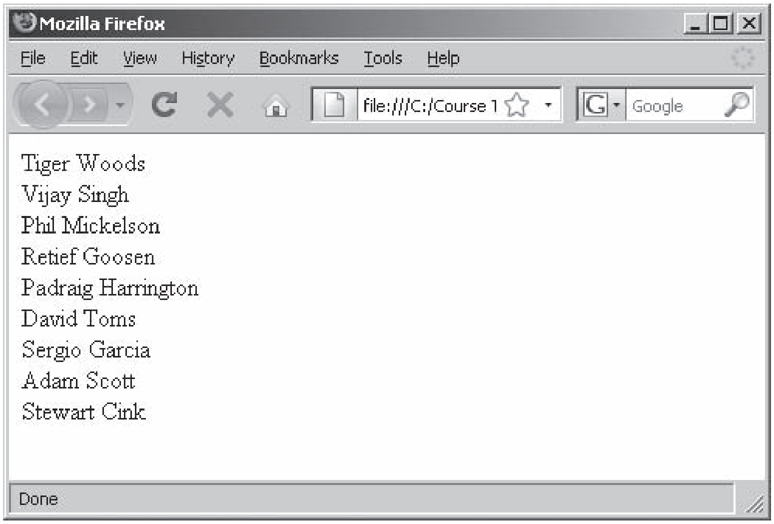


Figure 7-7 Output of an array modified with the `shift()` and `unshift()` methods

Adding and Removing Elements to and from the End of an Array

The easiest way to add additional elements to the end of an array is to use array's `length` property to determine the next available index. For example, the first statement in the following code uses the `Array()` constructor to create the initial `hospitalDepts[]` array. The second statement then adds a new value, "Pediatrics," as the fourth element of the array by using the array's `length` property as the element index.

```
var hospitalDepts = new Array(
        "Anesthesia",
        "Molecular Biology",
        "Neurology");
hospitalDepts[hospitalDepts.length] = "Pediatrics";
```

You can also add and remove elements to and from the end of an array by using the `pop()` and `push()` methods. The `pop()` method removes the last element from the end of an array, whereas the `push()` method adds one or more elements to the end of an array. You append the `pop()` method to the name of the array whose last element you want to remove. You append the `push()` method to the name of an array and pass to the method a comma-separated list of values for each element you want to add. In the following example, the `pop()` method removes the last department, "Pediatrics," from the end of the array and the push() method adds the two additional departments, "Psychiatry" and "Pulmonary Diseases," to the end of the array.

```
hospitalDepts = new Array(
    "Anesthesia",
    "Molecular Biology",
    "Neurology",
    "Pediatrics");
hospitalDepts.pop();
hospitalDepts.push("Psychiatry",
    "Pulmonary Diseases");
```

Adding and Removing Elements within an Array

So far, you have learned to add and remove elements from the beginning and end of an array. To add or remove elements anywhere else in an array, you need to use the `splice()` method. After adding or removing array elements, the `splice()` method also renumbers the indexes in the array. The syntax for the `splice()` method is `array_name.splice(start, characters_to_delete, value1, value2, ...);`. The *`array_name`* argument indicates the name of the array you want to modify. The *`start`* argument indicates the element within the array at which point elements should be added or removed. The *`characters_to_delete`* argument is an integer value that indicates the number of elements to remove from the array, starting with the element indicated by the *`start`* argument. The *`value`* arguments represent the values you want to add as new elements to an array.

To add an element within an array, include a value of 0 as the second argument to the `splice()` method. The `splice()` method in the following code adds a new element with a value of "Ophthalmology" between the "Neurology" and "Pediatrics" elements, and renumbers the elements:

```
var hospitalDepts = new Array(
     "Anesthesia",
     "Molecular Biology",
     "Neurology",
     "Pediatrics");
hospitalDepts.splice(3, 0, "Ophthalmology");
```

To add more than one element within an array, you must pass them as additional values to the `splice()` method. The following example shows how to add two new elements, "Ophthalmology" and "Otolaryngology", between the "Neurology" and "Pediatrics" elements:

```
var hospitalDepts = new Array(
     "Anesthesia",
     "Molecular Biology",
     "Neurology",
     "Pediatrics");
hospitalDepts.splice(3, 0, "Ophthalmology",
    "Otolaryngology");
```

You can also delete array elements by omitting the third argument from the `splice()` method. After you delete array elements with the `splice()` method, the remaining indexes are renumbered, just as when you add new elements. For example, to delete the second and third elements in the `hospitalDepts[]` array, you use the following statement:

If you do not include the second argument (*`characters_to_delete`*), the *`splice()`* method deletes all the elements from the first argument (*`start`*) to the end of the array.

```
var hospitalDepts = new Array(
     "Anesthesia",
     "Molecular Biology",
     "Neurology",
     "Pediatrics");
hospitalDepts.splice(1, 2);
```

If the `hospitalDepts[]` array contains four elements with the values "Anesthesia," "Molecular Biology," "Neurology," and "Pediatrics" (in that order), then executing the preceding statement removes the elements containing "Molecular Biology" and "Neurology" from the array.

Methods of the `Array` class are not available to a form's `options[]` array. In order to use the methods of the `Array` class with an `options[]` array, you must first create a new array and copy the elements from the `options[]` array to the new array. Once you are through using the methods of the `Array` class on the new array, you must copy its elements back to the `options[]` array. The procedures you added in the last exercise are sufficient for adding and deleting options to and from a selection list. For practice, in the next section you modify the recipient functions in the e-mail form so that they use methods of the `Array` class to add and delete recipients.

To use methods of the `Array` class in the e-mail form:

1. Return to the **email.html** document in your text editor.
2. Delete the following statements from the `addRecipient()` function:

```
var nextRecipient = document.forms[0].recipients
    .options.length;
var createRecipient = new Option(document.forms[0]
    .recipient_name.value + ", "
    + document.forms[0].recipient_email.value);
document.forms[0].recipients.options[nextRecipient]
    = createRecipient;
```


3. Add the following statements to the end of the `else` clause in the `addRecipient()` function. The first statement declares a new array, and the first `for` loop assigns the values of the `options[]` array to the new array. The `push()` statement then adds the new recipient to the end of the new array. The final `for` loop then recreates the `options[]`.

```
var recipientsArray = new Array();
for (var i=0; i < document.forms[0].recipients
    .options.length; ++i) {
    recipientsArray.push(document.forms[0]
        .recipients.options[i].value);
}
recipientsArray.push(document.forms[0]
    .recipient_name.value + ", "
    + document.forms[0].recipient_email.value);
for (var j=0; j<recipientsArray.length; ++j) {
    var createRecipient = new Option(
        recipientsArray[j], recipientsArray[j]);
    document.forms[0].recipients.options[j]
        = createRecipient;
}
```

4. Delete the two statements from the `deleteRecipient()` function.

5. Add the following statements to the `deleteRecipient()` function. The first statement declares a new array, and the `for` loop assigns the values of the `options[]` array to the new array.

```
var recipientsArray = new Array();
for (var i=0; i < document.forms[0].recipients
    .options.length; ++i) {
    recipientsArray.push(document.forms[0]
        .recipients.options[i].value);
}
```

6. Add the following statements to the end of the `deleteRecipient()` function. The `if` statement uses the `shift()` method to remove the first element if the selected index in the options list is 0. The `else...if` clause uses the `pop()` method to remove the last element if the selected index

is equal to the length of the `options[]` array minus one. If the selected index is not equal to 0 or to the length of the options array minus one, the `else` clause uses the `splice()` method to remove the element.

```
if (document.forms[0].recipients.selectedIndex == 0)
    recipientsArray.shift();
else if (document.forms[0].recipients.selectedIndex
    == document.forms[0].recipients.options
    .length-1)
    recipientsArray.pop();
else
    recipientsArray.splice(document.forms[0]
        .recipients.selectedIndex, 1);
```

7. Add the following statements to the end of the `deleteRecipient()` function to recreate the options array. Notice that the first statement removes all the options from the options array by assigning a value of 0 to the `length` property.

```
document.forms[0].recipients.options.length = 0;
for (var j=0; j<recipientsArray.length; ++j) {
    var createRecipient = new Option(
        recipientsArray[j], recipientsArray[j]);
    document.forms[0].recipients.options[j]
        = createRecipient;
}
```

8. Save the **email.html** document, and then open it in your Web browser. Test the selection list functionality by adding and deleting some e-mail addresses.

9. Close your Web browser window.

Sorting and Combining Arrays

In the preceding section, you studied techniques for working with the individual elements in an array. In this section, you study techniques for manipulating entire arrays. More specifically, this section discusses how to sort and compare arrays. First, you learn how to sort arrays.

Sorting Arrays

To sort elements of an array alphabetically, you use the `sort()` method. You append the `sort()` method to the name of the array you want to sort using the following syntax: *`array_name`*`.sort();`. For example, the following code shows how to use the `sort()` method to sort the elements of an array named `scientificFishNames[]`. Notice the order in which the values are assigned to the array elements.

Figure 7-8 shows the order of the elements after executing the `sort()` method.

```
scientificFishNames = new Array();
scientificFishNames[0] = "Quadratus taiwanae";
scientificFishNames[1] = "Macquaria australasica";
scientificFishNames[2] = "Jordania zonope";
scientificFishNames[3] = "Abudefduf sparoides";
scientificFishNames[4] = "Dactylopterus volitans";
scientificFishNames[5] = "Wattsia mossambica";
scientificFishNames[6] = "Bagrus urostigma";
scientificFishNames.sort();
for(var i=0;i<scientificFishNames.length;++i) {
    document.write(scientificFishNames[i]
        + "<br />");
}
```

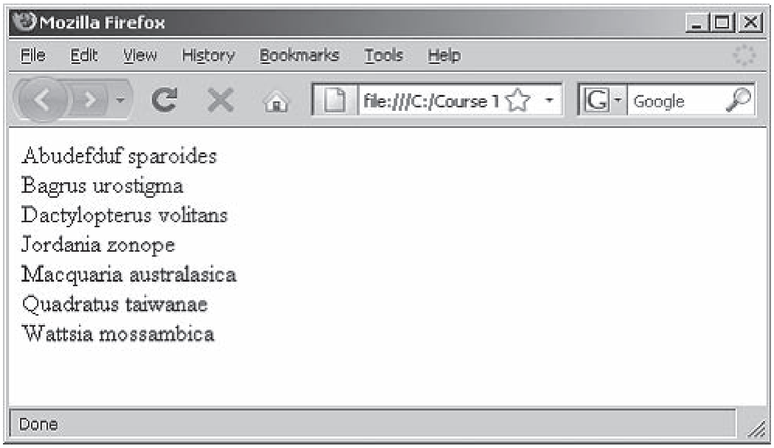


Figure 7-8: Output of a sorted array

The `reverse()` method simply transposes, or reverses, the order of the elements in an array; it does not perform a reverse sort (Z to A instead of A to Z). If you want to perform a reverse sort on an array, then you first need to execute the `sort()` method to sort the array alphabetically and then call the `reverse()` method to transpose the array elements. The following code shows how to perform a reverse sort on the `scientificFishNames[]` array. Figure 7-9 shows the output of the code in a Web browser.

```
scientificFishNames = new Array();
scientificFishNames[0] = "Quadratus taiwanae";
scientificFishNames[1] = "Macquaria australasica";
scientificFishNames[2] = "Jordania zonope";
scientificFishNames[3] = "Abudefduf sparoides";
scientificFishNames[4] = "Dactylopterus volitans";
scientificFishNames[5] = "Wattsia mossambica";
scientificFishNames[6] = "Bagrus urostigma";
```

```
scientificFishNames.sort();
scientificFishNames.reverse();
for(var i=0;i<scientificFishNames.length;++i) {
    document.write(scientificFishNames[i]
        + "<br />");
}
```

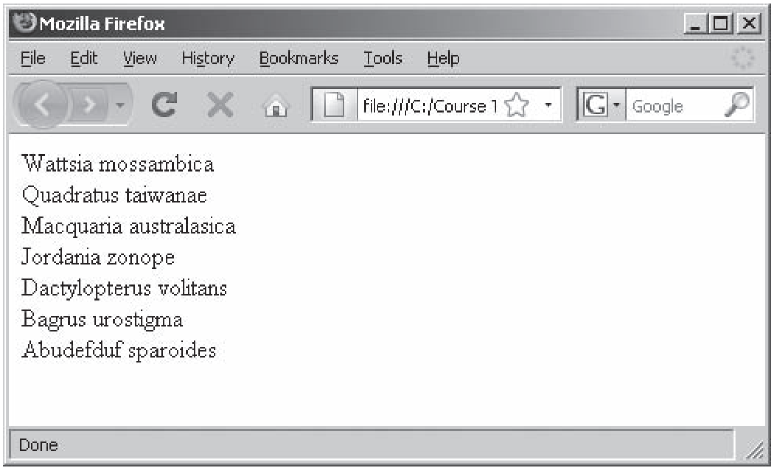



Figure 7-9 Output of a reverse-sorted array

Combining Arrays

If you want to combine arrays, you use the `concat()` method. The syntax for the `concat()` method is `array1.contact(array2, array3, ...);`. The *array2* array is appended to the *array1* array, the *array3* array is appended to the *array2* array, and so on. For example, consider the following code, which declares and initializes `Provinces[]` and `Territories[]` arrays. The `Territories[]` array is appended to the `Provinces[]` array with the `concat()` method, and the result is then assigned to a new array named `Canada[]`. Figure 7-10 shows the output.

```
var Provinces = new Array(
    "Newfoundland and Labrador",
    "Prince Edward Island", "Nova Scotia",
    "New Brunswick", "Quebec", "Ontario",
    "Manitoba", "Saskatchewan", "Alberta",
    "British Columbia");
var Territories = new Array("Nunavut",
    "Northwest Territories", "Yukon Territory");
var Canada = new Array();
Canada = Provinces.concat(Territories);
for(var i=0; i<Canada.length; ++i) {
    document.write(Canada[i] + "<br />");
}
```

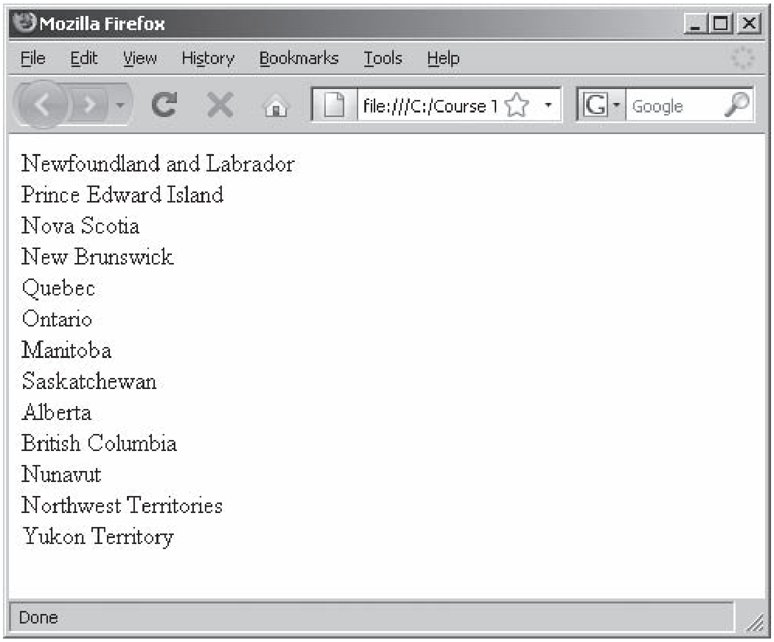


Figure 7-10 Output of two arrays combined with the `concat()` method

Converting Between Strings and Arrays

Depending on the type of data stored in a string, you may often find it easier to manipulate the data by converting it into an array. You use the **`split()` method** of the `String` class to split a string into an indexed array. The `split()` method splits each character in a string into an array element, using the syntax `array = string.split(separator[, limit]);`. The *`separator`* argument specifies the character or characters where the string will be separated into array elements, and the *`limit`* argument determines the maximum length of the array. If the string does not contain the specified separators, the entire string is assigned to the first element of the array. To split the individual characters in a string into an array, pass an empty string (`""`) as the *`separator`* argument.

The following code demonstrates how to convert a variable named `OPEC` into an array named `opecArray`. A comma and a space separate the country names in the `OPEC` variable. After the `split()` method converts the string to an array, a `for` loop prints the contents of each array element. Figure 7-11 shows the output.

```
var OPEC = "Algeria, Angola, Indonesia, Iran, ↵
    Iraq, Kuwait, Libya, Nigeria, Qatar, ↵
    Saudi Arabia, United Arab Emirates, ↵
    Venezuela";
```

```
var opecArray = OPEC.split(", ");
for (var i=0; i<opecArray.length; ++i) {
    document.write(opecArray[i] + "<br />");
}
```

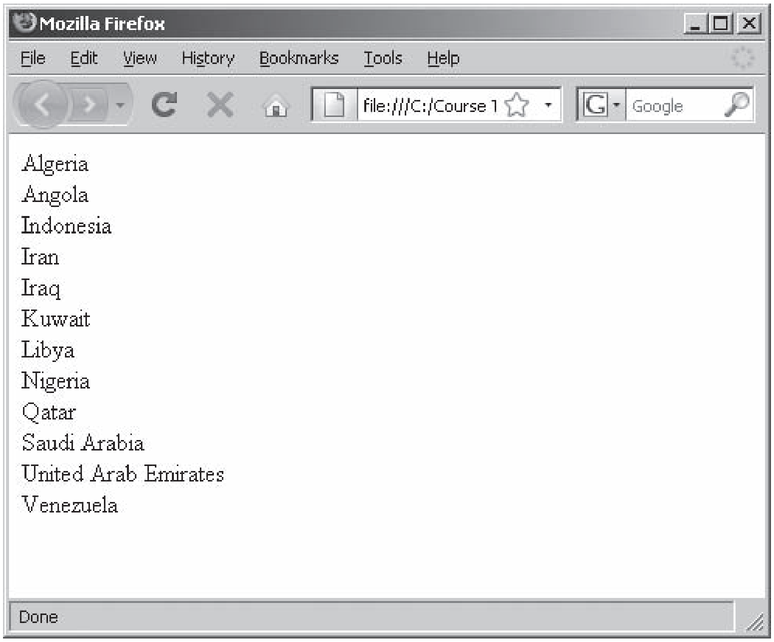


Figure 7-11 Output of an array that was converted from a string

The opposite of the `split()` method is the `Array` class's **`join()` method**, which combines array elements into a string, separated by a comma or specified characters. The syntax for the `join()` method is `array.join(["separator"]);`. The *`separator`* argument specifies the character or characters that will separate the contents of each array element in the returned string. If you do not include the *`separator`* argument, the `join()` method automatically separates elements with a comma. To prevent the elements from being separated by any characters in the new string, pass an empty string ("") as the *`separator`* argument. The following code demonstrates how to use the `join()` method to create a string from an array containing the names of the OPEC nations. Because the `join()` method does not include a *`separator`* argument, the OPEC nations are automatically separated by commas, as shown in Figure 7-12.

```
var OPEC = new Array("Algeria", "Angola",
    "Indonesia", "Iran", "Iraq", "Kuwait",
    "Libya", "Nigeria", "Qatar", "Saudi Arabia",
    "United Arab Emirates", "Venezuela");
var opecString = OPEC.join();
document.write("<p>" + opecString + "</p>");
```

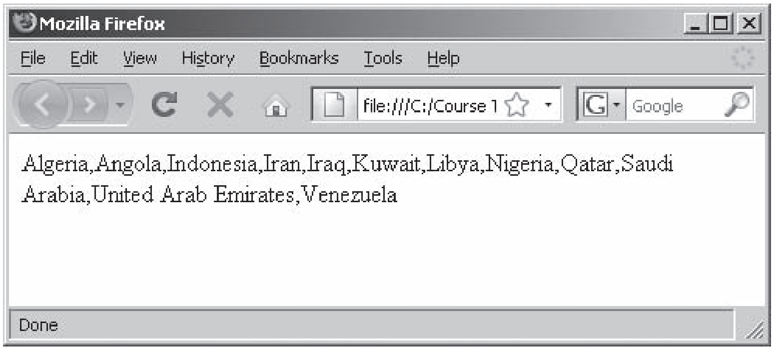


Figure 7-12 Output of a string that was converted from an array

In comparison, because the `join()` method in the following example includes a *`separator`* argument of ";", the OPEC nations are separated by semicolons, as shown in Figure 7-13.

```
var OPEC = new Array("Algeria", "Angola",
    "Indonesia", "Iran", "Iraq", "Kuwait", "Libya",
    "Nigeria", "Qatar", "Saudi Arabia",
    "United Arab Emirates", "Venezuela");
var opecString = OPEC.join(";");
document.write("<p>" + opecString + "</p>");
```

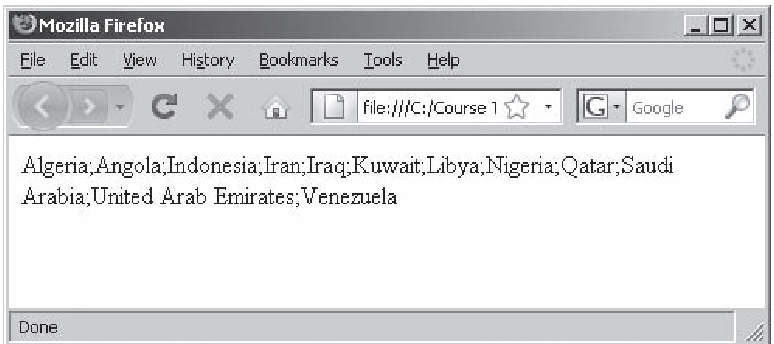


Figure 7-13 Output of a string that was converted from an array with a custom separator

In addition to the `join()` and `toString()` methods, you can also use the `toString()` and `toLocaleString()` method to convert an array to a string. The `toString()` method automatically separates converted array elements with commas. The `toLocaleString()` method formats the returned string according to the conventions of a particular language or country and also automatically separates each converted array element with that locale's separator character. The syntax for the `toString()` method is *`array`*`.toString();` and the syntax for the `toLocaleString()` method is *`array`*`.toLocaleString();`.

Next, you add code to the e-mail form that allows you to update recipient information and to submit the recipient's list as a single string. The code will use `split()` and `join()` methods.

To add code containing `split()` and `join()` methods to the e-mail form:

1. Return to the **email.html** document in your text editor.
2. Add the following `getRecipientInfo()` function to the end of the script section. When you select a recipient in the selection list, this function copies the name and e-mail address to the recipient form fields. Notice that the last three statements use the `split()` method to copy the name and e-mail address into elements of an array named `infoArray`.

```
function getRecipientInfo() {
    var selectedIndex = document.forms[0]
        .recipients.selectedIndex;
    var recipientInfo = document.forms[0].recipients
        .options[selectedIndex].value;
    var infoArray = recipientInfo.split(", ");
    document.forms[0].recipient_name.value
        = infoArray[0];
    document.forms[0].recipient_email.value
        = infoArray[1];
}
```

3. Add the following `updateSelectedRecipient()` function to the end of the script section. This function updates the recipient information in the selection list and is called when the user clicks the Update button.

```
function updateSelectedRecipient() {
    var selectedIndex = document.forms[0]
        .recipients.selectedIndex;
    document.forms[0].recipients
        .options[selectedIndex].value
        = document.forms[0].recipient_name.value
        + ", " + document.forms[0]
        .recipient_email.value;
    document.forms[0].recipients
        .options[selectedIndex].text
        = document.forms[0]
        .recipient_name.value + ", "
        + document.forms[0].recipient_email.value;
}
```

4. Add the following statements to the end of the `validateSubmission()` function. The first statement declares a new array, and the `for` loop assigns the values of the `options[]` array to the new array. The last statement then uses the `join()` method to convert the array values to a string, which is then assigned to a hidden form field named `recipientsList`.

```
var recipientsArray = new Array();
for (var i=0; i<document.forms[0].recipients
    .options.length; ++i) {
    recipientsArray.push(document.forms[0]
        .recipients.options[i].value);
}
document.forms[0].recipientsList.value
= recipientsArray.join(";");
```

5. Add the following `onclick` event handler to the opening `<select>` tag:

```
onclick="getRecipientInfo()"
```

6. Save the **email.html** document, and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and then open it in your Web browser. Enter values in each of the fields and test the update functionality by adding and modifying some recipient e-mail addresses. Click the **Submit** button and you should see the recipient list assigned to the `recipientsList` field.

7. Close your Web browser window and text editor.

Short Quiz 3

1. Explain how to find and extract elements and values in an array.

2. How do you add and remove elements to and from the beginning and end of an array?

3. How do you add and remove elements within an array?

4. Explain how to sort and reverse sort an array.

5. Explain how to convert between strings and arrays.

Summing Up

- When applied to text strings, the term parsing refers to the act of extracting characters or substrings from a larger string.
- All literal strings and string variables in JavaScript are represented by the `String` class, which contains methods for manipulating text strings.
- The `fromCharCode()` method of the `String` class constructs a text string from Unicode character codes that are passed as arguments.
- To change the case of letters in a string, you use the `toLowerCase()` and `toUpperCase()` methods of the `String` class.
- The `String` class contains a single property, the `length` property, which returns the number of characters in a string.
- There are two types of string search methods: methods that return a numeric position in a text string and methods that return a character or substring.
- The `replace()` method of the `String` class creates a new string with all instances of a specified pattern replaced with the value of the text argument.
- The `concat()` method of the JavaScript `String` class creates a new string by combining strings that are passed as arguments.
- The `localeCompare()` method of the `String` class compares strings according to the particular sort order of a language or country.
- Regular expressions are patterns that are used for matching and manipulating strings according to specified rules.
- The `RegExp` object contains methods and properties for working with regular expressions in JavaScript.
- Regular expression patterns consist of literal characters and metacharacters, which are special characters that define the pattern matching rules in a regular expression.
- A pattern that matches the beginning or end of a line is called an anchor.
- Metacharacters that specify the quantity of a match are called quantifiers.
- Characters contained in a set of parentheses within a regular expression are referred to as a subexpression or subpattern.

- You use character classes in regular expressions to treat multiple characters as a single item.
- To allow a string to contain an alternate set of substrings, you separate the strings in a regular expression pattern with the `|` metacharacter.
- You use the methods and `length` property of the `Array` class to manipulate arrays in your scripts.
- To extract elements and values from an array, you use the `slice()` method of the `Array` class to return (copy) a portion of an array and assign it to another array.
- You use the `shift()` and `unshift()` methods of the `Array` class to add or remove elements to and from the beginning of an array.
- You use the `pop()` and `push()` methods of the `Array` class to add and remove elements to and from the end of an array.
- The `splice()` method of the `Array` class adds or removes elements within an array.
- The `sort()` method of the `Array` class alphabetically sorts the elements of an array.
- The `reverse()` method of the `Array` class transposes, or reverses, the order of the elements in an array.
- The `concat()` method of the `Array` class combines arrays.
- The `split()` method of the `String` class splits a string into an indexed array.
- The `join()` method of the `Array` class combines array elements into a string, separated by a comma or specified characters.

Comprehension Check

1. When applied to text strings, the term ________________ refers to the act of extracting characters or substrings from a larger string.
   a. stripping
   b. compiling
   c. rendering
   d. parsing

2. The `toUpperCase()` and `toLowerCase()` methods do not convert the contents of the string to which they are appended. True or false?

3. Which of the following properties returns the number of characters in a string?

   a. `size`

   b. `length`

   c. `chars`

   d. `width`

4. Which of the following functions returns a value of -1 if the character or string is not found? (Choose all that apply.)

   a. `indexOf()`

   b. `lastIndexOf()`

   c. `search()`

   d. `substring()`

5. What is the difference between the `search()` and `indexOf()` methods?

6. Explain why you would specify negative argument values for the `slice()` method.

7. Which of the following is the correct syntax for using the `replace()` method to replace commas with semicolons in a variable named `userQuery`?

   a. `userQuery.replace(",", ";")`

   b. `replace.userQuery(",", ";")`

   c. `userQuery = replace(",", ";")`

   d. `userQuery(",").replace(";")`

8. Which of the following can you use to combine text strings? (Choose all that apply.)

   a. `concat()` method

   b. `join()` method

   c. concatenation operator (+)

   d. compound assignment operator (+=)

9. Because lowercase letters have higher values than uppercase letters, lowercase letters are evaluated as being “greater” than uppercase letters. True or false?

10. Which of the following provides correct syntax for creating a regular expression variable named `ftpProtocol` that contains the text ftp://? (Choose all that apply.)

    a. `var ftpProtocol = new RegExp("ftp://");`

    b. `var ftpProtocol = new RegExp(ftp://);`

    c. `var ftpProtocol = "ftp://";`

    d. `var ftpProtocol = /ftp:\/\//;`

11. Which of the following regular expression metacharacters matches characters at the beginning of a string?

    a. ^

    b. $

    c. ()

    d. []

12. Which of the following regular expression quantifiers specifies that zero or more of the preceding characters can match?

    a. ?

    b. +

    c. *

    d. {n}

13. Explain why you would use subexpressions.

14. Which of the following correctly specifies that case should be ignored when executing the regular expression that is assigned to the `newsStation` variable? (Choose all that apply.)

    a. `var newsStation = new RegExp("CNN");`
       `newsStation.ignoreCase = true;`

    b. `var newsStation = new RegExp("CNN", "i");`

    c. `var newsStation = /CNN/i;`

    d. `var newsStation = /CNN/ & i;`

15. Which of the following functions removes the first element from the beginning of an array?
    a. `shift()`
    b. `unshift()`
    c. `push()`
    d. `pop()`

16. Explain how to use the `splice()` function to add and remove elements to and from an array.

17. Explain how to use the `slice()` function to return a portion of an array and assign it to another array.

18. Explain how to perform a reverse sort of an array's elements.

19. Which of the following is the correct syntax for splitting a string variable that contains stock prices separated by semicolons into an array named `stockPriceArray[]`?
    a. `stockPrices.split(";") = new Array(stockPricesArray);`
    b. `split(stockPrices, stockArray, ";");`
    c. `var stockPriceArray.split(";",stockPrices);`
    d. `var stockPriceArray = stockPrices.split(";");`

20. By default, the `join()` method combines array elements into a string separated by forward slashes. True or false?

Reinforcement Exercises

Exercise 7-1

In this exercise, you create a document that uses `String` class methods and the `length` property.

1. Create a new document in your text editor.
2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and document body. Use the strict DTD and "String Class Examples" as the content of the `<title>` element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following statements containing examples of string operators to the script section. Use your own name and place of birth where indicated.

```
var name;
firstName = "your first name";
lastName = "your last name";
var placeOfBirth;
name = firstName + " ";
name += lastName;
placeOfBirth = "city where you were born";
placeOfBirth += ", state where you were born";
```

5. Add the following statements (which use `String` class methods and the `length` property) to the end of the script section:

```
nameArray = name.split(" ");
document.write("<p>My first name is: "
    + nameArray[0] + "<br />");
document.write("My last name is: " + nameArray[1]
    + "<br />");
document.write("There are " + firstName.length
    + " characters in my first name" + "<br />");
document.write("I was born in " + placeOfBirth
    + "<br />");
document.write("My initials are: "
    + firstName.charAt(0) + lastName.charAt(0)
    + "</p>");
```

6. Save the document as **StringExamples.html** in your Exercises folder for Chapter 7, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and then open it in your Web browser to see how it renders.

7. Close your Web browser window.

Exercise 7-2

You have probably seen Web pages with text that appears to scroll across the status bar or within a text box. Text scrollers are created using the `String` object. Although you may find them useful on your Web pages, use them sparingly, because some visitors find them annoying. In this exercise, you will create scrolling text in the status bar.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Scrolling Text" as the content of the <title> element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following statements to the script section. The first statement assigns a value to the status property of the Window object. The scrollStatusBar() function then uses the substring() method of the String object to modify the order of the characters in the text string.

```
window.status = "Elvis has left the building ... ";
function scrollStatusBar() {
     var message = window.status;
     window.status = message.substring(1)
          + message.substring(0, 1);
}
```

5. Finally, add an onload event handler to the opening <body> tag that uses a setInterval() method to continuously call the scrollStatusBar() function every tenth of a second:

```
<body onload
    ="setInterval('scrollStatusBar()', 100)">
```

6. Save the document as **ScrollingText.html** in your Exercises folder for Chapter 7, and validate it with the W3C Markup Validation Service. Once the ScrollingText.html document is valid, open it in your Web browser. The text should scroll across the status bar.

7. Close your Web browser window.

Exercise 7-3

In this exercise, you will create a script that converts cardinal numbers to ordinal numbers. For example, the program should be able to convert the cardinal number 23 to the ordinal number 23rd.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Ordinal Numbers" as the content of the <title> element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following text and elements to the document body. The first text box is where you will input a cardinal number, and the second text box will display the associated ordinal number. The button control calls a function named `convertOrdinal()`, which performs the conversion.

```
<h1>
    Ordinal Number</h1>
<hr />
<form action="">
<p>
    Cardinal number:
    <input type="text" name="cardinalNumber"
        value="0" />
    <br />
    Ordinal number:
    <input type="text" name="ordinalNumber"
        value="0" />
</p>
<p>
    <input type="button" value="Convert"
        onclick="convertOrdinal()" />
</p>
</form>
```

5. Add the following `convertOrdinal()` function to the script section. These statements in the function convert the cardinal number to an ordinal. The first `if` statement checks whether the number contains more than two digits. If it does, the first statement uses the `substring()` function and `length` property to retrieve just the last two digits in the variable. The nested `if` determines the ordinal form for just the numbers 11 through 13 because numbers that end with these values use "th" in their ordinal form. The `else` clause then determines the ordinal form for all other numbers. The last

`else...if` clause determines the ordinal form for the numbers 1 through 9.

```
function convertOrdinal() {
    var lastCharacters = 0;
    var cardinalNum = document.forms[0]
        .cardinalNumber.value;
    if (cardinalNum.length > 1) {
        lastCharacters = cardinalNum.substring(
            cardinalNum.length - 2);
        if (lastCharacters > 10 &&
            lastCharacters < 14)
            document.forms[0].ordinalNumber.value
                = cardinalNum + "th";
        else {
            lastCharacters = cardinalNum.substring(
                cardinalNum.length - 1);
            if (lastCharacters == 1)
                document.forms[0]
                    .ordinalNumber.value
                    = cardinalNum + "st";
            else if (lastCharacters == 2)
                document.forms[0]
                    .ordinalNumber.value
                    = cardinalNum + "nd";
            else if (lastCharacters == 3)
                document.forms[0]
                    .ordinalNumber.value
                    = cardinalNum + "rd";
            else
                document.forms[0]
                    .ordinalNumber.value
                    = cardinalNum + "th";
        }
    }
    else if (cardinalNum.length == 1) {
        if (cardinalNum == 1)
            document.forms[0].ordinalNumber.value
                = cardinalNum + "st";
        else if (cardinalNum == 2)
            document.forms[0].ordinalNumber.value
                = cardinalNum + "nd";
        else if (cardinalNum == 3)
            document.forms[0].ordinalNumber.value
                = cardinalNum + "rd";
        else
            document.forms[0].ordinalNumber.value
                = cardinalNum + "th";
    }
}
```

6. Save the document as **OrdinalNumbers.html** in your Exercises folder for Chapter 7, and validate it with the W3C Markup Validation Service. Once the OrdinalNumbers.html document is valid, open it in your Web browser. Test the form to see if the correct ordinal number prints.

7. Close your Web browser window.

Exercise 7-4

In this exercise, you will create a script that uses regular expressions to validate credit card numbers. Major credit card numbers must be in the following formats:

- **American Express**—Numbers start with 34 or 37 and consist of 15 digits.
- **Diners Club**—Numbers begin with 300 through 305, or 36 and 38 and consist of 14 digits.
- **Discover**—Numbers begin with 6011 or 65 and consist of 16 digits.
- **JCB**—Numbers beginning with 2131 or 1800 consist of 15 digits, while numbers beginning with 35 consist of 16 digits.
- **MasterCard**—Numbers start with the numbers 51 through 55 and consist of 16 digits.
- **Visa**—Numbers start with a 4; new cards consist of 16 digits and old cards consist of 13 digits.

The regular expressions that are used in this exercise are from *http://www.regular-expressions.info/regexbuddy.html.*

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Validate Credit Cards" as the content of the <title> element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following text and elements to the document body. The selection list control contains the names of the credit cards and the first text box control receives the credit card

numbers. The Validate button submits the Web form and the last text box displays a message indicating whether the credit card number is valid.

```
<form action="">
<h1>
    Validate Credit Cards</h1>
<p>
    Credit card:
    <select name="cardName">
        <option>American Express</option>
        <option>Diners Club</option>
        <option>Discover</option>
        <option>JCB</option>
        <option>Mastercard</option>
        <option>Visa</option>
    </select>
    <br />
    Number:
    <input type="text" name="cardNumber" />
</p>
<p>
    <input type="button" value="Validate"
        onclick="validateCard()" />
</p>
<p>
    <input type="text" name="ccResult" size="50" />
</p>
</form>
```

5. Add the following function, which validates the number for each credit card type:

```
function validateCard() {
    if (document.forms[0].cardName.value
        == "American Express") {
        var cardProtocol = new RegExp(
            "^3[47][0-9]{13}$");
        if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
    else if (document.forms[0].cardName.value
        == "Diners Club") {
        var cardProtocol = new RegExp(
            "^3(?:0[0-5]|[68][0-9])[0-9]{11}$");
        if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
```

```
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
    else if (document.forms[0].cardName
        .value == "Discover") {
        var cardProtocol = new RegExp(
            "^6(?:011|5[0-9]{2})[0-9]{12}$");
        if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
    else if (document.forms[0].cardName.value
        == "JCB") {
        var cardProtocol = new RegExp(
            "^(?:2131|1800|35\d{3})\d{11}$");
            if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
    else if (document.forms[0].cardName.value
        == "Mastercard") {
        var cardProtocol = new RegExp(
            "^5[1-5][0-9]{14}$");
        if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
    else if (document.forms[0].cardName.value
        == "Visa") {
        var cardProtocol = new RegExp(
            "^4[0-9]{12}(?:[0-9]{3})?$");
        if (cardProtocol.test(document.forms[0]
            .cardNumber.value))
            document.forms[0].ccResult.value
                = "Valid credit card number";
        else
            document.forms[0].ccResult.value
                = "Invalid credit card number";
    }
}
```

6. Save the document as **ValidateCreditCards.html** in your Exercises folder for Chapter 7, and validate it with the W3C Markup Validation Service. Once the document is valid, open it in your Web browser and test the form to see if it correctly validates credit card numbers.

7. Close your Web browser window.

Exercise 7-5

In this exercise, you create a To Do list using arrays. This exercise is not practical for use on a live Web page because it does not store the information you enter into a database; the data you enter will disappear after you refresh or leave the Web page. However, creating the To Do list is useful for learning how to work with arrays in JavaScript.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and "To Do List" as the content of the <title> element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following heading level element and form to the document body. The Add Task and Delete Selected Task buttons include `onclick` event handlers that call functions, which you will add in the next step.

```
<h1>To Do List</h1>
<form action="">
<p>New Task <input type="text" size="68"
name="newtask" />
</p><p><input type="button" value="Add Task"
onclick="addTask()"
style="width: 150px" />
<input type="button" value="Delete Selected Task"
onclick="deleteTask()" style="width: 150px" /><br />
<input type="button" value="Ascending Sort"
    onclick="ascendingSort()"
    style="width: 150px" /></p>
<p><select name="tasks" size="10" style="width: 500px">
<option value="tasks">Tasks</option></select></p>
</form>
```

5. Add to the script section the following `addTask()` function, which adds a new task to the selection list. The `if` statement first checks to ensure that the user has entered a value into the New Task field. If the field does not contain a value, then a `window.alert()` dialog box appears and informs the user that he/she must enter a value in the field. If the field does contain a value, then an `else` statement executes. The `else` statement first checks to see if the default option of "Tasks" is present as the first element in the `options[]` array. If so, it is deleted. Then, the `addTask()` function uses the `Option` object to add a new task.

```
function addTask() {
     if (document.forms[0].newtask.value == "")
          window.alert("You must enter a value ↵
               in the New Task field.");
     else {
          if (document.forms[0].tasks
               .options[0].value == "tasks")
               document.forms[0].tasks.options[0]
                    = null;
          var newTask = new Option();
          newTask.value = document.forms[0]
               .newtask.value;
          newTask.text = document.forms[0]
               .newtask.value;
          var numTasks = document.forms[0].tasks
              .options.length;
          document.forms[0].tasks.options[numTasks]
               = newTask;
          document.forms[0].newtask.value = "";
     }
}
```

6. Add the following `deleteTask()` function, which deletes a task from the selection list. The function uses a `while` statement to loop through each option in the selection list to determine which option is selected. Once the selected option is located, it is deleted from the `options[]` array.

```
function deleteTask() {
    var selectedTask = 0;
    var taskSelected = false;
    while (selectedTask < document.forms[0]
        .tasks.length) {
        if (document.forms[0].tasks
            .options[selectedTask].selected
            == true) {
            taskSelected = true;
            break;
            }
           ++selectedTask;
    }
```

```
          if (taskSelected == true)
              document.forms[0].tasks
                  .options[selectedTask] = null;
          else
              window.alert("You must select a task in ↵
                  the list.");
      }
```

7. To the end of the script section, add the following function, which sorts the tasks in the task list in ascending order. One problem with a form's `options[]` array is that you cannot use any of the array methods that are available to other types of arrays. Therefore, the following function creates a new array named `newTasks[]` and copies to it the values from each of the elements in the `options[]` array. The `sort()` method is then executed on the new array. Finally, the values from each of the elements in the `newTasks[]` array are copied back into the `options[]` array.

```
function ascendingSort() {
    var newTasks = new Array();
    for (var i =0; i < document.forms[0].tasks
        .length; ++i) {
        newTasks[i] = document.forms[0].tasks
            .options[i].value;
    }
    newTasks.sort();
    for (var j =0; j < document.forms[0].tasks
        .length; ++j) {
        document.forms[0].tasks.options[j].value
           = newTasks[j];
        document.forms[0].tasks.options[j].text
            = newTasks[j];
     }
}
```

8. Save the document as **ToDoList.html** in your Exercises folder for Chapter 7, and validate it with the W3C Markup Validation Service. Once the ToDoList.html document is valid, open it in your Web browser and test the functionality.

9. Close your Web browser window.

Exercise 7-6

In this exercise, you add code to the To Do List Web page that performs a reverse sort of the To Do list items.

1. Return to the **ToDoList.html** document in your text editor.

2. Add the following function to the end of the script section to perform a reverse sort on the To Do list:

```
function descendingSort() {
    var newTasks = new Array();
    for (var i =0; i < document.forms[0].tasks
       .length; ++i) {
        newTasks[i] = document.forms[0].tasks
            .options[i].value;
    }
    newTasks.sort();
    newTasks.reverse();
    for (var j =0; j < document.forms[0]
        .tasks.length; ++j) {
    document.forms[0].tasks.options[j].value
        = newTasks[j];
    document.forms[0].tasks.options[j].text
        = newTasks[j];
    }
}
```

3. Modify the form so it includes a Descending Sort button, which calls the `descendingSort()` function, as follows:

```
...
<input type="button" value="Ascending Sort"
onclick="ascendingSort()" style="width: 150px" />
<input type="button" value="Descending Sort"
onclick="descendingSort()" style="width: 150px" />
</p>
<p><select name="tasks" size="10"
style="width: 500px">
...
```

4. Save the **ToDoList.html** document, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and then open it in your Web browser and test the code.

5. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 7. Be sure to validate each Web page with the W3C Markup Validation Service.

Project 7-1

Create a script that presents a word-guessing game. Allow users to guess the word one letter at a time by entering a character in a form.

Start by assigning a secret word to a variable. After each guess, print the word using asterisks for each remaining letter, but fill in the letters that the user guessed correctly. Store the user's guess in a form field. For example, if the word you want users to guess is "suspicious" and the user has successfully guessed the letters "s" and "i," then store s*s*i*i**s in the form field. You need to use multiple arrays along with the `split()` and `join()` methods to create the game's functionality. Clear the guessed character from the form each time it is submitted, and add functionality that displays an alert dialog box if the user fails to enter a character. Save the document as **GuessingGame.html**.

Project 7-2

A palindrome is a word or phrase that is identical forward or backward, such as the word "racecar." A standard palindrome is similar to a perfect palindrome except that spaces and punctuation are ignored. For example, "Madam, I'm Adam" is a standard palindrome because the characters are identical forward or backward, provided that you remove the spaces and punctuation marks. Write a script that checks whether a word or phrase entered by a user is a palindrome. Use a form where the user can enter the word or phrase, and include one button that checks if the word or phrase is a perfect palindrome and another button that checks if the word or phrase is a standard palindrome. Both buttons should display an alert dialog box that states whether the phrase is a perfect or standard palindrome. For both types of palindromes, you need to use the `reverse()` method of the `Array` class. For the standard palindrome, use a regular expression to determine whether each character is an alphanumeric character; if not, then you need to remove the nonalphanumeric character (or space) before you can determine if the word or phrase is a standard palindrome. Save the document as **Palindromes.html**.

Project 7-3

Although the `String` object includes the `toUpperCase()` and `toLowerCase()` methods for converting strings to upper- or lowercase letters, it does not include a method for converting text to title case capitalization (Text That Appears Like This). Create a script that takes text that a user enters into a form field and converts it to title case capitalization. To accomplish this, use the `split()` method to split the words in the string into an indexed array. Then, create a `for` loop that uses another `split()` method that splits each word in the elements of the indexed array into another indexed array of characters. Within the `for` loop, use the `toUpperCase()` method to convert the first element in the second array (which represents the first character in the word to uppercase) to uppercase, and then use the `join()` method to rebuild the array of words in the text string. Execute a final `join()` method to convert the array of words back into a single text string. Call the JavaScript code that converts the text to title case by clicking a command button. Save the script as **TitleCase.html**.

Project 7-4

Create a Web page that contains a text box in which users can enter a date. Also include a button that executes the `test()` method to validate the date against a regular expression. Write a regular expression pattern that allows users to enter a one- or two-digit month, one- or two-digit date, and two- or four-digit year. Also, allow users to separate the month, date, and year by using either dashes or forward slashes. Users should be able to enter any of the following date formats: 11-2-07, 1-25-2007, or 01/25/2007. Save the script as **DateValidation.html**.

CHAPTER 8

Debugging and Error Handling

In this chapter, you will:

- Study debugging concepts, including error types
- Learn how to trace error messages
- Use comments to locate bugs
- Trace errors with debugging tools
- Study exception and error handling
- Study additional debugging techniques

The more JavaScript programs you write, the more likely you are to write programs that generate error messages. At times it may seem like your programs never function quite the way you want. Regardless of experience, knowledge, and ability, all programmers incorporate errors in their programs at one time or another. Thus, all programmers must devote part of their programming education to mastering the art of debugging. As you learned at the start of this book, debugging is the process of tracing and resolving errors in a program. Debugging is an essential skill for any programmer, regardless of the programming language.

In this chapter, you will learn techniques and tools that you can use to trace and resolve errors in JavaScript programs. However, you will not create any new programs. Instead, you will learn how to use JavaScript debugging techniques to locate errors in an existing program named Move Estimator. The Move Estimator program is designed to be used by a shipping company to calculate the costs of moving a household from one location to another, based on distance, weight, and several other factors. The program is fairly simple and uses functions to calculate the various types of moving costs, along with a function named `calcTotalEstimate()` that totals the estimate. Before you proceed with this chapter, try out the completed version of the program, named MoveEstimatorNoBugs.html, in the Chapter folder for Chapter 8. It includes six text boxes. Each time a user enters a value into one of the text boxes, an `onchange` event handler calls a function that calculates the item's cost. Each function then calls a function named `calcTotalEstimate()`, which calculates the total cost and places it in the Moving Estimate text box. Figure 8-1 shows an example of the program running in a Web browser after some information has been entered.

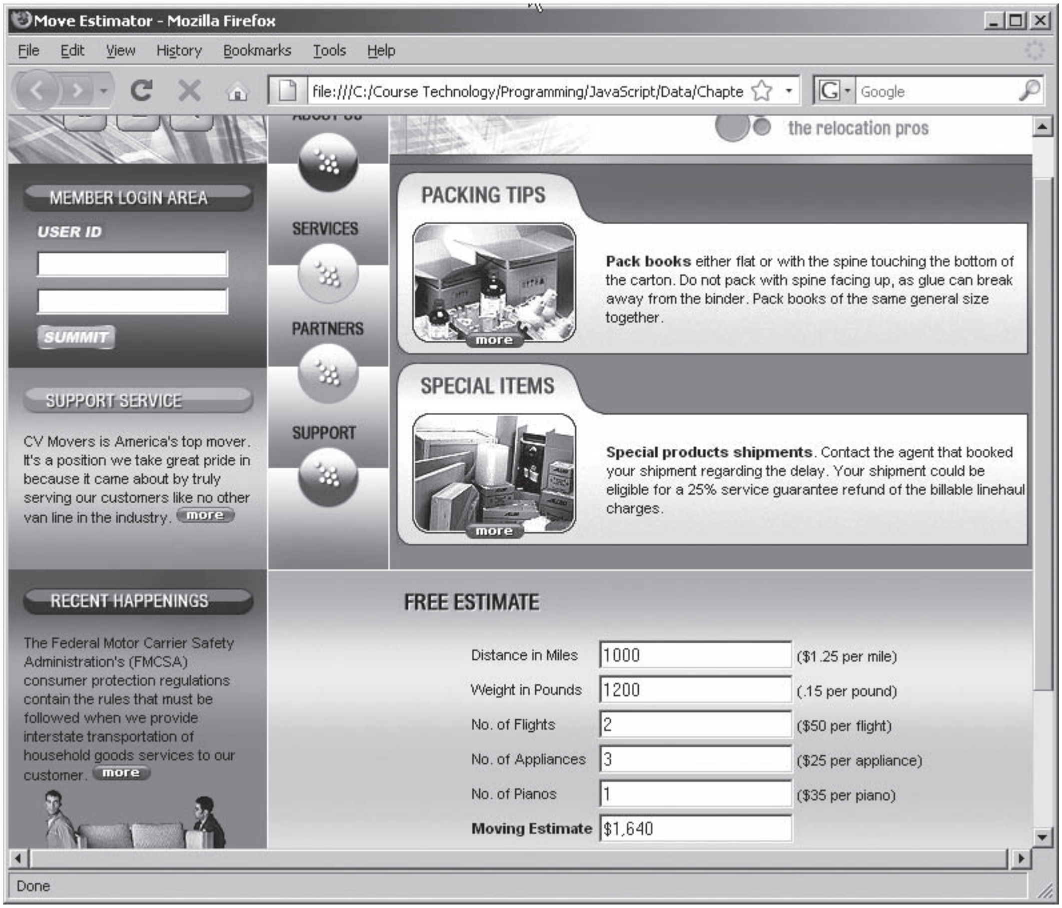


Figure 8-1 Move Estimator program

Note that you will not be working with the MoveEstimatorNoBugs.html document in this chapter. Rather, you will work with a version, MoveEstimatorWithBugs.html, that contains bugs. You need to use the "buggy" version in order to learn the debugging techniques presented in this chapter. If you get stuck, you can use the no-bugs version as a reference. However, remember that the goal of this chapter is to learn how to debug programs. If you give up and refer to the no-bugs version of the Move Estimator program, then you are defeating the purpose of this chapter.

Introduction to Debugging

All programming languages, including JavaScript, have their own **syntax**, or rules. To write a program, you must understand the syntax of the programming language you are using. You must also understand computer-programming logic. The term **logic** refers to the order in which various parts of a program run, or execute. The statements in a program must execute in the correct order to produce the desired results. In an analogous situation, although you know how to drive a car well, you may not reach your destination if you do not follow the correct route. Similarly, you might be able to write statements using the correct syntax but be unable to construct an entire, logically executed program, that works the way you want. A typical logical error might be multiplying two values when you meant to divide them. Another might be producing output before obtaining the appropriate input (for example, printing an order confirmation on the screen before asking the user to enter the necessary order information).

Do not confuse bugs with computer viruses. Bugs are problems within a program that occur because of syntax errors, design flaws, or run-time errors. Viruses are self-contained programs designed to "infect" a computer system and cause mischievous or malicious damage. Virus programs themselves can contain bugs if they contain syntax errors or do not perform as their creators envisioned.

Any error in a program that causes it to function incorrectly, whether because of incorrect syntax or flaws in logic, is called a **bug**. The term **debugging** refers to the act of tracing and resolving errors in a program. Grace Murray Hopper, a mathematician who was instrumental in developing the Common Business-Oriented Language (COBOL) programming language, is said to have first coined the term "debugging." As the story from the 1940s goes, a moth short-circuited a primitive computer that Hopper was using. Removing the moth from the computer "debugged" the system and resolved the problem. Today, the term bug refers to any sort of problem in the design and operation of a program.

Three types of errors can occur in a program: syntax errors, run-time errors, and logic errors. First, you will learn about syntax errors.

As you work through this book, keep in mind that debugging is not an exact science. Every program you write is different and requires different methods of debugging. While there are some tools available to help you debug your JavaScript code, your own logical and analytical skills are the best debugging resources you have.

Understanding Syntax Errors

Syntax errors occur when the interpreter fails to recognize code. In JavaScript, statements that are not recognized by a browser's scripting engine generate syntax errors. (Recall from Chapter 1 that a scripting engine is just one kind of interpreter, with the term "interpreter" referring generally to any program that executes scripting language code.) Syntax errors can be caused by incorrect use of JavaScript code or references to objects, methods, and variables that do not exist. For example, if a programmer attempts to use a method that does not exist or omits a method's closing parenthesis, the scripting engine generates a syntax error. Many syntax errors are

Syntax errors in compiled languages, such as C++, are also called compile-time errors, because they are usually discovered when a program is compiled. Because JavaScript is an interpreted language, syntax errors are not discovered until a program executes.

generated by incorrectly spelled or mistyped words. For example, the statement `writln("Hello World");` causes a syntax error because the `writeln()` method is misspelled as *`writln()`*. Similarly, the statement `Document.writeln("Hello World");` causes a syntax error because the `Document` object is incorrectly typed with an uppercase *D*. (Remember that most JavaScript objects, such as the `Document` object, should be all lowercase letters.)

Handling Run-Time Errors

The second type of error, a **run-time error**, occurs when the JavaScript interpreter encounters a problem while a program is executing. Run-time errors differ from syntax errors in that they do not necessarily represent JavaScript language errors. Instead, run-time errors occur when the interpreter encounters code that it cannot execute. For example, consider the statement `customFunction();`, which calls a custom JavaScript function. This statement does not generate a syntax error, because it is legal (and usually necessary) to create and then call custom functions in a JavaScript program. However, if your program includes the call statement but does not include code that creates the function in the first place, your program generates a run-time error. The error occurs when the interpreter attempts to call the function and is unable to find it.

The following shows another example of a run-time error. In this example, a `writeln()` method attempts to print the contents of a variable named `messageVar`. Because the `messageVar` variable is not declared (you can assume it has not been declared in another script section elsewhere in the document), a run-time error occurs.

```
document.writeln(messageVar);
```

Another point to remember is that a run-time error can be caused by a syntax error, because a syntax error does not occur until the interpreter attempts to execute the code. For example, you may have a function that contains a statement with a syntax error. However, the syntax error will not be caught until the function executes at run time. When the function does execute, it generates a run-time error because of the syntax error within the function.

Identifying Logic Errors

The third type of error, **logic errors**, are flaws in a program's design that prevent the program from running as you anticipate. In this context, the term "logic" refers to the execution of program statements and procedures in the correct order to produce the desired results. You're already accustomed to performing ordinary, nonprogramming tasks according to a certain logic. For example, when you do the laundry, you normally wash, dry, iron, then fold your clothes. If you decided to iron, fold, dry, and then wash the clothes, you would end up with a pile of wet laundry rather than the clean and pressed garments you desired. The problem, in that case, would be a type of logic error—you performed the steps in the wrong order.

One example of a logic error in a computer program is multiplying two values when you mean to divide them, as in the following code:

```
var divisionResult = 10 * 2;
document.write("Ten divided by two is equal to "
     + divisionResult);
```

Another example of a logic error is the creation of an infinite loop, in which a loop statement never ends because its conditional expression is never updated or is never false. The following code creates a `for` statement that results in the logic error of an infinite loop. The cause of the infinite loop is that the third argument in the `for` statement's parentheses never changes the value of the count variable.

```
for (var count = 10; count >= 0; count) {
     window.alert("We have liftoff in " + count);
}
```

Because the count variable is never updated in the preceding example, it continues to have a value of 10 through each iteration of the loop, resulting in the repeated display of an alert dialog box containing the text "We have liftoff in 10". To correct this logic error, you add a decrement operator to the third argument in the `for` statement's constructor, as follows:

```
for (var count = 10; count >= 0; --count) {
     window.alert("We have liftoff in " + count);
}
```

Interpreting Error Messages

The first line of defense in locating bugs in JavaScript programs are the error messages you receive when the JavaScript interpreter encounters a syntax or run-time error. Two important pieces of information displayed in error message dialog boxes are the line number in the document where the error occurred and a description of the error. Note that the line number in an error message is counted from the start of the document, not just from the start of a script section. Also, different Web browsers will report different line numbers for error messages. For example, Firefox usually reports the line number where the error occurred, whereas Internet Explorer usually reports the line number after the line where the error occurred. All error messages generated by a Web browser are run-time errors. However, keep in mind that run-time errors can be caused by syntax errors. Logic errors do not generate error messages because they do not prevent the script from running (as syntax errors do) or from executing properly (as run-time errors do). Instead, they prevent the program from running the way you anticipated. Computers are not smart enough (yet) to identify a flaw in a program's logic. For example, if you create an infinite loop with a `for` statement, the interpreter has no way of telling whether you really wanted to continually execute the `for` statement's code. Later in this chapter, you will learn how to trace the flow of your program's execution in order to locate logic errors.

Consider the following function, which causes a syntax error because it is missing the closing brace (}). Figure 8-2 shows the error message in Firefox Error Console. Figure 8-3 shows the error message in Internet Explorer.

```
function missingClosingBrace() {
    var message = "This function is missing ↵
        a closing brace.";
    window.alert(message);
```

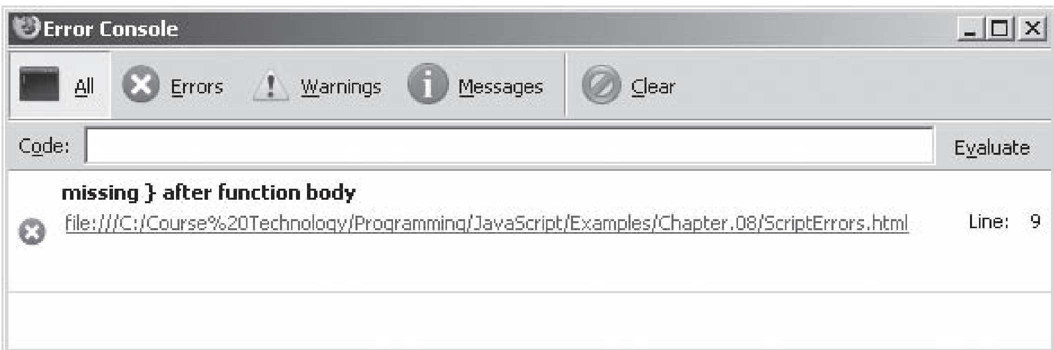


Figure 8-2 Firefox error message

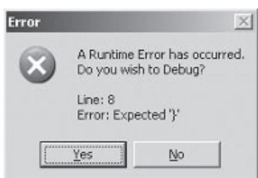


Figure 8-3 Internet Explorer error message

To view errors in Firefox Web browsers, you need to select Error Console from the Tools menu in Firefox 2.0 or later, or the JavaScript Console in Firefox versions earlier than 2.0. If you are using a version of Internet Explorer higher than 4.0, you need to turn on error notification. To verify that error notification is turned on in Internet Explorer, click Tools on the menu bar, click Internet Options, click the Advanced tab, in the Browsing category click the Display a notification about every script error check box to select it (if necessary), and then click OK. Other Web browsers may also require you to turn on error notification.

Remember that different Web browsers will report different line numbers for error messages. You should only rely on the error number to identify the approximate location of the error in your script.

Regardless of which browser you use, you can rely on error messages only to find the general location of an error in a program and not as the exact indicator of an error. You cannot always assume that the line specified by an error message is the actual problem in your program. For example, the `var result = amount * percentage;` statement in the following code causes a run-time error because the interpreter cannot locate the `amount` and `percentage` variables included in the statement. The `amount` and `percentage` variables are declared within the `variableDeclarations()` function, making them local variables, which are only available inside the function. Because the `amount` and `percentage` variables are not global variables, they are not visible to the `calculatePercentage()` function, which causes a run-time error. The `var result = amount * percentage;` statement generates the run-time error because it attempts to access variables that are local to another function. However, the real problem is that the percentage and amount variables are not declared at a global level.

```
function variableDeclarations() {
    var percentage = .25;
    var amount = 1600;
}
function calculatePercentage() {
    var result = amount * percentage;
    document.write("<p>Twenty-five percent of "
        + amount + " is ");
    document.write(result + "</p>");
}
```

When debugging JavaScript, it is important that you understand how a browser interprets a Web page and JavaScript code. A common complaint among professional programmers is that Web browsers do not strictly enforce JavaScript syntax. For example, browsers can interpret JavaScript statements that do not end in a semicolon. In contrast, in high-level languages such as C++ and Java, you *must* end a statement with a semicolon or you receive an error.

You can compare the way Web browsers render XHTML and interpret JavaScript to the way human beings comprehend language. Someone can speak to you using bad grammar or with a strong regional or foreign accent. Yet, provided the other person is speaking to you in the same root language, you can usually understand what he or she is saying. The same applies to a Web browser and JavaScript: Even if you write sloppy JavaScript code, the Web browser can often (but not always) figure out what the code is supposed to do. This means that a Web browser can run JavaScript code and render XHTML, even though your program contains bugs.

This lack of common bug enforcement makes writing and debugging programs more difficult. What can you do to mitigate bugs in your JavaScript programs? First, always use good syntax, such as ending statements with semicolons and declaring variables with `var` keywords. The more disciplined you are in your programming technique, the fewer bugs you will find in your programs. Second, be sure to thoroughly test your JavaScript programs with every browser type and version on which you anticipate your program will run. At the time of this writing, Firefox has the majority share of the browser market (approximately 47%), although at one time Internet Explorer controlled almost 95% of the market. Because browser loyalties continually shift, you need to write your JavaScript code so that it is compatible with as many Web browsers as possible. One rule of thumb is that if a browser is used by more than 1 percent of the market, then you need to write and debug your JavaScript programs for that browser.

You can find a great deal of information on the popularity of the various browsers by searching for "browser statistics" in a search engine.

Next, you will use error messages to help locate bugs in the Move Estimator program. The error messages shown in this exercise are generated with Firefox 2.0 and Internet Explorer 7. If you use a different Web browser or version, the error messages and dialog boxes you see will differ.

To use error messages to help locate bugs in the Move Estimator program:

1. Open in your Web browser the **MoveEstimatorWithBugs.html** document located in your Chapter folder for Chapter 8. If you are using Firefox, select **Error Console** from the **Tools** menu to display the Error Console, as shown in Figure 8-4. If you are using Internet Explorer, a confirmation dialog box, shown in Figure 8-5, displays and asks you if you want to debug the script. Click the **No** button to close the dialog box.

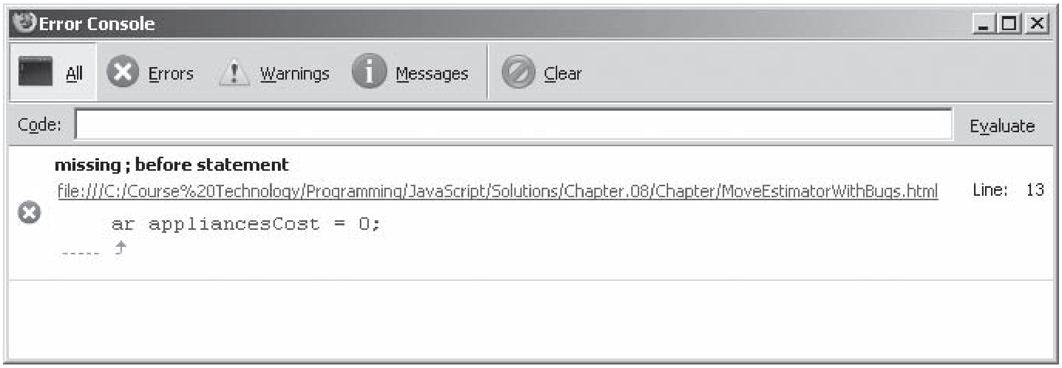


Figure 8-4 First run-time error message in Firefox Error Console

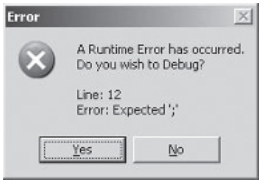


Figure 8-5 First run-time error message in Internet Explorer

2. Leave the MoveEstimatorWithBugs.html document open in your Web browser, but also open the document in your text editor. As shown in Figures 8-4 and 8-5, the error is located on line 13 in Firefox and line 12 in Internet Explorer. The statement referred to in the figures declares the `appliancesCost` variable; this statement is missing the letter *v* in the `var` keyword.

3. Add the missing *v* so that the statement reads as follows:

```
var appliancesCost = 0;
```

4. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page. If you are using Firefox, the Error Console should display the error message shown in Figure 8-6. If you are using Internet Explorer, the dialog box shown in Figure 8-7 should appear; click the **No** button to close the dialog box.

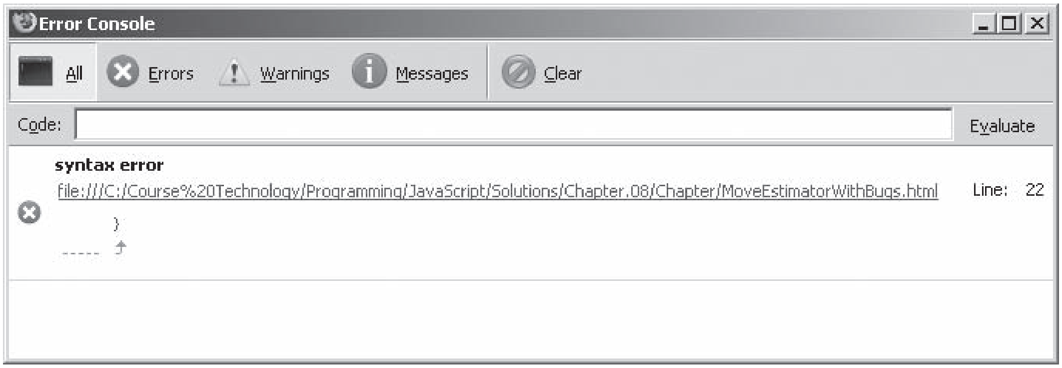


Figure 8-6 Second run-time error message in Firefox Error Console

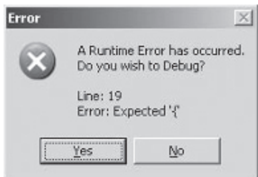


Figure 8-7 Second run-time error message in Internet Explorer

5. Return to the **MoveEstimatorWithBugs.html** document in your text editor and locate line 20, which contains this statement: `laborCost = pounds * .15;`. In this instance, the Web browser expected to find an opening ({) character before the `laborCost = pounds * .15;` statement. The problem is that the `calcLaborCost()` function is missing its opening ({) character, which should come before the `laborCost = pounds * .15;` statement. Add the missing ({) character so that the function looks like the following:

```
function calcLaborCost(pounds) {
     laborCost = pounds * .15;
     calcTotalEstimate();
}
```

6. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page. Another run-time error is displayed, this time on line 25 in Firefox and line 24 in Internet Explorer. If you are using Internet Explorer, click the **No** button to close the dialog box.

7. Return to the **MoveEstimatorWithBugs.html** document in your text editor and locate line 25. The problem is that the statement is missing an assignment operator. Add an

assignment operator to the statement so that it appears as follows:

```
flightsCost = flights * 50;
```

8. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page. Another run-time error occurs, this time on line 34 in Firefox and line 33 in Internet Explorer. If you are using Internet Explorer, click the **No** button to close the dialog box.
9. Return to the **MoveEstimatorWithBugs.html** document in your text editor and locate line 34, which is a statement in the `calcPianosCost()` function that calls the `calcTotalEstimate()` function. Notice that the function is missing its closing parenthesis. Add the missing parenthesis so that the statement appears as follows:

```
calcTotalEstimate();
```

10. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page a final time. You should receive no more error messages. However, do not try to use the program yet because it still contains plenty of bugs. Leave the document open in your Web browser.

Short Quiz 1

1. What is debugging and where does the term come from?
2. What is the difference between syntax errors, run-time errors, and logic errors?
3. How can you use error messages to help debug your programs?

Using Basic Debugging Techniques

Both Firefox and Internet Explorer include advanced features for debugging code. Before using these advanced features (which are covered later in this chapter), you need to understand how to use basic debugging techniques. Before studying basic debugging techniques, you should understand that the best weapon against bugs is writing good code.

Writing Good Code

The more disciplined you are in your programming technique, the fewer bugs you will find in your programs. Although error and warning messages will help you catch basic syntax errors, some syntax errors are still difficult to pinpoint. For example, if you have a deeply nested set of control structures and one of the control structures is missing a closing brace, the syntax error may not be able to tell you exactly which control structure is malformed.

Tracing Errors with the `window.alert()` Method

If you are unable to locate a bug in your program by using error messages, or if you suspect a logic error (which does not generate error messages), then you must trace your code. **Tracing** is the examination of individual statements in an executing program. The `window.alert()` method provides one of the most useful ways to trace JavaScript code. You place a `window.alert()` method at different points in your program and use it to display the contents of a variable, an array, or the value returned from a function. Using this technique, you can monitor values as they change during program execution.

For example, examine the following function, which calculates weekly net pay, rounded to the nearest integer. The program is syntactically correct and does not generate an error message. However, the function is not returning the correct result, which should be 485. Instead, the function is returning a value of 5169107.

```
function calculatePay() {
    var payRate = 15; numHours = 40;
    var grossPay = payRate * numHours;
    var federalTaxes = grossPay * .06794;
    var stateTaxes = grossPay * .0476;
    var socialSecurity = grossPay * .062;
    var medicare = grossPay * .0145;
    var netPay = grossPay - federalTaxes;
    netPay *= stateTaxes;
    netPay *= socialSecurity;
    netPay *= medicare;
    return Math.round(netPay);
}
```

To trace the problem, you can place a `window.alert()` method at the point in the program where you think the error may be located. For example, the first thing you may want to check in the `calculatePay()` function is whether the `grossPay` variable is being calculated correctly. To check whether the program calculates grossPay correctly, place a window.alert() method in the function following the calculation of the grossPay variable as follows:

```
function calculatePay() {
    var payRate = 15; numHours = 40;
    var grossPay = payRate * numHours;
window.alert(grossPay);
    var federalTaxes = grossPay * .06794;
    var stateTaxes = grossPay * .0476;
    var socialSecurity = grossPay * .062;
    var medicare = grossPay * .0145;
    var netPay = grossPay - federalTaxes;
    netPay *= stateTaxes;
    netPay *= socialSecurity;
    netPay *= medicare;
    return Math.round(netPay);
}
```

It is helpful to place any `window.alert()` methods you use to trace program execution at a different level of indentation to clearly distinguish them from the actual program.

Because the grossPay variable contained the correct value (600), you would move the window.alert() method to check the value of the netPay variable. You then continue with this technique until you discover the error. If you did, you would discover that the calculatePay() function does not perform properly because the lines that should subtract the stateTaxes, socialSecurity, and medicare variables from the netPay variable are incorrect; they use the multiplication assignment operator (*=) instead of the subtraction assignment operator (-=).

Instead of using the `window.alert()` method, you can write information to the status bar, using the `status` property of the `Window` object.

An alternative to using a single window.alert() method is to place multiple window.alert() methods throughout your code to check values as the code executes. For example, you could trace the calculatePay() function by using multiple window.alert() methods, as follows:

```
function calculatePay() {
    var payRate = 15; numHours = 40;
    var grossPay = payRate * numHours;
window.alert(grossPay);
    var federalTaxes = grossPay * .06794;
    var stateTaxes = grossPay * .0476;
    var socialSecurity = grossPay * .062;
    var medicare = grossPay * .0145;
    var netPay = grossPay - federalTaxes;
window.alert(netPay);
    netPay *= stateTaxes;
window.alert(netPay);
    netPay *= socialSecurity;
window.alert(netPay);
    netPay *= medicare;
window.alert(netPay);
    return Math.round(netPay);
}
```

One drawback to using multiple `window.alert()` methods to trace values is that you must close each dialog box for your code to continue executing. However, using multiple `window.alert()` methods is sometimes more efficient than moving a single `window.alert()` method. The key to using multiple `window.alert()` methods to trace program values is using them selectively at key points throughout a program. For example, suppose that you were debugging a large accounting program with multiple functions. You could place a `window.alert()` method at key positions within the program, such as wherever a function returns a value or a variable is assigned new data. In this way, you could get the general sense of what portion of the program contains the bug. Once you discover the approximate location of the bug, for instance in a particular function, you can then concentrate your debugging efforts on that one function.

Next, you will use alert dialog boxes to locate a bug in the Move Estimator program.

To use alert dialog boxes to locate a bug in the Move Estimator program:

1. Return to the **MoveEstimatorWithBugs.html** document in your Web browser.
2. Click the **No. of Appliances** text box, type **3**, and press the **Tab** key. Each of the text boxes in the form uses `onchange` event handlers to call a function, which updates the value of the associated item. Each item's function then calls the `calcTotalEstimate()` function, which should update the Moving Estimate text box. The `onchange` event handler for the No. of Appliances text box calls the `calcAppliancesCost()` function. The value in the Moving Estimate text box should have changed to $75. Instead, it changes to $0.

Do not enter values into any of the other text boxes—the program still contains many bugs.

3. To trace the problem, return to the **MoveEstimatorWithBugs.html** document in your text editor and locate the `calcAppliancesCost()` function. Add two `window.alert()` functions to the `calcAppliancesCost()` function, as follows. The first `window.alert()` function checks to see if the value from the text box that is passed to the function's `appliances` parameter is correct. The second `window.alert()` function checks to see if the calculation that totals the cost of moving the appliances assigns the correct value to the `appliancesCost` variable.

```
function calcAppliancesCost(appliances) {
window.alert(appliances);
    appliancesCost - appliances * 25;
window.alert(appliancesCost);
    calcTotalEstimate();
}
```


4. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page.
5. Click the **No. of Appliances** text box, type **3**, and press the **Tab** key. The first alert dialog box appears and correctly displays 3, which is the number you typed into the text box.
6. Click the **OK** button. The second alert dialog box appears and displays a value of 0 instead of the correct cost for moving three appliances ($75). This tells you that there is something wrong with the statement preceding the second alert dialog box.
7. Click the **OK** button. Return to your text editor and examine the statement above the second `window.alert()` statement. Note that instead of an assignment operator, the statement includes a subtraction operator.
8. Replace the subtraction operator with an assignment operator as follows:

   ```
   appliancesCost = appliances * 25;
   ```
9. Remove the two `window.alert()` statements from the `calcAppliancesCost()` function.
10. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page.
11. Click the **No. of Appliances** text box, type **3**, and press the **Tab** key. The value in the Moving Estimate text box should correctly change to $75. Leave the document open in your Web browser.

Tracing Errors with the `write()` and `writeln()` Methods

There may be situations in which you want to trace a bug in your program by analyzing a list of values rather than by trying to interpret the values displayed in alert dialog boxes on a case-by-case basis. You can create such a list by including code that opens a new browser window (called a pop-up window) and using the `write()` and `writeln()` methods to print values to this separate window. The following code shows an example of the `calculatePay()` function printing values to a separate window. Multiple `write()` methods that print values to the new window are included throughout the function. Figure 8-8 shows the contents of the new window after executing the `calculatePay()` function.

```
function calculatePay() {
valueWindow = window.open("", "",
    "height=150,width=350");
    var payRate = 15; numHours = 40;
    var grossPay = payRate * numHours;
    valueWindow.document.open();
valueWindow.document.write("grossPay is "
    + grossPay + "<br />");
    var federalTaxes = grossPay * .06794;
    var stateTaxes = grossPay * .0476;
    var socialSecurity = grossPay * .062;
    var medicare = grossPay * .0145;
    var netPay = grossPay - federalTaxes;
valueWindow.document.write(
    "netPay minus Federal taxes is "
        + netPay + "<br />");
    netPay *= stateTaxes;
valueWindow.document.write(
    "netPay minus State taxes is "
        + netPay + "<br />");
    netPay *= socialSecurity;
valueWindow.document.write(
    "netPay minus Social Security is "
        + netPay + "<br />");
    netPay *= medicare;
valueWindow.document.write(
    "netPay minus Medicare is "
        + netPay + "<br />");
valueWindow.document.close();
    return Math.round(netPay);
}
calculatePay();
```

For this technique to work, your browser must be configured to allow pop-up windows. To allow pop-up windows in Firefox, select the Tools menu and then select Options. Click the Content tab and then clear the Block pop-up windows box. To allow pop-up windows in Internet Explorer, select the Tools menu, point to Pop-up Blocker, and then select Turn Off Pop-up Blocker.

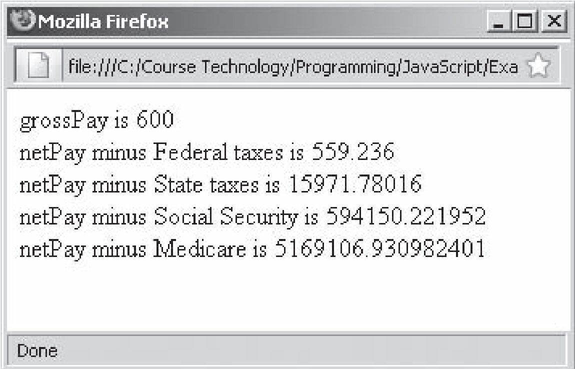


Figure 8-8 Contents of new window after executing the `calculatePay()` function

Using the contents of the window in Figure 8-8, you can evaluate each variable in the `calculatePay()` function as values change throughout the function execution. Quickly viewing a list of variable values in a separate window is a simple, yet effective technique for testing many types of code.

Next, you will use `write()` statements and another browser window to help you locate bugs in the Move Estimator program's `calcTotalEstimate()` function. The `calcTotalEstimate()` function should calculate the total of the `mileageCost`, `laborCost`, `flightsCost`, `appliancesCost`, and `pianosCost` variables. However, you need to be sure that the calculations are being performed properly before you can confidently include the function in the Move Estimator program. The `calcTotalEstimate()` function is a very simple function, but it serves the purpose of demonstrating how to use a driver program to debug a function.

To use `write()` statements and another browser window to help locate bugs in the Move Estimator program's `calcTotalEstimate()` function:

1. Return to the **MoveEstimatorWithBugs.html** document in your text editor, highlight the `calcTotalEstimate()` function, and then copy it to the Clipboard by clicking **Copy** on the **Edit** menu (or by pressing Ctrl+C).

2. Create a new document in your text editor, and add a script section to the document as follows. Because you are only using this document for testing purposes, you do not need to include a `<!DOCTYPE>` declaration, `<html>` element, or header and body sections.

When using `write()` and `writeln()` methods to trace bugs, it is helpful to use a **driver program**, which is a simplified, temporary program that is used for testing functions and other code. A driver program is simply a JavaScript program that contains only the code you are testing. Driver programs do not have to be elaborate; they can be as simple as a single function you are testing. This technique allows you to isolate and test an individual function without having to worry about Web page elements, event handlers, global variables, and other code that form your program's functionality as a whole.

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Paste the `calcTotalEstimate()` function, which you copied from the Move Estimator program, into the script section by clicking **Paste** on the **Edit** menu (or by pressing Ctrl+V).

4. Following `calcTotalEstimate()` function's closing brace, add a single statement that calls the `calcTotalEstimate()` function, as follows:

```
calcTotalEstimate();
```

5. The `total` variable should be assigned the combined values of the five other variables. Therefore, if each of the other variables contains a value of 100, the `total` variable should be assigned a total value of 500. To test how the calculations perform under these conditions, add the declarations and assignments for each variable, as follows. In the actual version of the program, the variables are global variables that receive their values from text boxes in a form. Each of the text boxes calls an associated function using an `onchange` event handler, which assigns the value entered into a text box to the associated global function.

```
function calcTotalEstimate() {
var mileageCost = 100;
var laborCost = 100;
var flightsCost = 100;
var appliancesCost = 100;
var pianosCost = 100;
    var total = mileageCost;
    total += laborCost;
    total = flightsCost;
    total = appliancesCost;
    total += pianosCost;
    document.forms[0].total.value = "$"
        + total.toLocaleString();
}
```

6. Next, add `write()` statements to the `calcTotalEstimate()` function that print the value of the total variable each time it is assigned a new value. Also, add a line comment to the last statement because this simple driver program does not include the form that displays the final total.

```
function calcTotalEstimate() {
...
    var total = mileageCost;
```

```
document.write("total variable after adding ↵
    mileageCost: " + total + "<br />");
    total += laborCost;
document.write("total variable after adding ↵
    laborCost: " + total + "<br />");
    total = flightsCost;
document.write("total variable after adding ↵
    flightsCost: " + total + "<br />");
    total = appliancesCost;
document.write("total variable after adding ↵
    appliancesCost: " + total + "<br />");
    total += pianosCost;
document.write("total variable after adding ↵
    pianosCost: " + total + "<br />");
// document.forms[0].total.value = "$"
    + total.toLocaleString();
}
```


7. Save the document as **MoveEstimatorFunctionTest.html** in your Chapter folder for Chapter 8, and then close it in your text editor.

8. Open **MoveEstimatorFunctionTest.html** in your Web browser. Your Web browser should resemble Figure 8-9. You can see from the output statements that the `calcTotalEstimate()` function did not assign a final value of 500 to the `total` variable. Instead, it assigned a value of 200 to the `total` variable. Looking back over the individual statements that printed the value of the `total` variable each time it was assigned a new value, you can see that the `flightsCost` and `appliancesCost` values were not added to the value of the `total` variable but instead replaced its value. As you have probably already noticed, the two statements that assign these values to the `total` variable used the assignment operator (=) instead of the compound addition assignment operator (+=). Although this is a very simple example, it demonstrates how output statements can help you analyze a variable's changing values.

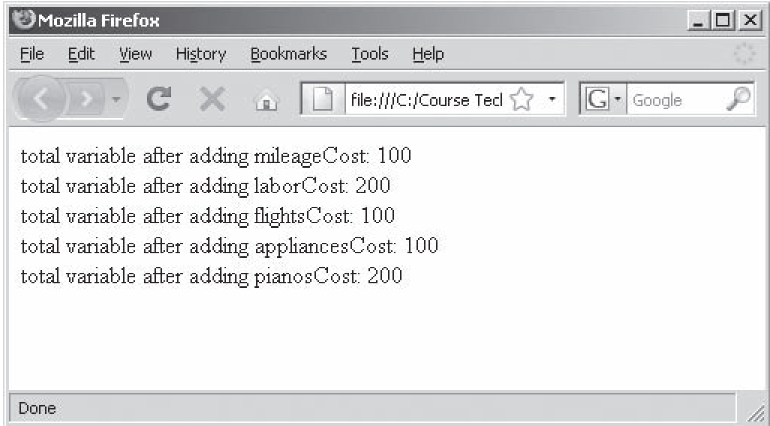


Figure 8-9 Output of the MoveEstimatorFunctionTest.html document

9. Close the browser window displaying the **MoveEstimatorFunctionTest.html** document.

10. Return to the **MoveEstimatorWithBugs.html** document in your text editor and modify the `calcTotalEstimate()` function so that the statements that assign the `flightsCost` and `appliancesCost` values to the total variable use the compound addition assignment operator (+=) instead of the assignment operator (=), as follows:

```
function calcTotalEstimate() {
    var total = mileageCost;
    total += laborCost;
    total += flightsCost;
    total += appliancesCost;
    total += pianosCost;
    document.forms[0].total.value = "$"
        + total.toLocaleString();
}
```

11. Save the **MoveEstimatorWithBugs.html** document, but do not try to use the program yet because it still contains some bugs.

Using Comments to Locate Bugs

Another method of locating bugs in a JavaScript program is to take lines that you think may be causing problems and transform them into comments. In other words, you can "comment out" problematic lines. This technique helps you isolate the statement that is causing the error. In some cases, you may choose to comment out individual lines that may be causing the error, or you may choose to comment out all lines except the lines that you know work. When you first receive an error message, start by commenting out only the statement specified by the line number in the error message. Save the document, and then open it again in your Web browser to see if you receive another error. If you receive additional error messages, comment out those statements as well. Once you eliminate the error messages, examine the commented out statements for the cause of the bug.

The cause of an error in a particular statement is often the result of an error in a preceding line of code.

The last five statements in the following code are commented out because they generate error messages stating that `yearlyIntrest` is not defined. The problem with the code is that the `yearlyInterest` variable is incorrectly spelled as `yearlyIntrest` in several of the statements. Commenting out the lines isolates the problem statements.

```
var amount = 100000;
var percentage = .08;
document.write("<p>The interest rate for a loan ↵
    in the amount of " + amount + " is "
    + percentage + "<br />");
var yearlyInterest = amount * percentage;
// document.writeln("The amount of interest for ↵
    one year is " + yearlyIntrest + "<br />");
// var monthlyInterest = yearlyIntrest / 12;
// document.writeln("The amount of interest for ↵
    one month is " + monthlyInterest + "<br />");
// var dailyInterest = yearlyIntrest / 365;
// document.writeln("The amount of interest for ↵
    one day is " + dailyInterest + "</p>");
```

Although the error in the preceding code may seem somewhat simple, it is typical of the types of errors you will encounter. Often you will see the error right away and, therefore, have no need to comment out code or use any other tracing technique. However, when you have been staring at the same code for long periods of time, simple spelling errors, like `yearlyIntrest`, are not always easy to spot. Commenting out the lines you know are giving you trouble is a good technique for isolating and correcting even the simplest types of bugs.

Combining Debugging Techniques

You can combine debugging techniques to aid in your search for errors. For example, the following code uses comments combined with an alert dialog box to trace errors in the `calculatePay()` function. Suppose that the `var grossPay = payRate * numHours;` statement is the last statement in the function that operates correctly. Therefore, all of the lines following that statement are commented out. You would then use an alert dialog box to check the value of each statement, removing comments from each statement in a sequential order, and checking and correcting syntax as you go.

```
function calculatePay() {
    var payRate = 15; numHours = 40;
    var grossPay = payRate * numHours;
window.alert(grossPay);
//   var federalTaxes = grossPay * .06794;
//   var stateTaxes = grossPay * .0476;
//   var socialSecurity = grossPay * .062;
//   var medicare = grossPay * .0145;
//   var netPay = grossPay - federalTaxes;
//   netPay *= stateTaxes;
//   netPay *= socialSecurity;
//   netPay *= medicare;
//   return Math.round(netPay);
}
```

Next, you will use comments to locate bugs in the Move Estimator program.

To use comments to locate bugs in the Move Estimator program:

1. Return to the **MoveEstimatorWithBugs.html** document in your Web browser, reload or refresh the Web page, and then enter the following data:

   ```
   Distance in Miles: 400
   Weight in Pounds: 900
   No. Flights: 2
   ```

2. Note the total value displayed in the Moving Estimate box. Instead of a correct value of 735, you see an incorrect value of 3,135. In order to locate the code that is causing this problem, you need to add comments to the `calcTotalEstimate()` function.

3. Return to the **MoveEstimatorWithBugs.html** document in your text editor and add comments to all of the statements in the `calcTotalEstimate()` function, except the first statement, which assigns the `mileageCost` variable to the `total` variable, and the last statement, which assigns the value of the `total` variable to its associated text box in the form. Your function should appear as follows:

   ```
   function calcTotalEstimate() {
        var total = mileageCost;
   //   total += laborCost;
   //   total += flightsCost;
   //   total += appliancesCost;
   //   total += pianosCost;
   ```

```
    document.forms[0].total.value = "$"
        + total.toLocaleString();
}
```

4. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload or refresh the Web page.

5. Enter **400** as the Distance in Miles value, and press the **Tab** key. The correct value of 500 is assigned to the Moving Estimate box. Therefore, the `mileageCost` variable is not the problem.

6. Return to the **MoveEstimatorWithBugs.html** document in your text editor, and remove the comment from the `total += laborCost;` statement. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload or refresh the Web page.

7. Enter **400** as the Distance in Miles value, press the **Tab** key, enter **900** as the Weight in Pounds value, and press the **Tab** key. At 15 cents a pound, the total cost of 900 pounds is $135. Adding 135 to the Distance in Miles amount of 500 results in 635. Therefore, the program is functioning correctly so far.

8. Return to the **MoveEstimatorWithBugs.html** document in your text editor, and remove the comment from the `total += flightsCost;` statement. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload or refresh the Web page.

9. Enter **400** as the Distance in Miles value, press the **Tab** key, enter **900** as the Weight in Pounds value, press the **Tab** key, enter **2** as the No. of Flights value, and then press the **Tab** key. At $50 per flight, a value of 2 should only increase the moving estimate by 100, for a total of 735. However, the Moving Estimate box incorrectly displays 3135. The program functioned correctly until it tried to call the `calcFlightsCost()` function.

10. Scroll to the `calcFlightsCost()` function in your text editor, and note that the function includes an unnecessary statement, `flights = 50;`, which causes the calculation error. Do not think this is a trivial example. As you develop your own applications, you will often find yourself adding and deleting statements that can introduce simple, hard-to-detect bugs in your programs.

11. Delete the `flights = 50;` statement from the `calcFlightsCost()` function.

12. Remove the remainder of the comments from the statements in the `calcTotalEstimate()` function, save the **MoveEstimatorWithBugs.html** document, and then refresh your Web browser. Enter the data listed in Step 1. The correct value of 735 should appear in the Moving Estimate box. Do not enter any numbers for the other calculations because the program still contains some errors.

Short Quiz 2

1. Explain how to trace errors with `window.alert()` statements.

2. Explain how to trace errors with `write()` and `writeln()` statements.

3. Explain how to trace errors with comments.

Tracing Errors with Debugging Tools

Many high-level programming languages, such as Visual C++, have debugging capabilities built directly into their development environments. These built-in debugging capabilities provide sophisticated commands for tracking errors. The JavaScript programming language does not have a development environment other than your text editor. The only true debugging tools you have in JavaScript are the error messages generated by a browser. To provide JavaScript with debugging capabilities, both Mozilla and Microsoft developed debugging tools that can be used with their browsers to debug JavaScript code. Mozilla's debugging tool is called **JavaScript Debugger** and can be used to debug JavaScript code in Mozilla-based Web browsers including Firefox. JavaScript Debugger is available to Firefox as an extension.

The term "extension" refers to additional functionality that can be added to a program.

To install JavaScript Debugger in Firefox, select the Tools menu, select Add-ons, click Get Add-ons in at the top of the Add-ons page, and then click Browse All Add-ons. This opens the Add-ons for Firefox Web page. Use this page to search for "JavaScript Debugger," and follow the instructions for installing it.

Microsoft's debugging tool, called **JScript debugger**, is part of Internet Explorer 8's Developer Tools feature. To access the JScript debugger, select the Tools menu and then select Developer Tools, which opens a separate Developer Tools window. The Developer Tools window allows you to debug HTML, CSS, and Web page scripts, and also includes a tool called the Profiler that you can use to improve your Web site's performance.

Up to this point, you have learned how to interpret error messages and correct the statements that cause the errors. As helpful as they are, error messages are useful only in resolving syntax and run-time errors. You have also learned some techniques that assist you in locating logic errors. Examining your code manually is usually the first step in resolving a logic error, or you may use an alert dialog box to track values. These techniques work fine with smaller programs. However, when you are creating a large program that includes multiple objects, methods, and functions, logic errors can be very difficult to spot. For instance, you may have a function that instantiates objects from several different constructor functions. Each instantiated object may then call methods or use properties from its parent object or from other ancestor objects. Attempting to trace the logic and flow of such a program using simple tools such as the alert dialog box can be difficult. Mozilla JavaScript Debugger and Microsoft JScript debugger provide several tools that can help you trace each line of code, creating a much more efficient method of finding and resolving logic errors.

Understanding the JavaScript Debugger and JScript Debugger Windows

This section describes the main windows for both JavaScript Debugger and JScript debugger.

Using JavaScript Debugger

To debug JavaScript with JavaScript Debugger, you open the document you want to debug in Firefox and then select JavaScript Debugger from the Tools menu. This opens the JavaScript Debugger window. All of the scripts that are currently loaded in the browser window or that are used by JavaScript Debugger itself are listed in the Loaded Scripts view portion of the JavaScript Debugger window. In Loaded Scripts view, icons represent different types of files, including a "J" icon for .js (JavaScript) files, an "H" icon for HTML files, and a square icon for a JavaScript function. To open a particular file, double-click it in Loaded Scripts view. The file opens in Source Code view, which is a read-only file viewer that you can use to help debug your scripts. Figure 8-10 displays the JavaScript Debugger window with the nsMicrosummaryService.js file (a JavaScript file that Firefox uses) opened in Source Code view.

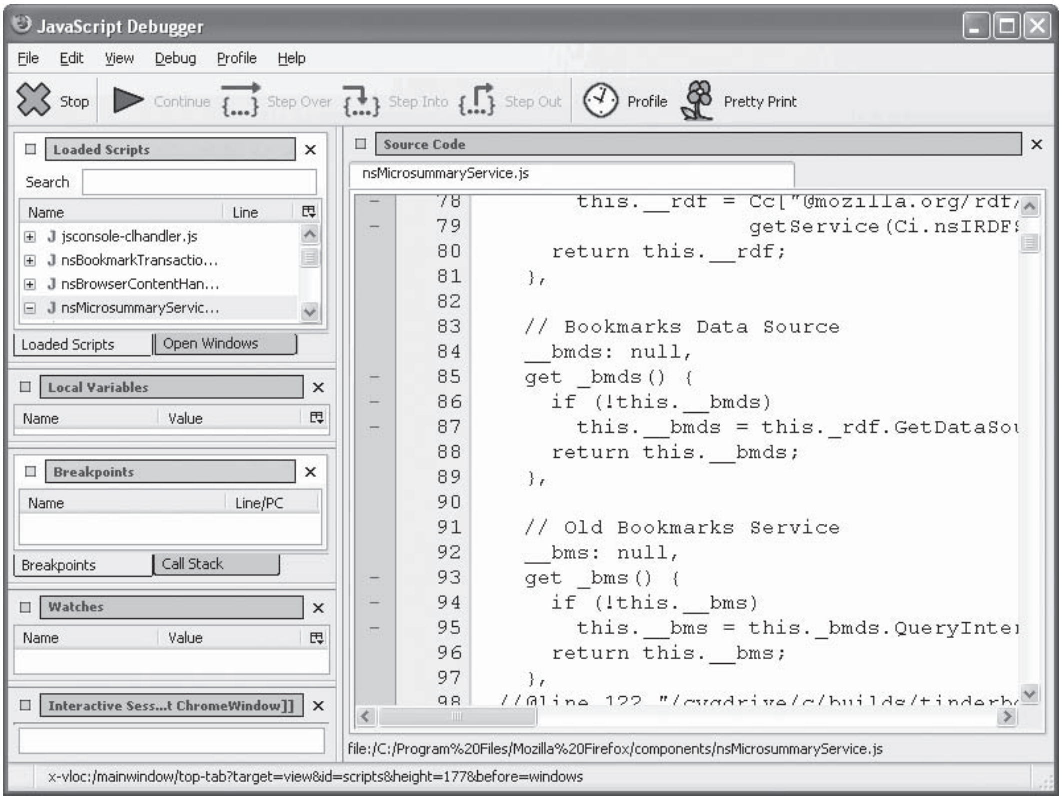


Figure 8-10 Document opened in JavaScript Debugger

Use the Show/Hide submenu on the View menu to toggle the display of the various views in JavaScript Debugger.

In addition to Loaded Scripts view, you can also use Open Windows view to open files in JavaScript Debugger. Open Windows view organizes each open file by the Web browser window where it is opened. However, note that you have limited debugging functionality with the files that are open in Open Windows view. For example, in Open Windows view you cannot set hard breakpoints, which you study later in this chapter.

JavaScript Debugger also includes some more advanced features, such as Interactive Session view, which allow you to debug your scripts from a command line instead of from JavaScript Debugger's graphical user interface (GUI).

Using JScript Debugger

To debug JavaScript with JScript debugger, you open the document you want to debug in Internet Explorer and select the Developer Tools command on the Tools menu. When the Developer Tools window opens, click the Script tab. Once you open a document in JScript debugger, icons appear in the left margin to indicate various elements. For example, a yellow arrow points to the statement that executes next. The types of code elements in a JavaScript program are distinguished by syntax color coding. This color coding makes it easier to understand the structure and code in a JavaScript program. For example, the default syntax coloring for JavaScript keywords is blue. Figure 8-11 shows an example of a document opened in JScript debugger. Although you can't see colors in the figure, the arrow and the highlighted statement are yellow.

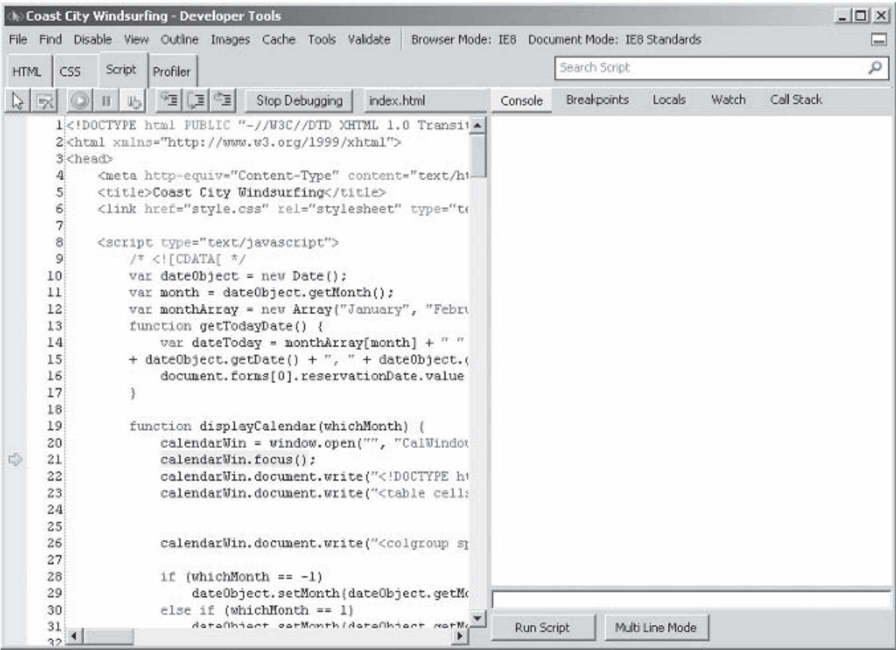


Figure 8-11 Document opened in JScript debugger

Next, you will open the Move Estimator program in JavaScript Debugger or JScript debugger, depending on which browser you prefer. If you are using Firefox, make sure that you have installed JavaScript Debugger as described earlier in this chapter. If you are using Firefox and JavaScript Debugger, perform the following steps. If you are using Internet Explorer and JScript debugger, skip to the next set of steps.

To open the Move Estimator program in JavaScript Debugger:

1. Return to the **MoveEstimatorWithBugs.html** document in Firefox.
2. Select **JavaScript Debugger** from the Tools menu. The JavaScript Debugger window opens.
3. Locate **MoveEstimatorWithBugs.html** in Loaded Scripts view, and double-click it. The MoveEstimatorWithBugs.html document opens in Source Code view, as shown in Figure 8-12. Leave the JavaScript Debugger window open.

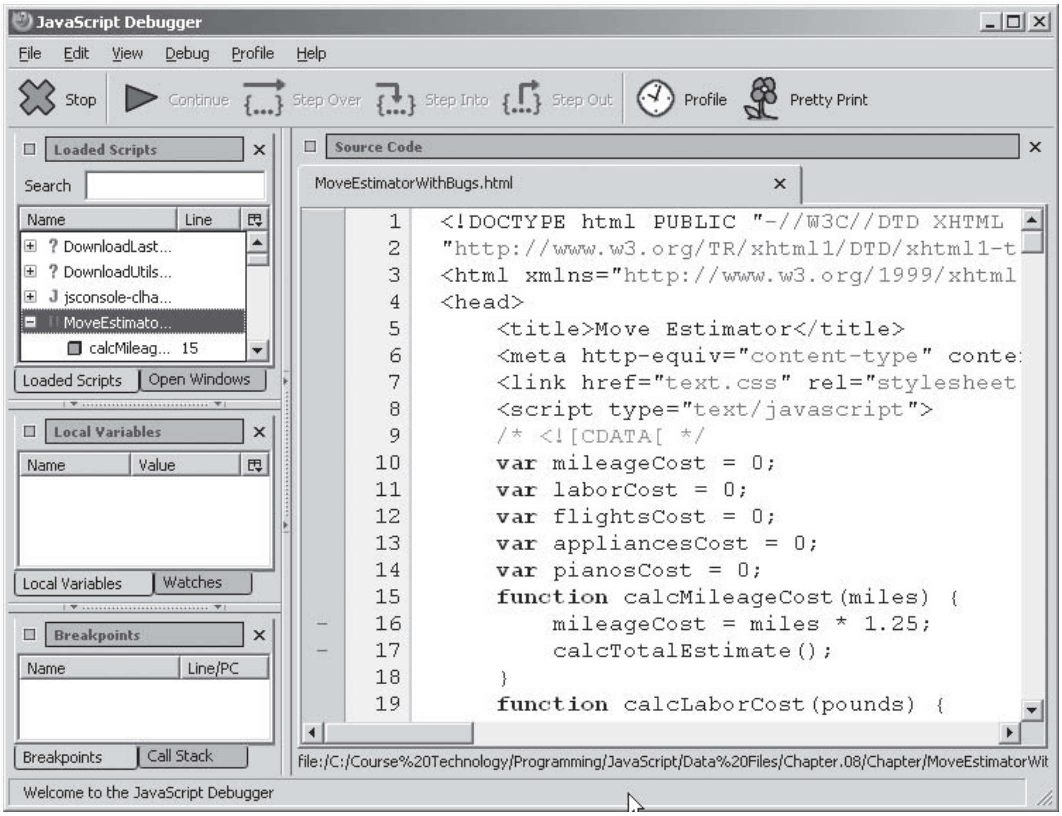


Figure 8-12 MoveEstimatorWithBugs.html open in JavaScript Debugger

To open the Move Estimator program in JScript debugger:

1. Return to the **MoveEstimatorWithBugs.html** document in Internet Explorer.
2. Select **Developer Tools** from the **Tools** menu, and then click the **Script** tab in the Developer Tools window. The JScript debugger window opens, as shown in Figure 8-13. Leave the JScript debugger window open.

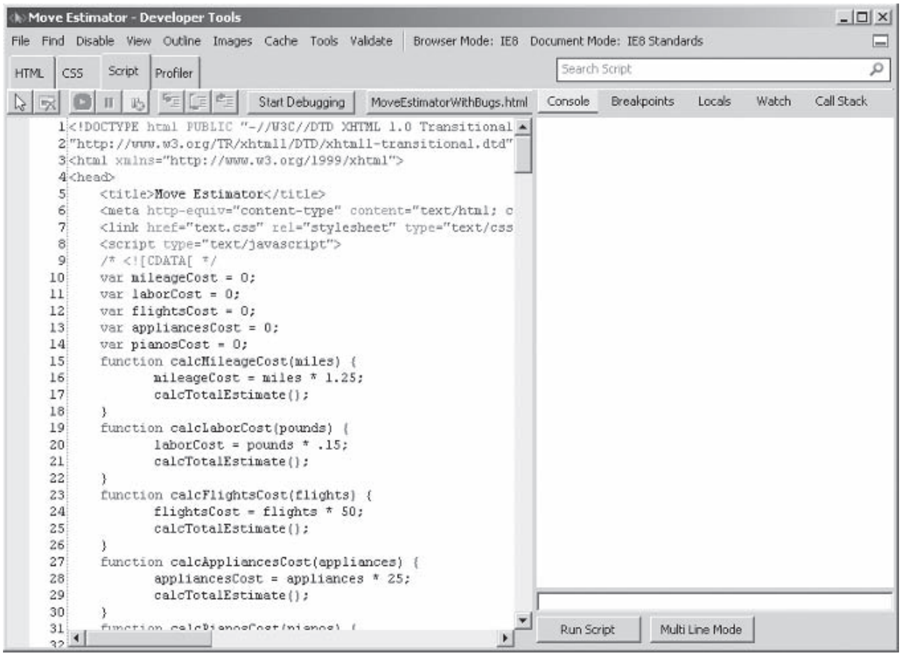


Figure 8-13 MoveEstimatorWithBugs.html open in JScript debugger

Setting Breakpoints

Both JavaScript Debugger and JScript debugger include commands that you can use to control program execution after your scripts enter break mode. The term **break mode** refers to the temporary suspension of program execution so that you can monitor values and trace program execution. Entering break mode requires inserting breakpoints into your code. A **breakpoint** is a statement in the code at which program execution enters break mode. Once a program is paused at a breakpoint, you can use command buttons within each window to trace program execution. When a program enters break mode, program execution is not stopped—it is only suspended. This section describes how to set breakpoints in JavaScript Debugger and JScript debugger.

This text instructs you to use the JavaScript Debugger and JScript debugger menus to execute commands. However, many of the commands are also available as icons on the JavaScript Debugger and JScript debugger toolbars.

Entering Break Mode in JavaScript Debugger

JavaScript Debugger allows you to enter two types of breakpoints: hard breakpoints and future breakpoints. **Hard breakpoints** can be set for executable statements within a local function and notify JavaScript Debugger to enter break mode before the statement executes. **Future breakpoints** can be set for any type of statement and notify JavaScript Debugger to enter break mode as soon as possible before the statement executes. In most cases, you only need to use future breakpoints for statements that exist outside of any local functions, such as variable declaration statements or function calls. As soon as JavaScript Debugger can enter break mode for a future breakpoint, it changes the future breakpoint to a hard breakpoint. The steps for working with breakpoints in JavaScript Debugger are as follows:

1. Open the document you want to debug in Firefox and select JavaScript Debugger from the Tools menu.
2. To set a breakpoint in the script, right-click the line in Source Code view where you want to set the breakpoint, and then select Set Breakpoint or Set Future Breakpoint from the shortcut menu. For hard breakpoints, a "B" icon appears in the left column next to the line in Source Code view. For future breakpoints, an "F" icon appears in the left column next to the line in Source Code view. The breakpoints you set also appear in Breakpoints view.
3. To execute the script and stop at the first set breakpoint, return to the Web browser window where the script is running and click the Reload icon or press Ctrl+R. The script begins to execute and then focus changes to the JavaScript Debugger, paused at the first set breakpoint.

Once a program is paused at a breakpoint, you can use the commands on the Debug menu to trace program execution. When a program enters break mode, program execution is not stopped—it is only suspended. To resume program execution after entering break mode, click the Continue button. The **Continue button** executes the rest of the program normally or until another breakpoint is encountered. Multiple breakpoints provide a convenient way to pause program execution at key positions in your code at which you think there may be a bug. You can also end a debugging session without executing the rest of the program by clicking the **Stop button**.

Next, you will practice using breakpoints with the Move Estimator program in Firefox.

To practice using breakpoints with the Move Estimator program in Firefox:

1. Return to the **MoveEstimatorWithBugs.html** document in the JavaScript Debugger window.
2. Right-click the first statement in the script section, `var mileageCost = 0;`, and select **Set Future Breakpoint** from the shortcut menu. An "F" icon appears in the left

margin of Source Code view next to the line containing the breakpoint.

3. In the `calcMileageCost()` function, right-click the `mileageCost = miles * 1.25;` statement and select **Set Breakpoint** from the shortcut menu. A "B" icon appears in the left margin of Source Code view next to the line containing the breakpoint. Figure 8-14 shows the JavaScript Debugger window with the two breakpoints.

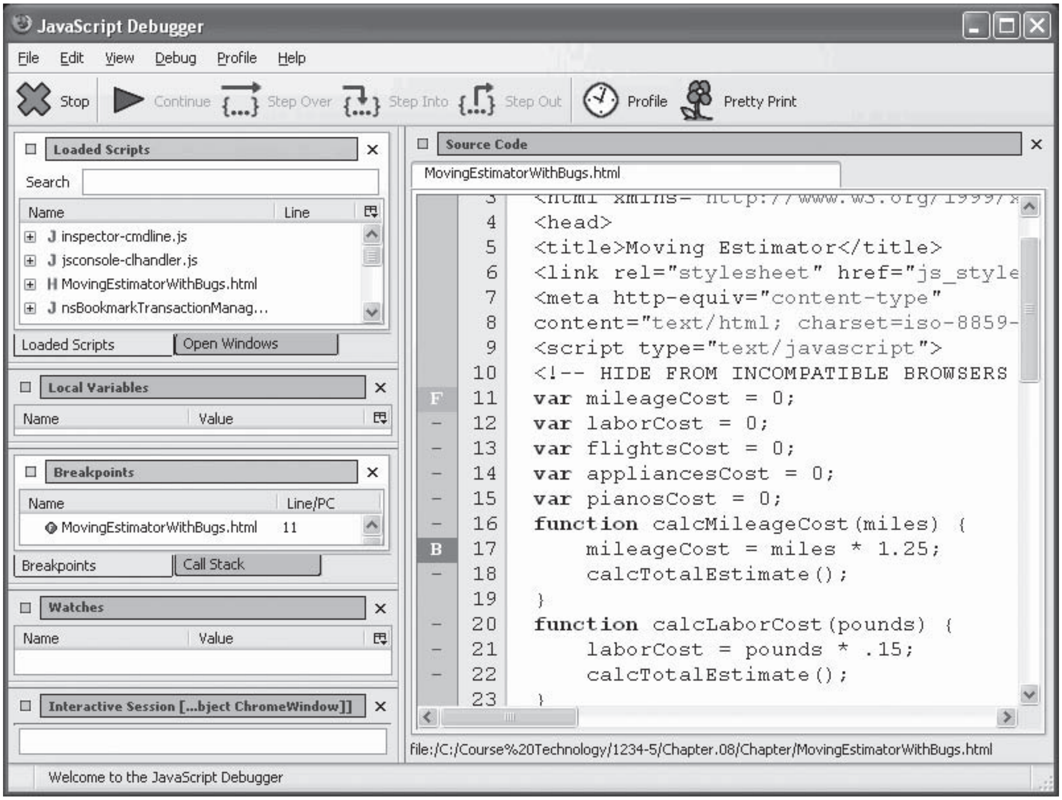


Figure 8-14 Breakpoints in JavaScript Debugger

4. Switch back to the Web browser window, and click the **Reload** icon or press **Ctrl+R**. The script begins to execute, and then focus changes to the JavaScript Debugger, paused at the future breakpoint. Notice that the "F" icon has changed to a "B" icon.

5. Click the **Continue** button. The remainder of the initialization statements execute.

6. Switch back to the Web browser window, type **400** in the **Distance in Miles** text box, and press the **Tab** key. Focus switches to the JavaScript Debugger window, paused at the breakpoint in the `calcMileageCost()` function.

7. Click the **Continue** button. The code finishes executing.

Entering Break Mode in JScript Debugger

The steps for opening a document in the JScript debugger window and entering break mode at the first statement are as follows:

1. Open the document you want to debug in Internet Explorer, select Developer Tools from the Tools menu, and then click the Script tab.

2. To set a breakpoint in the script, right-click the line where you want to set the breakpoint, and then select Insert Breakpoint from the shortcut menu. A red circle appears in the left column next to the line.

3. To execute the script and stop at the first set breakpoint, click the Start Debugging button, and then return to the Web browser window where the script is running and click the Refresh button or press F5. The script begins to execute and then focus changes to the JScript debugger, paused at the first set breakpoint.

To resume program execution after entering break mode, click the Continue button. The **Continue button** executes the rest of the program normally or until another breakpoint is encountered. Multiple breakpoints provide a convenient way to pause program execution at key positions in your code at which you think there may be a bug. You can also end a debugging session without executing the rest of the program by clicking the **Stop Debugging button**.

Next, you will practice using breakpoints with the Move Estimator program in Internet Explorer.

To practice using breakpoints with the Move Estimator program in Internet Explorer:

1. Return to the **MoveEstimatorWithBugs.html** document in the JScript debugger window.

2. Right-click the first statement in the script section, `var mileageCost = 0;`, and select **Insert Breakpoint** from the shortcut menu. A red circle appears in the left margin next to the line containing the breakpoint.

3. In the `calcMileageCost()` function, right-click the `mileageCost = miles * 1.25;` statement and select **Insert**

Breakpoint from the shortcut menu. A red circle appears in the left margin next to the line containing the breakpoint. Figure 8-15 shows the JScript debugger window with the two breakpoints.

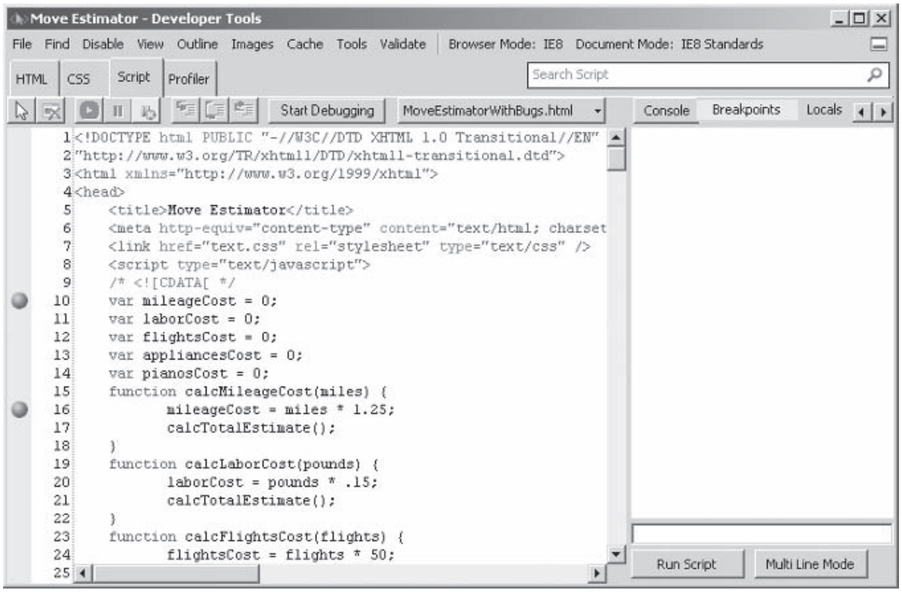


Figure 8-15 Breakpoint in JScript debugger

4. Click the **Start Debugging** button. If you see a dialog box prompting you to refresh the Web page to begin debugging, click **OK**. Otherwise, switch back to the Web browser window, and click the **Refresh** button or press **F5**. The script begins to execute, and then focus changes to the JScript debugger, paused at the future breakpoint.

5. Click the **Continue** button. The remainder of the initialization statements execute.

6. Switch back to the Web browser window, type **400** in the **Distance in Miles** text box, and press the **Tab** key. Focus switches to the JScript debugger window, paused at the breakpoint in the `calcMileageCost()` function.

7. Click the **Continue** button. The code finishes executing.

Stepping Through Your Scripts

The Step Into, Step Over, and Step Out buttons in both JavaScript Debugger and JScript debugger allow you to continue program execution after you enter break mode. The **Step Into button** executes an individual line of code and then pauses until you instruct the debugger to continue. This feature gives you an opportunity to evaluate program flow and structure as code is being executed.

As you use the Step Into button to move through code, the debuggers stop at each line within every function of the JavaScript program. However, when stepping through a program to trace a logical error, it is convenient to be able to skip functions that you know are functioning correctly. The **Step Over button** allows you to skip function calls. The program still executes the function that you step over, but it appears in each debugger as if a single statement executes.

The **Step Out button** executes all remaining code in the current function. If the current function was called from another function, all remaining code in the current function executes and the debugger stops at the next statement in the calling function.

Next, you will practice tracing program execution using the Step buttons.

To practice tracing program execution using the Step buttons:

1. Return to the **MoveEstimatorWithBugs.html** document in your Web browser window and type **400** in the **Distance in Miles** text box, and press the **Tab** key. Focus switches to the JavaScript Debugger (for Firefox) window or JScript debugger (for Internet Explorer) window, paused at the breakpoint in the `calcMileageCost()` function.
2. Select the **Step Into** button to execute the `mileageCost = miles * 1.25;`. Control transfers to the `calcTotalEstimate()` statement.
3. Select the **Step Into** button again to execute the `calcTotalEstimate()` statement. Control transfers to the `calcTotalEstimate()` function.
4. Because you already know the `calcTotalEstimate()` function works correctly, select the **Step Out** button to finish executing the remainder of the `calcMileageCost()` function.
5. Select the **Continue** button to complete debugging and program execution.

Clearing Breakpoints

This section explains how to clear breakpoints in JavaScript Debugger and JScript debugger.

Clearing Breakpoints in JavaScript Debugger

To clear a breakpoint in JavaScript Debugger, right-click a line in Source Code view that contains the breakpoint and select Clear Breakpoint or Clear Future Breakpoint from the shortcut menu. To remove all breakpoints from a document in JavaScript Debugger, right-click anywhere in Breakpoints view and select Clear All Breakpoints or Clear All Future Breakpoints from the shortcut menu. Note that when you clear a hard breakpoint, it automatically changes to a future breakpoint. This means that after you clear a hard breakpoint, you must then clear the resulting future breakpoint.

To remove breakpoints from the Move Estimator program in JavaScript Debugger:

1. Return to the **MoveEstimatorWithBugs.html** document in JavaScript Debugger.
2. Right-click anywhere in Breakpoints view, and select **Clear All Breakpoints** from the shortcut menu.
3. Right-click anywhere in Breakpoints view, and select **Clear All Future Breakpoints** from the shortcut menu.

Clearing Breakpoints in JScript Debugger

To clear a breakpoint in JScript debugger, right-click a line that contains the breakpoint and select Delete Breakpoint from the shortcut menu. To remove all breakpoints from a document in JScript debugger, click the Breakpoints button to display all of the breakpoints. Right-click anywhere in the breakpoints list view and select Delete All from the shortcut menu.

To remove breakpoints from the Move Estimator program in JScript debugger:

1. Return to the **MoveEstimatorWithBugs.html** document in JScript debugger.
2. Click the **Breakpoints** button.
3. Right-click anywhere in the breakpoints list and select **Delete All** from the shortcut menu.

Tracing Variables and Expressions

As you trace program execution by using Step commands and breakpoints, you may also need to trace how variables and expressions change during the course of program execution. For example, suppose that you have a statement that reads `resultNum = firstNum /`

`secondNum;`. If you attempt to divide by zero, a value of `infinity` is returned. You know this line is causing a divide-by-zero error, but you do not know exactly when `secondNum` is being changed to a zero value. To pinpoint the cause of the logic problem, you need a way to trace program execution and locate the exact location at which `secondNum` is being changed to a zero value.

Tracing Variables and Expressions in JavaScript Debugger

JavaScript Debugger includes two views that you can use to trace variables and expressions during the course of program execution: Local Variables and Watches. **Local Variables view** displays all local variables within the currently executing function, regardless of whether they have been initialized. Local Variables view helps you see how different values in the currently executing function affect program execution. You use Local Variables view when you need to be able to see all of a function's variables, regardless of whether they have been assigned a value. You can change the value of a variable in Local Variables view by right-clicking the variable and selecting Change Value from the shortcut menu. **Watches view** monitors both variables and expressions in break mode. To open Watches view, select Watches from the Show/Hide submenu on the View menu. To display the value of a variable or expression, you right-click Watches view and select Add Watch Expression from the shortcut menu. Enter the variable or expression you want to watch, and click OK. The variable or expression you enter displays in Watches view, along with its value. The Watches view in Figure 8-16 shows Watches view as it monitors the value of the `mileageCost` and `total` variables in the `calcTotalEstimate()` function. The other JavaScript Debugger views have been hidden to make it easier for you to locate Watches view.

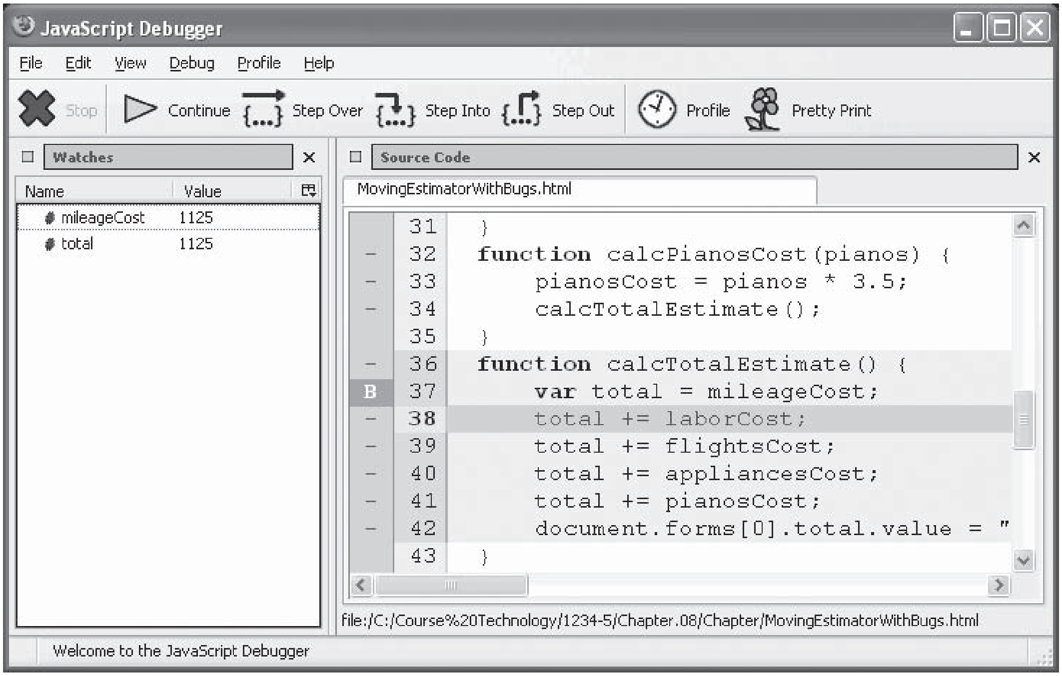


Figure 8-16 Variables in Watches view

Tracing Variables and Expressions in JScript Debugger

To remove a watch expression, right-click the expression in Watches view and select Remove Watch.

JScript debugger includes three panes that you can use to trace variables and expressions during the course of program execution: Console, Locals, and Watch. The **Console pane** monitors variables and expressions in break mode. You can also change variables and expressions in break mode from within the Console pane. To display the value of a variable or expression in the Console pane, you enter the variable or expression and press Enter. The value prints directly beneath the variable or expression in the Console pane. To change the value of a variable, type the variable name in the Console pane followed by an equal sign and the new value, and then press Enter. The new value prints beneath the statement you entered. The **Locals pane** displays all local variables within the currently executing function, regardless of whether they have been initialized. The Locals pane helps you see how different values in the currently executing function affect program execution. You use the Locals pane when you need to be able to see all of a function's variables, regardless of whether they have been assigned a value. You can change the value of a variable in the Locals pane by right-clicking the variable and selecting Edit Value from the shortcut menu. The **Watch pane** monitors both variables and expressions in break mode. To display the value of a variable or expression, click in the next available row where it says

"Click to add…" Enter the variable or expression you want to watch, and press Enter. The variable or expression you enter displays in the Watch pane, along with its value. Figure 8-17 shows the Watch pane as it monitors the value of the `mileageCost` and total variables in the `calcTotalEstimate()` function.

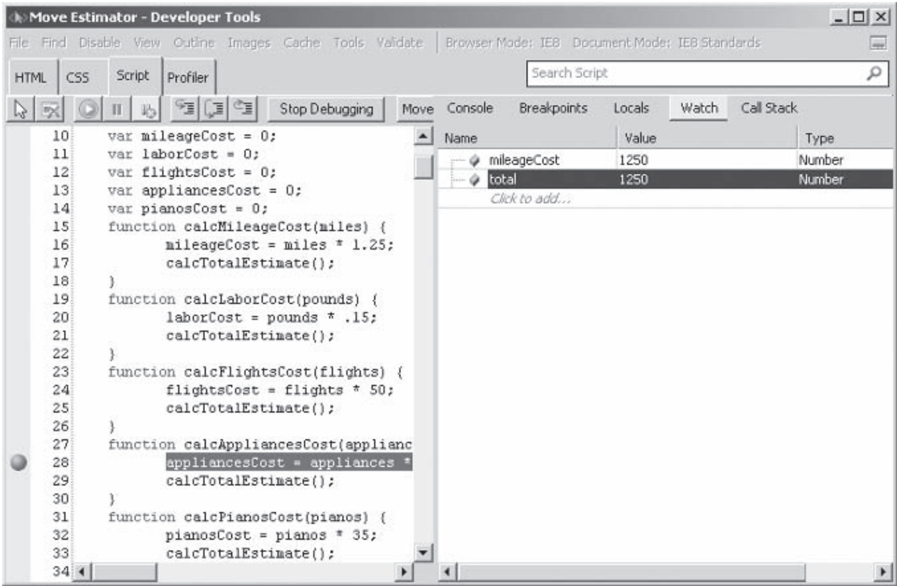


Figure 8-17 Variables in Watch pane

Next, you use Watches view or the Watch pane to find a bug in the Move Estimator program.

To use Watches view or the Watch pane to find a bug in the Move Estimator program:

1. Return to the **MoveEstimatorWithBugs.html** document in your Web browser.
2. Enter the following data for each of the moving cost calculations:

```
Distance in Miles: 1000
Weight in Pounds: 500
No. of Flights: 2
No. of Appliances: 3
No. of Pianos: 2
```

3. After you enter the preceding numbers, the Moving Estimate text box displays a value of $1,507, which isn't right. (The value should be $1,570.) Because you have already corrected the Distance in Miles, Weight in Pounds, and No. of

Flights calculations earlier in this chapter, you will start by examining the No. of Appliances calculation. You will examine the two values required by the appliances calculation: the `appliances` variable, which receives its value from the associated form text box, and the `appliancesCost` variable, which receives the result of the calculation. First, return to the **MoveEstimatorWithBugs.html** document in the JavaScript Debugger or JScript debugger window and insert a breakpoint on the **`appliancesCost = appliances * 25;`** statement.

4. Return to the **MoveEstimatorWithBugs.html** document in the Web browser window and refresh the window. Then enter the values from Step 2 into the Distance in Miles, Weight in Pounds, and No. of Flights text boxes. Click the **No. of Appliances** text box, type **3** for the number of appliances, then press the **Tab** key. The program enters break mode on the `appliancesCost = appliances * 25;` statement. Click the **Step Into** button to execute the function's calculation statement.

5. If you are using JavaScript Debugger, right-click anywhere in Watches view, select **Add Watch Expression** from the shortcut menu, and type **appliancesCost** in the prompt dialog box and press **Enter**. If you are using JScript debugger, click the Watch button, click where it says "Click to add…", type **appliancesCost**, and press **Enter**. The correct value, 75, appears in both Watches view in JavaScript Debugger and in the Watch pane in JScript debugger. Therefore, the problem does not appear to be related to the appliances cost calculation.

6. Click the **Continue** button.

7. Remove the breakpoint from the **`appliancesCost = appliances * 25;`** statement in the `calcAppliancesCost()` function.

8. Next, you will examine the two values required by the piano calculation: the `pianos` variable and the `pianosCost` variable. Insert a breakpoint on the **`pianosCost = pianos * 3.5;`** statement in the `calcPianosCost()` function.

9. Return to the **MoveEstimatorWithBugs.html** document in the Web browser window, and enter the following values:

```
Distance in Miles: 1000
Weight in Pounds: 500
No. of Flights: 2
No. of Appliances: 3
```

10. Type 2 for the number of pianos, and then press the **Tab** key. The program enters break mode on the `pianosCost = pianos * 3.5;` statement. Click the **Step Into** button to execute the function's calculation statement.

11. If you are using JavaScript Debugger, right-click anywhere in Watches view, select **Add Watch Expression** from the shortcut menu, type **pianosCost** in the prompt dialog box, and press **Enter**. If you are using JScript debugger, click in the Watch pane where it says "Click to add…", type **pianosCost**, and press **Enter**. Because the cost to move a single piano is $35, the `pianosCost` variable should be updated to 70 after you execute the `pianosCost = pianos * 3.5;` statement. The correct value of 70 should appear in Watches view or the Watch pane. Instead a value of 7 appears. If you are observant, you have probably already noticed that the calculation is multiplying the `pianos` variable by 3.5 instead of 35.

12. Click the **Continue** button. Return to the **MoveEstimatorWithBugs.html** document in your text editor, and modify the incorrect statement in the `calcPianosCost()` function so the `pianos` variable is multiplied by 35 instead of 3.5, as follows:

    ```
    pianosCost = pianos * 35;
    ```

13. Remove the breakpoint from the **`pianosCost = pianos * 3.5;`** statement in the `calcPianosCost()` function.

14. Save the **MoveEstimatorWithBugs.html** document in your text editor, then return to your Web browser and reload the Web page. Enter the values from Step 2. The program should now function correctly, calculating a moving estimate of $1,570.

Examining the Call Stack

When you are working with a JavaScript program that contains multiple functions, the computer must remember the order in which functions are executed. For example, if you have an `accountsPayable()` function that calls an `accountsReceivable()` function, the computer must remember to return to the `accountsPayable()` function after the `accountsReceivable()` function finishes executing. Similarly, if the `accountsReceivable()` function calls a `depositFunds()` function after it has been called by the `accountsPayable()` function, then the computer must remember to return to the `accountsReceivable()` function after the `depositFunds()` function finishes executing, then return to the `accountsPayable()` function after the `accountsReceivable()` function finishes executing. The term **call stack** refers to the order in which procedures, such as functions, methods, or event handlers, execute in a program. Each time a program calls a procedure, the procedure is added to the top of the call stack, and then removed after it finishes executing.

The ability to view the contents of a call stack is very useful when tracing logic errors in large programs with multiple functions. For example, suppose that you have a variable that is passed as an argument among several functions. Suppose also that the variable is being assigned the wrong value. Viewing the call stack, along with using tracing commands, makes it easier to locate the specific function causing the problem. JavaScript Debugger and JScript debugger include Call Stack features that provide the ability to view the contents of a call stack when debugging a program. To display Call Stack view in JavaScript Debugger, select Show/Hide on the View menu, and then click Call Stack. To display the Call Stack pane in JScript debugger, click the Call Stack button.

Short Quiz 3

1. Explain how to use break mode to trace program execution. What commands can you use to enter break mode?
2. Once your program is in break mode, which command do you use to execute all remaining code in the current function?
3. Explain how to use the Local Variables and Watches views in JavaScript Debugger.
4. Explain how to use the Console, Locals, and Watch panes in JScript debugger.

Handling Exceptions and Errors

Although standard error messages that are generated by programming languages such as JavaScript are very helpful to programmers, they tend to scare users, who tend to think they somehow caused the error. Errors can and will occur, but you should never let your users think that they did something wrong. Your goal should be to write code that anticipates any problems that may occur and includes graceful methods of dealing with those problems. Writing code that anticipates and handles potential problems is often called **bulletproofing**. One bulletproofing technique you have already used has to do with validating submitted form data. For example, in Chapter 7, you created the following function to validate e-mail addresses. This example contains a nested `if` statement that uses a regular expression to test whether the passed `formObject` variable contains a valid e-mail address.

```
function validateEmail(formObject) {
    var email = formObject.value;
    var emailCheck = /^[_\w-]+(\.[_\w-]+)*@[\w-] ↵
        +(\.[\w-]+)*(\.[\D]{2,3})$/;
    if (emailCheck.test(email) == false) {
        window.alert("One or more of the e-mail ↵
            addresses you entered does not appear ↵
            to be valid.");
        return false;
    }
    formObject.value = email.toLowerCase();
    return true;
}
```

Another method of bulletproofing your code is to use **exception handling**, which allows programs to handle errors, or **exceptions** as they are often called, as they occur in the execution of a program. Many advanced programming languages, including ECMAScript Edition 3, include exception-handling capabilities. You use exception handling to test any type of input or functionality that is external to a program. For most programming languages, exception handling is most useful when connecting to a database or when trying to access some other type of external program. Because JavaScript cannot connect to databases and is mostly limited to working within the confines of a user's Web browser, the main reason for using exception handling is to evaluate user input. Although you could technically use exception handling for all of your JavaScript programs, your code should be tested thoroughly enough that it anticipates any potential problems that may occur. However, one area that you cannot control is whether users enter the correct type of data.

Throwing Exceptions

You execute code that may contain an exception in a **`try` statement**. The syntax for a `try` statement is as follows:

```
try {
     statements;
}
```

You use a **`throw` statement** to indicate that an error occurred within a `try` block. Using a throw statement to indicate that an error occurred is called "throwing an error". The error that you "throw" with a throw statement can be any type of expression. The following example demonstrates how to use a `try` statement with a regular expression to test whether the passed `formObject` variable contains a valid e-mail address.

```
try {
    var email = formObject.value;
    var emailCheck = /^[_\w-]+(\.[_\w-]+)*@[\w-] ↵
        +(\.[\w-]+)*(\.[\D]{2,3})$/;
    if (emailCheck.test(email) == false)
        throw "One or more of the e-mail addresses ↵
            you entered does not appear to be ↵
            valid.";
}
```

Catching Exceptions

After you throw an error, you use a **`catch` statement** to handle, or "catch" the error. The syntax for a `catch` statement is as follows:

```
catch(error) {
    statements;
}
```

The `catch` statement accepts a single argument that you can use to refer to the thrown exception. The following `catch` statement demonstrates how to catch the exception that is thrown by the `try` statement that evaluates the e-mail address. Notice that the `window.alert()` statement displays the passed `emailError` variable as its value. The `catch` statement also returns a value of false to the calling statement, which indicates that the form's `onsubmit` event handler should not execute.

```
catch(emailError) {
    window.alert(emailError)
    return false;
}
```

Executing Final Exception Handling Tasks

JavaScript's exception handling functionality also includes a **`finally` statement** that executes regardless of whether its associated `try` block throws an exception. You normally use a `finally` statement to perform some type of cleanup or any necessary tasks after code is evaluated with a `try` statement. The syntax for a `finally` statement is as follows:

```
finally {
     statements;
}
```

Whenever a `try` statement throws an exception, the JavaScript interpreter executes the nearest `catch` statement. If a `catch` statement is not located within the construct that throws an exception, the JavaScript interpreter looks at the next higher level of code for a `catch` statement. For example, if an `if` statement contains a `throw` statement, but it does not contain a `catch` statement, the JavaScript interpreter looks in a function that contains the `if` statement. Then, if the function does not contain a `catch` statement, the JavaScript interpreter looks for a `catch` statement at the global level. If a construct contains `try` and `finally` statements, but no `catch` statement, the `finally` statement executes before the JavaScript constructor begins searching at a higher level for a `catch` statement.

The following example contains the entire `validateEmail()` function from Chapter 7, with `try`, `throw`, `catch`, and `finally` statements that evaluate the e-mail address:

```
function validateEmail(formObject) {
    try {
        var email = formObject.value;
        var emailCheck = /^[_\w-]+(\.[_\w-]+)*@ ↵
            [\w-]+(\.[\w-]+)*(\.[\D]{2,3})$/;
            if (emailCheck.test(email) == false)
                throw "One or more of the e-mail ↵
                    addresses you entered does ↵
                    not appear to be valid.";
        }
        catch(emailError) {
            window.alert(emailError)
            return false;
        }
        finally {
            formObject.value = email.toLowerCase();
        }
        return true;
}
```

Next, you will modify the Move Estimator program so that it uses exception handling to prevent users from entering any values except for numbers in the form's text boxes. Before you can add this functionality, you need to understand how to find more information about events that occur in JavaScript. An `Event` object represents every event in JavaScript. When you call an event handler function, you can pass an argument named `event`, which is an object that contains information about the event that occurred. For example, the `Event` object contains a `type` property that specifies the type of event that occurred. The button created with the following statement generates an alert dialog box that uses the `type` property of the `Event` object to display the type of event that occurred. Clicking the button displays "You generated a click event." in the alert dialog box.

You must refer to the `Event` object in your JavaScript statements with lowercase letters.

```
<input type="button" onclick="window.alert('You ↵
    generated a ' + event.type + ' event.')"
    value="Click Me" />
```

To prevent users from entering any values except for numbers, you can use the `onkeypress` event with the `Event` object to determine which values were entered. The `Event` object generated by the `onkeypress` event contains the Unicode character that represents the pressed key. Unfortunately, Internet Explorer and Netscape-based browsers (including Firefox) store the Unicode characters in different properties; Internet Explorer stores the Unicode character in the `keyCode` property, whereas Netscape-based browsers store the Unicode character in the `charCode` property. You can handle this by using the `Navigator` object to determine which browser type is running; once you determine the browser type, you can access the Unicode character from the correct property. Then, you can use the `fromCharCode()` method of the `String` class to convert the Unicode character to its equivalent print character. Finally, the code will use a regular expression within the exception-handling structure to determine the type of character the user pressed. If the user did not press a numeric character, the `onkeypress` event is canceled and a message is displayed to the user.

To add exception handling to the Move Estimator program:

1. Return to the **MoveEstimatorWithBugs.html** document in your text editor.

2. Add the following function, named `validateInput()`, to the end of the script section. The function accepts a single parameter representing the generated event.

```
function validateInput(keyPressEvent) {
}
```

3. Add to the `validateInput()` function the following `if...else` structure, which determines whether the Web browser is Internet Explorer or a Netscape-based browser. If the browser is Internet Explorer, the value of the Event object's `keyCode` property is assigned to the `enteredKey` variable. For Netscape-based browsers, the value of the `charCode` property is assigned to the `enteredKey` variable.

```
if (navigator.appName
    == "Microsoft Internet Explorer")
    var enteredKey = keyPressEvent.keyCode;
else if (navigator.appName == "Netscape")
    var enteredKey = keyPressEvent.charCode;
```

4. Next, add the following two statements to the end of the `validateInput()` function. The first statement uses the `fromCharCode()` method of the `String` class to convert the Unicode character in the `enteredKey` variable to its equivalent print character. The result is assigned to a variable named `enteredChar`. The second statement declares a variable named `retValue` that is assigned a value of true. The value assigned to the `retValue` variable will be returned from the function in the `finally` statement, which you will add next.

```
var enteredChar = String.fromCharCode(enteredKey);
var retValue = true;
```

5. Now, add the following exception handling code to the end of the `validateInput()` function. The `try` statement uses the `\d` character class expression to determine if the value assigned to the `enteredChar` variable is not a numeric value, and the

\W character class expression to determine if the character is not a nonalphanumeric character, such as a Tab character. (You studied character class expressions in Chapter 7.) If the value is not a number or a nonalphanumeric character, then an exception is thrown to the catch statement, which displays the error in an alert dialog box and assigns a value of false to the retValue variable. The finally statement returns the retValue variable, which tells the calling statement if the entered character is a numeric value.

```
try {
    if (!/\d/.test(enteredChar)
        &&  !/\W/.test(enteredChar))
        throw "You did not enter a numeric value.";
}
catch(inputError) {
    window.alert(inputError);
    retValue = false;
}
finally {
    return retValue;
}
```

6. Finally, add the following onkeypress event handler to each of the <input> elements in the form. The event handler calls the validateInput() function and passes the Event object to it. If an entered character is a numeric value, then the validateInput() function returns a value of true and the character is allowed in the text box. If the entered character is not a numeric value, then the validateInput() function returns a value of false, which prevents the character from being entered in the text box.

```
onkeypress="return validateInput(event)"
```

7. Save the **MoveEstimatorWithBugs.html** document, validate it with the W3C Markup Validation Service, and fix any errors that the document contains. Once the document is valid, close it in your text editor and open it in your Web browser. Test the form fields to ensure that you can only enter numeric values.

8. Close your Web browser window and text editor.

Implementing Custom Error Handling

The primary purpose of exception handling is to prevent users from seeing errors that may occur in your programs, and to provide a graceful way to handle those errors. As you learned earlier in this chapter, the main reason for using exception handling with JavaScript is to evaluate user input. Instead of just using exception handling with specific types of code, you can also write your own custom code for handling any types of errors that occur on a Web page. Regardless of the programming language, many programmers often prefer to write their own error-handling code. Not only does this allow programmers to write user-friendly messages, but it also gives them greater control over any errors that occur in their programs. You will also find custom error handling useful in debugging your scripts, particularly with browsers such as Firefox that display error messages in a separate window. This section explains how to add custom error-handling code to your JavaScript programs.

In the early days of JavaScript, most Web browsers displayed alert dialog boxes for each and every error that occurred on a Web page. These alert dialog boxes grew extremely annoying to users, especially when they visited Web pages containing poorly written JavaScript programs. To help make the Web surfing experience more enjoyable, most modern Web browsers suppress error messages or display them in a separate Window that must be specifically opened by the user.

Be warned that this section explains how to override a Web browser's default error-handling functionality. In most cases, you should just thoroughly test and debug your scripts, and then let a Web browser's default error handling default error handling functionality deal with whatever errors you missed. However, there may be cases when you will find it necessary to write your own error-handling functionality, particularly with interactive Web pages that require user input.

Catching Errors with the `onerror` Event

JavaScript includes an `onerror` event that executes whenever an error occurs on a Web page. Unlike other types of events, you do not call the `onerror` event handler with an XHTML tag. Instead, you must use the `onerror` event handler as a property of the Window object. You assign to the `onerror` event handler the name of a function that you want to handle JavaScript errors. For example, the following statement assigns a function named `processErrors()` to handle any JavaScript errors that occur on a page. Notice that you do not include parentheses following the function name.

```
window.onerror=processErrors;
```

To prevent a Web browser from executing its own error-handling functionality, you return a value of true from the `onerror` event handler function, as demonstrated in the following example of the `processErrors()` function:

```
function processErrors() {
     return true;
}
```

To ensure that all of the JavaScript code on your Web page can find the error-handling function, add the function to the beginning of a script section in the document head, immediately followed by a `window.onerror` statement that assigns the function as the event handler function.

Writing Custom Error-Handling Functions

When you specify a custom error-handling function by assigning it to the `onerror` event handler, the JavaScript interpreter automatically passes three arguments in the following order to the function for any JavaScript errors that occur: error message, URL, and line number.

The `onerror` event handler does not fix errors in your JavaScript programs; its only purpose is to prevent them from being reported by a Web browser and to give you an opportunity to handle them with custom code. Also note that some versions of Internet Explorer ignore the `onerror` event handler if the Disable Script Debugging option is selected on the Advanced tab of the Internet Options dialog box. You display the Internet Options dialog box in Internet Explorer by selecting Internet Options from the Tools menu.

You can use the values in your custom error-handling function by adding parameters to the function definition. You can then use the parameters in your function to point out to a user the location of any JavaScript errors that may occur. For example, the following code shows a modified version of the `processErrors()` function containing parameters that are assigned the three arguments that are passed by the JavaScript interpreter.

```
function processErrors(errMessage, errURL,
    errLineNum) {
    window.alert("The file " + errURL
        + " generated the following error: "
        + errMessage + " on line " + errLineNum);
    return true;
}
window.onerror=processErrors;
```

If you include the preceding code on your Web page, an alert dialog box will be displayed for any JavaScript errors the page contains. In the following code, the `document.write()` statement is misspelled as `document.wrte()`. This causes the alert dialog box shown in Figure 8-18 to appear in Firefox and the alert dialog box shown in Figure 8-19 to appear in Internet Explorer.

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>onerror Event Handler</title>
<meta http-equiv="content-type"
content="text/html; charset=iso-8859-1" />
<script type="text/javascript">
/* <![CDATA[ */
function processErrors(errMessage, errURL,
    errLineNum) {
    window.alert("Error: " + errMessage + "\n"
        + "File: " + errURL + "\n"
        + "Line: " + errLineNum);
    return true;
}
window.onerror=processErrors;
/* ]]> */
</script>
</head>
<body>
<script type="text/javascript">
/* <![CDATA[ */
document.wrte("My name is Don.");
/* ]]> */
</script>
</body>
</html>
```

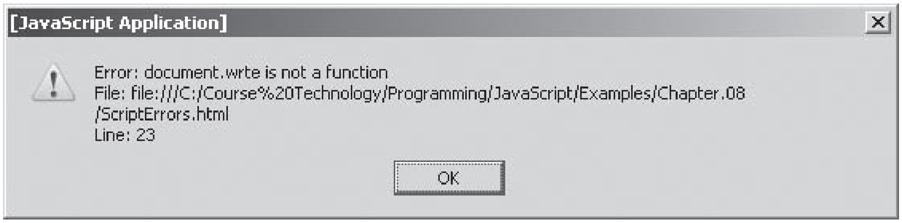


Figure 8-18 Alert dialog box displayed in Firefox by a custom error handler function

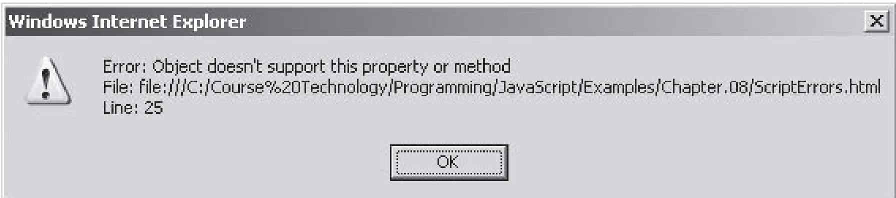


Figure 8-19 Alert dialog box displayed in Internet Explorer by a custom error handler function

Short Quiz 4

1. What does the term "bulletproofing" mean when it comes to writing code?
2. What is an exception?
3. Explain how to create a `try...catch` block.
4. What is the purpose of a `finally` statement?
5. Explain how to implement custom error handling.

Additional Debugging Techniques

The rest of this section discusses additional methods and techniques for locating and correcting errors in your JavaScript programs, including checking XHTML elements, analyzing logic, testing statements with JavaScript URLs, and reloading a Web page.

Checking XHTML Elements

There will be occasions when you cannot locate the source of a bug, no matter how long you search. In such cases, the flaw may not lie in your JavaScript code at all, but in your XHTML elements. If you cannot locate a bug using any of the methods described in this chapter, then perform a line-by-line analysis of your XHTML code, making sure that all tags have opening and closing brackets. Also, be sure that all necessary opening and closing tags, such as the `<script>...</script>` tag pair are included. Better yet, use the W3C Markup Validation Service to validate your Web page; this is usually much easier than performing a line-by-line analysis.

The following code contains flawed XHTML elements that can cause problems with JavaScript. Examine the code and look for the errors, which can be difficult to spot.

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Error Example</title>
<meta http-equiv="content-type"
content="text/html; charset=iso-8859-1" />
<script type="text/javascript"
     document.write("<p>Hello World</p>");
</script>
</head>
<body>
<h2>Error Example</h2>
</body>
</html>
```

The problem with the preceding code is that the opening `<script>` element is missing a closing bracket. Without the closing bracket, the browser sees only the script section that you want to include in the head section of the document. Because the contents of the head section are not rendered, you never receive an error message, nor do you see the output from the `document.write()` method. In your debugging efforts, you may think the JavaScript code is not functioning properly when actually it does not function at all. It's worth mentioning again that the W3C Markup Validation Service would have caught this immediately, so validate your Web pages frequently.

Analyzing Logic

At times, errors in JavaScript code stem from logic problems that are difficult to spot using tracing techniques. When you suspect that your code contains logic errors, you must analyze each statement on a case-by-case basis. For example, the following code contains a logic flaw that prevents it from functioning correctly:

```
var displayAlert = false, conditionTrue;
if (displayAlert == true)
    conditionTrue = "condition is true";
    window.alert(conditionTrue);
```

If you were to execute the preceding code, you would always see the alert dialog box, although it should not appear, because the `displayAlert` variable is set to false. However, if you examine the `if` statement more closely, you would see that the `if` statement ends after the declaration of the `conditionTrue` variable. The `window.alert()` method following the variable declaration is not part of the `if` structure, because the `if` statement does not include a set of braces to enclose the lines it executes when the conditional evaluation returns true. The `window.alert()` method also displays the value "undefined". This is because the `conditionTrue` variable was not assigned a value when it was declared in the first statement, and because the statement that assigns a value to the `conditionTrue` variable is bypassed when the `if` statement conditional expression evaluates to false. For the code to execute properly, the `if` statement must include braces as follows:

```
var displayAlert = false, conditionTrue;
if (displayAlert == true) {
    conditionTrue = "condition is true";
    window.alert(conditionTrue);
}
```

The following `for` statement shows another example of an easily overlooked logic error:

```
var count = 0;
for (count = 1; count < 6; ++count);
    document.write(count + "<br />");
```

The preceding code should print the numbers 1 through 5 to the screen. However, the line `for (var count = 1; count < 6; ++count);` contains an ending semicolon, which marks the end of the `for` loop. The loop executes five times and changes the value of `count` to 6, but does nothing else, because there are no statements before its ending semicolon. The line `document.write(count + "<br />");` is a separate statement that executes only once, printing the number 6 to the screen. The code is syntactically correct but does not function as you anticipated. As you can see from these examples, it is easy to overlook very minor logic errors in your code.

Testing Statements with JavaScript URLs

If you find that the error in your code is the result of a single statement, you can test the statement using a JavaScript URL without rerunning the entire program. A **JavaScript URL** is used for testing and executing JavaScript statements without an XHTML document or JavaScript source file. The syntax for a JavaScript URL is `javascript:`*`statement(s)`*. You enter a JavaScript URL into your Web browser's address box, just like a normal URL. When your browser sees the URL's `javascript:` protocol, it executes the JavaScript statements that follow. For example, to display an alert dialog box without executing a script, enter `javascript:window.alert("Hello World")` into your browser Address or Location box. You can include multiple statements in a JavaScript URL if a semicolon separates them. To declare a variable and display its value using an alert dialog box, you use the following statement syntax:

The code example to the right is broken onto multiple lines because of space limitations in this text. To check code using a JavaScript URL, you must enter the JavaScript code all on one line before pressing Enter.

```
javascript:var stringVar="Hello
World";window.alert(stringVar)
```

JavaScript URLs are particularly useful if you are trying to construct the correct syntax for a mathematical expression. The following code calculates the total amount due on a mortgage of $100,000. The calculation adds eight percent interest and a $35 late fee. However, the calculation does not function correctly because of an order of precedence problem.

```
mortgageBalance = 100000;
interest = .08;
lateFees = 35;
document.write(mortgageBalance + lateFees * 1
    + interest);
```

Although you can modify the structure of the formula directly within a JavaScript program, you can also use a JavaScript URL to test the calculation. The following statement displays the result of the formula in an alert dialog box, using a JavaScript URL. Parentheses that correct the order of precedence problem have been added to the formula.

```
javascript:mortgageBalance=100000;
interest=.08; lateFees=35;
window.alert((mortgageBalance
    + lateFees) * (1 + interest));
```

Reloading a Web Page

When you edit the JavaScript code in a document, it is usually sufficient to save the document and click the Reload or Refresh button in your browser to test your changes. However, it is important to understand that with complex scripts, a Web browser cannot always completely clear its memory of the remnants of an old bug, even though you have fixed the code. Therefore, it is sometimes necessary to close and then reopen the document in your browser. You can also force the reload of a Web page by holding down your Shift key and clicking the browser's Reload or Refresh button. At times, however, even reopening the file does not completely clear the browser memory of the old JavaScript code. Instead, you must close the browser window completely and start a new session. You may also find it necessary to delete the frequently visited Web pages that your browser temporarily stores either in your computer's memory or on the hard drive.

To delete cookies in Firefox, select the Tools menu and then select Clear Recent History. In the Clear Recent History dialog box, select Everything in the Time range to clear box (if necessary), click the Details button (if necessary), and then select the Cache button. Be sure to deselect any items in the Details section that you do not want to clear, and then click the Clear Now button. To delete temporary files in Internet Explorer, select Internet Options from the Tools menu, click the General tab, and then click Delete in the Browsing history section. Do not forget to perform these tasks if you are certain that you have fixed an error in your code, but are unable to get your program to perform properly.

Using a `for...in` Statement to Check Object Properties

Sometimes program errors are caused by using the wrong object properties or by assigning the wrong value to an object property. As you learned in Chapter 6, the `for...in` statement is a looping statement that executes the same statement or command block for all of the properties within an object. You can use a `for...in` loop to determine if values are being assigned to the correct properties in an object. This technique is useful when you have an object with many properties, and you cannot trace the cause of incorrect values being assigned to properties. Consider the following constructor function, which creates a `CandyOrder` object:

```
function CandyOrder(customer, candy, boxes) {
    this.customerName = customer; // customer name
    this.candyType = candy; // chocolate, caramel, ↵
        and so on
    this.numBoxes = boxes; // number of boxes ↵
        ordered
}
```

When you instantiate a new `CandyOrder` object using the statement `var valentinesDay = new CandyOrder("Don", 2, "chocolate");`, you discover that the type of candy is incorrectly assigned to the `numBoxes` property, and the number of boxes is incorrectly assigned to the `candyType` property. To help trace the problem, you can use the following `for...in` statement to loop through the properties in the `CandyOrder` object and display their values in an alert dialog box:

```
var valentinesDay = new CandyOrder("Don", 2,
    "chocolate");
var propertiesList = "";
for (prop in valentinesDay) {
    propertiesList += prop + "="
        + valentinesDay[prop] + "\n";
}
window.alert(propertiesList);
```

The preceding code creates the dialog box displayed in Figure 8-20.

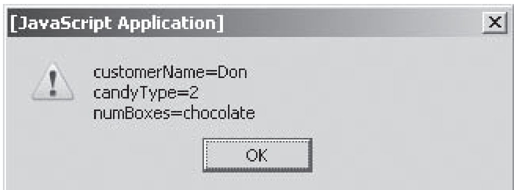


Figure 8-20 Alert dialog box created with a `for...in` statement

From the values listed in the alert box, you can see that the `candyType` and `numBoxes` properties are assigned the wrong values because the argument list in the statement that instantiates the `valentinesDay` object is incorrect. Instead of `var valentinesDay = new CandyOrder("Don", 2, "chocolate");`, the statement should be `var valentinesDay = new CandyOrder("Don", "chocolate", 2);`. Although this example of using the `for...in` statement to track down property values is fairly simple, it gives you an idea of how to use this technique to locate bugs in the assignment of object properties.

Identifying JavaScript Language and Browser Bugs

If you have tried everything you can think of to fix a bug in your program, consider the possibility that you may be encountering a bug in the JavaScript language or in a specific Web browser. As an example of a bug that exists in Firefox, consider the following statement, which uses the `Window` object's `status` property to write the text "Student Healthcare Services" to the Web browser's status bar:

```
window.status("Student Healthcare Services");
```

Because the `Window` object is the global object, it is technically not necessary to include it in your statements. However, if you exclude the `Window` object, as shown in the following example, Firefox ignores the statement and doesn't generate an error message, while Internet Explorer correctly interprets the statement and writes the text to the status bar.

```
status("Student Healthcare Services");
```

Even though Firefox ignores the preceding statement because it does not reference the `Window` object, it does correctly interpret the following statement, which assigns a value to the `defaultStatus` property, even though it also does not reference the `Window` object:

```
defaultStatus("Student Healthcare Services");
```

Unfortunately, there is no comprehensive or official list of JavaScript language bugs. If you suspect that you have encountered a JavaScript language bug or a browser bug, your best bet is to visit the browser vendor's support site. Mozilla's support site is *http://www.mozilla.com/en-US/support/* and Microsoft's support site is *http://msdn.microsoft.com*. Note, however, that the manufacturer of a software program is not always the first to know about a bug in its product. Innovative users often discover bugs first, and then report them to the program creator. These users also usually love to share their bug discoveries with other users. Take advantage of the many JavaScript programmers who are often more than happy to help you solve a problem or track down a bug. You can find help on many different Web sites by searching for "JavaScript" in any search engine.

Short Quiz 5

1. Why should you check your XHTML elements if you have a bug in your program?
2. Explain how to use a JavaScript URL to test statements for bugs.
3. How do you use a `for...in` statement to check object properties?

Summing Up

- Three types of errors can occur in a program: syntax errors, run-time errors, and logic errors. Syntax errors occur when the interpreter fails to recognize code. Run-time errors occur when the JavaScript interpreter encounters a problem while a program is executing. Logic errors are flaws in a program's design that prevent the program from running as you anticipate.
- The first line of defense in locating bugs in JavaScript programs are the error messages you receive when the JavaScript interpreter encounters a syntax or run-time error.
- The more disciplined you are in your programming technique, the fewer bugs you will find in your programs.
- Tracing is the examination of individual statements in an executing program. You can use the `window.alert()`, `document.write()`, and `document.writeln()` methods to trace JavaScript code.
- When using `write()` and `writeln()` methods to trace bugs, it is helpful to use a driver program, which is a simplified, temporary program that is used for testing functions and other code.
- Another method of locating bugs in a JavaScript program is to transform lines that you think may be causing problems into comments.
- Mozilla's debugging tool is called JavaScript Debugger and can be used to debug JavaScript code in Mozilla-based Web browsers including Firefox. Microsoft's debugging tool, called JScript debugger, can be used with Internet Explorer 8 to debug JavaScript code.
- The term break mode refers to the temporary suspension of program execution so that you can monitor values and trace program execution.
- A breakpoint is a statement in the code at which program execution enters break mode.
- The Step Into, Step Over, and Step Out buttons in both JavaScript Debugger and JScript debugger allow you to continue program execution after you enter break mode.
- JavaScript Debugger includes two views that you can use to trace variables and expressions during the course of program execution: Local Variables and Watches. In JScript debugger, you can use

the Console, Locals, and Watch panes to monitor variables and expressions in break mode.

- The term call stack refers to the order in which procedures, such as functions, methods, or event handlers, execute in a program.
- Writing code that anticipates and handles potential problems is often called bulletproofing.
- Exception handling allows programs to handle errors as they occur in the execution of a program. The term exception refers to some type of error that occurs in a program.
- You execute code that may contain an exception in a `try` statement. You use a `throw` statement to indicate that an error occurred within a `try` block. After you `throw` an error, you use a `catch` statement to handle, or "catch" the error. A `finally` statement that is included with a `try` statement executes regardless of whether its associated `try` block throws an exception.
- JavaScript includes an `onerror` event that executes whenever an error occurs on a Web page. You can combine the `onerror` event with your own custom code for handling any types of errors that occur on a Web page. When you specify a custom error-handling function by assigning it to the `onerror` event handler, the JavaScript interpreter automatically passes three arguments in the following order to the function for any JavaScript errors that occur: error message, URL, and line number.
- Additional methods and techniques for locating and correcting errors in your JavaScript programs include checking your XHTML elements, analyzing your logic, testing statements with JavaScript URLs, reloading a Web page, using a `for...in` statement to check object properties, and identifying JavaScript language and browser bugs.

Comprehension Check

1. ________________ errors are problems in the design of a program that prevent it from running as you anticipate.

    a. Syntax

    b. Logic

    c. Run-time

    d. Application

2. If the JavaScript interpreter encounters a problem while a program is executing, that problem is called a(n) ________________ error.

    a. run-time

    b. logic

    c. application

    d. syntax

3. Which of the following statements causes a syntax error?

    a. `myDate = New Date();`

    b. `document.writeln("Available points: " + availPoints)`

    c. `return salesTotal;`

    d. `window.prompt("Do you really want to submit the form?");`

4. Which of the following functions causes a divide-by-zero error?

    a.
```
function calcProfit() {
     var grossProfit = 50000;
     var netProfit = 40000;
     var margin = grossProfit - netProfit;
     var marginPercent = margin / grossProfit;
}
```

    b.
```
function calcProfit() {
     var grossProfit = 60000;
     var netProfit = 50000;
     var margin = grossProfit - netProfit;
     var marginPercent = margin / grossProfit;
}
```

    c.
```
function calcProfit() {
     var grossProfit = 50000;
     var netProfit = 50000;
     var margin = grossProfit - netProfit;
     var marginPercent = margin / grossProfit;
}
```

    d.
```
function calcProfit() {
    var grossProfit = 20000;
    var netProfit = 30000;
    var margin = grossProfit - netProfit;
    var marginPercent = margin / grossProfit;
}
```

5. Which of the following `if` statements is logically incorrect?

   a.
   ```
   if (/\.(com|org|net)$/.test(urlVariable))
        document.write("Invalid URL.");
   ```

   b.
   ```
   if (/\.(com|org|net)$/.test(urlVariable))
        document.write( "Invalid URL.");
   ```

   c.
   ```
   if (/\.(com|org|net)$/.test(urlVariable));
        document.write("Invalid URL.");
   ```

   d.
   ```
   if (/\.(com|org|net)$/.test(urlVariable)) {
        document.write("Invalid URL.");
   }
   ```

6. JavaScript error messages identify the exact location in a document where the error occurred. True or false?

7. Explain the various techniques and tools that you can use to trace the individual statements in an executing program.

8. The following simple form should call a function named `checkEmail()` when the user clicks the Submit button. What is wrong with the function that prevents the form from being submitted?

   ```
   <html>
   <head>
   <script type="text/javascript">
   /* <![CDATA[ */
   function confirmSubmit() {
       var submitForm = window.confirm(
           "Are you sure you ↵
           want to submit the form?");
       if (submitForm == true)
           return true;
       return false;
   }
   /* ]]> */
   </script>
   </head>
   <body>
   <form action="FormProcessor.html" method="get"
        onsubmit="checkEmail()">
   <p>E-Mail Address<br /><input type="text"
   name="email" />
   <input type="button" value="Submit" /></p>
   </form>
   </body>
   </html>
   ```

9. Explain how to use a driver program.

10. Which of the following modes temporarily suspends, or pauses, program execution so that you can monitor values and trace program execution?
    a. Step
    b. Break
    c. Continue
    d. Suspend

11. In most cases, you only need to use future breakpoints in JavaScript Debugger for statements that exist outside of any local functions, such as variable declaration statements or function calls. True or false?

12. Explain how to open a JavaScript document in JavaScript Debugger and JScript debugger and how to enter break mode.

13. Which of the following commands do you use in JavaScript Debugger and JScript debugger to execute the rest of the program normally or until another breakpoint is encountered?
    a. Continue
    b. Run
    c. End
    d. Stop

14. Which command executes all the statements in the next function in both JavaScript Debugger and JScript debugger?
    a. Step
    b. Step Into
    c. Step Out
    d. Step Over

15. What is the purpose of the call stack? How can you use it to debug your JavaScript programs?

16. When and why should you use exception handling with your JavaScript programs?

17. After you throw an error, you use a(n) ______________ statement to handle the error.

    a. `exception`

    b. `try`

    c. `catch`

    d. `finally`

18. Which of the following statements assigns a function named `handleProblems()` to handle any JavaScript errors that occur on a page?

    a. `handleProblems(throw);`

    b. `window.onerror=(handleProblems);`

    c. `window.onerror=handleProblems;`

    d. `window.onerror=handleProblems();`

19. Which of the following arguments does the JavaScript interpreter automatically pass to the `onerror` event handler for any JavaScript errors that occur? (Choose all that apply.)

    a. Error number

    b. Error message

    c. Line number

    d. URL

20. Explain how to use at least three additional debugging methods and techniques for locating and correcting errors in your JavaScript programs.

Reinforcement Exercises

Exercise 8-1

In this project, you create and fix a script that prints text strings.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Babe Ruth" as the content of the `<title>` element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```


4. Add the following statements to the script section:

```
document.write("<p>Babe Ruth was also known as ↵
    the "Bambino" and the "Sultan of Swat."</p>");
```

5. Save the document as **BabeRuth.html** in your Exercises folder for Chapter 8, and then open it in your Web browser. You should receive an error message about a missing parenthesis. The problem with the code is that the string in the `document.write()` statement contains nested double quotation marks. To fix the problem, you need to escape the double quotation marks with a backslash character.

6. Return to the **BabeRuth.html** document in your text editor, and add escape characters to the string in the `document.write()` statement, as follows:

```
document.write("<p>Babe Ruth was also known as ↵
    the \"Bambino\" and the \"Sultan of ↵
    Swat\".</p>");
```

7. Save the **BabeRuth.html** document, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and reload it in your Web browser window. The text should be displayed correctly without any error messages.

8. Close your Web browser window.

Exercise 8-2

In this project, you will create and fix a script that contains the formula for converting Celsius temperatures to Fahrenheit.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and “Convert to Fahrenheit” as the content of the <title> element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add to the script section the following declaration for a variable named `cTemp` that represents a Celsius temperature. The variable is assigned a value of 20 degrees.

```
var cTemp = 20;
```

5. Add the following two statements to the end of the script section. The first statement declares a variable named `fTemp` that will store the converted temperature. The right operand includes the formula for converting from Celsius to Fahrenheit. The last statement prints the value assigned to the `fTemp` variable.

```
var cTemp = 20;
var fTemp = 9 / 5 * (cTemp + 32);
document.write("<p>" + cTemp
    + " degrees Celsius is equal to "
    + fTemp.toFixed(0)
    + " degrees Fahrenheit.</p>");
```

6. Save the document as **ConvertToFahrenheit.html** in the Exercises folder for Chapter 8, and then open it in your Web browser. Twenty degrees Celsius is equivalent to 68 degrees Fahrenheit. However, the formula is incorrectly calculating that 20 degrees Celsius is equivalent to a value of 94 Fahrenheit. You will need to modify the formula so that it uses the correct order of precedence to convert the temperature.

7. Close your Web browser window, and return to the **ConvertToFahrenheit.html** document in your text editor.

8. Modify the order of precedence in the Celsius-to-Fahrenheit formula by adding parentheses as follows:

```
var fTemp = ((9 / 5) * cTemp) + 32;
```

9. Save the document as **ConvertToFahrenheit.html** document, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor, and then open it in your Web browser. The temperature should be calculated correctly, yielding a result of 68 degrees Fahrenheit.

10. Close your Web browser window.

Exercise 8-3

In this project, you will create and fix a document with a simple form that displays the value of a letter grade.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the Transitional DTD and "Letter Grades" as the content of the <title> element.

3. Create a script section in the document head that includes the following `checkGrade()` function and `switch` statement:

```
<script type="text/javascript">
/* <![CDATA[ */
function checkGrade() {
     switch (grade)
          case "A":
               window.alert("Your grade is excellent.";
               break;
          case "B":
               window.alert("Your grade is good.";
               break;
          case "C":
               window.alert("Your grade is fair.";
               break;
          case "D":
               window.alert("You are barely passing.";
               break;
          case "F":
               window.alert("You failed.";
               break;
          default:
              window.alert("Invalid letter!";
      }
/* ]]> */
</script>
```

4. Add the following form to the document body that includes an `onclick` event handler that calls the `checkGrade()` function. The value of the single text box is passed to the `checkGrade()` function.

```
<form action=""
enctype="application/x-www-form-urlencoded">
<p><input type="text" name="grade" />
<input type="button"
value="Check Grade"
onclick="checkGrade(this.value);" /></p>
</form>
```

5. Save the document as **LetterGrades.html** in the Exercises folder for Chapter 8, and then open it in your Web browser. You should receive an error message about a missing brace. The problem is that the statements within the `switch` statement are not contained within braces. Modify the `switch` statement so that it includes braces, as follows:

```
switch (grade) {
    case "A":
        window.alert("Your grade is excellent.";
        break;
    case "B":
        window.alert("Your grade is good.";
        break;
    case "C":
        window.alert("Your grade is fair.";
        break;
    case "D":
        window.alert("You are barely passing.";
        break;
    case "F":
        window.alert("You failed.";
        break;
    default:
        window.alert("Invalid letter!";
}
```

6. Save the **LetterGrades.html** document, and reload it in your Web browser window. You should receive another error message about a missing closing parenthesis. Each of the `window.alert()` statements in the switch statement is missing a closing parenthesis. Add the closing parenthesis to each of the `window.alert()` statements, between the closing quotation mark and the semicolon.

7. Save the **LetterGrades.html** document, and reload it in your Web browser window. You should not receive any more error messages when you reload the page. However, if enter a grade into the text box and click the Check Grade button, you will see an additional error about "grade" not being defined. The problem that causes this error is that the `checkGrade()` function definition does not include the `grade` parameter, which is used in the `switch` statement to evaluate the letter grade. Add the `grade` parameter to the `checkGrade()` function definition, as follows:

```
function checkGrade(grade) {
...
```

8. Save the **LetterGrades.html** document, and reload it in your Web browser window. Try entering a valid grade into the text box and clicking the Check Grade button. No matter what

value you enter, you will always see the message "Invalid letter!" in the alert box. The problem that is causing this error is that the button element, which calls the `checkGrade()` function, is incorrectly passing a value to the function of `this.value`. The value of the grade text box, not the value of the button, must be passed to the `checkGrade()` function. Modify the argument that is passed to the `checkGrade()` function, as follows:

```
onclick="checkGrade(document.forms[0].grade.value);"
```

9. Save the **LetterGrades.html** document, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and reload it in your Web browser window. The script should now function correctly.

10. Close your Web browser window.

Exercise 8-4

In this project, you will create a password validation script that uses exception handling and a regular expression to ensure that the password entered by a user is between 6 and 15 characters long and contains at least one uppercase letter, one lowercase letter, and one numeric digit.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the Transitional DTD and "Validate Password" as the content of the `<title>` element.

3. Create a script section in the document head that includes the following `validatePassword()` function. The `try` block uses an `if` statement with a regular expression to evaluate the password, which must be between 6 and 15 characters long and contain at least one uppercase letter, one lowercase letter, and one numeric digit. If the password does not match the regular expression, an exception is thrown. The `try` block also uses another `if` statement that determines whether the values in a password field and a password confirmation field match. If not, an exception is also thrown. The `finally` block removes the values that the user entered into the password and password confirmation fields. If the `catch` block does not return a value of false, meaning that no exception was thrown, the

final statements in the function print the text "You entered a valid password."

```
<script type="text/javascript">
/* <![CDATA[ */
function validatePassword(password) {
    try {
        if (document.forms[0].password.value
            != document.forms[0]
            .password_confirm.value)
        throw "You did not enter the same ↵
            password.";
        else if (!/^(?=.*\d)(?=.*[a-z])(?=.* ↵
            [A-Z]).{6,15}$/.test(password))
            throw "You did not enter a valid ↵
                password.";
    }
    catch(inputError) {
        window.alert(inputError);
        return false;
    }
    finally {
        document.forms[0].password.value = "";
        document.forms[0].password_confirm.value
            = "";
    }
    document.open();
    document.write("<strong>You entered a valid ↵
        password.</strong>");
    document.close();
}
/* ]]> */
</script>
```

4. Add the following form to the document body. The form contains a password field, a password confirmation field, and a command button that calls the `validatePassword()` function.

```
<form action=""
enctype="application/x-www-form-urlencoded">
<p>Password<br />
<input type="password" name="password" /></p>
<p>Confirm Password<br />
<input type="password"
name="password_confirm" /></p>
<p><input type="button" value="Validate Password"
onclick="validatePassword(document.forms[0] ↵
    .password.value);" /></p>
</form>
```

5. Save the document as **ValidatePassword.html** in your Exercises folder for Chapter 8, and then validate the document with the W3C Markup Validation Service. Once the

document is valid, close it in your text editor and then open it in your Web browser, and test the code.

6. Close your Web browser window.

Discovery Projects

After you fix the bugs in the following projects, be sure to validate each document with the W3C Markup Validation Service.

Project 8-1

The Projects folder for Chapter 8 on your Data Disk contains copies of some of the programs you created earlier in this text. However, all of the programs contain errors. Use any of the debugging skills you have learned in this section to correct the errors. You may review earlier tutorials to see how the program should function—but do ***not*** copy or review the correct syntax. Use these exercises as an opportunity to test and improve your debugging skills. The tutorial number in which you created each program is appended to the name of the document. After you fix each document, rename the file by replacing the "_Chapter0*x*" portion of the filename with "_Fixed" and save the document. The documents you must correct are:

- BondRatings_Chapter03.html
- TargetHeartRate_Chapter03.html
- Redirect_Chapter04.html
- ValentinesDayOrders_Chapter04.html
- AutoNextField_Chapter05.html
- MoveMenuItems_Chapter05.html
- DigitalClock_Chapter06.html
- TipCalculator_Chapter06.html
- GuessingGame_Chapter07.html
- ToDoList_Chapter07.html

Project 8-2

Many Web sites today use "challenge questions" that you can use to reset a forgotten password. Among other things, challenge questions might ask you to provide your mother's maiden name, the name of your favorite pet, or the city where you were born. Create a Web page that contains a form with several challenge questions. For challenge questions that require alphabetic answers, such as mother's maiden name, use an `onkeypress` event to call an event handler function. Within the function, use exception handling with a regular expression to prevent users from entering numeric values in fields that require text answers. If a user enters a numeric value in a field that requires a text answer, display an alert dialog box with the text "You can only enter letters into this field.", and return a value of false to prevent the character from being entered. Also include challenge question fields that require numeric answers, such as Social Security number and number of siblings. Use the `onkeypress` event with another event handler function to prevent users from entering text values in the fields that require numeric answers. The second function should also use exception handling with a regular expression to prevent users from entering text values in fields that require numeric answers. If a user enters a text value in a field that requires a numeric answer, display an alert dialog box with the text "You can only enter numbers into this field.", and return a value of false to prevent the character from being entered. Remember that you need to use different code to retrieve the Unicode character for Internet Explorer and Mozilla-based Web browsers. Save the document as ChallengeQuestions.html in your Projects folder for Chapter 8.

Project 8-3

One of the most important aspects of creating a good program is the design and analysis phase of the project. Conducting a good design and analysis phase is critical to minimizing bugs in your program. Search the Internet or your local library for information on this topic. Explain the best way to handle the design and analysis phase of a software project.

Project 8-4

Equally important as minimizing bugs during software development is the testing phase. Search the Internet or your local library for information on software testing. Then design a plan for thoroughly testing your JavaScript programs before deploying them on the Web.

CHAPTER 9

Managing State Information and Security

In this chapter, you will:

- Learn about state information
- Save state information with hidden form fields, query strings, and cookies
- Learn about security issues

The Web was not originally designed to store information about a user's visit to a Web site. However, the ability to store user information, including preferences, passwords, and other data, is very important because it allows you to improve the usability of a Web page. The three most common tools for maintaining state information are hidden form fields, query strings, and cookies, which you will study in this chapter. Given the sensitive nature of user information, it's also essential that you have a good understanding of the JavaScript security issues described in this chapter.

Understanding State Information

Hypertext Transfer Protocol (HTTP) manages the hypertext links used to navigate the Web and ensures that Web browsers correctly process and display the various types of information contained in Web pages. Information about individual visits to a Web site is called **state information**. HTTP was originally designed to be **stateless**, which means that Web browsers stored no persistent data about a visit to a Web site. The original stateless design of the Web allowed early Web servers to quickly process requests for Web pages, since they did not need to remember any unique requirements for different clients. Similarly, Web browsers did not need to know any special information to load a particular Web page from a server. Although this stateless design was efficient, it was also limiting; because a Web server could not remember individual user information, the Web browser was forced to treat every visit to a Web page as an entirely new session. This was true regardless of whether the browser had just opened a different Web page on the same server. This design hampered interactivity and limited the amount of personal attention a Web site could provide. Today, there are many reasons for maintaining state information. Among other things, maintaining state information allows a server to:

- Customize individual Web pages based on user preferences.
- Temporarily store information for a user as a browser navigates within a multipart form.
- Allow a user to create bookmarks for returning to specific locations within a Web site.
- Provide shopping carts that store order information.
- Store user IDs and passwords.
- Use counters to track the number of times a user has visited a site.

Saving State Information with Hidden Form Fields

A special type of form element, called a **hidden form field**, is not displayed by the Web browser and, therefore, allows you to hide information from users. You create hidden form fields with the `<input>` element. Hidden form fields temporarily store data that needs to be sent to a server along with the rest of a form, but that a user does not need to see. Examples of data stored in hidden fields include the result of a calculation or some other type of information that a program on the Web server might need. You create hidden form fields by using the same syntax used for other fields created with the `<input>` element: `<input type="hidden">`. The only attributes that you can include with a hidden form field are the `name` and `value` attributes.

Creating a Calculator Script with Storage Functionality

To get some practice saving state with hidden form fields, you will now use JavaScript to create a calculator script using push buttons and `onclick` event handlers. You will use a variable named `inputString` to contain the operands and operators of a calculation. After a calculation is added to the `inputString` variable, the calculation is performed using the `eval()` function. The script will include a single function named `updateString()` that accepts a single value representing a number or operator. The value is then added to the `inputString` variable using the += assignment operator. After the `inputString` variable is updated, it is assigned as the value of a text box in a form.

To create a calculator script:

1. Create a new document in your text editor.
2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and `<body>` element. Use the strict DTD and "Calculator" as the content of the `<title>` element.
3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following function to the script section. This function is used to update the `inputString` variable:

```
var inputString = "";
function updateString(value) {
     inputString += value;
     document.forms[0].input.value = inputString;
}
```

5. Add the following <form> and <p> elements to the document body:

```
<form action="">
<p>
</p>
</form>
```

6. Add a text box named `input` and a break element to the paragraph in the form, as follows:

```
<input type="text" name="input"
style="width: 170px" /><br />
```

7. Add the following <input> elements to the form; these elements create buttons representing the numbers and calculator operators. Each element sends a value to the `updateString()` function, using an `onclick` method:

```
<input type="button" name="seven"
style="width: 40px" value="7"
onclick="updateString('7')" />
<input type="button" name="eight"
style="width: 40px" value="8"
onclick="updateString('8')" />
<input type="button" name="nine" style="width: 40px"
    value="9" onclick="updateString('9')" />
<input type="button" name="div" style="width: 40px"
    value="/" onclick="updateString('/')" /><br />
<input type="button" name="four" style="width: 40px"
    value="4" onclick="updateString('4')" />
<input type="button" name="five" style="width: 40px"
    value="5" onclick="updateString('5')" />
<input type="button" name="six" style="width: 40px"
    value="6" onclick="updateString('6')" />
<input type="button" name="times"
style="width: 40px" value="*"
onclick="updateString('*')" /><br />
<input type="button" name="one" style="width: 40px"
    value="1" onclick="updateString('1')" />
<input type="button" name="two" style="width: 40px"
    value="2" onclick="updateString('2')" />
<input type="button" name="three"
style="width: 40px" value="3"
onclick="updateString('3')" />
<input type="button" name="minus"
style="width: 40px" value="-"
onclick="updateString('-')" /><br />
<input type="button" name="zero"
style="width: 40px" value="0"
onclick="updateString('0')" />
<input type="button" name="point"
style="width: 40px" value="."
onclick="updateString('.')" />
<input type="button" name="clear"
```

```
style="width: 40px" value="C"
onclick="document.forms[0].input.value=''; ↵
    inputString=''" />
<input type="button" name="plus" style="width: 40px"
    value="+" onclick="updateString('+')" /><br />
```

8. Finally, locate the end of the paragraph in the form. At the end of that paragraph, add the following element for the `calc` button (the one with the equal sign). Notice that the `onclick` event for the `calc` button performs the calculation by using the `eval()` function with the `inputString` variable. The calculated value is then assigned as the value of the `input` text box.

```
<input type="button" name="calc"
style="width: 172px" value="="
onclick="document.forms[0].input.value ↵
   =eval(inputString); inputString=''" />
```

9. Save the document as **Calculator.html** in the Chapter folder for Chapter 9, and then validate it with the W3C Markup Validation Service at *validator.w3.org/file-upload.html* and fix any errors that the document contains. Once the document is valid, open the **Calculator.html** document in your Web browser and test the calculation's functionality. Figure 9-1 shows how the Calculator.html document looks in a Web browser.

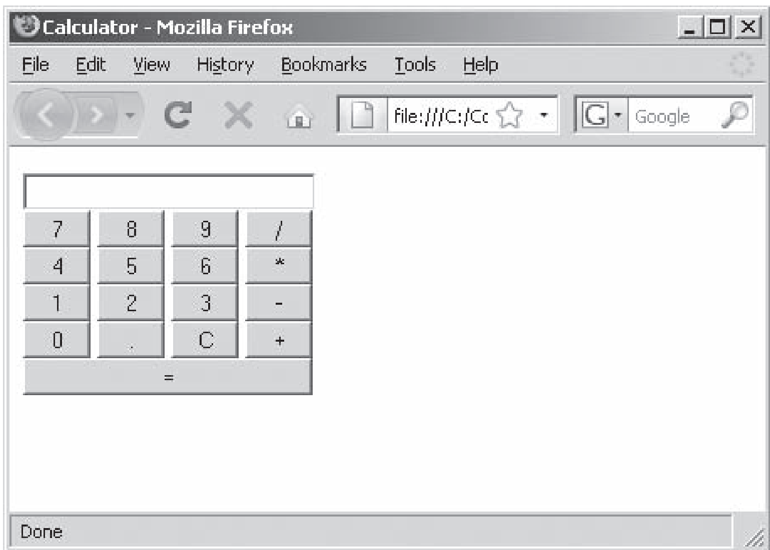


Figure 9-1 Calculator.html in a Web browser

10. Close your Web browser window.

Next, you will modify the calculator so that it includes storage functionality using a hidden form field.

To add storage functionality to the calculator:

1. Return to the **Calculator.html** file in your text editor.
2. Locate the button that performs the calculation, and change the value assigned to the width style from 172px to **40px**.
3. Add the following elements above the closing `</p>` tag in the form. The first new button, named `mem`, adds the value of the `input` text box to the value stored in the hidden form field named `storedValue`. Notice that the `mem` button's `onclick` event handler uses two calls to the `parseInt()` function. Form text fields only store data in the form of text strings. For this reason, you must use the built-in `parseInt()` function to convert the contents of a text field to an integer. After this conversion, the contents of the text field can be used in a JavaScript calculation. If you do not use the `parseInt()` function in the `mem` button's `onclick` event handler, when you attempt to assign another number to the hidden `storedValue` field, the new number is concatenated with the contents of the `storedValue` field, just as when you combine two text fields. The second new button, named `recall`, retrieves the information stored in the hidden `storedValue` field and passes it to the `updateString()` function. The third new button, named `memClear`, clears the contents of the hidden `storedValue` field.

```
<input type="button" name="mem"
style="width: 40px" value="M +"
onclick="document.forms[0].storedValue.value ↵
   = parseInt(document.forms[0].storedValue.value) ↵
   + parseInt(document.forms[0].input.value)" />
<input type="button" name="recall"
style="width: 40px" value="MRC"
onclick="updateString(document.forms[0] ↵
   .storedValue.value)" />
<input type="button" name="memClear"
style="width: 40px" value="MC"
onclick="document.forms[0].storedValue.value=0" />
<input type="hidden" name="storedValue" value="0" />
```

4. Save the **Calculator.html** document and then validate it with the W3C Markup Validation Service at *validator.w3.org/file-upload.html*, and fix any errors that the document contains. Once the document is valid, open the **Calculator.html** document in your Web browser and test the storage functionality. Figure 9-2 shows how the Calculator.html document looks in a Web browser after adding the new buttons.

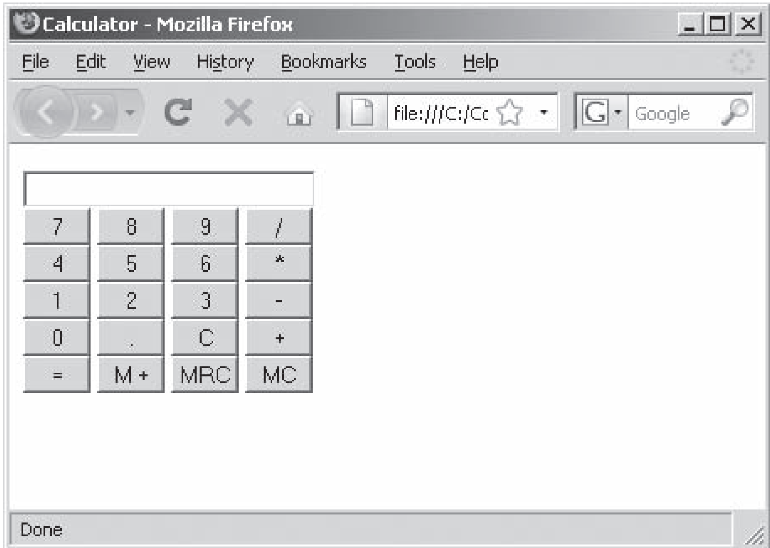


Figure 9-2 Calculator script after adding storage functionality

You can also use a global JavaScript variable to add storage functionality to the calculator script.

5. Close your Web browser window and the **Calculator.html** file in your text editor.

Using Hidden Form Fields with the Printer Product Registration Page

For learning state preservation techniques, the calculator script is limited because you can only save the most recently calculated value in a hidden form field. To learn more advanced state information techniques, you will turn your attention to a frame-based Printer Product Registration Web page. The Printer Product Registration

Web page consists of two Web pages: the first page contains a form for recording customer information, and the second page contains a form for recording product information. The documents are already created for you; you can find them in your Chapter folder for Chapter 9. Figure 9-3 shows the Customer Information form and Figure 9-4 shows the Product Information form of the Printer Product Registration page.

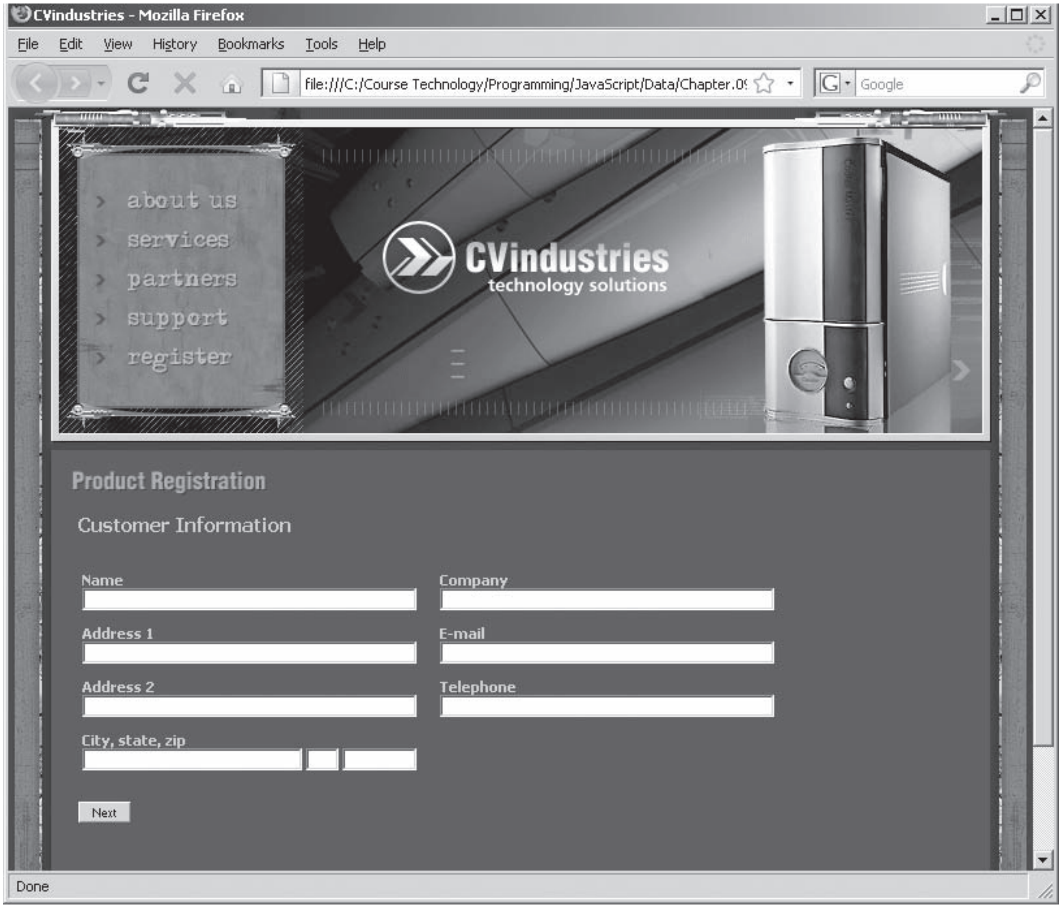


Figure 9-3 Customer Information form of the Printer Product Registration Web page

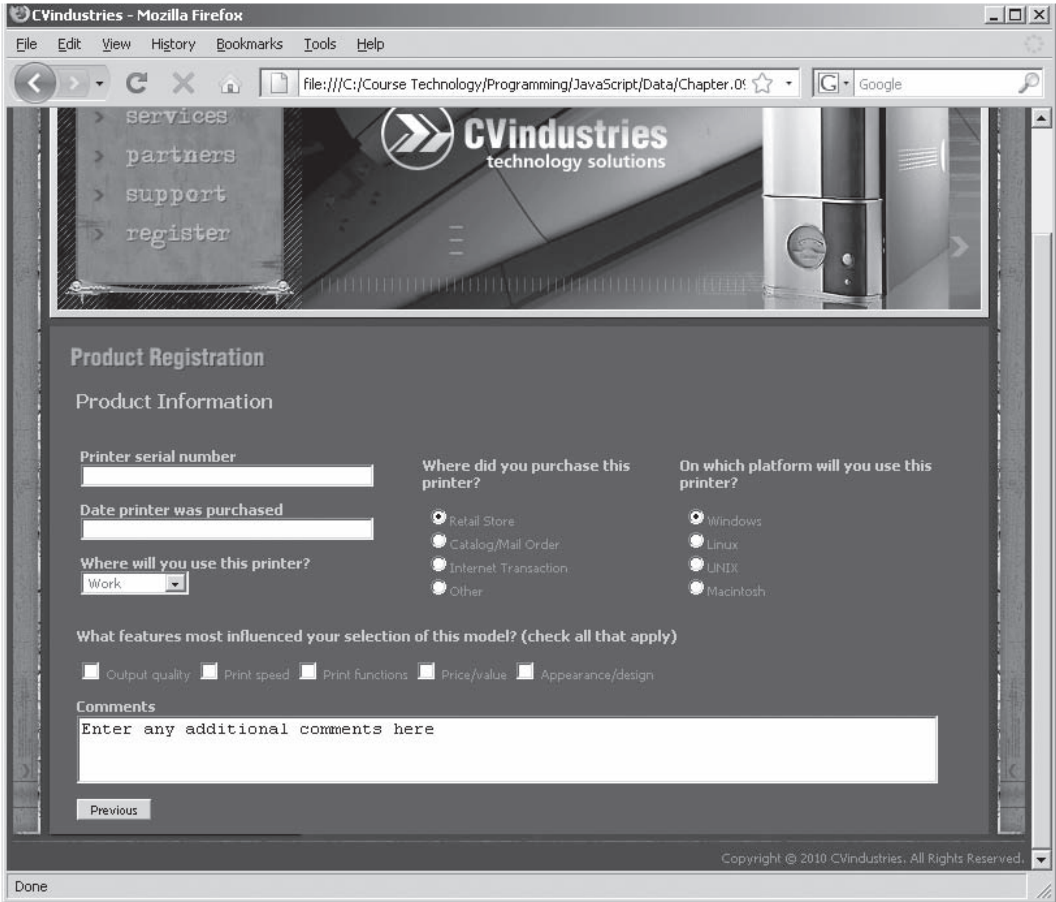


Figure 9-4 Product Information form of the Printer Product Registration Web page

The forms are designed so that data entered by the user on both forms can be submitted to a Web server simultaneously. This makes sense because the data collected by both forms are really part of the same data set; the forms are broken into two Web pages only to make it easier for the user to enter the necessary information. The problem with these Web pages is that, if a user moves from the Customer Information page to the Product Information page, the data entered on the Customer Information page is lost. In this chapter, you will learn how to save the values entered into the two Web pages by using hidden form fields, query strings, and cookies.

The frameset Web page, which is named ProductRegistration.html, creates a top frame and a bottom frame. The top frame is not visible because it is assigned a height of 0px and because the border attribute is also assigned a value of 0px. The invisible top frame will be used to maintain state information with hidden form fields, which you will study first.

Next, you add hidden form fields to the Printer Product Registration script. These fields will store customer information when the user moves from the Customer Information form to the Product Information form. The Web pages containing the forms are displayed in the bottom frame of a frame-based Web page. The Product Information form is displayed when a user clicks the Next button at the bottom of the Customer Information form. The problem is that once you click the Next button to move to the Product Information page (when you click the Previous button to move from the Product Information page back to the Customer Information page), the form values are lost. To fix this problem, you will add hidden form fields to the hidden top frame. When you click the Next or Previous buttons, the values in the forms will be copied into the hidden form fields in the top frame. You will also add a Submit button to the Product Information form that will not, in fact, submit the Product Information form to a Web server. Instead, the Submit button will copy the values of the Product Information form's fields into the hidden form fields in the top frame. Then, the form within the top frame will be submitted to a document named FormProcessor.html, using the Form object's `submit()` method. First, you will add the hidden form fields to the top frame.

You will not add validation code to the Printer Product Registration forms; this way, you can focus on the techniques presented in this chapter.

To add the hidden form fields to the top frame of the Printer Product Registration frameset:

1. Start your text editor and open the **TopFrame.html** document from the CVindustries_hiddenfields folder in your Chapter folder for Chapter 9.

2. Add the following form and hidden form fields above the closing `</body>` tag. The form contains hidden form fields that will store values from both the Customer Information form and the Product Information form. Notice that the form will be submitted to the FormProcessor.html document.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded">
<p><input type="hidden" name="name" />
<input type="hidden" name="address1" />
<input type="hidden" name="address2" />
<input type="hidden" name="city" />
<input type="hidden" name="state" />
<input type="hidden" name="zip" />
<input type="hidden" name="company" />
<input type="hidden" name="email" />
<input type="hidden" name="telephone" />
<input type="hidden" name="serial" />
<input type="hidden" name="date" />
<input type="hidden" name="usedWhere" />
<input type="hidden" name="purchasedWhere" />
```

```
<input type="hidden" name="platform" />
<input type="hidden" name="quality" />
<input type="hidden" name="speed" />
<input type="hidden" name="functions" />
<input type="hidden" name="price" />
<input type="hidden" name="design" />
<input type="hidden" name="comments" /></p>
</form>
```

3. Save the **TopFrame.html** document, and then close it in your text editor.

Next, you add code to the Customer Information and Product Information documents that copies the form field values to the hidden form fields in the top frame of the Printer Product Registration frameset. For the Customer Information document, the values will be copied when you click the Next button, and for the Product Information document, the values will be copied when you click the Previous button.

To copy the form field values in the Customer Information and Product Information documents to the hidden form fields in the top frame of the Printer Product Registration frameset:

1. Open the **CustomerInfo.html** document from the CVindustries_hiddenfields folder in your Chapter folder for Chapter 9 in your text editor.

2. The form in the CustomerInfo.html document includes a Next button with an `onclick` event handler that calls a function named `nextForm()`. The `nextForm()` function contains a single statement that opens the Product Information document using the `href` property of the `Location` object. Add the following statements above the single statement in the `nextForm()` function. The statements use the `parent` property to copy the values of the Customer Information form to the corresponding hidden form fields in the top frame.

```
parent.topframe.document.forms[0].name.value =
     document.forms[0].name.value;
parent.topframe.document.forms[0].address1.value =
     document.forms[0].address1.value;
parent.topframe.document.forms[0].address2.value =
     document.forms[0].address2.value;
parent.topframe.document.forms[0].city.value =
     document.forms[0].city.value;
parent.topframe.document.forms[0].state.value =
     document.forms[0].state.value;
parent.topframe.document.forms[0].zip.value =
     document.forms[0].zip.value;
parent.topframe.document.forms[0].company.value =
     document.forms[0].company.value;
parent.topframe.document.forms[0].email.value =
     document.forms[0].email.value;
```

```
parent.topframe.document.forms[0].telephone.value =
     document.forms[0].telephone.value;
```

3. Save the **CustomerInfo.html** document.
4. Open the **ProductInfo.html** document from the CVindustries_hiddenfields folder in your Chapter folder for Chapter 9 in your text editor.
5. Add the following new function, named `saveProductData()`, to the end of the script section. The statements use the `parent` property to copy the values of the Product Information form to the corresponding hidden form fields in the top frame.

```
function saveProductData() {
    parent.topframe.document.forms[0].serial.value
        = document.forms[0].serial.value;
    parent.topframe.document.forms[0].date.value
        = document.forms[0].date.value;
    for (var i = 0; i < document.forms[0]
        .useLocation.length; ++i) {
        if (document.forms[0].useLocation
            .options[i].selected == true) {
            parent.topframe.document
                .forms[0].usedWhere.value
                = document.forms[0].useLocation
                .options[i].value;
            break;
        }
    }
    for (var j = 0; j < 4; ++j) {
        if (document.forms[0]
            .purchaseLocation[j].checked == true) {
            parent.topframe.document
                .forms[0].purchasedWhere.value
                = document.forms[0]
                .purchaseLocation[j].value;
            break;
        }
    }
    for (var k = 0; k < 4; ++k) {
        if (document.forms[0].platform[k]
            .checked == true) {
            parent.topframe.document
                .forms[0].platform.value
                = document.forms[0]
                .platform[k].value;
            break;
        }
    }
    if (document.forms[0].quality.checked == true)
        parent.topframe.document
            .forms[0].quality.value = "true";
    if (document.forms[0].speed.checked == true)
        parent.topframe.document
            .forms[0].speed.value = "true";
```

```
    if (document.forms[0].functions.checked == true)
        parent.topframe.document
            .forms[0].functions.value = "true";
    if (document.forms[0].price.checked == true)
        parent.topframe.document
            .forms[0].price.value = "true";
    if (document.forms[0].design.checked == true)
        parent.topframe.document
            .forms[0].design.value = "true";
    parent.topframe.document.forms[0].comments.value
        = document.forms[0].comments.value;
}
```

6. The form in the ProductInfo.html document includes a Previous button with an `onclick` event handler that calls a function named `previousForm()`. The `previousForm()` function contains a single statement that opens the Customer Information document using the `href` property of the `Location` object. To call the `saveProductData()` function when you click the Previous button, add the following statement above the single statement in the `previousForm()` function.

```
function previousForm() {
    saveProductData();
    location.href = "CustomerInfo.html";
}
```

7. Save the **ProductInfo.html** document.

Next, you will add functions to the CustomerInfo.html and ProductInfo.html files that populate the form fields when you navigate between the pages. The functions will be called with an `onload` event handler in the opening <body> tag.

To add code that populates the CustomerInfo.html and ProductInfo.html files:

1. Return to the **CustomerInfo.html** document in your text editor.

2. Add the following `populateCustomerInfo()` function to the end of the script section. The statements in the function simply copy the values from the form in the top frameset to the corresponding fields in the bottom frameset.

```
function populateCustomerInfo() {
    document.forms[0].name.value
        = parent.topframe.document
        .forms[0].name.value;
    document.forms[0].address1.value
        = parent.topframe.document
        .forms[0].address1.value;
    document.forms[0].address2.value
        = parent.topframe.document
        .forms[0].address2.value;
```

```
    document.forms[0].city.value
        = parent.topframe.document
        .forms[0].city.value;
    document.forms[0].state.value
        = parent.topframe.document
        .forms[0].state.value;
    document.forms[0].zip.value
        = parent.topframe.document
        .forms[0].zip.value;
    document.forms[0].company.value
        = parent.topframe.document
        .forms[0].company.value;
    document.forms[0].email.value
        = parent.topframe.document
        .forms[0].email.value;
    document.forms[0].telephone.value
        = parent.topframe.document
        .forms[0].telephone.value;
}
```

3. Add an `onload` event handler to the opening `<body>` tag to call the `populateCustomerInfo()` function, as follows:

```
<body onload="populateCustomerInfo()">
```

4. Save the **CustomerInfo.html** document, and then close it in your text editor.

5. Return to the **ProductInfo.html** document in your text editor.

6. Add the following `populateProductData()`function to the end of the script section. The statements in the function are a little more complicated than the ones found in the `populateCustomerInfo()` function. These new functions need to evaluate the values found in the fields in the top frame in order to select the correct values in the select list and radio buttons lists in the bottom frame.

```
function populateProductData() {
    document.forms[0].serial.value
        = parent.topframe.document
        .forms[0].serial.value;
    document.forms[0].date.value
        = parent.topframe.document
        .forms[0].date.value;
    if (parent.topframe.document
        .forms[0].usedWhere.value == "work")
        document.forms[0].useLocation
            .options[0].selected = true;
    else if (parent.topframe.document
        .forms[0].usedWhere.value == "school")
        document.forms[0].useLocation
            .options[1].selected = true;
```

```
else if (parent.topframe.document
    .forms[0].usedWhere.value == "home")
    document.forms[0].useLocation
        .options[2].selected = true;
else if (parent.topframe.document
    .forms[0].usedWhere.value == "home_office")
    document.forms[0].useLocation.
        options[3].selected = true;
if (parent.topframe.document
    .forms[0].purchasedWhere.value == "retail")
    document.forms[0].purchaseLocation[0]
        .checked = true;
else if (parent.topframe.document
    .forms[0].purchasedWhere.value
    == "catalog_mail")
    document.forms[0].purchaseLocation[1]
        .checked = true;
else if (parent.topframe.document
    .forms[0].purchasedWhere.value
    == "internet")
    document.forms[0].purchaseLocation[2]
        .checked = true;
else if (parent.topframe.document.forms[0]
    .purchasedWhere.value == "other")
    document.forms[0].purchaseLocation[3]
        .checked = true;
if (parent.topframe.document
    .forms[0].platform.value == "windows")
    document.forms[0].platform[0].checked
        = true;
else if (parent.topframe.document
    .forms[0].platform.value == "linux")
    document.forms[0].platform[1].checked
        = true;
else if (parent.topframe.document
    .forms[0].platform.value == "unix")
    document.forms[0].platform[2].checked
        = true;
else if (parent.topframe.document
    .forms[0].platform.value == "mac")
    document.forms[0].platform[3].checked
         = true;
if (parent.topframe.document
    .forms[0].quality.value == "true")
    document.forms[0].quality.checked = true;
if (parent.topframe.document
    .forms[0].speed.value == "true")
    document.forms[0].speed.checked = true;
if (parent.topframe.document
    .forms[0].functions.value == "true")
    document.forms[0].functions.checked = true;
if (parent.topframe.document
    .forms[0].price.value == "true")
    document.forms[0].price.checked = true;
```

```
    if (parent.topframe.document
        .forms[0].design.value == "true")
        document.forms[0].design.checked = true;
    document.forms[0].comments.value
        = parent.topframe.document
        .forms[0].comments.value;
}
```


7. Add an onload event handler to the opening <body> tag to call the populateProductData() function, as follows:

```
<body onload="populateProductData()">
```

8. Save the **ProductInfo.html** document, and then open the **ProductRegistration.html** file in your Web browser. Enter some data into the customer information form, click the **Next** button, and then enter some data into the product information form. Test the Previous and Next buttons to ensure that the data is still visible as you navigate between the two pages.

9. Close your Web browser window.

Next, you add code to the Product Information document that submits the Printer Product Registration to the FormProcessor.html document.

To add code to the Product Information document that submits the Printer Product Registration to the FormProcessor.html document:

1. Return to the **ProductInfo.html** document in your text editor.

2. Add a submit button to the end of the form, immediately after the Previous button, as follows:

```
<p><input type="button" name="previous" value="
Previous " onclick="previousForm()" />
<input type="submit" value="Register Product" /></p>
```

3. Add to the opening <form> tag the following onsubmit event handler, which calls a function named submitForm():

```
onsubmit="return submitForm()"
```

4. Now add the following submitForm() function to the end of the script section in the document head. The first statement calls the saveProductData() function to copy the values in the Product Information form to the corresponding hidden form fields in the top frame. The second statement uses the Form object's submit() function to submit the form in the top frame to the FormProcessor.html document. (The action attribute in the <form> element in the top frame is assigned

"FormProcessor.html", which submits the top frame's form to the FormProcessor.html document.) Notice that the last statement returns a value of false, which prevents the form in the ProductInfo.html document from submitting its data.

```
function submitForm() {
     saveProductData();
     parent.topframe.document.forms[0].submit();
     return false;
}
```

5. Save the **ProductInfo.html** document, and then open the **ProductRegistration.html** document in a Web browser. Enter some data into the Customer Information form fields, and click the **Next** button. Then, enter some data into the Product Information form fields, and click the **Register Product** button. The FormProcessor.html document should open and display the data you entered, as shown in Figure 9-5.

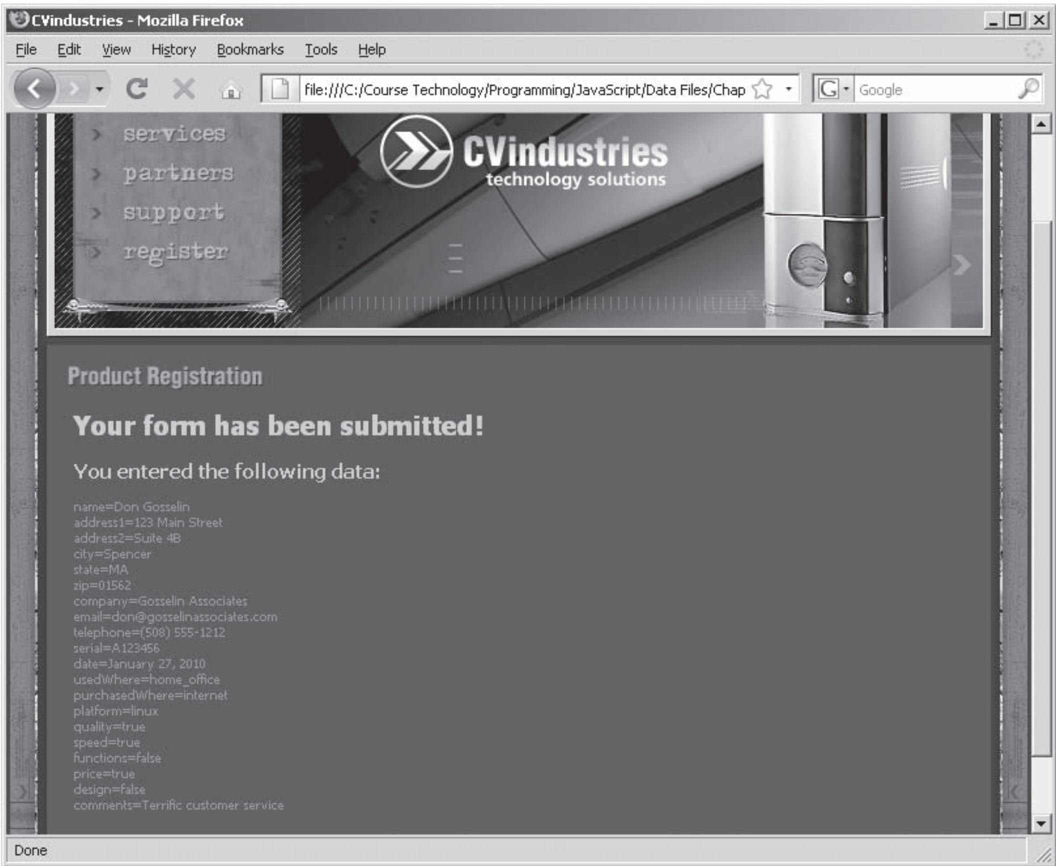


Figure 9-5 Data submitted from the Product Registration page

6. Close your Web browser window and the ProductInfo.html file in your text editor.

Saving State Information with Query Strings

One way to preserve information following a user's visit to a Web page is to append a query string to the end of a URL. A **query string** is a set of name=value pairs appended to a target URL. It consists of a single text string containing one or more pieces of information. You can use a query string to pass information, such as search criteria, from one Web page to another.

Passing Data with a Query String

To pass data from one Web page to another using a query string, add a question mark (?) immediately after a URL, followed by the query string (in name=value pairs) for the information you want to preserve. In this manner, you are passing information to another Web page, similarly to the way you can pass arguments to a function or method. You separate individual name=value pairs within the query string by using ampersands (&). The following code provides an example of an <a> element that contains a query string consisting of three name=value pairs:

```
<a href="http://www.URL.com/TargetPage.html? ↵
firstName=Don&lastName=Gosselin&occupation=writer">
Link Text</a>
```

The search property of the Location object gets its name from the fact that many Internet search engines use the query string it contains to store search criteria.

The passed query string is then assigned to the `search` property of the target Web page `Location` object. The `search` property of the `Location` object contains a URL's query or search parameters. For the preceding example, after the TargetPage.html document opens, the query string `"?firstName=Don&lastName=Gosselin&occupation=writer"` is available as the value of the `search` property of the `Location` object.

Next, you will begin to modify the Printer Product Registration pages so that the registration information is passed as query strings instead of being stored in hidden form fields.

To begin modifying the Printer Product Registration pages so that the registration information is passed as query strings:

1. First, copy the CVindustries_hiddenfields folder to a folder named **CVindustries_querystrings**.

2. Open the **CustomerInfo.html** document in the CVindustries_querystrings folder in your text editor.

3. Replace all of the statements in the `nextForm()` function with the following code, which builds the query string using each form element name and value in a variable named `savedData`. Notice that the `if` statement checks to see if the `savedData` variable, which is assigned the search string, contains a value. If it does, that means the page was opened from the ProductInfo.html page and contains product information fields. If the variable does contain product information, then the query string fields for the ProductInfo.html page are extracted to the `productData` variable by searching for "serial", which is the first field on the Product Information form, and then by using the `substring()` method to retrieve all of the data to the end of the string. The query string is then built for the customer information fields and assigned to the `savedData` variable. The name of each form element is entered as a literal string and concatenated with the `value` property of each element, using the + and += assignment operators. Then, the product information `productData` variable is appended to the `savedData` variable. The last statement appends the `savedData` query string to the ProductInfo.html URL that is assigned to the `href` property of the `Location` object.

```
var savedData = location.search;
var productData = "";
if (savedData != "")
    productData = savedData.substring(
       savedData.search("&serial"), savedData.length);
savedData = "?name=" + document.forms[0].name.value;
savedData += "&address1=" +
document.forms[0].address1.value;
savedData += "&address2=" +
document.forms[0].address2.value;
savedData += "&city=" +
document.forms[0].city.value;
savedData += "&state=" +
document.forms[0].state.value;
savedData += "&zip=" +
document.forms[0].zip.value;
savedData += "&company=" +
document.forms[0].company.value;
savedData += "&email=" +
document.forms[0].email.value;
savedData += "&telephone=" +
document.forms[0].telephone.value;
savedData += productData;
location.href = "ProductInfo.html" + savedData;
```

4. Save the **CustomerInfo.html** document.

5. Open the **ProductInfo.html** document in the CVindustries_querystrings folder in your text editor.

6. Replace the statements in the `saveProductData()` function with the following code, which builds and returns a query string. The first `if` statement uses the `substring()` method to return only the customer information fields in the query string by extracting the characters up to a value of "serial", which is the first field in the product information form. Although they appear complicated, the remaining statements are very similar to the statements in the previous version of the function that copied the values of the Product Information form to the corresponding hidden form fields in the top frame. In this version, they instead copy the values to the `savedData` variable.

```
var savedData = location.search;
if (savedData.search("serial") != -1)
    savedData = savedData.substring(0,
    savedData.search("serial"));
savedData += "&serial=" +
document.forms[0].serial.value;
savedData += "&date=" + document.forms[0].date.value;
for (var i = 0; i <
document.forms[0].useLocation.length; ++i) {
    if (document.forms[0].useLocation.options[i]
        .selected == true) {
        savedData += "&useLocation="
            + document.forms[0].useLocation
            .options[i].value;
        break;
    }
}
for (var j = 0; j < 4; ++j) {
    if (document.forms[0].purchaseLocation[j]
        .checked == true) {
        savedData += "&purchaseLocation="
            + document.forms[0].purchaseLocation[j]
            .value;
        break;
    }
}
for (var k = 0; k < 4; ++k) {
    if (document.forms[0].platform[k]
        .checked == true) {
        savedData += "&platform="
            + document.forms[0].platform[k].value;
        break;
    }
}
if (document.forms[0].quality.checked == true)
    savedData += "&quality=true";
else
    savedData += "&quality=false";
```

```
if (document.forms[0].speed.checked == true)
    savedData += "&speed=true";
else
    savedData += "&speed=false";
if (document.forms[0].functions.checked == true)
    savedData += "&functions=true";
else
    savedData += "&functions=false";
if (document.forms[0].price.checked == true)
    savedData += "&price=true";
else
    savedData += "&price=false";
if (document.forms[0].design.checked == true)
    savedData += "&design=true";
else
    savedData += "&design=false";
savedData += "&comments="
    + document.forms[0].comments.value;
return savedData;
```

7. Modify the `previousForm()` function so that the first statement assigns the query value returned from the `saveProductData()` function to a variable named `queryString`. Then, append the `queryString` variable to the CustomerInfo.html file and assign the combined value to the `location.href` property. The modified `previousForm()` function should appear as follows:

```
function previousForm() {
    var queryString = saveProductData();
   location.href = "CustomerInfo.html" + queryString;
}
```

8. Modify the `submitForm()` function as follows. The first statement assigns the query value returned from the `saveProductData()` function to a variable named `savedData`. The second statement appends the `savedData` variable to the FormProcessor.html file and assigns it to the `top.location.href` property.

```
function submitForm() {
    var savedData = saveProductData();
    top.location.href = "FormProcessor.html"
        + savedData;
    return false;
}
```

9. Save the **ProductInfo.html** document.

Before you can test the new code, you need learn how to manipulate query strings.

Parsing Data from a Query String

For a Web page to use the information in a query string, your JavaScript program must first parse the string, using a combination of several methods and the `length` property of the `String` object. (This is also true when you want to use data contained in a cookie, as you'll learn later in this chapter.) The first parsing task is to remove the question mark at the start of the query string, using the `substring()` method combined with the `length` property. As you recall from Chapter 7, the `substring()` method takes two arguments: a starting index number and an ending index number. The first character in a string has an index number of 0, similar to the first element in an array. Because you want to exclude the first character of the string (the question mark), which has an index of 0, you use a starting index of 1. For the ending index number you use the `length` property, which tells the `substring()` method to include the rest, or length, of the string. The following code assigns the `search` property of the `Location` object to a variable named `queryData` and uses the `substring()` method and `length` property to remove the starting question mark:

```
// Assigns the query string to the queryData variable
var queryData = location.search;
// Removes the opening question mark from the string
queryData = queryData.substring(1,
    queryData.length);
```

The next step is to convert the individual pieces of information in the `queryData` variable into array elements, using the `split()` method. You pass to the `split()` method the character that separates each individual piece of information in a string. In this case, you will pass the ampersand character, because that is the character that separates the name=value pairs in the query string. However, keep in mind that you can split a string at any character. The code to convert the information in the `queryData` variable into an array named `queryArray[]` is as follows:

```
// splits queryData into an array
var queryArray = queryData.split("&");
```

The following code shows a completed version of the parsing script that uses a `for` loop to print the values in `queryArray[]`:

```
// Assigns the query string to queryData
var queryData = location.search;
// Removes the opening question mark from the string
queryData = queryData.substring(1, queryData.length);
// splits queryData into an array
var queryArray = queryData.split("&");
for (var i=0; i<queryArray.length; ++i) {
     document.write(queryArray[i] + "<br />");
}
```

Figure 9-6 shows the output in a Web browser when the `location.search` property in the preceding code contains the following string value:

```
?firstName=Don&lastName=Gosselin&occupation=writer
```

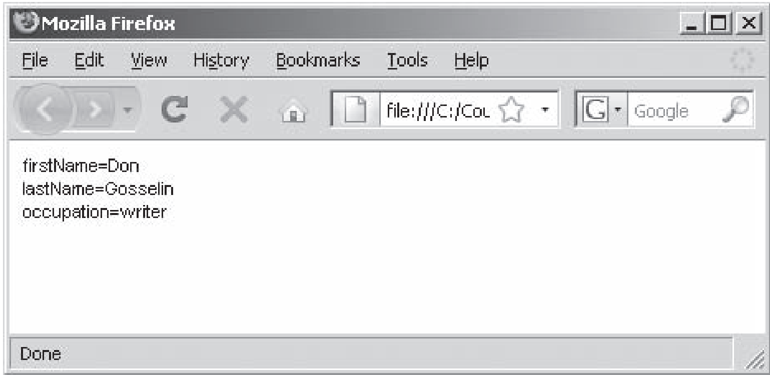


Figure 9-6 Parsing script in a Web browser

Next, you will modify the `populateCustomerInfo()` and `populateProductData()` functions so they extract and display the data in the query strings that are passed between the CustomerInfo.html and ProductInfo.html files.

To modify the `populateCustomerInfo()` and `populateProductData()` functions so that they extract and display the data in the query strings that are passed between the CustomerInfo.html and ProductInfo.html files:

1. Return to the `CustomerInfo.html` file in your text editor.
2. Modify the `populateCustomerInfo()` function as follows. The first few statements retrieve the value assigned to the `location.search` property and then split the data into an array named `queryArray[]`. Each subsequent statement then uses the `substring()` method of the `String` object to extract and display the value portion of each name=value pair, based on its index in the array. For example, the name value is located at `queryArray[0]`, while the telephone value is located at `queryArray[8]`.

```
function populateCustomerInfo() {
    if (location.search) {
        var queryData = location.search;
        queryData = queryData.substring(1,
            queryData.length);
        var queryArray = queryData.split("&");
```

```
            document.forms[0].name.value = queryArray[0]
                .substring(queryArray[0]
                .lastIndexOf("=") + 1);
            document.forms[0].address1.value
                = queryArray[1].substring(queryArray[1]
                .lastIndexOf("=") + 1);
            document.forms[0].address2.value
                = queryArray[2].substring(queryArray[2]
                .lastIndexOf("=") + 1);
            document.forms[0].city.value = queryArray[3]
                .substring(queryArray[3]
                .lastIndexOf("=") + 1);
            document.forms[0].state.value
                 = queryArray[4].substring(queryArray[4]
                .lastIndexOf("=") + 1);
            document.forms[0].zip.value = queryArray[5]
                .substring(queryArray[5]
                .lastIndexOf("=") + 1);
            document.forms[0].company.value
                 = queryArray[6].substring(queryArray[6]
                .lastIndexOf("=") + 1);
            document.forms[0].email.value
                 = queryArray[7].substring(queryArray[7]
                .lastIndexOf("=") + 1);
            document.forms[0].telephone.value
                = queryArray[8].substring(queryArray[8]
                .lastIndexOf("=") + 1);
        }
    }
```


3. Save the **CustomerInfo.html** file, and then close it in your text editor.

4. Return to the **ProductInfo.html** file in your text editor.

5. Modify the `populateProductData()` function as follows. The first statement retrieves the value of the `location.search` property and assigns it to the `queryData` variable. The `if` statement then uses the `search()` method of the String object to search the `queryData` variable for `"serial"`. If the method returns a value other than `-1`, then data for the product information page is stored in the query string. In that case, the statements within the `if` statement use the `substring()` method of the `String` object to extract and display the value portion of each name=value pair, based on its index in the array. For example, the serial value is located at `queryArray[9]` and the date value is located at `queryArray[10]`.

```
function populateProductData() {
    var queryData = location.search;
    if (queryData.search("serial") != -1) {
        queryData = queryData.substring(1,
           queryData.length);
        var queryArray = queryData.split("&");
        document.forms[0].serial.value
            = queryArray[9].substring(
            queryArray[9].lastIndexOf("=") + 1);
        document.forms[0].date.value
            = queryArray[10].substring(
            queryArray[10].lastIndexOf("=") + 1);
        if (queryArray[11].substring(
            queryArray[11].lastIndexOf("=") + 1)
            == "work")
            document.forms[0].useLocation.options[0]
                .selected = true;
        else if (queryArray[11].substring(
            queryArray[11].lastIndexOf("=") + 1)
            == "school")
            document.forms[0].useLocation.options[1]
                .selected = true;
        else if (queryArray[11].substring(
            queryArray[11].lastIndexOf("=") + 1)
             == "home")
            document.forms[0].useLocation.options[2]
                .selected = true;
        else if (queryArray[11].substring(
            queryArray[10].lastIndexOf("=") + 1)
            == "home_office")
            document.forms[0].useLocation.options[3]
                .selected = true;
        if (queryArray[12].substring(
            queryArray[12].lastIndexOf("=") + 1)
            == "retail")
            document.forms[0].purchaseLocation[0]
                .checked = true;
        else if (queryArray[12].substring(
            queryArray[12].lastIndexOf("=") + 1)
             == "catalog_mail")
            document.forms[0].purchaseLocation[1]
                .checked = true;
        else if (queryArray[12].substring(
            queryArray[12].lastIndexOf("=") + 1)
            == "internet")
            document.forms[0].purchaseLocation[2]
                .checked = true;
        else if (queryArray[12].substring(
            queryArray[12].lastIndexOf("=") + 1)
            == "other")
            document.forms[0].purchaseLocation[3]
                .checked = true;
```

```
            if (queryArray[13].substring(
                queryArray[13].lastIndexOf("=") + 1)
                == "windows")
                document.forms[0].platform[0].checked
                    = true;
            else if (queryArray[13].substring(
                queryArray[13].lastIndexOf("=") + 1)
                == "linux")
                document.forms[0].platform[1].checked
                    = true;
            else if (queryArray[13].substring(
                queryArray[13].lastIndexOf("=") + 1)
                == "unix")
                document.forms[0].platform[2].checked
                    = true;
            else if (queryArray[13].substring(
                queryArray[13].lastIndexOf("=") + 1)
                == "mac")
                document.forms[0].platform[3].checked
                    = true;
            if (queryArray[14].substring(
                queryArray[14].lastIndexOf("=") + 1)
                == "true")
                document.forms[0].quality.checked
                    = true;
            if (queryArray[15].substring(
                queryArray[15].lastIndexOf("=") + 1)
                == "true")
                document.forms[0].speed.checked = true;
            if (queryArray[16].substring(
                queryArray[16].lastIndexOf("=") + 1)
                == "true")
                document.forms[0].functions.checked
                    = true;
            if (queryArray[17].substring(
                queryArray[17].lastIndexOf("=") + 1)
                == "true")
                document.forms[0].price.checked = true;
            if (queryArray[18].substring(
                queryArray[18].lastIndexOf("=") + 1)
                == "true")
                document.forms[0].design.checked = true;
            document.forms[0].comments.value
                = queryArray[19].substring(
            queryArray[19].lastIndexOf("=") + 1);
        }
    }
```


6. Save the **ProductInfo.html** document, and then open the **ProductRegistration.html** document in a Web browser. Enter some data into the Customer Information form fields, and click the **Next** button. Next, enter some data into the Product Information form fields, and click the **Register**

Product button. The FormProcessor.html document should open and display the data you entered, just as it did with the hidden forms version of the script.

7. Close your Web browser window and the **ProductInfo.html** file in your text editor.

Short Quiz 1

1. Explain how to use hidden form fields to maintain state information.
2. Explain how to pass state information with query strings.
3. Explain how to parse query strings.

Saving State Information with Cookies

Query strings do not permanently maintain state information. The information contained in a query string is available only during the current session of a Web page. Once a Web page that reads a query string closes, the query string is lost. Hidden form fields maintain state information between Web pages, but the data they contain are also lost once the Web page that reads the hidden fields closes. You can save the contents of a query string or hidden form fields by submitting the form data by using a server-side scripting language, but that method requires a separate, server-based application. To make it possible to store state information beyond the current Web page session, Netscape created cookies. **Cookies** are small pieces of information about a user that are stored by a Web server in text files on the user's computer. The W3C DOM defines cookie specifications.

Each time the Web client visits a Web server, saved cookies for the requested Web page are sent from the client to the server. The server then uses the cookies to customize the Web page for the client. Cookies were originally created for use with CGI scripts but are now commonly used by JavaScript and other scripting languages.

You have probably seen cookies in action if you have ever visited a Web site where you entered a username in a prompt dialog box or in a text field and then found that you were greeted by that username the next time you visited the Web site. This could occur with each subsequent visit to the same Web site, whether during the same browser session or during a different browser session days or weeks later. The Web page remembers this information by storing it locally on your computer in a cookie. Another example of a cookie is a counter that counts the number of times an individual user has visited a Web site.

Cookies can be temporary or persistent. **Temporary cookies** remain available only for the current browser session. **Persistent cookies** remain available beyond the current browser session and are stored in a text file on a client computer. In this section, you will create both persistent and temporary cookies.

There are a number of limitations on the use of cookies that are enforced by Web browsers. Each individual server or domain can store only a maximum of 20 cookies on a user's computer. In addition, the total cookies per browser cannot exceed 300, and the largest cookie size is 4 KB. If these limits are exceeded, a Web browser may start discarding older cookies.

Creating and Modifying Cookies

You use the `cookie` property of the `Document` object to create cookies in name=value pairs, the same way you used name=value pairs with a query string. The syntax for the `cookie` property is as follows:

```
document.cookie = name + "=" + value;
```

The cookie property is created with a required `name` attribute and four optional attributes: `expires`, `path`, `domain`, and `secure`.

To modify an existing cookie, you simply assign a new name=value pair to the `document.cookie` property. If the name=value pair already exists it will be overwritten.

The name Attribute

The only required parameter of the `cookie` property is the `name` attribute, which specifies the cookie's name=value pair. Cookies created with only the `name` attribute are temporary cookies, because they are available for only the current browser session. The following code creates a cookie with a name=value pair of "firstName=Don":

```
document.cookie = "firstName=" + "Don";
```

The `cookie` property of the `Document` object can be confusing. For other JavaScript properties, assigning a new value to a property *replaces* the old value. In contrast, assigning a new value to the `cookie` property adds another entry to a list of cookies, rather than simply replacing the last value. The following example builds a list of cookies:

```
document.cookie = "firstName=" + "Don";
document.cookie = "lastName=" + "Gosselin";
document.cookie = "occupation=" + "writer";
```

A Web browser automatically separates each name=value pair in the `cookie` property with a semicolon and a space. Therefore, the value assigned to the `cookie` property for the preceding cookies contains the following value:

```
firstName=Don; lastName=Gosselin; occupation=writer
```

By default, cookies themselves cannot include semicolons or other special characters, such as commas or spaces. Cookies cannot include special characters because they are transmitted between Web browsers and Web servers using HTTP, which does not allow certain nonalphanumeric characters to be transmitted in their native format. However, you can use special characters in your cookies if you use **encoding**, which involves converting special characters in a text string to their corresponding hexadecimal ASCII value, preceded by a percent sign. For example, 20 is the hexadecimal ASCII equivalent of a space character, and 25 is the hexadecimal ASCII equivalent of a percent sign (%). In URL encoded format, each space character is represented by %20, and each percent sign is represented by %25. After encoding, the contents of the string "tip=A standard tip is 15%" would read as follows:

```
tip=A%20standard%20tip%20is%2015%25
```

The built-in **`encodeURIComponent()` function** is used in JavaScript for encoding the individual parts of a URI. More specifically, the `encodeURIComponent()` function converts special characters in the individual parts of a URI to their corresponding hexadecimal ASCII value, preceded by a percent sign. The syntax for the `encodeURIComponent()` function is `encodeURIComponent(`*`text`*`);`. The `encodeURIComponent()` function does not encode standard alphanumeric characters such as A, B, C, or 1, 2, 3, or any of the following special characters: - _ . ! ~ * ' ( ). It also does not encode the following characters, which have a special meaning in a URI: ; / ? : % @ & = + $,. For example, the / character is not encoded because it is used for designating a path on a file system. When you read a cookie or other text string encoded with the `encodeURIComponent()` function, you must first decode it with the **`decodeURIComponent()` function**. The syntax for the `decodeURIComponent()` function is `decodeURIComponent(`*`text`*`);`. The following code encodes several cookies with the `encodeURIComponent()` function and assigns them to the `cookie` property of the `Document` object:

```
document.cookie = "firstName="
    + encodeURIComponent("Don");
document.cookie = "lastName="
    + encodeURIComponent("Gosselin");
document.cookie = "occupation="
    + encodeURIComponent("writer");
```

JavaScript also includes the `encodeURI()` and `decodeURI()` functions, which can be used to encode and decode entire URIs. Be sure to distinguish these functions from the `encodeURIComponent()` and `decodeURIComponent()` functions, which encode and decode the individual parts of a URI.

If you transmit a URI containing spaces from current Web browsers (including Firefox and Internet Explorer), the Web browser automatically encodes the spaces for you before transmitting the cookie. However, special characters, such as the percent sign, are not automatically encoded. This can cause problems with older browsers and Web servers that do not recognize certain special characters unless they are encoded. Additionally, older Web browsers do not automatically encode spaces in URIs. For these reasons, you should manually encode and decode cookies using the `encodeURIComponent()` and `decodeURIComponent()` functions if you anticipate that your scripts will run in older Web browsers.

Next, you will modify the Customer Information and Product Information forms so that the fields are saved in temporary cookies instead of in query strings.

Older versions of JavaScript use the deprecated `escape()` and `unescape()` methods for encoding and decoding text strings.

To modify the Customer Information and Product Information forms so that the fields are saved in temporary cookies instead of in query strings:

1. Copy the CVindustries_querystrings folder to a folder named **CVindustries_cookies**.
2. Open the **CustomerInfo.html** document in the CVindustries_cookies folder in your text editor.
3. Delete the following statements from the `nextForm()` function:

```
var savedData = location.search;
var productData = "";
if (savedData != "")
    productData = savedData.substring(
        savedData.search("&serial"),
        savedData.length);
```

4. Next, in each of the lines that build the `savedData` variable, replace `savedData` with **`document.cookie`**. Remove the question mark from the statement that stores the name field, and change the += assignment operators to standard assignment operators (=). Also remove the ampersands (&) from the name portion of each name=value pair, and encode each of the values that are assigned as cookies using the `encodeURIComponent()` method. Finally, delete the `savedData += productData;` statement and the portions of the `location.href` statement that append the query string, so that it reads **`location.href = "ProductInfo.html";`**.

The statements in the modified `nextForm()` function should appear as follows:

```
document.cookie = "name="
    + encodeURIComponent(
    document.forms[0].name.value);
document.cookie = "address1="
    + encodeURIComponent(
    document.forms[0].address1.value);
document.cookie = "address2="
    + encodeURIComponent(
    document.forms[0].address2.value);
document.cookie = "city="
    + encodeURIComponent(
    document.forms[0].city.value);
document.cookie = "state="
    + encodeURIComponent(
    document.forms[0].state.value);
document.cookie = "zip="
    + encodeURIComponent(
    document.forms[0].zip.value);
document.cookie = "company="
    + encodeURIComponent(
    document.forms[0].company.value);
document.cookie = "email="
    + encodeURIComponent(
    document.forms[0].email.value);
document.cookie = "telephone="
    + encodeURIComponent(
    document.forms[0].telephone.value);
location.href = "ProductInfo.html";
```

5. Save the **CustomerInfo.html** document.

6. Open the **ProductInfo.html** document in the CVindustries_cookies folder in your text editor.

7. Delete the following statements from the `saveProductData()` function:

```
var savedData = location.search;
if (savedData.search("serial") != -1)
    savedData = savedData.substring(0,
        savedData.search("serial"));
```

8. Next, in each of the lines that build the `savedData` variable, replace `savedData` with **`document.cookie`** and change the += assignment operators to standard assignment operators (=). Also, remove the ampersands (&) from the name portion of each name=value pair and encode each of the values that are assigned as cookies using the `encodeURIComponent()` method. Finally, delete the return statement at the end of the function. The statements in the modified `saveProductData()` function should appear as follows:

```
document.cookie = "serial=" + encodeURIComponent(
    document.forms[0].serial.value);
document.cookie = "date="
    + encodeURIComponent(
    document.forms[0].date.value);
for (var i = 0; i < document.forms[0].useLocation
    .length; ++i) {
    if (document.forms[0].useLocation.options[i]
        .selected == true) {
        document.cookie = "useLocation="
            + encodeURIComponent(
         document.forms[0].useLocation
            .options[i].value);
        break;
    }
}
for (var j = 0; j < 4; ++j) {
    if (document.forms[0].purchaseLocation[j]
        .checked == true) {
        document.cookie = "purchaseLocation="
            + encodeURIComponent(
            document.forms[0].purchaseLocation[j].value);
        break;
    }
}
for (var k = 0; k < 4; ++k) {
    if (document.forms[0].platform[k].checked
        == true) {
        document.cookie = "platform="
            + encodeURIComponent(
            document.forms[0].platform[k].value);
        break;
    }
}
if (document.forms[0].quality.checked == true)
    document.cookie = "quality=true";
else
    document.cookie = "quality=false";
if (document.forms[0].speed.checked == true)
    document.cookie = "speed=true";
else
    document.cookie = "speed=false";
if (document.forms[0].functions.checked == true)
    document.cookie = "functions=true";
else
    document.cookie = "functions=false";
if (document.forms[0].price.checked == true)
    document.cookie = "price=true";
else
    document.cookie = "price=false";
if (document.forms[0].design.checked == true)
    document.cookie = "design=true";
```

```
else
    document.cookie = "design=false";
document.cookie = "comments=" + encodeURIComponent(
    document.forms[0].comments.value);
```

9. Modify the `previousForm()` function so it no longer appends the query string to the `href` property of the `Location` object. The modified form should appear as follows:

```
function previousForm(){
    saveProductData();
    location.href = "CustomerInfo.html";
}
```

10. Save the **ProductInfo.html** document.

Before you can open the Printer Product Registration document, you need to learn how to read cookies, as explained later in this chapter. Before you learn how to read cookies, you will learn about other cookie parameters.

Setting Cookie Expiration Dates

For a cookie to persist beyond the current browser session, you must use the `expires` attribute of the `cookie` property. The **`expires` attribute** of the `cookie` property determines how long a cookie can remain on a client system before it is deleted. Cookies created without an `expires` attribute are available for only the current browser session. The syntax for assigning the `expires` attribute to the `cookie` property, along with an associated name=value pair, is `expires=`*`date`*. The name=value pair and the `expires=`*`date`* pair are separated by a semicolon. The date portion of the `expires` attribute must be a text string in Coordinated Universal Time (usually abbreviated as UTC) format, which looks like this:

```
Weekday Mon DD HH:MM:SS Time Zone YYYY
```

The following is an example of Coordinated Universal Time:

```
Mon Dec 27 14:15:18 PST 2010
```

You can manually type a string in UTC format, or you can create the string with the `Date` object, which automatically creates the string in UTC format. (You first learned about the `Date` object in Chapter 6.) To use a `Date` object with the `expires` attribute, you specify the amount of time you want a cookie to be valid by using a combination of the set and get methods of the `Date` object. The following statement declares a `Date` object named `cookieDate`, and then changes the date portion of the new object by using the `setDate()` and `getDate()` methods. Notice that you can nest `Date` object methods inside other `Date` object methods. In the example, the `setDate()`

Coordinated Universal Time is also known as Greenwich Mean Time (GMT), Zulu time, and world time.

Take care not to encode the `expires` attribute using the `encodeURIComponent()` method. JavaScript does not recognize a UTC date when it is in URI-encoded format. If you use the `encodeURIComponent()` method with the `expires` attribute, JavaScript is not able to set the cookie expiration date.

method sets the date portion of `cookieDate` by using the `getDate()` method to retrieve the date, and adding seven to increase the date by one week. You might use a cookie that expires after one week (or less) to store data that needs to be maintained for a limited amount of time. For example, a travel agency may store data in a cookie that temporarily holds a travel reservation that expires after a week.

```
cookieDate.setDate(myDate.getDate() + 7);
```

After you create a `Date` object and specify the date you want the cookie to expire, you must use the `toUTCString()` method to convert the `Date` object to a string, formatting it in Coordinated Universal Time. The following code creates a new cookie and assigns an expiration date one year from now. Before the `expires` attribute is assigned to the `cookie` property, the `Date` object uses the `toUTCString()` method to convert the date to a string in Coordinated Universal Time.

```
var expiresDate = new Date();
expiresDate.setFullYear(expiresDate.getFullYear() + 1);
document.cookie = "firstName=" + encodeURIComponent("Don")
    + "; expires=" + expiresDate.toUTCString();
```

Deleting Cookies from your Browser

When developing a JavaScript program, you may accidentally create, but not delete, persistent cookies that your program does not need. Unused persistent cookies can sometimes interfere with the execution of a JavaScript cookie program. For this reason, it's a good idea to delete your browser cookies periodically, especially while developing a JavaScript program that uses cookies. To delete cookies in Firefox, select the Tools menu and then select Clear Recent History. In the Clear Recent History dialog box, select Everything in the Time range to clear box (if necessary), click the Details button (if necessary), and then select the Cookies button. Be sure to deselect any items in the Details section that you do not want to clear, and then click the Clear Now button. To delete cookies in Internet Explorer, select Internet Options from the Tools menu, click the General tab of the Internet Options dialog box, and then click the Delete button. In the Delete Browsing History dialog box, select Cookies, along with any other items you want to delete, and then click Delete.

Configuring Availability of Cookies to Other Web Pages on the Server

The **`path` attribute** determines the availability of a cookie to other Web pages on a server. The `path` attribute is assigned to the `cookie` property, along with an associated name=value pair, using the syntax `path=`*`path name`*. By default, a cookie is available to all Web pages in the same directory. However, if you specify a path, then a cookie is available to all Web pages in the specified path as well as to all Web pages in all subdirectories in the specified path. For example, the following statement makes the cookie named `firstName` available to all Web pages located in the /marketing directory or any of its subdirectories:

```
document.cookie = "firstName="
    + encodeURIComponent("Don"
    + ";path=/marketing");
```

To make a cookie available to all directories on a server, use a slash to indicate the root directory, as in the following example:

```
document.cookie = "firstName="
    + encodeURIComponent("Don" + ";path=/");
```

When you are developing JavaScript programs that create cookies, your programs may not function correctly if the directory containing your Web page contains other programs that create cookies. Cookies from other programs that are stored in the same directory along with unused cookies you created during development can cause your JavaScript cookie program to run erratically. Therefore, you should always place JavaScript cookie programs in their own directory and use the `path` attribute to specify any subdirectories your program requires.

Sharing Cookies Across a Domain

Using the `path` attribute allows cookies to be shared across a server. Some Web sites, however, are very large and use a number of servers. The **`domain` attribute** is used for sharing cookies across multiple servers in the same domain. Note that you cannot share cookies outside of a domain. The `domain` attribute is assigned to the `cookie` property, along with an associated name=value pair, using the syntax `domain=`*`domain name`*. For example, if the Web server `programming.gosselin.com` needs to share cookies with the Web server `writing.gosselin.com`, the `domain` attribute for cookies set by `programming.gosselin.com` should be set to `.gosselin.com`. That way, cookies created by `programming.gosselin.com` are available to `writing.gosselin.com` and to all other servers in the domain `gosselin.com`.

The following code shows how to make a cookie at `programming.gosselin.com` available to all servers in the `gosselin.com` domain:

```
document.cookie = "firstName="
    + encodeURIComponent("Don"
    + ";domain=.gosselin.com");
```

Securing Cookie Transmissions

Internet connections are not always considered safe for transmitting sensitive information. It is possible for unscrupulous people to steal personal information, such as credit card numbers, passwords, Social Security numbers, and other types of private information online. To protect private data transferred across the Internet, Netscape developed Secure Sockets Layer, or SSL, to encrypt data and transfer it across a secure connection. The URLs for Web sites that support SSL usually start with the HTTPS protocol instead of HTTP. The **secure attribute** indicates that a cookie can only be transmitted across a secure Internet connection using HTTPS or another security protocol. Generally, when working with client-side JavaScript, the `secure` attribute should be omitted. However, if you wish to use this attribute, you assign it to the `cookie` property with a Boolean value of true or false, along with an associated name=value pair, using the syntax `secure=`*`boolean value`*. For example, to activate the secure attribute for a cookie, you use a statement similar to the following:

```
document.cookie = "firstName="
    + encodeURIComponent("Don"
    + ";secure=true");
```

Reading Cookies with JavaScript

So far, you have stored both temporary and persistent cookies. Next, you need to learn how to retrieve stored cookie values—in other words, how to read cookies. The cookies for a particular Web page are available in the `cookie` property of the `Document` object. Cookies consist of one continuous string that must be parsed before the data they contain can be used. To parse a cookie, you must:

1. Decode it using the `decodeURIComponent()` function.
2. Use the methods of the `String` object to extract individual name=value pairs.

Parsing cookie data is very similar to parsing query strings, except that you do not need to remove the question mark at the beginning of the string; also, the individual cookies are separated by a semicolon and a space instead of ampersands. To give you an idea of what is involved in extracting data from cookies, the following code creates three encoded cookies, then reads them from the `cookie` property and decodes them. The `split()` method is then used to copy each name=value pair into the elements of an array named `cookieArray[]`.

```
document.cookie = "city=" + encodeURIComponent("Boston");
document.cookie = "team="
    + encodeURIComponent("Red Sox");
document.cookie = "sport="
    + encodeURIComponent("baseball");
var cookieString = decodeURIComponent(
    document.cookie);
var cookieArray = cookieString.split("; ");
```

Notice that the `split()` method in the preceding code splits the cookies by using two characters: a semicolon and a space. If you do not include the space in the `split()` method, then the name portion of each name=value pair in the new array has an extra space before it. Once you split the cookies into separate array elements, you still need to determine which cookie holds the value you need. The following `for` loop cycles through each element in the array, using an `if` statement and several string methods to check if the name portion of each name=value pair is equal to *team*. The conditional expression in the `if` statement uses the `substring()` method to return the name portion of the name=value pair in the variable named `yourTeam`. The first argument in the `substring()` method specifies the starting point of the substring as the first character (0). The second argument in the `substring()` method is the `indexOf()` method appended to the `yourTeam` variable, which returns the index number of the equal sign. If the substring is equal to *team*, then the `for` loop ends using a `break` statement, and the text *Your team is the* is written to the browser along with the value portion of the name=value pair. The statements that return the value portion of the name=value pair also use the `substring()` method along with the `indexOf()` method. However, this time the first argument starts the substring at the index number of the equal sign plus one, which is the character following the equal sign. The second argument in the `substring()` method specifies that the ending point of the `substring` is the length of the data variable.

```
var yourTeam;
for (var count = 0; count < 3; ++count) {
     yourTeam = cookieArray[count];
     if (yourTeam.substring(0,yourTeam.indexOf("="))
           == "team") {
          document.writeln("Your team is the "
              + yourTeam.substring(
              yourTeam.indexOf("=")+ 1,
              yourTeam.length));
          break;
     }
}
```

Using string methods to parse a cookie is the only way to extract individual pieces of information from a long cookie string, so it is important that you understand how they work.

The preceding code is a little difficult to understand at first. If you are having trouble understanding how to manipulate strings, try experimenting with different string methods and see what you come up with.

Next, you will modify the `populateCustomerInfo()` and `populateProductData()` functions in the CustomerInfo.html and the ProductInfo.html files so that they read the stored cookies instead of query strings. The code in each function is almost identical to the query string versions, except that the cookie string is split with a semicolon and a space instead of an ampersand.

To modify the `populateCustomerInfo()` and `populateProductData()` functions in the CustomerInfo.html and the ProductInfo.html files so that they read the stored cookies instead of query strings:

1. Return to the **CustomerInfo.html** file in your text editor.
2. In the `populateCustomerInfo()` function, modify the conditional expression in the `if` statement so that it checks if the `document.cookie` exists instead of the `location.search` string.
3. Modify the statement that declares the `queryData` variable so that it is assigned `document.cookie` instead of the `location.search` string.
4. Modify the statement that declares the `queryArray[]` array so that it splits the array with a semicolon and a space instead of an ampersand. The modified function should appear as follows:

```
function populateCustomerInfo() {
    if (document.cookie) {
        var queryData = decodeURIComponent(
            document.cookie);
        var queryArray = queryData.split("; ");
        document.forms[0].name.value = queryArray[0]
            .substring(queryArray[0]
            .lastIndexOf("=") + 1);
        document.forms[0].address1.value
            = queryArray[1].substring(
            queryArray[1].lastIndexOf("=") + 1);
        document.forms[0].address2.value
            = queryArray[2].substring(
            queryArray[2].lastIndexOf("=") + 1);
        document.forms[0].city.value
            = queryArray[3].substring(
            queryArray[3].lastIndexOf("=") + 1);
        document.forms[0].state.value
            = queryArray[4].substring(
            queryArray[4].lastIndexOf("=") + 1);
        document.forms[0].zip.value
            = queryArray[5].substring(
            queryArray[5].lastIndexOf("=") + 1);
        document.forms[0].company.value
            = queryArray[6].substring(
            queryArray[6].lastIndexOf("=") + 1);
```

```
            document.forms[0].email.value
                = queryArray[7].substring(
                queryArray[7].lastIndexOf("=") + 1);
            document.forms[0].telephone.value
                = queryArray[8].substring(
                queryArray[8].lastIndexOf("=") + 1);
        }
    }
```


5. Save the **CustomerInfo.html** document.
6. Return to the **ProductInfo.html** file in your text editor.
7. Replace the first statement in the `populateProductData()` function with the following statement, which assigns the `document.cookie` value to the `queryData` variable:

   ```
   var queryData = decodeURIComponent(document.cookie);
   ```

8. Modify the second statement in the `if` statement so that the `queryData` variable is split with a semicolon and space instead of an ampersand, as follows:

   ```
   var queryArray = queryData.split("; ");
   ```

9. Finally, modify the `submitForm()` function so that the first statement does not assign the returned value to the `savedData` variable. Then, add the following two statements after the statement that calls the `saveProductData()` function. The first statement creates a string variable named `savedData` and assigns to it a question mark and the contents of the `document.cookie` property. The second statement then uses a regular expression to replace all instances of "; " with ampersands so that the string can be passed as a query string.

   ```
   var savedData = "?" +
   decodeURIComponent(document.cookie);
   savedData = savedData.replace(/; /g, "&");
   ```

10. Save the **ProductInfo.html** document and then open the **ProductRegistration.html** document in a Web browser. The script should function the same as the query string version.
11. Close your Web browser window and the **CustomerInfo.html** and **ProductInfo.html** files in your text editor.

Deleting Cookies with JavaScript

You can delete cookies, although the way in which you delete them is not intuitive. To delete a cookie, you must set its expiration to a date in the past. The following code deletes the `firstName` cookie by setting its expires attribute to one week ago:

```
var expiresDate = new Date();
expiresDate.setDate(expiresDate.getDate() - 7);
document.cookie = "firstName=don" + "; expires="
    + expiresDate.toUTCString();
```


Short Quiz 2

1. Explain the difference between temporary and persistent cookies. How do you configure a cookie to be persistent?
2. How do you configure cookies to be available to other Web pages on the server?
3. How do you secure cookie transmissions?
4. How do you determine if a cookie exists?
5. How do you delete cookies?

Understanding Security Issues

Viruses, worms, data theft by hackers, and other types of security threats are now a fact of life when it comes to Web-based applications. If you put an application into a production environment without considering security issues, you are asking for trouble. To combat security violations, you need to consider both Web server security issues and secure coding issues. Web server security involves technologies such as firewalls, which combine software and hardware to prevent access to private networks connected to the Internet. One very important technology is the Secure Sockets Layer (SSL) protocol, which encrypts data and transfers it across a secure connection. These types of security technologies work well in the realm of the Internet. However, JavaScript programs are downloaded and execute locally within the Web browser of a client computer, and are not governed by security technologies such as firewalls and Secure Sockets Layer.

Although Web server security issues are critical, they are properly covered in books on Apache, Internet Information Services, and other types of Web servers. Be sure to research security issues for your Web server and operating system before activating a production Web site.

This section discusses security issues that relate to Web browsers and JavaScript.

Secure Coding with JavaScript

To provide even stronger software security, many technology companies, including Microsoft and Oracle, now require their developers and other technical staff to adhere to secure coding practices and principles. **Secure coding**, or **defensive coding**, refers to the writing of code in such a way that minimizes any intentional or accidental security issues. Secure coding has become a major goal for many information technology companies, primarily because of the exorbitant cost of fixing security flaws in commercial software. According to one study, it is 100 times more expensive to fix security flaws in released software than it is to apply secure coding techniques during the development phase. The National Institute of Standards & Technology estimates that $60 billion a year is spent identifying and correcting software errors. In addition, politicians have recently shown a great deal of interest in regulating software security. Tom Ridge, former Secretary of the U.S. Department of Homeland Security, recently said, "A few lines of code can wreak more havoc than a bomb." Intense government scrutiny gives information technology companies a strong incentive to voluntarily improve the security of software products before state and federal governments pass legislation that requires security certification of commercial software.

Basically, all code is insecure unless proven otherwise. Unfortunately, there is no magic formula for writing secure code, although there are various techniques that you can use to minimize security threats in your scripts. Your first line of defense in securing your JavaScript programs is to validate all user input. You have studied various techniques in this book for validating user input, including how to validate data with regular expressions and how to use exceptions to handle errors as they occur in your scripts. Be sure to use these techniques in your scripts, especially scripts that run on commercial Web sites. The remainder of this section discusses security issues that relate to Web browsers and JavaScript.

JavaScript Security Concerns

The Web was originally designed to be read-only, which is to say its primary purpose was to locate and display documents that existed on other areas of the Web. With the development of programming languages such as JavaScript, Web pages can now contain programs in addition to static content. This ability to execute programs within a Web page raises several security concerns. The security areas of most concern to JavaScript programmers are:

- Protection of a Web page and JavaScript program against malicious tampering
- Privacy of individual client information
- Protection of the local file system of the client or Web site from theft or tampering

Another security concern is the privacy of individual client information in the Web browser window. Your e-mail address, bookmarks, and history list are valuable pieces of information that many direct marketers would love to get their hands on in order to bombard you with advertising geared toward your likes and dislikes. Without security restrictions, a JavaScript program could read this information from your Web browser. One of the most important JavaScript security features is its *lack* of certain types of functionality. For example, many programming languages include objects and methods that make it possible for a program to read, write, and delete files. To prevent mischievous scripts from stealing information or causing damage by changing or deleting files, JavaScript does not allow any file manipulation whatsoever. Similarly, JavaScript does not include any sort of mechanism for creating a network connection. This limitation prevents JavaScript programs from infiltrating a private network or intranet from which information may be stolen or damaged. Another helpful limitation is the fact that JavaScript cannot run system commands or execute programs on a client. The ability to read and write cookies is the only type of access to a client that JavaScript has. Web browsers, however, strictly govern cookies and do not allow access to cookies from outside the domain that created them.

The Same Origin Policy

Another JavaScript security feature has to do with the **same origin policy**, which restricts how JavaScript code in one window or frame accesses a Web page in another window or frame on a client computer. For windows and frames to view and modify the elements and properties of documents displayed in other windows and frames, they must have the same protocol (such as HTTP) and exist on the same Web server. For example, documents from the following two domains cannot access each other's elements and properties because they use different protocols. The first domain's protocol is HTTP and the second domain's protocol is HTTPS, which, as mentioned earlier, is used on secure networks (that is, networks that run SSL).

```
http://www.gosselin.com
https://www.gosselin.com
```

The same origin policy applies not only to the domain name but also to the server on which a document is located. Therefore, documents from the following two domains cannot access each other's elements and properties, since they are located on different servers, even though they exist in the same domain of `gosselin.com`:

```
http://www.programming.gosselin.com
http://www.writing.gosselin.com
```

The same origin policy prevents malicious scripts from modifying the content of other windows and frames and prevents the theft of private browser information and information displayed on secure Web pages. How crucial is the same origin policy? Consider the `src` attribute of the `Document` object, which determines the URL displayed in a window or frame. If a client has multiple windows or frames open on its system and the same origin policy did not exist, then a Web page in one window or frame could change the Web pages displayed in other windows or frames. There are plenty of unscrupulous or simply malicious advertisers who would try to force you to view only their Web pages. The security of private networks and intranets would also be at risk without the same origin policy. Consider a user who has one Web browser open to a page on the Internet and another Web browser open to a secure page from his or her private network or intranet. Without the same origin policy, the Internet Web page would have access to the information displayed on the private Web page.

The same origin policy also protects the integrity of the design of your Web page. For example, without the same origin policy, a frame in one window or frame could modify the elements and properties of JavaScript objects and XHTML code in other windows and frames. To give you an idea of how the same origin policy prevents this type of scenario from occurring, you will now create a frame set in which one frame uses JavaScript code to try to change the status bar text of another frame, using the `status` property of the `Document` object.

To test the same origin policy:

1. Create a new document in your text editor.
2. Type the following code to create a frameset document. The code causes the Yahoo! Web page to appear in the second frame.

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Frameset//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1- ↵
frameset.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Same Origin Policy</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
</head>
<frameset cols="20%, *">
     <frame src="WrongOrigin.html"
         name="wrongFrame" />
     <frame src="http://www.yahoo.com"
         name="yahooFrame" />
</frameset>
</html>
```

3. Save the document as **MainFrame.html** in your Chapter folder for Chapter 9, and then validate it with the W3C Markup Validation Service. Once the MainFrame.html document is valid, close it in your text editor.

4. Create another document in your text editor. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and document body. Use the strict DTD and "Same Origin Policy" as the content of the `<title>` element.

5. Add the following simple form, which contains a single button, which is called Change Status. The button uses an `onclick` event that tries to change the status bar text of the frame containing the Yahoo! Web page.

```
<form action="">
<p><input type="button" value="Change Status"
onclick="parent.yahooFrame.document.status='Visit ↵
    Don\'s Bait and Tackle Shop!'" /></p>
</form>
```

6. Save the document as **WrongOrigin.html** in your Chapter folder for Chapter 9, and then validate it with the W3C Markup Validation Service. Once the WrongOrigin.html document is valid, close it in your text editor.

7. Open the MainFrame.html document in your Web browser, and click the **Change Status** button. If you are using Firefox and the Error Console is open, you should receive an error message similar to the one shown in Figure 9-7. If you are using Internet Explorer and script debugging is enabled, you will see the error message shown in Figure 9-8.

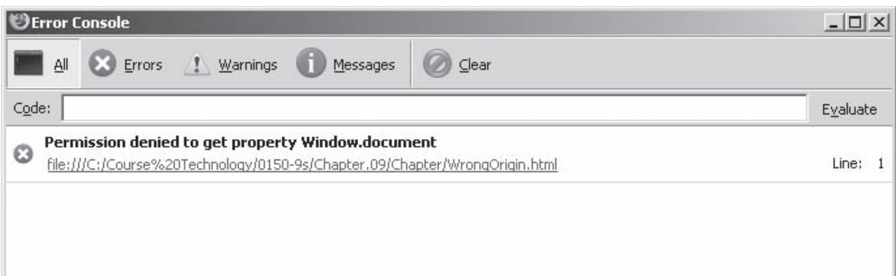


Figure 9-7 Firefox error message demonstrating the same origin policy

To view errors in Firefox Web browsers, you need to select Error Console from the Tools menu in Firefox 2.0 or later, or the JavaScript Console in Firefox versions earlier than 2.0. If you are using a version of Internet Explorer higher than 4.0, you need to turn on error notification. To verify that error notification is turned on in Internet Explorer, click Tools on the menu bar, click Internet Options, click the Advanced tab, in the Browsing category click the Display a notification about every script error check box to select it (if necessary), and then click OK. Other Web browsers may also require you to turn on error notification.

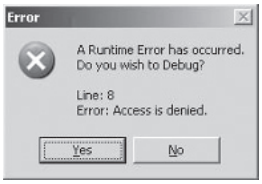


Figure 9-8 Internet Explorer error message demonstrating the same origin policy

8. Close your Web browser window.

In some circumstances, you will want two documents from related Web sites on different servers to be able to access each other's elements and properties. Consider a situation in which a document in the `programming.gosselin.com` domain needs to access content, such as form data, from a document in the `writing.gosselin.com` domain. To allow documents from different origins in the same domain to access each other's elements and properties, you use the `domain` property of the `Document` object. The **`domain` property** of the `Document` object changes the origin of a document to its root domain name by using the statement `document.domain = "`*`domain`*`";`. Adding the statement `document.domain = "gosselin.com";` to documents from both `programming.gosselin.com` and `writing.gosselin.com` allows the documents to access each other's elements and properties, even though they are located on different servers.

Short Quiz 3

1. What is secure coding, and why is it so important?
2. What are some of the security areas of most concern to JavaScript?
3. What is the same origin policy?

Summing Up

- Information about individual visits to a Web site is called state information.
- HTTP was originally designed to be stateless, which means that Web browsers stored no persistent data about a visit to a Web site.
- A special type of form element, called a hidden form field, is not displayed by the Web browser. You can hide information from users in a hidden form field.
- A query string is a set of name=value pairs appended to a target URL. A query string consists of a single text string containing one or more pieces of information.
- Cookies are small pieces of information about a user that are stored by a Web server in text files on the user's computer.
- Cookies can be temporary or persistent. Temporary cookies remain available only for the current browser session. Persistent cookies remain available beyond the current browser session and are stored in a text file on a client computer.
- The `cookie` property is created with a required name attribute and four optional attributes: `expires`, `path`, `domain`, and `secure`.
- You can use special characters in your cookies if you use encoding, which involves converting special characters in a text string to their corresponding hexadecimal ASCII value, preceded by a percent sign.
- The built-in `encodeURIComponent()` function encodes the individual parts of a URI.
- When you read a cookie or other text string encoded with the `encodeURIComponent()` function, you must first decode it with the `decodeURIComponent()` function.
- Cookies consist of one continuous string that must be parsed before the data they contain can be used.
- To delete a cookie, you must set its expiration to a date in the past.
- The term "secure coding," or "defensive coding," refers to the writing of code in a way that minimizes any intentional or accidental security issues.
- The same origin policy restricts how JavaScript code in one window or frame accesses a Web page in another window or frame on a client computer.

- The `domain` property of the `Document` object changes the origin of a document to its root domain name using the statement `document.domain = "domain";`.

Comprehension Check

1. What is state information as it applies to Web sites?

2. Which of the following attributes can you use with an `<input type="hidden">` element? (Choose all that apply.)

   a. `visible`

   b. `name`

   c. `type`

   d. `value`

3. The data stored in a hidden form field is not sent to a server along with the rest of the form. True or false?

4. What character is used for appending a query string to a URL?

   a. `*`

   b. `$`

   c. `?`

   d. `%`

5. From where can you access a query string that is passed to a Web page? (Choose all that apply.)

   a. at the end of the URL in the Address box

   b. the `search` property of the `Window` object

   c. the `search` property of the `Document` object

   d. the `search` property of the `Location` object

6. What character separates entries in a query string?

   a. `@`

   b. `^`

   c. `&`

   d. `~`

7. What is the first task in parsing data from a query string?

   a. Use the `split()` method to convert the individual pieces of information in the query string into array elements.

   b. Encode the string with the `encodeURIComponent()` function.

   c. Use the `toString()` method to convert the query string to a JavaScript text string.

   d. Remove the question mark from the beginning of the string.

8. What is the difference between temporary and persistent cookies?

9. What is the correct syntax for creating a temporary cookie?

   a. `document.cookie = "language=" + "french";`

   b. `document.cookie = "language" + "french";`

   c. `cookie.temporary = "language" + "&" + "french";`

   d. `document.cookie = "?language" + "; " + "french";`

10. Explain why you should use encoding with cookie values. What methods and procedures do you use to encode and decode cookie values?

11. In URL encoded format, what character is represented by `%20`?

    a. a space character

    b. an ampersand (&)

    c. an uppercase letter 'A'

    d. a dollar sign ($)

12. You should always encode the value assigned to the `expires` attribute. True or false?

13. The availability of a cookie to other Web pages on a server is determined by the ________________ attribute.

    a. `system`

    b. `path`

    c. `directory`

    d. `server`

14. Why should you store your JavaScript programs that create cookies in separate directories?

15. Which attribute is used for sharing cookies outside of a domain?

    a. `share`

    b. `secure`

    c. `domain`

    d. You cannot share cookies outside of a domain.

16. To delete a cookie, you must set its expiration to a date in the past. True or false?

17. Explain some of the steps you can take to write secure JavaScript code.

18. What are some of the ways in which JavaScript enforces the privacy of individual client information in the Web browser window?

19. Which of the following statements best describes the same origin policy?

    a. The same origin policy determines if and how a user allows cookies to be set on his or her computer.

    b. The same origin policy restricts how JavaScript code in one window or frame accesses a Web page in another window or frame on a client computer.

    c. The same origin policy allows Web sites to access e-mail addresses, bookmarks, history lists, and other types of client information that are stored in a user's Web browser.

    d. The same origin policy is a security protocol that verifies whether JavaScript code is running secure or unsecure mode as determined by the Web site's domain protocol.

20. To allow documents from different origins in the same domain to access each other's elements and properties, you use the ________________.

    a. `path` attribute of the `cookie` property

    b. `domain` attribute of the `cookie` property

    c. `domain` property of the `Document` object

    d. `origin` property of the `Window` object

Reinforcement Exercises

Exercise 9-1

In this project, you will create a cookies program that stores the date and time of your last visit.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and <body> element. Use the strict DTD and "Last Visit" as the content of the <title> element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following `if` statement to the script section, which checks to see if a cookie exists for the current Web page. If it does, then statements within the `if` statement will extract and display the date and time of the last visit.

```
if (document.cookie) {
    var cookieString = decodeURIComponent(
        document.cookie);
    var cookieArray = cookieString.split("; ");
    var lastVisit =
            cookieArray[0].substring(
            cookieArray[0].indexOf("=")
            + 1, cookieArray[0].length);
     document.write("<p>Your last visit was "
          + lastVisit + "</p>");
}
else
     document.write("<p>This is your first ↵
          visit.</p>");
```

5. Next, to the end of the script section, add the following statements, which use a `Date` object to assign the date and time of the current visit to the document's cookie:

```
var now = new Date();
var day = now.getDay();
var date = now.getDate();
var year = now.getFullYear();
var month = now.getMonth();
var hours = now.getHours();
var minutes = now.getMinutes();
```

```
var seconds = now.getSeconds();
var days = new Array();
days[0] = "Sunday"; days[1] = "Monday";
days[2] = "Tuesday"; days[3] = "Wednesday";
days[4] = "Thursday"; days[5] = "Friday";
days[6]="Saturday";
var thisVisit = days[day] + " " + month + "/"
    + date + "/" + year + " at " + hours + ":"
    + minutes + ":" + seconds;
document.cookie = encodeURIComponent(thisVisit);
```


6. Save the document as **LastVisit.html** in a folder named LastVisit in your Exercises folder for Chapter 9, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

7. Open the LastVisit.html document in your Web browser. The first time you open the document, you should see the text "This is your first visit." Refresh your Web browser and you should see the date and time of your last visit.

8. Close your Web browser window.

Exercise 9-2

In the next few projects, you will create a Web site that simulates online banking for a company named Forestville Funding. Each customer's user information will be stored in cookies. When a user visits the Web page again, he or she will be prompted to enter the stored user name and password. If the user does not enter the correct information within three tries, the script will prompt him or her to reregister. Note that for security reasons, browser cookies should never be the primary repository for a user's login name and password. The purpose of this exercise is to demonstrate how you can use cookies to remember user data, including login information.

The Forestville Funding site will not include validation functionality in order to allow you to focus on the cookie techniques.

In this project, you will create the registration page for the Forestville Funding online banking site.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and document body. Use the strict DTD and "Forestville Funding Online Banking" as the content of the `<title>` element.

3. Add the following text and elements to the document body. The form gathers each customer's first name, last

name, account number, user ID, and password. Clicking the Register button will call a function named `registerForm()` that stores the form values in cookies. You will create the `registerForm()` function next.

```
<h1>Forestville Funding</h1><hr />
<h2>Online Banking Registration</h2>
<form action="" method="get"
    enctype="application/x-www-form-urlencoded">
<p><strong>First Name</strong><br />
<input type="text" name="firstname" /></p>
<p><strong>Last Name</strong><br />
<input type="text" name="lastname" /></p>
<p><strong>Account Number</strong><br />
<input type="text" name="acctnum" /></p>
<p><strong>User ID</strong><br />
<input type="text" name="username" /></p>
<p><strong>Password</strong><br />
<input type="password" name="userpassword" /></p>
<p><input type="button" value="Register"
onclick="registerForm();" /></p>
</form>
```

4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Start creating the `registerForm()` function in the script section, as follows:

```
function registerForm() {
}
```

6. Add the following statements to the `registerForm()` function. These statements declare and initialize variables with the contents of the form fields.

```
var firstName = document.forms[0].firstname.value;
var lastName = document.forms[0].lastname.value;
var acctnum = document.forms[0].acctnum.value;
var userName = document.forms[0].username.value;
var userPassword = document.forms[0]
    .userpassword.value;
```

7. Add the following statements to the end of the `registerForm()` function. These statements declare a new `Date` object and set the year to one year from the current date. You will use the `Date` object to make the user information cookies persistent.

```
var myDate = new Date();
myDate.setFullYear(myDate.getFullYear() + 1);
```

8. Next, add the following statements to the end of the `registerForm()` function. These statements create persistent cookies out of the variables containing the values from the form fields.

```
document.cookie = "firstname=" +
encodeURIComponent(firstName)
    + "; expires=" + myDate.toUTCString();
document.cookie = "lastname="
    + encodeURIComponent(lastName)
    + "; expires=" + myDate.toUTCString();
document.cookie = "acctnum="
    + encodeURIComponent(acctnum)
    + "; expires=" + myDate.toUTCString();
document.cookie = "name="
    + encodeURIComponent(userName)
    + "; expires=" + myDate.toUTCString();
document.cookie = "password="
    + encodeURIComponent(userPassword)
    + "; expires=" + myDate.toUTCString();
```

9. Finally, add the following statements to the end of the function. The first statement displays an alert dialog box after the cookies are successfully created. The last statement opens the Forestville Funding online banking login page, which you will create in the next project.

```
window.alert("Thank you for registering!");
location.href = "ForestvilleFundingLogin.html";
```

10. Save the document as **ForestvilleFundingRegistration.html** in a folder named ForestvilleFunding in your Exercises folder for Chapter 9, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

Exercise 9-3

In this project, you create the login page for the Forestville Funding online banking Web site.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and document body. Use the strict DTD and “Forestville Funding Online Banking” as the content of the `<title>` element.

3. Add the following text and elements to the document body. The form allows customers to enter their user IDs

and passwords. Clicking the Log In button will call a function named `checkUser()` that determines whether the user entered a valid ID and password. You will create the `checkUser()` function next.

```
<h1>Forestville Funding</h1><hr />
<h2>Online Banking</h2>
<form action="" method="get"
    enctype="application/x-www-form-urlencoded">
<p><strong>User ID</strong><br />
<input type="text" name="username" /></p>
<p><strong>Password</strong><br />
<input type="password" name="userpassword" /></p>
<p><input type="button" value="Log In"
    onclick="checkUser();" /></p>
</form>
<p><a href="ForestvilleFundingRegistration.html">
    Register</a></p>
<hr />
<p>Forestville Funding. Member FDIC. Equal Housing
Lender.<br />
&copy; 2008 Forestville Funding. All rights
reserved.</p>
```


4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Start creating the `checkUser()` function in the script section, as follows:

```
function checkUser() {
}
```

6. Add the following statements to the `checkUser()` function. The `if` statement checks whether the `cookie` property exists. If it doesn't, then the ForestvilleFundingRegistration.html document opens. The `attempts` variable will track the number of times the user has attempted to log in.

```
if (document.cookie.length == 0){
    location.href = "ForestvilleFundingRegistration.html";
    return false;
}
var attempts = 0;
```

7. Add the following statements to the end of the `checkUser()` function. These statements declare and initialize variables with the contents of the form fields. The first statement decodes the contents of the document cookie and assigns its value to a variable named `savedData`. The second statement declares two variables, `storedName` and `storedPassword`,

which will store the user ID and password from the cookies. The third and fourth statements assign the user ID and password values that the user entered into the form to variables named `userName` and `userPassword`. The final statement uses the `split()` method to create a variable named `dataArray[]` that contains the contents of the cookie, split into array elements.

```
var savedData = decodeURIComponent(document.cookie);
var storedName, storedPassword;
var userName = document.forms[0].username.value;
var userPassword = document.forms[0]
    .userpassword.value;
var dataArray = savedData.split("; ");
```

8. Add to the end of the `checkUser()` function the following `for` statement, which retrieves and assigns the user name and password values from `dataArray[]` to the `storedName` and `storedPassword` variables.

```
for (var i = 0; i < dataArray.length; ++i) {
    if (dataArray[i].substring(0,dataArray[i]
        .indexOf("="))== "name") {
        storedName = dataArray[i]
            .substring(dataArray[i].indexOf("=")
            + 1,dataArray[i].length);
    }
    if (dataArray[i].substring(0,dataArray[i]
        .indexOf("=")) == "password") {
        storedPassword = dataArray[i]
            .substring(dataArray[i].indexOf("=")
            + 1,dataArray[i].length);
    }
}
```

9. Finally, add the following statements to the end of the `checkUser()` function. The first statement increments the `attempts` variable by a value of one. The `if` statement determines whether the user ID and password entered by the user match the values stored in the cookies. If so, a new temporary "login=successful" cookie is created and the ForestvilleFunding.html page opens. (You will create the ForestvilleFunding.html page in the next project.) The `else` statement displays an alert dialog box informing the user that his or her login attempt was unsuccessful. If the user has made three attempts to log in (as determined by the `attempts` variable), the ForestvilleFundingRegistration.html page opens.

```
++attempts;
if (userName != "" && userPassword != "") {
     if (userName == storedName && userPassword ==
     storedPassword) {
        document.cookie = "login=" +
        encodeURIComponent("successful");
        location.href = "ForestvilleFunding.html";
     }
     else {
        window.alert("Incorrect login or password.
        Please try again.");
        if (attempts == 3)
            location.href =
            "ForestvilleFundingRegistration.html";
     }
}
```

10. Save the document as **ForestvilleFundingLogin.html** in the ForestvilleFunding folder in your Exercises folder for Chapter 9, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

Exercise 9-4

In this project, you create the main Forestville Funding online banking page that users see after they log in successfully.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and document body. Use the strict DTD and “Forestville Funding Online Banking” as the content of the `<title>` element.

3. Add the following text and elements to the document body:

```
<h1>Forestville Funding</h1><hr />
<h2>Online Banking</h2>
<hr />
<p>Forestville Funding. Member FDIC. Equal
Housing Lender.<br />
&copy; 2008 Forestville Funding. All rights
reserved.</p>
```

4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add the following statements to the end of the script section. The first statement assigns the cookie value to the `savedData` variable. The `if` statement uses the `search()` method of the `String` object to determine whether the cookie value that is assigned to the `savedData` variable contains the value "login=successful". If it does not, then the user has not logged in during the current browser session and the ForestvilleFundingLogin.html document opens. If the "login=successful" cookie is found, then the `split()` method creates a variable named `dataArray[]` that contains the contents of the cookie, split into array elements. The final statement declares `firstName`, `lastName`, and `acctNum` variables that will be assigned the values stored in the cookies.

```
var savedData = decodeURIComponent(document.cookie);
if (savedData.search("login=successful") == -1)
    location.href = "ForestvilleFundingLogin.html";
var dataArray = savedData.split("; ");
var firstName, lastName, acctNum;
```

6. Add to the end of the script section the following `for` statement, which retrieves and assigns the user's first name, last name, and account number from `dataArray[]` to the `firstName`, `lastName`, and `acctNum` variables:

```
for (var i = 0; i < dataArray.length; ++i) {
    if (dataArray[i].substring(0,dataArray[i]
        .indexOf("=")) == "firstname") {
        firstName = dataArray[i]
            .substring(dataArray[i].indexOf("=")
            + 1,dataArray[i].length);
    }
    if (dataArray[i].substring(0,dataArray[i]
        .indexOf("=")) == "lastname") {
        lastName = dataArray[i]
           .substring(dataArray[i].indexOf("=")
           + 1,dataArray[i].length);
    }
    if (dataArray[i].substring(0,dataArray[i]
        .indexOf("=")) == "acctnum") {
        acctNum = dataArray[i]
            .substring(dataArray[i].indexOf("=")
            + 1,dataArray[i].length);
    }
}
```

7. Finally, add the following script section to the document body, immediately after the `<h2>` element. The script section prints the values assigned to the `firstName`, `lastName`, and `acctNum` variables:

```
<script type="text/javascript">
/* <![CDATA[ */
document.write("<p>You are currently logged in as "
    + firstName + " " + lastName + ".<br />");
document.write("Your account number is " + acctNum
    + ".</p>");
/* ]]> */
</script>
```


8. Save the document as **ForestvilleFunding.html** in the ForestvilleFunding folder in your Exercises folder for Chapter 9, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and open it in your Web browser. Because you have not yet logged in, the ForestvilleFunding.html document should open the ForestvilleFundingLogin.html document. The ForestvilleFundingLogin.html document should in turn open the ForestvilleFundingRegistration.html document because you have not yet entered any registration information.

9. Enter information into the fields on the registration page, and click **Register**. An alert dialog box should appear, thanking you for registering. Click the **OK** button in the alert dialog box. This displays the login page.

10. Enter the user ID and password for the account that you just created into the fields on the login page, and then click **Log In**. The main Forestville Funding online banking page should appear, displaying the name and account number you entered.

11. Close your Web browser window.

Exercise 9-5

Many Web sites require cookies to be enabled in order to support certain types of Web page functionality, especially when it comes to logging in to a Web site. For example, if you attempt to log in to American Express at *https://www.americanexpress.com* when cookies are disabled in your browser, the login attempt will fail because the American Express Web site requires cookies to be enabled on client browsers to store security information and other types of data. Cookies are also required for the Forestville Funding online banking page. You will also add functionality that “remembers” login names and passwords so users won’t need to log in every time they visit the Forestville Funding Web site. Note that with commercial applications, a user's login name and password are stored in cookies and are then retrieved by a Web server. Because you already stored the login name and password in cookies, you will just create another cookie named `remember` that is assigned a value of true.

1. Create a new document in your text editor.
2. Type the <!DOCTYPE> declaration, <html> element, document head, and document body. Use the strict DTD and "Forestville Funding Online Banking" as the content of the <title> element.
3. Add the following text and elements to the document body:

```
<h1>Forestville Funding</h1><hr />
<h2>Online Banking</h2>
<p>This Web site requires that your browser
accept cookies.</p>
<hr />
<p>Forestville Funding. Member FDIC. Equal
Housing Lender.<br />
&copy; 2008 Forestville Funding. All rights
reserved.</p>
```

4. Save the document as **ForestvilleFundingNoCookies.html** in the ForestvilleFunding folder in your Exercises folder for Chapter 9, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.
5. Open in your text editor the **ForestvilleFundingLogin.html** document from the ForestvilleFunding folder in your Exercises folder for Chapter 9. Modify the first `if` statement in the script section as follows. If no document cookie exists, then the first statement in the `if` statement writes a test cookie. The nested `if` statement then checks again to see if a document cookie exists, indicating that the test cookie was written successfully. If the cookie exists, the page is redirected to the ForestvilleFundingRegistration.html and the test cookie is deleted. If the cookie does not exist, it indicates that the browser is blocking cookies and the else clause redirects the page to ForestvilleFundingNoCookies.html.

```
if (!document.cookie) {
    document.cookie = "test";
    if (document.cookie.length = 0) {
        location.href
            = "ForestvilleFundingRegistration.html";
```

```
        var expiresDate = new Date();
        expiresDate.setDate(
            expiresDate.getDate() - 7);
        document.cookie = "test" + "; expires="
            + expiresDate.toUTCString();
    }
    else
        location.href
            = "ForestvilleFundingNoCookies.html";
}
```

6. Add the following text and elements immediately above the paragraph in the document body that contains the Log In button:

```
<p><input type="checkbox" name="remember_me" />
Remember my login information</p>
```

7. Modify the `if` statement at the end of the `checkUser()` function so that it includes the following bolded `if` statement, which creates a "remember=true" cookie if the `remember_me` check box is selected:

```
if (userName == storedName && userPassword
    == storedPassword) {
    document.cookie = "login="
        + encodeURIComponent("successful");
    if (document.forms[0].elements[2].checked) {
        var myDate = new Date();
        myDate.setFullYear(myDate.getFullYear()
            + 1);
        document.cookie = "remember="
            + encodeURIComponent("true")
            + "; expires=" + myDate.toUTCString();
    }
    location.href = "ForestvilleFunding.html";
}
```

8. Save the **ForestvilleFundingLogin.html** document, and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

9. Open in your text editor the **ForestvilleFunding.html** document from the ForestvilleFunding folder in your Exercises folder for Chapter 9, and modify the statement that checks for the "login=successful" cookie so that it also checks for the "remember=true" cookie, as shown with the following bolded code. If both `search()` methods return a value of -1 for both cookies, then the ForestvilleFundingLogin.html document opens because the user: (1) is not logged in for the current session, and (2) has not selected the `remember_me` button on the ForestvilleFundingLogin.html page.

An easier way to determine whether cookies are enabled in a Web browsers is to use the `cookieEnabled` property of the `Navigator` object. However, current versions of Internet Explorer contain a bug that results in the `cookieEnabled` property always being set to true, even when cookies are disabled in Internet Explorer. For this reason, you need to use the preceding longer code.

```
if (savedData.search("login=successful") == -1
    && savedData.search("remember=true") == -1)
    location.href = "ForestvilleFundingLogin.html";
```


10. Save the **ForestvilleFunding.html** document, and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

11. Open your Web browser and disable cookies.
    - To disable cookies in Firefox, select **Options** from the Tools menu and click the **Privacy** tab. On the Privacy tab, select **Use custom settings for history** from the **Firefox will** box, and then deselect the **Accept cookies from sites** box and click **OK**.
    - To disable cookies in Internet Explorer, select **Internet Options** from the Tools menu and click the **Privacy** tab. On the Privacy tab, click the **Advanced** button to display the Advanced Privacy Settings dialog box. In the Advanced Privacy Settings dialog box, select the **Override automatic cookie handling** box and then select the **Block** radio buttons in the First-party Cookies and Third-party Cookies sections. Click **OK** to close the Advanced Privacy Settings dialog box and click **OK** again to close the Internet Options dialog box.

12. Close your Web browser after you have disabled cookies.

13. Open the **ForestvilleFunding.html** document in your Web browser. Because you have disabled cookies, the ForestvilleFundingNoCookies.html document should open. Follow the same procedures listed in Step 11 to reenable cookies, and then close your Web browser.

14. Open the **ForestvilleFunding.html** document again in your Web browser. Because you are starting a new brower session, the temporary "login=successful" cookie has ceased to exist, so the ForestvilleFundingLogin.html document should open. Enter your user ID and password, click the **Remember my login information** box, and then click **Log In**. Your account information should display on the ForestvilleFunding.html page.

15. Close your Web browser and then reopen the **ForestvilleFunding.html** document again in your Web browser. Because you selected the Remember my login

information box, your account information should appear immediately on the ForestvilleFunding.html page; you will not be redirected to the ForestvilleFundingLogin.html page.

16. Close your Web browser window.

Exercise 9-6

In this project, you will correct errors in a cookie program.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and "Cookie Errors" as the content of the <title> element.

3. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
var visitData = decodeURIComponent(document.cookie);
if (visitData.length = 0)
     document.write("<p>You have visited ↵
         before.</p>");
else
     document.write("<p>This is your first ↵
         visit.</p>");
var expiresDate = new Date();
expiresdate.setFullYear(expiresDate.getFullYear()
    - 1);
document.cookie = encodeURIComponent("expires="
     + expiresDate.toUTCString());
/* ]]> */
</script>
```

4. Save the document as **CookieErrors.html** in a folder named CookieErrors in your Exercises folder for Chapter 9, and validate it with the W3C Markup Validation Service. Once the CookieErrors.html document is valid, open it in your Web browser. The first time you open the document, you should see the text "This is your first visit." If you close and then reopen your Web browser (rather than refreshing your Web browser window), you will continue to receive the message "This is your first visit." Fix the errors in the document. (*Hint*: There is more than one error in the program.)

5. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 9. Be sure to validate the documents you create with the W3C Markup Validation Service. Also, be sure to create each document in its own folder in order to avoid conflicts with cookies that are set by other Web pages.

Project 9-1

Create a document that stores and reads cookies that track the number of times a user has visited your Web site and the date of his or her last visit. The first time the user visits, display a message welcoming him or her to your Web site and reminding him or her to bookmark the page. Whenever a user visits the site, display the cookies using `document.write()` statements, increment the counter cookie by one, and then reset the counter cookie expiration date to one year from the current date. Save the document as Counter.html.

Project 9-2

Create a document with a "nag" counter that reminds users to register. Save the counter in a cookie and display a message reminding users to register every fifth time they visit your site. Create a form in the body of the document that includes text boxes for a user's name and e-mail address along with a Register button. Once a user fills in the text boxes and clicks the Register button, delete the nag counter cookie and replace it with cookies containing the user's name and e-mail address. After registering, display the name and e-mail address cookies in an alert message whenever the user revisits the site. Save the document as NagCounter.html.

Project 9-3

Create a document with a form that registers users for a marketing seminar. When a user submits the registration form, store cookies containing the user's information such as name, company, and so on. If a user attempts to register a second time with the same name, display a confirm dialog box asking if he or she wants to register again. Save the document as MarketingSeminar.html.

Project 9-4

Create a document with a form for reserving a rental car. As a user creates a reservation, store cookies containing the user's reservation information, including name and address, telephone, pickup and return dates, and car type. Also, create a button that redisplay a user's reservation information with an alert message. Set the cookies so that they expire one day after a visit. Save the document as CarRentals.html.

CHAPTER 10

Introduction to the Document Object Model (DOM)

In this chapter, you will:

- Study the HTML Document Object Model (DOM)
- Work with the `Image` object
- Learn how to access document elements

Today, more and more businesses want their Web sites to include formatting and images that can be updated without the user having to reload a Web page from the server. They also want innovative ways to use animation and interactive Web pages to attract and retain visitors and to make their Web sites effective and easy to navigate. You cannot create these kinds of effects with standard Extensible Hypertext Markup Language (XHTML); instead, you need to use Dynamic HTML (DHTML). One of the most important aspects of DHTML is the Document Object Model (DOM). In this chapter, you will learn about the DOM and how it fits in with DHTML.

Understanding the HTML Document Object Model

As you have probably realized by now, Web pages are much more useful when they are dynamic. In Internet terminology, the word **dynamic** means several things. Primarily, it refers to Web pages that respond to user requests through buttons or other kinds of controls. Among other things, a dynamic Web page can allow a user to change the document background color, submit a form, process a query, and participate in an online game or quiz. The term "dynamic" also refers to various kinds of effects, such as animation, that appear automatically in a Web browser. To make Web pages truly dynamic, you need more than just XHTML. **Dynamic HTML (DHTML)** refers to a combination of technologies that make Web pages dynamic. The term DHTML is actually a combination of JavaScript, XHTML, CSS, and the Document Object Model. You should already be familiar with JavaScript, XHTML, and CSS. In order to be successful with JavaScript, you also need to learn about the Document Object Model.

Remember that "DHTML" does not refer to a single technology but to several combined technologies.

At the core of DHTML is the **Document Object Model**, or **DOM**, which represents the HTML or XML of a Web page that is displayed in a browser. The Document Object Model that represents HTML content is referred to as the HTML DOM, and the Document Object Model that represents XML content is referred to as the XML DOM. Throughout this book, you have created Web pages that conform to XHTML. Because XHTML documents are just another type of XML document, you can manipulate them with both the HTML DOM and the XML DOM. But which is preferable? The W3C formally recommends using the XML DOM instead of the HTML DOM. Nonetheless, it's easier to use the HTML DOM with basic types of DHTML techniques, such as those discussed in this and the next chapter. Keep in mind, however, that you must use the XML DOM when using some advanced JavaScript techniques, such as AJAX, which is discussed in Chapter 12.

Each element on a Web page is represented in the HTML DOM by its own object. The fact that each element is an object makes it possible for a JavaScript program to access individual elements on a Web page and change them individually, without having to reload the page from the server. Although the individual technologies that make up DHTML have been accepted standards for some time, the implementation of DHTML has evolved slowly. One of the main delays in implementation has to do with the DOM. Earlier versions of Internet Explorer and Navigator included DOMs that were almost completely incompatible with each other. This meant that you needed to write different JavaScript code sections for different browsers. At the time of this writing, Internet Explorer 5.0 and higher, and Mozilla-based Web browsers, including Firefox are all compatible with a standardized version of the DOM, Level 3, that is recommended by the World Wide Web Consortium (W3C).

For a complete listing of objects in the HTML DOM, see the W3Schools' HTML DOM reference at *http://w3schools.com/jsref/default.asp*.

When it comes to Web page authoring, the most important part of the HTML DOM is the `Document` object. Through the `Document` object, you can access other objects that represent elements on a Web page. Throughout this book, you have used the HTML DOM to access and manipulate form elements. Similarly, you can use JavaScript to manipulate the images on a Web page through the `Image` object. The value you assign to an `<img>` element's `name` attribute becomes the name of an associated `Image` object. In order to access an `Image` object named `companyLogo`, you must append the image name to the `Document` object as follows: `document.companyLogo`. (You will learn how to work with the `Image` object in the next section.)

Next, you will spend a little time studying more of the `Document` object's properties and methods.

HTML DOM `Document` Object Methods

The `Document` object contains several methods used for dynamically generating Web pages and manipulating elements. Table 10-1 lists the methods of the `Document` object that are specified in the W3C DOM.

Method	Description
`close()`	Closes a new document that was created with the `open()` method
`getElementsByName(`*name*`)`	Returns a collection of elements represented by *name*
`getElementsByTagName(`*tag name*`)`	Returns a collection of elements represented by *tag name*
`getElementById(`*ID*`)`	Returns the element represented by *ID*
`open()`	Opens a new document in a window or frame
`write(`*text*`)`	Writes new text to a document
`writeln(`*text*`)`	Writes new text to a document, followed by a line break

Table 10-1 HTML DOM `Document` object methods

HTML DOM `Document` Object Properties

The HTML DOM `Document` object contains various properties used for manipulating Web page objects. Table 10-2 lists the properties of the `Document` object that are specified in the W3C DOM.

Property	Description
`anchors[]`	Returns an array of the document's anchor elements
`body`	Returns the document's `<body>` or `<frameset>` element
`cookie`	Returns the current document's cookie string, which contains small pieces of information about a user that are stored by a Web server in text files on the user's computer
`domain`	Returns the domain name of the server where the current document is located
`forms[]`	Returns an array of the document's forms
`images[]`	Returns an array of the document's images
`links[]`	Returns an array of a document's links
`referrer`	Returns the Uniform Resource Locator (URL) of the document that provided a link to the current document
`title`	Returns or sets the title of the document as specified by the `<title>` element in the document `<head>` section
`URL`	Returns the URL of the current document

Table 10-2 HTML DOM's `Document` object properties

The only property you can dynamically change after a Web page is rendered is the `title` property, which allows you to change the title of the document that is specified by the `<title>` element in the document `<head>` section. For example, the following statement can be used to change the text displayed in the title bar after the Web page is rendered:

```
document.title = "Pete's Pizzeria Home Page";
```

Opening and Closing the Document Object

Although the `Document` object's `write()` and `writeln()` methods are part of the DOM, they cannot be used to change content after a Web page has been rendered. You can write code that executes the `write()` and `writeln()` methods in the current document after it is rendered, but they replace the content that is currently displayed in the Web browser window.

You can, however, use the **`open()` method** to create a new document in a window or frame and then use the `write()` and `writeln()` methods to add content to the new document. The **`close()` method** notifies the Web browser that you are finished writing to the window or frame and that the document should be displayed. Although later versions of Internet Explorer and Netscape do not require you to use the `open()` and `close()` methods with the `write()` and `writeln()` methods, some older browsers do not display any content in the window until you execute the `close()` method. In addition, some browsers, including Firefox, do not stop the spinning icon in the browser's upper-right corner that indicates a document is loading until the `close()` method executes. Because Firefox is the most widely used browser, you should always use the `open()` and `close()` methods when dynamically creating document content.

You should always use the `open()` and `close()` methods when you want to use the `write()` and `writeln()` methods to update the text displayed in an existing window or frame. Specifically, if you do not use the `close()` method to notify the Web browser that you are finished writing to the window or frame, then any new calls to the `write()` and `writeln()` methods are appended to the existing text that is currently displayed in the window or frame. For example, consider the links in the following code. Each link uses a `write()` method to print a property of the `Navigator` object in another frame of a frame-based document. When you click a link, the contents in the right frame should be replaced. However, each time you click a link, the `Navigator` object property value is appended to the frame; the entire contents of the frame are not replaced. Figure 10-1 shows how the target frame appears after clicking the `appCodeName`, `appName`, and `appVersion` links.

```
<p>
<a href=""
onclick="top.frames[2].document.write( ↵
    navigator.appCodeName);return false;">
appCodeName</a><br />
```

```
<a href=""
onclick="top.frames[2].document.write( ↵
    navigator.appName);return false;">
appName</a><br />
<a href=""
onclick="top.frames[2].document.write( ↵
    navigator.appVersion);return false;">
appVersion</a><br />
<a href=""
onclick="top.frames[2].document.write( ↵
    navigator.platform);return false;">
platform</a><br />
<a href=""
onclick="top.frames[2].document.write( ↵
    navigator.userAgent);return false;">
userAgent</a><br />
</p>
```

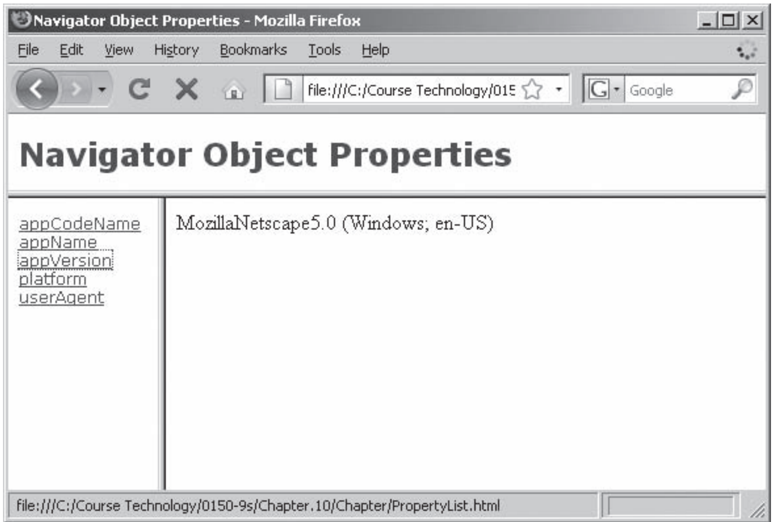


Figure 10-1 Output of `document.write()` statements without using the `open()` and `close()` methods

In order for the links to work correctly, you must add `open()` and `close()` methods to each event handler, as follows:

```
<p>
<a href="" onclick="top.frames[2] ↵
    .document.open();top.frames[2] ↵
    .document.write(navigator.appCodeName); ↵
    top.frames[2].document.close();↵
    return false;">appCodeName</a><br />
<a href="" onclick="top.frames[2]. ↵
    document.open();top.frames[2] ↵
    .document.write(navigator.appName); ↵
    top.frames[2].document.close(); ↵
    return false;">appName</a><br />
```

```
<a href="" onclick="top.frames[2] ↵
    .document.open();top.frames[2] ↵
    .document.write(navigator.appVersion); ↵
    top.frames[2].document.close(); ↵
    return false;">appVersion</a><br />
<a href="" onclick="top.frames[2] ↵
    .document.open();top.frames[2] ↵
    .document.write(navigator.platform); ↵
    top.frames[2].document.close(); ↵
    return false;">platform</a><br />
<a href="" onclick="top.frames[2] ↵
    .document.open();top.frames[2] ↵
    .document.write(navigator.userAgent); ↵
    top.frames[2].document.close(); ↵
    return false;">userAgent</a><br />
</p>
```

You can find copies of the Navigator Object Properties frameset in the Chapter folder for Chapter 10 on your Data Disk.

Next, you start working on a Web site for a flight-training school called DRG Aviation. You will find three prewritten Web pages, index.html, flighttraining.html, and instruments.html, in the DRGAviation folder in your Chapter folder for Chapter 10. The index.html file is the home page, the flighttraining.html file contains information on private pilot training, and the instruments.html file contains information on flight instrument training. You will modify these Web pages throughout the chapter.

The DRG Aviation Web pages do not contain <h1> elements. You will write code that uses the `title` property of each DRG Aviation Web page as its <h1> element.

To write code that uses the `title` property of each DRG Aviation Web page as its <h1> element:

1. Start your text editor and open the home page for DRG Aviation, **index.html**, from the DRGAviation folder in your Chapter folder for Chapter 10.

2. Locate the first paragraph element in the document body, and add the following script section above it. The script section contains statements that add the value of the `Document` object's `title` property to the Web page as an <h1> element.

```
<script type="text/javascript">
/* <![CDATA[ */
document.open();
document.write("<h1>" + document.title
    + "</h1>");
document.close();
/* ]]> */
</script>
```

3. Save the **index.html** file, but leave the document open in your text editor.
4. Open the **flighttraining.html** file and, above the first paragraph element in the document body, add the script section shown in Step 2.
5. Save the **flighttraining.html** file, but leave the document open in your text editor.
6. Open the **instruments.html** file and, above the first paragraph element in the document body, add the script section shown in Step 2.
7. Save the **instruments.html** file, but leave the document open in your text editor.
8. Open the **index.html** file in your Web browser. Figure 10-2 shows how it appears. The first heading on the page, DRG Aviation, is created by using the value assigned to the Web page's `Document` object's `title` property.

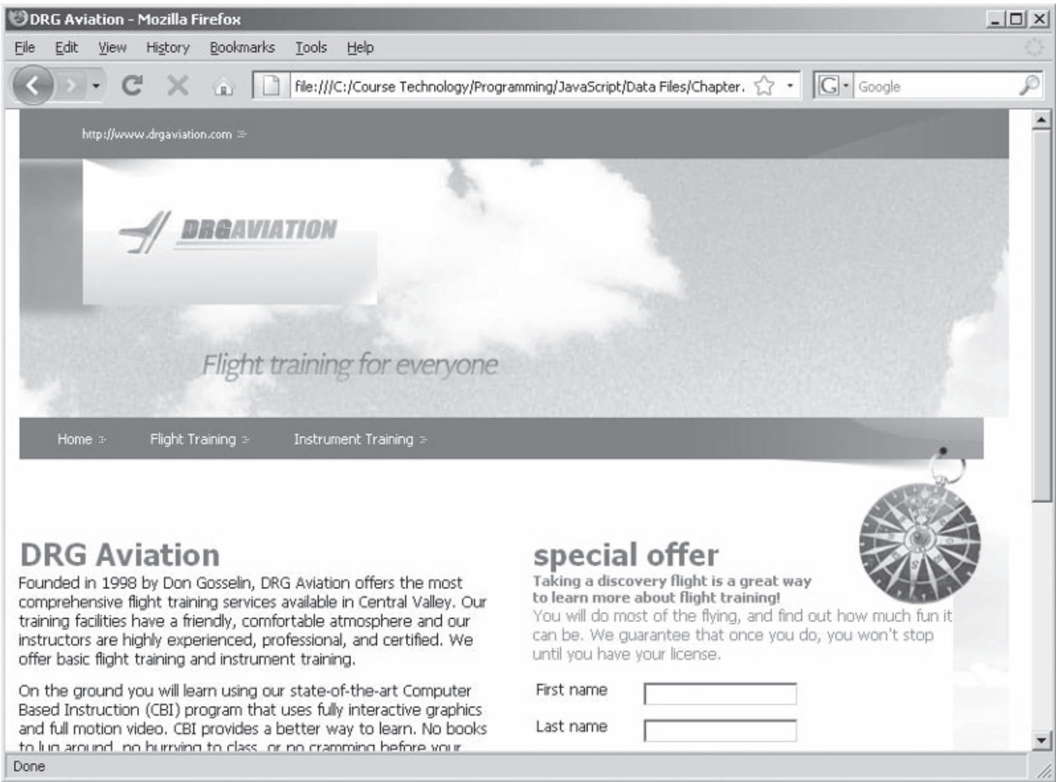


Figure 10-2 index.html

9. Close your Web browser window.

Short Quiz 1

1. How can you make Web pages dynamic?
2. What is the most important part of DHTML and why?
3. Explain why you would use the `open()` and `close()` methods of the DOM.

Using the `Image` Object

There's not enough space in this chapter to investigate all objects in the HTML DOM, but one object you should be familiar with is the `Image` object. An **`Image` object** represents an image created using the `<img>` element. You need to use an `Image` object if you want to dynamically change an image that is displayed on a Web page. As you learned in Chapter 4, the `images[]` array contains `Image` objects that represent all the `<img>` elements on a Web page. `Image` objects for each `<img>` element are assigned to the elements of the `images[]` array in the order that they appear on the Web page. The first `Image` object is represented by `images[0]`, the second `Image` object is represented by `images[1]`, and so on.

The `Image` object contains various properties that you can use to manipulate your objects. Table 10-3 lists the properties of the `Image` object.

Property	Description
`align`	Returns or sets the alignment of an image in relation to the surrounding text; you can assign one of the following values to this property: left, right, top, middle, or bottom
`alt`	Returns or sets the image's alternate text
`border`	Returns or sets the border width, in pixels
`height`	Returns or sets the image height, in pixels
`isMap`	Returns a Boolean value that indicates whether the image is a server-side image map

Table 10-3 Image object properties (continues)

Property	Description
`isMap`	Returns a Boolean value that indicates whether the image is a server-side image map
`longDesc`	Returns or sets an image's long description
`name`	Returns or sets the image name
`src`	Returns or sets the URL of the displayed image
`useMap`	Returns or sets the image to be used as a client-side image map
`vspace`	Returns or sets the amount of vertical space, in pixels, above and below the image
`width`	Returns or sets the image width, in pixels

Table 10-3 Image object properties (continued)

You have already used one of the most important parts of the `Image` object, the **`src` property**, which allows JavaScript to dynamically change an image. Changing the value assigned to the `src` property changes the `src` attribute associated with an `<img>` element, which dynamically changes an image displayed on a Web page. For instance, you can change the displayed image for an image named `companyLogo` by using a statement such as `document.companyLogo.src = "new_image.jpg";`.

Next, you will add an image to the DRG Aviation home page that asks visitors if they have ever dreamed of flying. Clicking the image displays another image that advertises a "discovery flight" from DRG Aviation. The DRGAviation/images folder in your Chapter folder for Chapter 10 contains two images, dream.gif and discover.gif, that you can use for the exercise.

To add an image to the DRG Aviation home page:

1. Return to the **index.html** file in your text editor.
2. In the first table in the file, locate the image element that displays the head5.jpg image. Replace the value assigned to the `src` attribute with "dream.gif". Also, add an `onclick` event handler that uses the `this` reference to change the value assigned to the `src` property with "discover.gif". Recall that the `this` reference simply refers to the current element. The modified image element should appear as follows:

```
<img src="images/dream.gif" width="388" height="204"
alt="Visual formatting element"
onclick="this.src='images/discover.gif'" />
```

3. Save the **index.html** file and open it in your Web browser. When the file first opens, it displays the image shown in Figure 10-3.

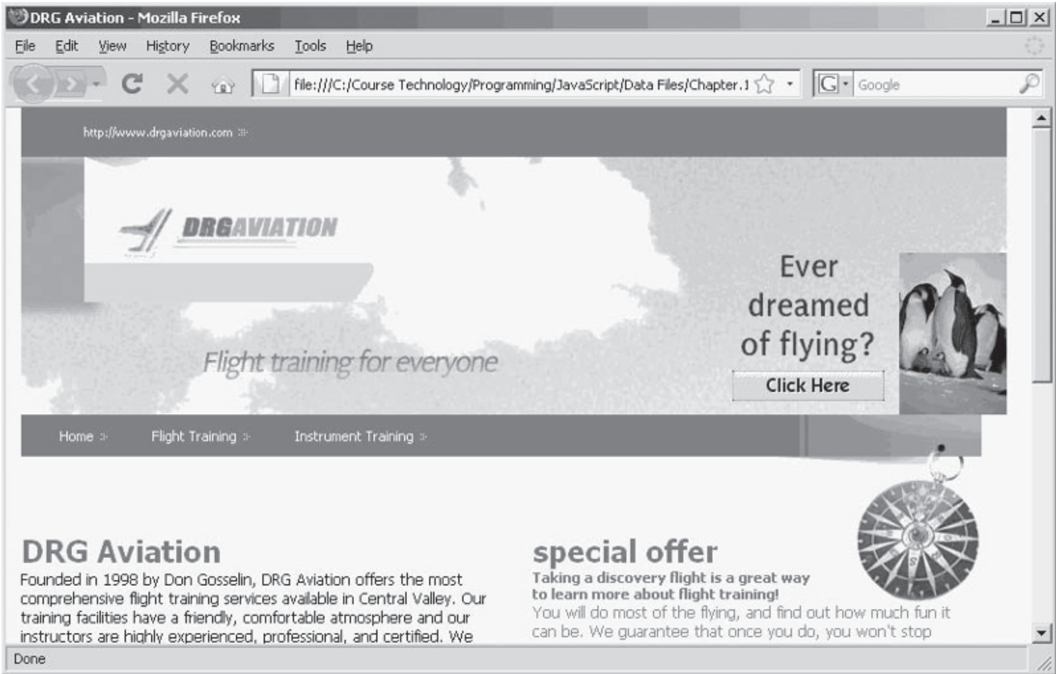


Figure 10-3 Default image displayed on the DRG Aviation home page

4. Click the image. The current image is replaced with the image shown in Figure 10-4.

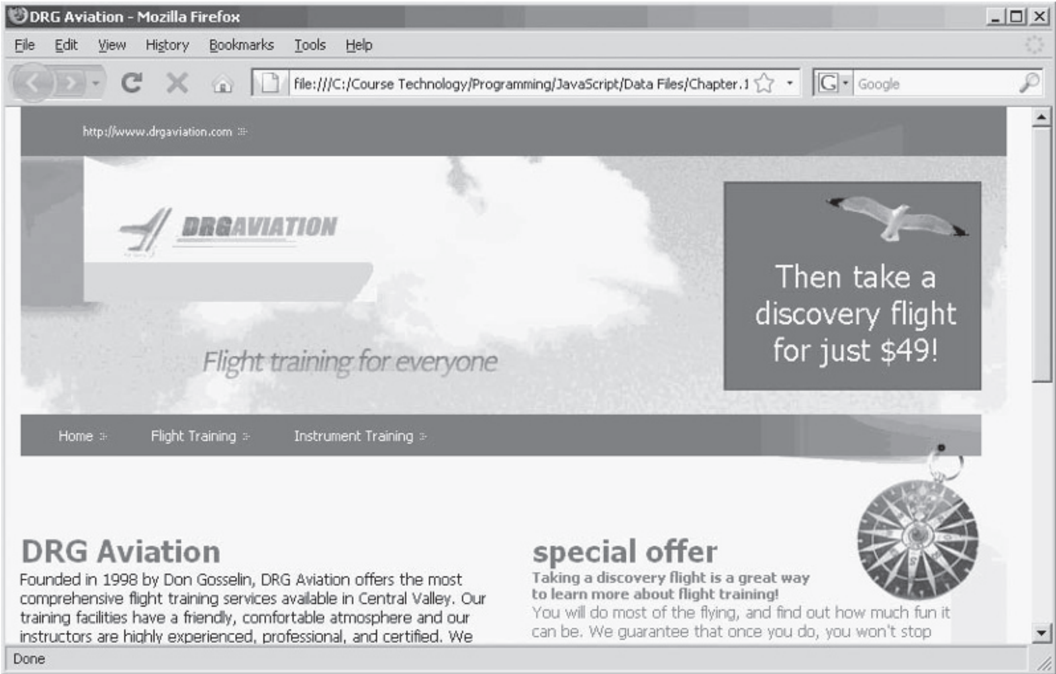


Figure 10-4 DRG Aviation home page after clicking the banner image

5. Close your Web browser window.

Animation with the `Image` Object

As you learned in Chapter 4, you can create simple animation on a Web page by combining the `src` attribute of the `Image` object with the `setTimeout()` or `setInterval()` methods. In Chapter 4, you saw the following code, which uses the `setInterval()` method to automatically swap two advertising images every couple of seconds. Figure 10-5 shows the two images displayed in a browser.

```
...
<script type="text/javascript">
/* <![CDATA[ */
var curBanner="soccer1";
function changeBanner() {
     if (curBanner == "soccer2") {
          document.images[0].src
              = "soccer1.gif";
          curBanner = "soccer1";
     }
```

```
        else {
              document.images[0].src
                  = "soccer2.gif";
              curBanner = «soccer2»;
        }
}
/* ]]> */
</script>
</head>
<body onload="var begin=setInterval('changeBanner()',2000);">
<p><img src="soccer1.gif" name="banner"
    alt="Changing image for Central Valley ↵
    Sporting Goods" /></p>
</body>
</html>
```

The Central Valley Sporting Goods Web page is provided as a file named SportingGoods.html in the Chapter folder for Chapter 10 on your Data Disk.

Figure 10-5 Advertising images

This book does not teach the artistic skills necessary for creating frames in an animation sequence. Instead, the goal is to show how to use JavaScript and the `Image` object to perform simple animation by swapping frames displayed by an `<img>` element.

While the advertising images can be loosely termed "animation," true animation involving movement requires a different image, or frame, for each movement that a character or object makes. While swapping two images is simple enough, you need to understand a little more about how to work with the `Image` object when you want your animation to include multiple images.

Do not confuse animation frames and frames created with the `<frameset>` and `<frame>` elements.

As an example of a more complex animation sequence, Figure 10-6 shows 16 frames, with each frame showing a unicycle in a slightly different position.

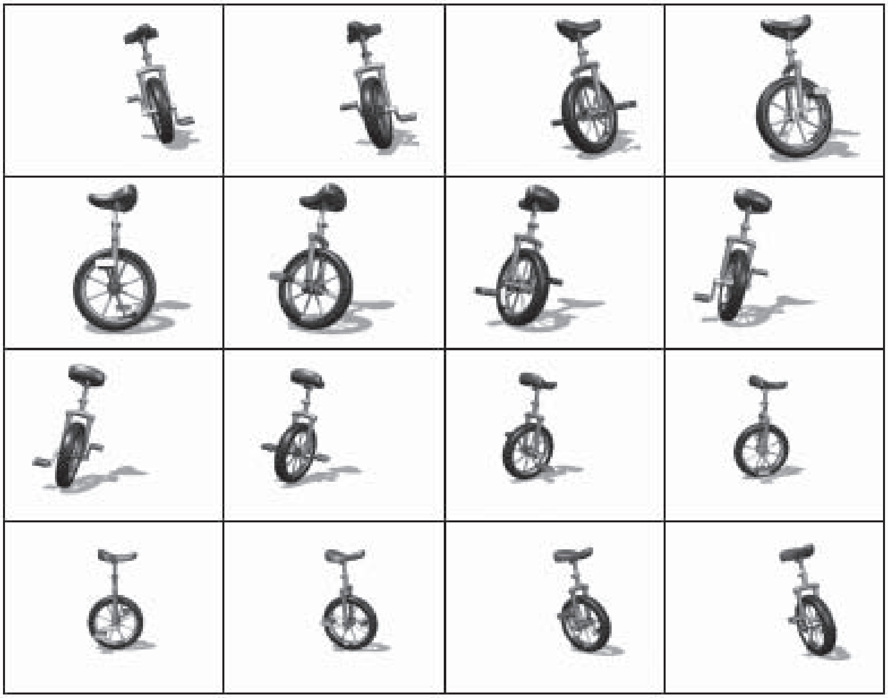


Figure 10-6 Unicycle animation frames

You create an animated sequence with JavaScript by using the `setInterval()` or `setTimeout()` methods to cycle through the frames in an animation series. Each iteration of a `setInterval()` or `setTimeout()` method changes the frame displayed by an `<img>` element. The speed of the animation depends on how many milliseconds are passed as an argument to the `setInterval()` or `setTimeout()` methods.

The following code animates the frames in Figure 10-6. The code assigns the frames to a `unicycle[]` array. Once the Turn button is clicked, a `setInterval()` method calls the `turn()` function, which executes an `if...else` statement that changes the displayed frame based on the `curUnicycle` variable. Once the `curUnicycle` variable reaches 15 (the highest element in an array with sixteen elements), it resets to zero (the first element in the array), and the animation sequence starts over from the beginning. The name of each image for the frames corresponds to an element number in the `unicycle[]` array. The Stop button uses the `clearInterval()` method to stop the `setInterval()` method. Figure 10-7 shows an example of the script in a Web browser.

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Unicycle</title>
<meta http-equiv="content-type"
     content="text/html;charset=iso-8859-1" />
<script type="text/javascript">
/* <![CDATA[ */
var turnUnicycle;
var unicycle = new Array(16);
var curUnicycle = 0;
unicycle[0] = "unicycle0.gif";
unicycle[1] = "unicycle1.gif";
unicycle[2] = "unicycle2.gif";
unicycle[3] = "unicycle3.gif";
unicycle[4] = "unicycle4.gif";
unicycle[5] = "unicycle5.gif";
unicycle[6] = "unicycle6.gif";
unicycle[7] = "unicycle7.gif";
unicycle[8] = "unicycle8.gif";
unicycle[9] = "unicycle9.gif";
unicycle[10] = "unicycle10.gif";
unicycle[11] = "unicycle11.gif";
unicycle[12] = "unicycle12.gif";
unicycle[13] = "unicycle13.gif";
unicycle[14] = "unicycle14.gif";
unicycle[15] = "unicycle15.gif";
function turn() {
    if (curUnicycle == 15)
        curUnicycle = 0;
    else
        ++curUnicycle;
    document.images[0].src
        = unicycle[curUnicycle];
}
function startTurning() {
    if (turnUnicycle != null)
        clearInterval(turnUnicycle);
    turnUnicycle = setInterval("turn()", 100);
}
/* ]]> */
</script>
</head>
<body>
<p><img src="unicycle1.gif" height="75"
width="75" /></p>
<form action="">
<p><input type="button" value=" Turn "
onclick="startTurning();" />
<input type="button" value=" Stop "
onclick="clearInterval(turnUnicycle);" /></p>
</form>
</body>
</html>
```

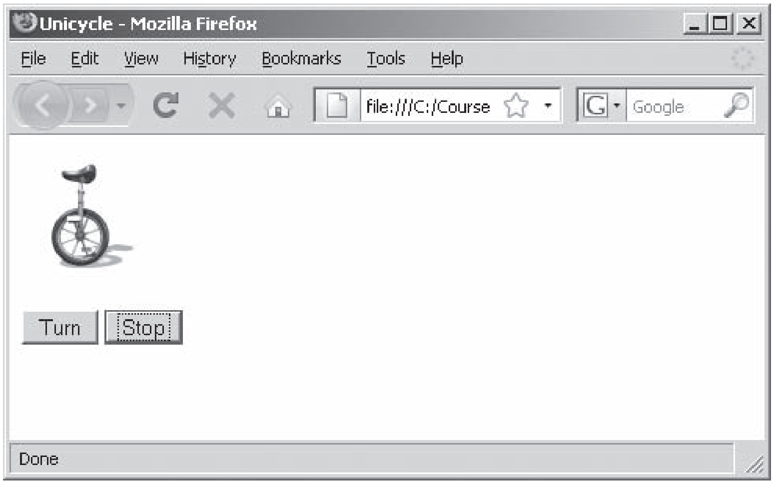


Figure 10-7 Unicycle animation in a Web browser

You can find a copy of the preceding Unicycle animation page, named Unicycle.html, along with the required image files in the Chapter folder for Chapter 10 on your Data Disk.

Notice that the preceding code includes a function, `startTurning()`, which is called from the Turn button in the document body. The `if` statement determines whether the animation is already running by checking to see if the `turnUnicycle` variable is equal to null. This technique enables you to quickly check whether an object exists or if a variable has been initialized. If the `setInterval()` method has been called and assigned to the `turnUnicycle` variable, then the conditional expression returns a value of true, which causes the `if` statement to execute the `clearInterval()` method to cancel the animation. If you do not include the `if` statement, then the user could click the Turn button several times, which would cause multiple instances of the `setInterval()` method to occur. Multiple instances of the same `setInterval()` method cause your computer to execute as many animation sequences as there are instances of the `setInterval()` method, which could make the animation appear to run faster than desired or function erratically.

Next, you will modify the Private Pilot Training page so that it includes an animated image of an airplane. The DRGAviation/images folder in your Chapter folder for Chapter 10 contains 24 images, airplane0.gif through airplane23.gif, that you can use for this exercise.

To modify the Private Pilot Training page so that it includes an animated image of an airplane:

1. Return to the **flighttraining.html** file in your text editor.

2. Add the following script section to the document head, just above the closing </head> tag:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Add to the script section the following variable definitions and function, which change the displayed image. The code is very similar to the unicycle animation code you saw in this section.

```
var plane = new Array(24);
var curPlane = 0;
plane[0] = "airplane0.gif";
plane[1] = "airplane1.gif";
plane[2] = "airplane2.gif";
plane[3] = "airplane3.gif";
plane[4] = "airplane4.gif";
plane[5] = "airplane5.gif";
plane[6] = "airplane6.gif";
plane[7] = "airplane7.gif";
plane[8] = "airplane8.gif";
plane[9] = "airplane9.gif";
plane[10] = "airplane10.gif";
plane[11] = "airplane11.gif";
plane[12] = "airplane12.gif";
plane[13] = "airplane13.gif";
plane[14] = "airplane14.gif";
plane[15] = "airplane15.gif";
plane[16] = "airplane16.gif";
plane[17] = "airplane17.gif";
plane[18] = "airplane18.gif";
plane[19] = "airplane19.gif";
plane[20] = "airplane20.gif";
plane[21] = "airplane21.gif";
plane[22] = "airplane22.gif";
plane[23] = "airplane23.gif";
function fly() {
     if (curPlane == 23)
          curPlane = 0;
     else
          ++curPlane;
     document.images[4].src = "images/"
          + plane[curPlane];
}
```

4. Add an `onload` event handler to the opening <body> element as follows that uses the `setInterval()` method to start the animation:

```
<body onload="setInterval('fly()', 150)">
```

5. Locate the <td> element containing the <img> element that displays the head5.jpg file and modify it so the `style` attribute uses the head5.jpg file as a background image and the <img> element displays the first file in the airplane animation, airplane0.gif. Your modified <td> element should appear as follows:

```
<td rowspan="2" style="background-image: ↵
    url('images/head5.jpg'); ↵
    padding-left: 88px">
    <img src="images/airplane0.gif"
        width="300" height="200"
        alt="Image of an airplane."  />
</td>
```

6. Save the **flighttraining.html** file, and then open it in your Web browser. An image of an airplane appears to fly on your screen, as shown in Figure 10-8.

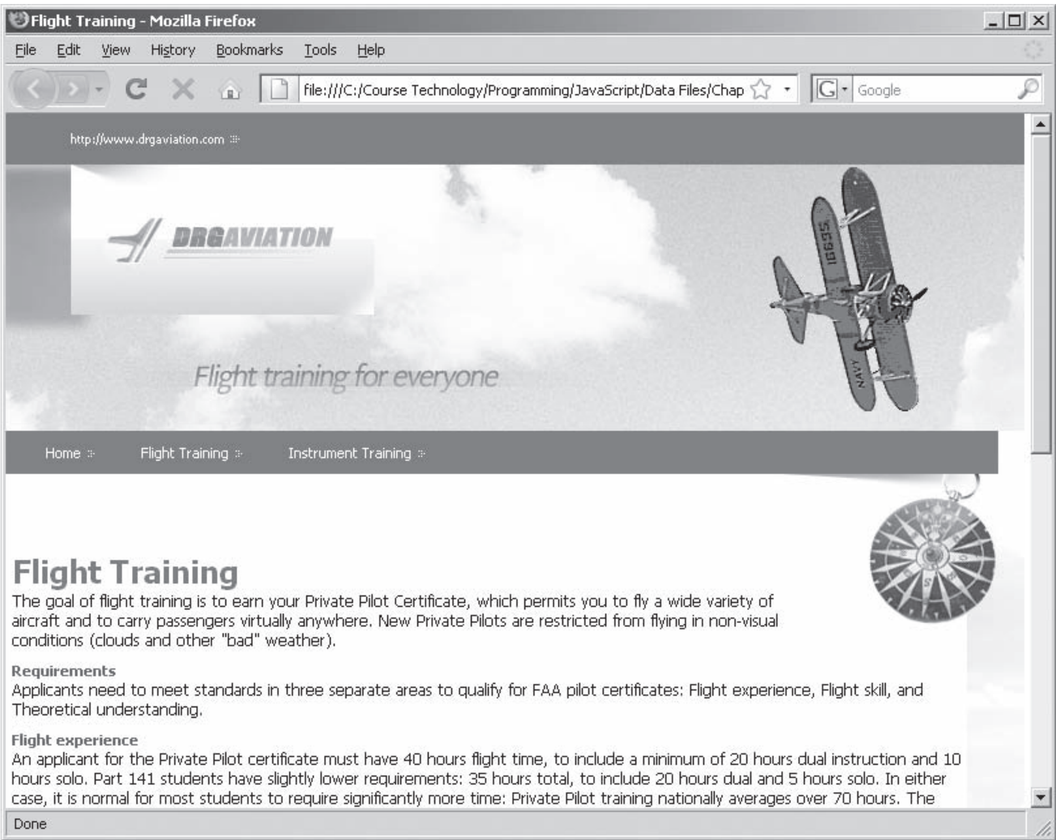


Figure 10-8 flighttraining.html after adding an animated image of an airplane

7. Close your Web browser window.

Image Caching

In the airplane program, you may have noticed that the loading of each image appears to be jerky, erratic, or slow, and that the URL for each image flickers in the status bar each time the image changes. This happens because JavaScript does not save a copy of the image in memory that can be used whenever necessary. Instead, each time a different image is loaded by an `<img>` element, JavaScript must open or reopen the image from its source. You probably accessed the airplane image files directly from the Data Disk on your local computer, and if you have a particularly fast computer, you may not have noticed a loading problem. If you did notice erratic loading of the images, then you can imagine how erratic and slow the animation would appear if you had to download the images from the Web server each time they are loaded. A technique for eliminating multiple downloads of the same file is called **image caching**. Image caching temporarily stores image files in memory on a local computer. This technique allows JavaScript to store and retrieve an image from memory rather than download the image each time it is needed.

Images are cached using the `Image()` constructor of the `Image` object. The `Image()` constructor creates a new `Image` object. There are three steps for caching an image in JavaScript:

1. Create a new object using the `Image()` constructor.
2. Assign a graphic file to the `src` property of the new `Image` object.
3. Assign the `src` property of the new `Image` object to the `src` property of an `<img>` element.

In the following code, the `src` attribute of the `<img>` element is initially set to an empty string `""`. In the script section, a new `Image` object named `newImage` is created. The `newImage` object is used to save and access the memory cache containing the image file. A file named graphic.jpg is assigned to the `src` property of the `newImage` object. The `src` property of the `newImage` object is then assigned to the `src` property of the `<img>` element.

```
<body>
<img src="" height="100" width="100" alt="Description" />
<script type="text/javascript">
/* <![CDATA[ */
var newImage = new Image();
newImage.src = "graphic.jpg";
document.images[0].src = newImage.src;
/* ]]> */
</script>
</body>
```

Be sure to understand that, in the preceding code, the graphic.jpg file is not assigned directly to the `src` property of the `<img>` element. Instead, the `newImage` object is assigned to the `src` property of the `<img>` element. If you assigned the graphic.jpg file directly to the `src` property of the `<img>` element using the statement `document.myImage.src = "graphic.jpg";`, then the file would reload from its source each time it was needed. The `newImage` object opens the file once and saves it to a memory cache.

The following code shows a version of the unicycle animation code modified to use image caching. The lines that add each image file to the `unicycle[]` array have been replaced by a `for` loop, which assigns a new object to each element of the `unicycle[]` array until the `imagesLoaded` variable is greater than the length of the array. In the `for` loop, each object in the `unicycle[]` array is assigned an image file using the `src` property. In the `turn()` function, the `unicycle[curUnicycle]` operator in the statement `document.images[0].src = unicycle[curUnicycle];` now includes the `src` property so that the statement reads `document.images[0].src = unicycle[curUnicycle].src;`.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/ ↵
    xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Unicycle</title>
<meta http-equiv="content-type"
    content="text/html;charset=iso-8859-1" />
<script type="text/javascript">
/* <![CDATA[ */
var turnUnicycle;
var unicycle = new Array(16);
var curUnicycle = 0;
for (var imagesLoaded=0; imagesLoaded < 16;
    ++imagesLoaded) {
    unicycle[imagesLoaded] = new Image();
    unicycle[imagesLoaded].src = "unicycle"
        + imagesLoaded + ".gif";
}
function turn() {
    if (curUnicycle == 15)
        curUnicycle = 0;
    else
        ++curUnicycle;
    document.images[0].src
        = unicycle[curUnicycle].src;
}
```

```
function startTurning() {
    if (turnUnicycle != null)
        clearInterval(turnUnicycle);
    turnUnicycle = setInterval("turn()",
        100);
}
/* ]]> */
</script>
</head>
<body>
<p><img src="unicycle0.gif" height="75"
    width="75" /></p>
<form action="">
<p><input type="button" value=" Turn "
onclick="startTurning();" />
<input type="button" value=" Stop "
onclick="clearInterval(turnUnicycle);" /></p>
</form>
</body>
</html>
```

You can find a copy of the preceding Unicycle Web page, named UnicycleCache1.html, along with the required image files in the Chapter folder for Chapter 10 on your Data Disk.

Next, you will modify the airplane animation in the flighttraining.html document to include image caching.

To modify the airplane animation in the flighttraining.html document to include image caching:

1. Return to the **flighttraining.html** file in your text editor.
2. Replace the 24 statements that assign each airplane frame to the `plane[]` array with the following `for` loop. The `imagesLoaded` variable keeps track of the number of cached images, and the `for` loop creates a new `Image` object within each element of the `plane[]` array. Each object in the `plane[]` array is then assigned an image file using the `src` property.

```
for (var imagesLoaded=0; imagesLoaded < 24;
    ++imagesLoaded) {
    plane[imagesLoaded] = new Image();
    plane[imagesLoaded].src
        = "images/airplane"
        + imagesLoaded + ".gif";
}
```

3. Delete the "images/" string from and add the `src` property to the `document.images[4].src = plane[curPlane];` statement in the `fly()` function so that it reads as follows:

```
document.images[4].src = "images/" + plane[curPlane].src;
```

4. Save the **flighttraining.html** document, and open it in your Web browser. If you previously experienced erratic animation, the new animation should appear smoother.
5. Close your Web browser window.

Even when you use image caching, the images must all be loaded into an `Image` object before the animation will function correctly. Often, you will want animation to start as soon as a page finishes loading, as is the case with the airplane animation. However, even though a page has finished loading, all the images may not have finished downloading and may not be stored in image caches. If you run the airplane animation across an Internet connection, the `onload` event handler of the `<body>` element may execute the animation sequence before all the frames are transferred and assigned to `Image` objects (depending on Internet connection speed). The animation will still function, but it will be erratic until all the images have been successfully stored in `Image` objects. To be certain that all images are downloaded into a cache before commencing an animation sequence, you use the `onload` event handler of the `Image` object.

The following code shows another modified version of the unicycle script. This time, the program does not include a Turn or Stop button. Instead, the `for` loop now contains an `if` statement that checks whether the `imagesLoaded` variable is equal to 15, which indicates that all the images have been downloaded. Once the `imagesLoaded` variable equals 15, the `turn()` function executes using the same `setInterval()` statement that was originally located in the `onclick` event for the Turn button. Notice that the code no longer includes the `startTurning()` function, nor does it include an `onload` event handler in the `<body>` element. Once all the images are cached in the `unicycle[]` array, the `turn()` function executes automatically.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/ ↵
    xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>Unicycle</title>
<meta http-equiv="content-type"
    content="text/html;charset=iso-8859-1" />
<script type="text/javascript">
/* <![CDATA[ */
var turnUnicycle;
var unicycle = new Array(16);
var curUnicycle = 0;
for (var imagesLoaded=0; imagesLoaded < 16;
    ++imagesLoaded) {
    unicycle[imagesLoaded] = new Image();
    unicycle[imagesLoaded].src = "unicycle"
        + imagesLoaded + ".gif";
    if (imagesLoaded == 15)
         turnUnicycle
             = setInterval("turn()", 100);
}
```

```
function turn() {
    if (curUnicycle == 15)
        curUnicycle = 0;
    else
        ++curUnicycle;
    document.images[0].src
        = unicycle[curUnicycle].src;
}
/* ]]> */
</script>
</head>
<body>
<p><img src="unicycle0.gif" height="75"
    width="75" /></p>
</body>
</html>
```


You can find a copy of the preceding Unicycle Web page, named UnicycleCache2.html, along with the required image files in the Chapter folder for Chapter 10 on your Data Disk.

Next, you add an `if` statement that executes the animation after all the images load.

To add an `if` statement to the airplane animation that executes the animation after all the images load:

1. Return to the **flighttraining.html** file in your text editor.
2. Add the following `if` statement to the end of the `for` loop. After all the images are loaded, the `if` statement uses the `setInterval()` method to call the `fly()` function.

   ```
   if (imagesLoaded == 23)
        setInterval("fly()", 150);
   ```

3. Delete the `onload` event handler from the opening `<body>` tag. You no longer need it because the animation is started by the image `onload` event handler.
4. Save the **flighttraining.html** file and open it in your Web browser. The animation should begin as soon as all the images load.
5. Close your Web browser window.

Short Quiz 2

1. Why do you need to use the `Image` object?
2. How do you create basic animation with the `Image` object?
3. Why and how do you need to ensure that all images are downloaded into a cache before commencing an animation sequence?

Accessing Document Elements

Up to this point in the book, you have accessed HTML elements as properties of the `Document` object. For example, the statement `document.forms[0].email.value` returns the value in a text box named `email` from the first form in a document. Although this method works well, it has its limitations because you can only access anchor, form, image, and link elements. But what if you want to access a paragraph (`<p>`) or table (`<table>`) element? To access any element in a document with JavaScript—and modify it dynamically—you must use one of the following methods of the `Document` object: `getElementsByName()`, `getElementsByTagName()`, or `getElementById()`. The use of these methods is required for many types of DHTML and AJAX techniques, so you will use them for the remainder of this book.

Accessing Elements by Name

The **`getElementsByName()` method** returns an array of elements with a `name` attribute that matches a specified value. You append the `getElementsByName()` method to the `Document` object and pass to it a single argument representing the `name` attribute of the elements you want to retrieve. For example, consider the following form, which creates four check boxes. The `name` attribute of each check box is assigned a value of `committees`.

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded"
onsubmit="return submitForm()">
<h3>Which committees would you like to serve on? </h3>
<p><input type="checkbox" name="committees"
value="program_dev" />Program Development
<br />
<input type="checkbox" name="committees"
value="fundraising" />Fundraising<br />
<input type="checkbox" name="committees"
value="pub_relations" />Public Relations
<br />
<input type="checkbox" name="committees"
value="education" />Education</p>
<p><input type="submit" /></p>
</form>
```

In Chapter 5, you saw the following event handler function, which executes when the form is submitted. This function uses the `forms[]` array to access the array of elements that represent the check boxes with the `name` attribute of `committees` to determine whether at least one check box in the group is selected.

```
function submitForm() {
    var committeesSelected = false;
    for (var i=0; i< document.forms[0]
        .committees.length; ++i) {
        if (document.forms[0].committees[i]
            .checked == true) {
            committeesSelected = true;
            break;
        }
    }
    if (committeesSelected == false) {
        window.alert("You must select at ↵
            least one committee.");
            return committeesSelected;
    }
    else
        return committeesSelected;
}
```

Now, consider the following modified version of the event handler function. In this version, the function uses the `getElementsByName()` method to return an array of elements that represent the check boxes with the `name` attribute of `committees`.

```
function submitForm() {
    var committeesSelected = false;
    var selectedCommittees = document
        .getElementsByName("committees");
    for (var i=0; i<selectedCommittees.length;
        ++i) {
        if (selectedCommittees[i].checked
            == true) {
            committeesSelected = true;
            break;
        }
    }
    if (committeesSelected == false) {
        window.alert("You must select at ↵
            least one committee.");
        return committeesSelected;
    }
    else
        return committeesSelected;
}
```

Keep in mind that the `getElementsByName()` method always returns an array, even if there is only one element in the document with a matching `name` attribute. This means that even if the document only contains a single element with the specified name, you must refer to it in your JavaScript code by using the first index (0) of the returned array. For example, suppose that you have a form with a text box whose `name` attribute is assigned a value of "email", and it is the only element in the document with that value assigned to its `name` attribute. The following statement demonstrates how to create an array consisting of a single element with a value of "email" assigned to its `name` attribute, and then display its value in an alert dialog box:


```
var email = document.getElementsByName(
    "email");
window.alert(email[0].value);
```

With methods like the `getElementsByName()` method, which always return an array, you can also append the index number of the element you want to access to the statement containing the method, as follows:

```
window.alert(document.getElementsByName(
    "email")[0].value);
```

Next, you will modify the flighttraining.html document so that it uses the `getElementsByName()` method to refer to the element containing the airplane image.

To modify the flighttraining.html document so that it uses the `getElementsByName()` method to refer to the element containing the airplane image:

1. Return to the **flighttraining.html** file in your text editor.
2. Locate the following statement in the `fly()` function:

   ```
   document.images[4].src = plane[curPlane].src;
   ```

3. Modify the statement you located in the previous step so that it uses the `getElementsByName()` method to refer to the element containing the airplane image:

   ```
   document.getElementsByName(
       "airplaneImage")[0].src
       = plane[curPlane].src;
   ```

4. Add the following bolded `name` attribute (with a value of "airplaneImage"), to the element containing the airplane image:

   ```
   <td><img src="airplane0.gif"
   name="airplaneImage" height="300" width="200"
   alt="Image of an airplane." /></td>
   ```

5. Save the **flighttraining.html** file, and open it in your Web browser. The animation should begin as soon as all the images load.
6. Close your Web browser window.

Be sure not to include the tag name's brackets (such as "<p>") in the argument you pass to the `getElementsByTagName()` method.

Accessing Elements by Tag Name

The **`getElementsByTagName()` method** is similar to the `getElementsByName()` method, except that, instead of returning an array of elements with a `name` attribute that matches a specified value, it returns an array of elements that matches a specified tag name. You append the `getElementsByTagName()` method to the `Document` object and pass to it a single argument representing the name of the elements you want to retrieve. As an example, the following statement returns an array of all the paragraph (<p>) tags in a document:

```
var docParagraphs = document
    .getElementsByTagName("p");
```

Consider the following modified version of the form containing the committee check boxes. This version contains radio buttons that allow users to select "Yes" if they want to serve on a committee or "No" if they don't. Clicking one of the radio buttons calls a function named `enableCommittees()` and passes to it a Boolean value of either true (to disable the committee check boxes) or false (to enable them).

```
<form action="FormProcessor.html" method="get"
enctype="application/x-www-form-urlencoded"
onsubmit="return submitForm()">
<p>Would you like to serve on a committee?</p>
<p><input type="radio" name="committeeInvolvement"
checked="checked" onclick="enableCommittees(false)" /> Yes
<input type="radio" name="committeeInvolvement" onclick=
"enableCommittees(true)" /> No</p>
<p>Which committees would you like to serve on? </p>
<p><input type="checkbox" name="committees"
value="program_dev" />Program Development
<br />
<input type="checkbox" name="committees"
value="fundraising" />Fundraising<br />
<input type="checkbox" name="committees"
value="pub_relations" />Public Relations
<br />
<input type="checkbox" name="committees"
value="education" />Education</p>
</form>
```

The following `enableCommittees()` function demonstrates how to use the `getElementsByTagName()` function. The function's first statement uses the `getElementsByTagName()` method to return an array of all the `<input>` elements in the document, which is then assigned to a variable named `committeeBoxes[]`. Then, the `for` loop iterates through each of the elements in the `committeeBoxes[]` array and checks the value of each `Input` object's `type` property. If the `type` property is equal to "checkbox", then the element is enabled or disabled by assigning the value of the `boolValue` variable to the `disabled` property of the `Input` object.

```
function enableCommittees(boolValue) {
    var committeeBoxes = document
        .getElementsByTagName("input");
    for (var i=0; i<committeeBoxes.length;
        ++i) {
        if (committeeBoxes[i].type
            == "checkbox")
            committeeBoxes[i].disabled
                = boolValue;
    }
}
```

The `getElementsByTagName()` method works the same way as the `getElementsByName()` method in that it always returns an array, even if there is only one element in the document that matches the specified tag name. For example, with a document that contains a single form that is submitted with the `POST` method, the following `document.write()` statement refers to the first element in the array returned from a `getElementsByTagName()` method that is passed a value of "form". The statement prints, "The form will be submitted with the post method."

```
document.write(
    "<p>The form will be submitted with the "
    + document.getElementsByTagName(
    "form")[0].method + " method.</p>");
```

Next, you will modify the flighttraining.html document so that it uses the `getElementsByTagName()` method instead of the `getElementsByName()` method to refer to the element containing the airplane image.

To modify the flighttraining.html document so that it uses the `getElementsByTagName()` method instead of the `getElementsByName()` method to refer to the element containing the airplane image:

1. Return to the **flighttraining.html** file in your text editor.
2. Modify the last statement in the `fly()` function so that it uses the `getElementsByTagName()` method and the `<img>` tag name to refer to the element containing the airplane image, as follows:

   ```
   document.getElementsByTagName("img")[4].src
       = plane[curPlane].src;
   ```

3. Save the **flighttraining.html** file, and open it in your Web browser. The animation should begin as soon as all the images load.
4. Close your Web browser window.

Accessing Elements by ID

The `getElementsByName()` and `getElementsByTagName()` methods are extremely useful if you need to work with collections of elements that have the same `name` attribute or are of the same type. However, if you are only interested in accessing a single element, you should use the **`getElementById()` method**, which returns the first element in a document with a matching `id` attribute. You append the `getElementById()` method to the `Document` object and pass to it a single argument representing the ID of the element you want to retrieve. For example, consider again a document that contains a single form that is submitted with the `POST` method and that is also assigned a value of `customerInfo` to its `ID` attribute. The following `document.write()` statement uses the `getElementById()` method to access the form and its method attribute:

```
document.write(
    "<p>The form will be submitted with the "
    + document.getElementById(
    "customerInfo").method + " method.</p>");
```

As another example, the following statement uses the `getElementById()` method to retrieve the value entered into a text box that is assigned an `id` attribute of `email`:

```
window.alert(
"You entered the following e-mail address: "
    + document.getElementById("email").value);
```

A common mistake when using the `getElementById()` method is to capitalize the last "d," as in `getElementByID()`, which causes an error because JavaScript is case sensitive.

Be sure to notice that the `getElementById()` method does not refer to an array because it only returns a single element instead of an array, as do the `getElementsByName()` and `getElementsByTagName()` methods. If your document contains multiple elements with the same `id` attribute, then the `getElementById()` method only returns the first matching element.

Next, you will modify the flighttraining.html document so that it uses the `getElementById()` method instead of the `getElementsByTagName()` method to refer to the element containing the airplane image.

To modify the flighttraining.html document so that it uses the `getElementById()` method instead of the `getElementsByTagName()` method to refer to the element containing the airplane image:

1. Return to the **flighttraining.html** file in your text editor.
2. Modify the `name="airplaneImage"` attribute in the `<img>` element to **`id="airplaneImage"`**.

3. Modify the last statement in the `fly()` function so that it uses the `getElementById()` method and the `airplaneImage` ID to refer to the element containing the airplane image, as follows:

```
document.getElementById("airplaneImage").src
    = plane[curPlane].src;
```

4. Save the **flighttraining.html** file, and open it in your Web browser. The animation should begin as soon as all the images load.

5. Close your Web browser window.

Modifying Elements with the `innerHTML` Property

Another element that is used for accessing elements is the **`innerHTML` property**, which sets and retrieves the contents of a specified element. The `innerHTML` property was originally introduced by Microsoft into Internet Explorer browsers but has been adopted by most current Web browsers. The W3C has not officially approved the `innerHTML` property as part of the DOM but probably will at some point because of the method's growing popularity and versatility. In comparison to the `document.write()` and `document.writeln()` methods, which cannot be used to change content after a Web page has been rendered, the `innerHTML` property allows you to retrieve and modify the contents of almost any element without having to reload the entire Web page. In fact, many JavaScript programmers view the `innerHTML` property as a replacement for the `document.write()` and `document.writeln()` methods.

Although the `innerHTML` property is popular with many JavaScript programmers, it also has its detractors. To learn about the arguments against using the `innerHTML` property, along with some alternative solutions, search the Web for "alternatives to innerHTML". The alternative solutions to the `innerHTML` property primarily use some fairly complex techniques involving the XML DOM. Yet, it's important to point out that one of the greatest benefits of JavaScript is its simplicity and ease-of use, and using the XML DOM to manipulate Web pages is anything but simple. In this author's opinion, any techniques that continue to make JavaScript easier to understand and use, such as the `innerHTML` property, should be embraced in favor of more complex solutions.

To use the `innerHTML` property, you append it to an object representing the element whose value you want to retrieve or modify. As an example, the following paragraph element contains an anchor element that displays the text "How's this for a deal?". An `onmouseover` event uses the `innerHTML` property and a `this` reference to change the contents of the anchor element to “Order now and receive 20% off!”. Then, an `onmouseout` event uses the `innerHTML` property and a `this` reference to change the contents of the anchor element back to “How\’s this for a deal?”.

```
<p><a href="sales.html" id="salesLink"
onmouseover="this.innerHTML='Order now ↵
    and receive 20% off!'"
onmouseout="this.innerHTML='How\'s this for ↵
    a deal?'">How's this for a deal?</a></p>
```

You can also append the `innerHTML` property to an element that is returned from the `getElementById()`, `getElementsByName()`, or `getElementsByTagName()` methods. The following example shows the same code that uses the `innerHTML` property to change the link text, but this version uses the `getElementById()` method instead of a `this` reference:

```
<p><a href="sales.html" id="salesLink"
onmouseover="document.getElementById( ↵
    'salesLink').innerHTML='Order now and ↵
    receive 20% off!'"
onmouseout="document.getElementById( ↵
    'salesLink').innerHTML='How\'s this for ↵
    a deal?'">How's this for a deal?</a></p>
```

Next, you will modify the DRG Aviation pages so that they use the `innerHTML` property to set the value assigned to the <h1> element.

To modify the DRG Aviation pages so that they use the `innerHTML` property to set the value assigned to the <h1> element:

1. Return to the **flighttraining.html** file in your text editor.
2. Replace the `document.open()`, `document.write()`, and `document.close()` statements in the second script section with the following statements, which use the `getElementById()` method, `getElementsByTagName()` method, and `innerHTML` property to set the value assigned to the <h1> element:

```
document.write("<h1 id='mainHeading'></h1>");
document.getElementById("mainHeading")
    .innerHTML = document
    .getElementsByTagName("title")[0]
    .innerHTML;
```

3. Save the **flighttraining.html** file, and validate it with the W3C Markup Validation Service. Once the file is valid, close it in your text editor.
4. Return to the **index.html** file in your text editor, and modify the script section with the same changes you made in Step 2.

5. Save the **index.html** file, and validate it with the W3C Markup Validation Service. Once the file is valid, close it in your text editor.
6. Return to the **Instruments.html** file in your text editor, and modify the script section with the same changes you made in Step 2.
7. Save the **Instruments.html** file, and validate it with the W3C Markup Validation Service. Once the file is valid, close it in your text editor.
8. Open the **index.html** file in your Web browser. The first heading on the page, DRG Aviation, uses the `innerHTML` property to access the value assigned to the Web page's `document` object's `title` property. Test the links for the Flight Training and Instrument Training Web pages. The headings should display the value assigned to each Web page's `document` object's `title` property.
9. Close your Web browser and text editor.

Short Quiz 3

1. Explain how to access elements by name.
2. Explain how to access elements by tag name.
3. Explain how to access elements by ID.
4. Explain how to modify elements with the `innerHTML` property.

Summing Up

- Dynamic HTML (DHTML) refers to a combination of technologies that make Web pages dynamic.
- DHTML is a combination of JavaScript, XHTML, CSS, and the `Document` Object Model.
- At the core of DHTML is the Document Object Model, or DOM, which represents the Web page displayed in a window.

- The Document Object Model that represents HTML content is referred to as the HTML DOM, and the Document Object Model that represents XML content is referred to as the XML DOM.
- Through the `Document` object, you can access other objects that represent elements on a Web page.
- The `open()` method creates a new document in a window or frame.
- The `close()` method notifies the Web browser that you are finished writing to the window or frame and that the document should be displayed.
- You should always use the `open()` and `close()` methods when you want to use the `document.write()` and `document.writeln()` methods to update the text displayed in an existing window or frame.
- An `Image` object represents an image created using the `<img>` element.
- One of the most important properties of the `Image` object is the `src` property, which allows JavaScript to change an image dynamically.
- By combining the `src` attribute of the `Image` object with the `setTimeout()` or `setInterval()` methods, you can create simple animation on a Web page.
- A technique for eliminating multiple downloads of the same file is called image caching, which temporarily stores image files in memory. This technique allows JavaScript to store and retrieve an image from memory rather than downloading the image each time it is needed.
- You use the `onload` event handler of the `Image` object to be certain that all images are downloaded into a cache before commencing an animation sequence.
- The `getElementsByName()` method returns an array of elements with a name attribute that matches a specified value.
- The `getElementsByTagName()` method returns an array of elements that matches a specified tag name.
- The `getElementById()` method returns the first element in a document with a matching `id` attribute.
- The `innerHTML` property sets and retrieves the content of a specified element.

Comprehension Check

1. Explain what the word "dynamic" means in Internet terminology.

2. DHTML refers to a combination of which of the following technologies? (Choose all that apply.)

   a. JavaScript

   b. XHTML

   c. CSS

   d. DOM

3. Which of the following Document Object Models can you use to manipulate an XHTML document? (Choose all that apply.)

   a. HTML DOM

   b. XHTML DOM

   c. JSCRIPT DOM

   d. XML DOM

4. Current Mozilla-based Web browsers including Firefox, Internet Explorer 5.0 and higher, and Netscape 6 and higher are not compatible with a standardized version of the DOM; in other words, you must write different JavaScript code sections for each type of browser. True or false?

5. The only element on a Web page that is represented in the DOM by its own object is the `Document` object. True or false?

6. Which of the following `Document` object methods should you always use when you want to use the `write()` and `writeln()` methods to update the text displayed in an existing window or frame? (Choose all that apply.)

   a. `close()`

   b. `open()`

   c. `getElementById()`

   d. `getElementsByName()`

7. Which of the following `Document` object properties can be dynamically changed after a Web page is rendered?
   a. `referrer`
   b. `title`
   c. `URL`
   d. domain
8. The `close()` method of the `Document` object closes the current window. True or false?
9. Which of the following `Document` object properties returns an array? (Choose all that apply.)
   a. `anchors`
   b. `cookies`
   c. `images`
   d. `forms`
10. Which of the following can be used to refer to an image with JavaScript code? (Choose all that apply.)
    a. `name` attribute
    b. `src` attribute
    c. `value` attribute
    d. `images[]`
11. Which property of the `Image` object allows JavaScript to change an image dynamically?
    a. `URL`
    b. `value`
    c. `href`
    d. `src`
12. Why should you use image caching, and what are the procedures for adding image caching to your Web pages?

13. To be certain that all images are downloaded into a cache before commencing an animation sequence, you use the ________________ of the `Image` object.

    a. `images[]` array

    b. `animation` property

    c. `loadImages()` method

    d. `onload` event handler

14. Why do you need to the `getElementsByName()`, `getElementsByTagName(), or getElementById()` methods?

15. What value must you pass to the `getElementsByName()` method?

    a. the `id` attribute of the element you want to retrieve

    b. the tag name of the elements you want to retrieve

    c. the index of the element in the `elements[]` array

    d. the `name` attribute of the elements you want to retrieve

16. The `getElementsByName()` method only returns an array if it locates multiple elements that match the passed argument; a single variable is returned if only one array element is returned. True or false?

17. Which of the following is the correct syntax for executing the `getElementsByTagName()` method and returning all of a document's <p> tags?

    a. `document.getElementsByTagName("<p>")`

    b. `document.getElementsByTagName("p")`

    c. `document.getElementsByTagName(<p>)`

    d. `document.getElementsByTagName() = "<p>"`

18. The `getElementById()` method always returns an array even if only one element is returned. True or false?

19. Which of the following can be used to access the `innerHTML` property? (Choose all that apply.)

    a. the `this` reference

    b. the `getElementsByName()`method

    c. the `getElementsByTagName()`method

    d. the `getElementById()` method

20. The W3C has not officially approved the `innerHTML` property as part of the DOM. True or false?

Reinforcement Exercises

Exercise 10-1

The DOM `Anchor` object represents a link on a Web page that is created with an `<a>` element. Attributes of the `<a>` element, such as the `href` attribute, are also available as properties of the `Anchor` object. This project demonstrates how to use `href` property of the `Anchor` object, along with the `innerHTML` property, to dynamically change the URL and text of an anchor element. The project is an investment recommendation page that provides a link to a recommended investment on Yahoo! Finance according to a particular sector, such as consumer goods or healthcare.

1. Create a new document in your text editor.
2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Investment Picks" as the content of the `<title>` element.
3. Add the following heading to the document body:

```
<h1>Investment Picks</h1>
```

4. Add the following elements and text to the end of the document body. The form contains buttons for stock recommendations in the nine major sectors (according to Yahoo! Finance). Each radio button contains an `onclick` event that calls an event handler named `updateInvestmentLink()`, which you will add next. Two arguments are passed to the `updateInvestmentLink()` function: the name of the investment (which will be used as link text) and a URL (which will be used as the link's URL).

```
<form action=""
enctype="application/x-www-form-urlencoded">
<p><input type="radio" name="industry"
onclick="updateInvestmentLink('Gold', ↵
'http://finance.yahoo.com/q?s=^YHOh714')" />
Basic Materials<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink('General Electric ↵
Industries Ltd.', 'http://finance.yahoo.com/ ↵
q/pr?s=ge')" /> Conglomerates<br />
```

```
<input type="radio" name="industry"
onclick="updateInvestmentLink('Tyson Foods ↵
Inc.', 'http://finance.yahoo.com/ ↵
q/pr?s=tsn')" /> Consumer Goods<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink( ↵
'Catalyst Health Solutions', ↵
'http://finance.yahoo.com/q/pr?s=chsi')" />
Financial<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink('Genentech ↵
Inc.', 'http://finance.yahoo.com/ ↵
q/pr?s=dna')" /> Healthcare<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink( ↵
'Toll Brothers', ↵
'http://finance.yahoo.com/q/pr?s=tol')" />
Industrial Goods<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink( ↵
'Sinclair Broadcast Group Inc.', ↵
'http://finance.yahoo.com/q/pr?s=sbgi')" />
Services<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink( ↵
'Verizon Communications Inc.', ↵
'http://finance.yahoo.com/q/pr?s=vz')" />
Technology<br />
<input type="radio" name="industry"
onclick="updateInvestmentLink( ↵
'Northwest Natural Gas Co.', ↵
'http://finance.yahoo.com/q/pr?s=nwn')" />
Utilities</p>
</form>
<p><a href="http://finance.yahoo.com/"
id="recommendedInvestment">Yahoo! Finance</a></p>
```


5. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

6. Add the following `updateInvestmentLink()` function to the script section. The first statement uses the `innerHTML` property and the `urlText` parameter (which is passed as the first argument from the radio buttons) to change the text of the anchor element. The second statement uses the `href` property of the `Anchor` object and the `urlValue` parameter (which is passed as the second argument from the radio buttons) to change the value of the `href` attribute.

```
function updateInvestmentLink(urlText,
    urlValue) {
    document.getElementById(
        'recommendedInvestment').innerHTML
        = urlText + " (Yahoo! Finance)";
    document.getElementById(
        'recommendedInvestment').href
        = urlValue;
}
```

7. Save the document as **InvestmentPicks.html** in your Exercises folder for Chapter 10, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

8. Open the **InvestmentPicks.html** document in your Web browser and test the radio buttons. Clicking each radio button should change the text and URL of the link at the bottom of the page. Be sure to test the link to ensure that it opens the correct URL.

9. Close your Web browser window.

Using the `oncontextmenu` event to prevent users from displaying the context menu does not completely protect your content. There are various ways that users can circumvent this functionality, including viewing the Web page source code, taking a screen capture of the content, or disabling JavaScript altogether. Therefore, you can really only rely on this method to notify users that the content they are attempting to copy is copyrighted.

For more information on the `Event` object, see the DOM event Web page in the W3C's DHTML tutorial at *http://www.w3schools.com/jsref/dom_obj_event.asp*.

Exercise 10-2

In Chapter 8 you used the `Event` object to check which values a user entered into a text box. Like the `Image` object, the `Event` object is also part of the HTML DOM. Another event type that you haven't studied yet is the `oncontextmenu` event, which is triggered whenever a user attempts to display the context menu (or "shortcut" menu) by clicking his or her right mouse button. Like the `innerHTML` property, the `oncontextmenu` event was originally introduced by Microsoft into Internet Explorer browsers but has been adopted by most current Web browsers. The `oncontextmenu` event is supported by most current Web browsers, so you can safely use it in your JavaScript programs.

Users often copy images or document content from Web pages by right-clicking them to display the context menu, from which you can select the Save Picture As or Copy Image command. One trick that some JavaScript programmers employ to prevent users from copying images or other types of content (that may be protected by copyrights) from a Web page is to use the `oncontextmenu` event to prevent users from displaying the context menu. In this project, you will add code to the instruments.html file that prevents users from right-clicking the logo image and saving it. You will also add code that prevents users from copying any content on the page.

1. Copy the DRGAviation folder in your Chapter folder for Chapter 10 to your Exercises folder for Chapter 10.

2. Open in a text editor the **instruments.html** document from your Exercises folder for Chapter 10.

3. Add the following `oncontextmenu` event handler to the image element for the logo. When the users right-click the image, an alert dialog box informs them that DRG Aviation owns the copyrights to the image. Then, a value of false is returned, which prevents the context menu from being displayed.

```
oncontextmenu="window.alert('This image is ↵
     copyrighted by DRG Aviation.'); ↵
     return false"
```

4. Save the **instruments.html** document, and open it in your Web browser. Right-clicking the image should display the alert dialog box and prevent the context menu from opening. However, you should be able to use the context menu to copy the text on the page.

5. Now you will add code that prevents users from using the context menu to copy any content on the instruments.html page. First, add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

6. Add the following statement to the script section in the document head. This statement assigns a function named `noContextMenu()` as the event handler that will handle any `oncontextmenu` events. Notice that you do not include parentheses following the function name.

```
document.oncontextmenu=noContextMenu;
```

7. Now add the following `noContextMenu()` function to the end of the script section in the document head. The function displays an alert dialog box informing users that DRG Aviation owns the copyrights to the content. Then, a value of false is returned, which prevents the context menu from being displayed.

```
function noContextMenu() {
    window.alert("This content is ↵
        copyrighted by DRG Aviation.");
    return false;
}
```

8. Save the **instruments.html** document, and reload it in your Web browser. Right-clicking any portion of the Web page should display the alert dialog box and prevent the context menu from opening.

9. Close your Web browser window.

Exercise 10-3

In this project, you will create a Web page with an animation of a man using a jackhammer. Your Exercises folder for Chapter 10 contains 11 images that are required for this program: jackhammer0.gif through jackhammer10.gif.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Jackhammer" as the content of the `<title>` element.

3. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following text and elements to the document body. The text and elements include an `<img>` element to display the image, and a form with buttons that controls the animation.

```
<h1>Jackhammer Man</h1>
<p><img src="jackhammer1.gif" height="113" width="100"
alt="Image of a man with a jackhammer." /></p>
<form action="" enctype="text/plain"><p>
<input type="button"
value="Start Bouncing"
onclick="startBouncing();" />
<input type="button" value="Stop Bouncing"
onclick="clearInterval(begin);" /></p>
</form>
```

5. Add the following variable declarations to the script section:

```
var jackhammers = new Array(11);
var curJackhammer = 0;
var direction;
var begin;
jackhammers[0] = "jackhammer0.gif";
jackhammers[1] = "jackhammer1.gif";
jackhammers[2] = "jackhammer2.gif";
```

```
jackhammers[3] = "jackhammer3.gif";
jackhammers[4] = "jackhammer4.gif";
jackhammers[5] = "jackhammer5.gif";
jackhammers[6] = "jackhammer6.gif";
jackhammers[7] = "jackhammer7.gif";
jackhammers[8] = "jackhammer8.gif";
jackhammers[9] = "jackhammer9.gif";
jackhammers[10] = "jackhammer10.gif";
```


6. Now add the following functions to the script section, which control the animation:

```
function bounce() {
    if (curJackhammer == 10)
        curJackhammer = 0;
    else
        ++curJackhammer;
    document.getElementsByTagName(
        "img")[0].src
        = jackhammers[curJackhammer].src;
    if (curJackhammer == 0)
        direction = "up";
    else if (curJackhammer == 10)
        direction = "down";
    document.getElementsByTagName(
        "img")[0].src
        = jackhammers[curJackhammer];
}
function startBouncing() {
    if (begin)
        clearInterval(begin);
    begin = setInterval("bounce()",90);
}
```

7. Save the document as **Jackhammer.html** in your Exercises folder for Chapter 10, and validate it with the W3C Markup Validation Service. Once the document is valid, open it in your Web browser and test the animation buttons.

8. Close your Web browser window.

Exercise 10-4

In this project, you will add image caching to the jackhammer animation.

1. Return to the Jackhammer.html document in your text editor, and immediately save it as **JackhammerCache.html**.

2. First, delete the following statements from the script section, which assign the image filenames to the `jackhammers[]` array:

```
jackhammers[0] = "jackhammer0.gif";
jackhammers[1] = "jackhammer1.gif";
jackhammers[2] = "jackhammer2.gif";
jackhammers[3] = "jackhammer3.gif";
jackhammers[4] = "jackhammer4.gif";
jackhammers[5] = "jackhammer5.gif";
jackhammers[6] = "jackhammer6.gif";
jackhammers[7] = "jackhammer7.gif";
jackhammers[8] = "jackhammer8.gif";
jackhammers[9] = "jackhammer9.gif";
jackhammers[10] = "jackhammer10.gif";
```

3. Now add the following `for` loop to handle the image caching. Add the code above the `bounce()` function.

```
for(var i = 0; i < 11; ++i) {
    jackhammers[i] = new Image();
    jackhammers[i].src = "jackhammer"
        + i + ".gif";
    if (i == 10)
        begin = setInterval("bounce()", 90);
}
```

4. Replace the last statement in the `bounce()` function with the following statement, which assigns the cached image to the `<img>` element:

```
document.getElementsByTagName("img")[0].src
    = jackhammers[curJackhammer].src;
```

5. Delete the `startBouncing()` function at the end of the script section. You no longer need the function because the animation starts automatically after the images finish loading.

6. Delete the form in the document body. You no longer need the animation buttons either because the animation starts automatically after the images finish loading.

7. Save the **JackhammerCache.html** document, and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor and open it in your Web browser. The animation should begin as soon as the images finish loading.

8. Close your Web browser window.

Exercise 10-5

The DOM also includes `Table`, `TableRow`, and `TableCell` objects that you can use to dynamically manipulate tables on a Web page.

Each of these objects includes various methods and properties for manipulating tables. For example, the `Table` object contains `insertRow()` and `deleteRow()` methods that allow you to add and delete rows in a table, while the `TableRow` object contains the `insertCell()` and `deleteCell()` methods, which allow you to add and delete cells in a table. To refer to a table, you use the `getElementById()` method to access the table through its `id` attribute. The `Table` object also contains a `row[]` array that stores all the rows in the selected table. Similarly, the `TableRow` object contains a `cells[]` array that stores all the cells in the selected row. To access an array containing all of the cells in the first row of a table with an `id` attribute of `myTable`, you use a statement similar to `document.getElementById("myTable").rows[selectedItem].cells`.

For more information on the `Table`, `TableRow`, and `TableCell` objects, see the W3School's HTML DOM Reference at *http://w3schools.com/jsref/default.asp*.

Next, you will create a Web page for Central Valley Chocolates that allows users to add and remove chocolate orders from a "shopping cart" table.

1. Create a new document in your text editor.
2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Central Valley Chocolates" as the content of the `<title>` element.
3. Add the following text and heading elements to the document body:

```
<h1>Central Valley Chocolates</h1>
<h2>Gourmet Chocolates</h2>
```

4. Now add the following table to the end of the document body. Each row in the table contains three cells: the first cell describes the type of chocolate, the second cell lists the price, and the third cell contains an Add button that will call a function named `addItem()`. The argument passed to the `addItem()` function uses the `getElementById()` method to access the current row through its `id` attribute. The `rowIndex` property is a property of the `TableRow` object and returns the current row's index number in the `Table` object's `rows[]` array.

```
<table border="1" id="chocolateTable">
<tr id="ch1">
<td>Chocolate Truffles</td><td>$34.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch1').rowIndex)" /></td></tr>
<tr id="ch2">
<td>Pecan Caramel Duets</td><td>$14.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch2').rowIndex)" /></td></tr>
```

```
<tr id="ch3">
<td>Chocolate Covered Cherries</td><td>$28.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch3').rowIndex)" /></td></tr>
<tr id="ch4">
<td>White Chocolate Ganaches</td><td>$22.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch4').rowIndex)" /></td></tr>
<tr id="ch5">
<td>Chocolate Mints</td><td>$17.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch5').rowIndex)" /></td></tr>
<tr id="ch6">
<td>Chocolate Caramels</td><td>$14.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch6').rowIndex)" /></td></tr>
<tr id="ch7">
<td>Chocolate Toffee Bark</td><td>$9.99</td><td>
<input type="button" value="Add"
onclick="addItem(document.getElementById( ↵
'ch7').rowIndex)" /></td></tr>
</table>
```

5. Add the following text and elements to the end of the document body. The table will store the shopping cart items selected by the user, and the paragraph element will display the sales total.

```
<h2>Your Shopping Cart</h2>
<table id="shoppingCart" border="1">
<tr><td>Your shopping cart is empty</td></tr>
</table>
<p id="total"> </p>
```

6. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

7. Add the following global variables and function definition to the script section. The `emptyCart` variable will determine whether the shopping cart is empty, and the `salesTotal` variable will store the current sales total. The `curRow` variable will be incremented to create unique ids for each table row. The function is passed a single parameter representing the current row's index number in the `Table` object's `rows[]` array.

```
var emptyCart = true;
```

```
var salesTotal = 0;
var curRow = 1;
function addItem(selectedItem) {
}
```

8. Add the following `if` statement to the `addItem()` function. This code determines whether the shopping cart is empty; if so, it uses the `deleteRow()` method of the `Table` object to delete the single row in the table that displays the text "Your shopping cart is empty".

```
if (emptyCart == true) {
    document.getElementById('shoppingCart')
        .deleteRow(0);
    emptyCart = false;
}
```

9. Add to the end of the `addItem()` function the following statements, which assign the description and price to the `selectedItem` and `itemPrice` variables. Notice that the statements use the `cells[]` array of the `TableRows` object to access the cell values through the `innerHTML` property.

```
var curItem = document.getElementById(
    "chocolateTable")
.rows[selectedItem].cells;
var selectedItem = curItem[0].innerHTML;
var itemPrice = curItem[1].innerHTML;
```

10. Add to the end of the `addItem()` function the following statements, which use the `insertRow()` and `insertCell()` methods, and the `innerHTML` property to create a new row and cell in the shopping cart table. The second-to-last statement uses the `innerHTML` property to create a button element that calls a function named `removeItem()` and the last statement increments the `curRow` variable, which assigns unique IDs to each table row. The function is passed a single argument, the `rowIndex` property of the `TableRow` object.

```
var lastItem = document.getElementById(
    "shoppingCart").rows.length;
var cartTable = document.getElementById(
    "shoppingCart");
var newRow = cartTable.insertRow(lastItem);
document.getElementById("chocolateTable")
    .rows[lastItem].id = "R" + curRow;
var itemCell = newRow.insertCell(0);
itemCell.innerHTML = selectedItem;
var priceCell = newRow.insertCell(1);
priceCell.innerHTML = itemPrice;
var actionCell = newRow.insertCell(2);
actionCell.innerHTML
    = "<input type='button' value='Remove' "
```

```
    + "onclick=\"removeItem('R" + curRow
    + "')\" />";
++curRow;
```


11. Add the following statements to the end of the `addItem()` function. These statements update the sales total and assign the new value to the paragraph element with the `id` attribute of `total`.

```
salesTotal += parseFloat(
    itemPrice.substring(1));
document.getElementById('total').innerHTML
    = "<strong>Sales total</strong>: $"
    + salesTotal.toFixed(2);
```

12. Finally, add the following `removeItem()` function to the end of the script section. This function removes items from the shopping cart table when the user clicks the item's Remove button.

```
function removeItem(rowNum) {
    if (document.getElementById(
        "shoppingCart").rows.length == 1) {
        document.getElementById(
            "shoppingCart").rows[0].cells[0]
            .innerHTML = "<td>Your shopping ↵
            cart is empty</td>";
        document.getElementById(
            "shoppingCart").rows[0].cells[1]
            .innerHTML = "<td>$0.00</td>";
        salesTotal = 0;
        document.getElementById(
            'total').innerHTML = "$"
            + salesTotal.toFixed(2);
        emptyCart = true;
    }
    else {
        var selectedRow = document
            .getElementById(rowNum).rowIndex;
        document.getElementById(
            "shoppingCart").deleteRow(
            selectedRow);
        var itemPrice = document
            .getElementById("shoppingCart")
            .rows[0].cells[1].innerHTML;
        salesTotal = salesTotal - parseFloat(
            itemPrice.substring(1));
        document.getElementById('total')
            .innerHTML = "$"
            + salesTotal.toFixed(2);
    }
}
```

13. Save the document as **ChocolateOrder.html** in your Exercises folder for Chapter 10, and validate it with the W3C Markup Validation Service. Once the document is valid, open it in your Web browser and test the program's functionality.

14. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 10. Be sure to validate the files you create with the W3C Markup Validation Service.

Project 10-1

Create a document with two vertical frames. Create a series of links in the left frame. Each button should represent the name of a country. Use Wikipedia (*http://www.wikipedia.com*) or another source to look up statistical information on different countries, such as the name of the capital, languages spoken, population, and so on. Use the `open()`, `close()`, and `write()` methods to write the information to the right frame when a user clicks a country link and create separate functions for each country. Save the frameset document as **CountryStats.html** and the document containing the list of country links as **CountryInfo.html**.

Project 10-2

Create a Web page that generates addition tables and multiplication tables for the values zero through ten. The document should include buttons that open a new window that displays each table. Generate each table using `document.write()` methods. Both tables should reuse the same window. Save the document as **MathTables.html**.

Project 10-3

You have probably seen many sites that use thumbnail images to display smaller versions of an image file. If visitors want to see the image in a larger size, they can click the thumbnail version of the image. The link will then open a larger-sized version of the image or another Web page that displays the larger image along with more information. The important thing to understand is that the thumbnail version of the image is not the original image reduced by using the height and width attributes of the `<img>` element. Rather, the thumbnail images are entirely separate images that have been resized using image-editing software. Real estate agents commonly use thumbnails on their Web sites to display pictures of homes and other types of property. Create a Web page for a real estate company that allows visitors to toggle between small and large versions of a property photo. Your Projects folder for Chapter 10 includes two photos, cottage_small.jpg and cottage_large.jpg, that you can use for this exercise. Start by displaying the small version of the image on the Web page, and include a link that reads "View larger image". Clicking the link should replace the image file on the Web page with the larger version and change the link text to read "View smaller version". Then, clicking the "View smaller version" link should change the picture back to the smaller version. Use the `getElementById()` method to access the image element on the Web page, and be sure to remember to change the height and width of the image each time you replace it. Save the document as **PineKnollProperties.html**.

Project 10-4

Create a Web page that allows you to dynamically build a table containing a team roster for a bowling league. Use the same techniques that you learned in Reinforcement Exercise 10-5 for dynamically manipulating tables on a Web page, including the `Table`, `TableRow`, and `TableCell` objects. The Web page should include two forms: one form in which users can enter the names of team members and click an Add Bowler button, and another form that contains the dynamic table and that lists the names of the bowling team members in individual rows. Each row should also contain a Remove Bowler button that removes a bowler's name from the list. The second form should be submitted to the FormProcessor.html document (a copy is in your Projects folder for Chapter 10). In order to submit bowler names that are added dynamically to the table, you will need to dynamically add `<input>` elements for each bowler. Use two functions: `addBowler()`, which adds bowlers' names to the list, and `removeBowler()`, which removes bowlers' names from the list. Also, include the text "Your team roster is empty." if no bowlers have been entered or if all bowler names have been removed. Save the document as **BowlingTeam.html**.

Project 10-5

Your Projects folder for Chapter 10 contains an animated GIF file of a running puppy, along with six individual images (puppy0.gif through puppy5.gif) that are used in the animation. Create a JavaScript program that animates the six images the same as the animated GIF file. Use image caching to start the animation as soon as the images finish loading, and be sure to use either the `getElementsByName()`, `getElementsByTagName()`, or `getElementById()` method to dynamically update the image element. Save the document as **RunningPuppy.html**.

Project 10-6

Your Projects folder for Chapter 10 contains an animated GIF file of a pushpin that is bouncing back and forth, along with nine individual images (pin0.gif through pin9.gif) that are used in the animation. Create a JavaScript program that animates the nine images the same as the animated GIF file. You will need to write code that displays pin0.gif through pin9.gif, and then from pin9.gif to pin0.gif. Use image caching to start the animation as soon as the images finish loading, and be sure to use either the `getElementsByName()`, `getElementsByTagName()`, or `getElementById()` method to dynamically update the image element. Save the document as **BouncingPushPin.html**.

CHAPTER 11

Creating Dynamic HTML (DHTML)

In this chapter, you will:

- Use JavaScript to modify CSS styles
- Work with CSS positioning
- Create DHTML menus

In the last chapter, you learned about the DOM and how it fits in with Dynamic HTML (DHTML). In this chapter, you will become acquainted with some basic DHTML techniques. As you work through this chapter, keep in mind that DHTML is a large subject that could take up an entire book. Also, there is a steep learning curve with DHTML, mainly because it requires a strong knowledge of XHTML, Cascading Style Sheets (CSS), and JavaScript. Therefore, this chapter only touches upon the most basic aspects of DHTML. Specifically, you will learn how to use JavaScript to dynamically modify CSS styles and dynamically position elements. You will also learn how to create DHTML menus and check for browser compatibility.

You need a solid understanding of CSS in order to be successful in this chapter.

Manipulating CSS with JavaScript

Although the primary purpose of CSS is to format the display of a Web page, you can use JavaScript to modify CSS styles to make the document dynamic after a Web browser renders the document. As mentioned in Chapter 10, prior to the release of the W3C standardized version of the DOM, no DHTML standard worked with both Internet Explorer and Mozilla-based browsers such as Firefox. This incompatibility was particularly evident to programmers who needed to use JavaScript to manipulate CSS styles. Earlier versions of Internet Explorer and Mozilla-based browsers supported incompatible `Document` object properties and methods. Because JavaScript uses `Document` object properties and methods to access CSS styles, if you wanted to use JavaScript code to manipulate CSS in older browsers, you had three options:

- Write code that functioned only in Mozilla-based browsers.
- Write code that functioned only in Internet Explorer.
- Write both sets of code and design the script so that the correct set would execute depending on which browser rendered the page.

This chapter primarily discusses DOM techniques that are compatible with the W3C's standardized version of DHTML. That makes sense because, at the time of this writing, well over 90% of Internet users access the Web with a W3C-compliant browser. If you anticipate that your DHTML code will run in older browsers, you need to learn the DHTML techniques for each type of browser.

Modifying Styles with the `this` Reference

In Chapter 4, you learned how to manipulate CSS styles in JavaScript with the `this` reference and the `style` property in an event handler within the element itself. As a refresher, in order to refer to a style with the `this` reference, you use a period to append the `style` property to it, followed by another period and a CSS property. CSS properties without hyphens are referred to in JavaScript with all lowercase letters. However, when you refer to a CSS property containing a hyphen in JavaScript code, you remove the hyphen, convert the first word to lowercase, and convert the first letter of subsequent words to uppercase. For example, the `text-decoration` property is referred to as `textDecoration`, `font-family` is referred to as `fontFamily`, `font-size` is referred to as `fontSize`, and so on. To use the `onclick` event handler to modify the font size of the current element, you use the following statement:

```
onclick="this.style.fontSize='2em';"
```

The next example shows how to use `onmouseover` and `onmouseout` event handlers to give users the option of changing the text to make it easier to read. Specifically, it allows users to change the text color and weight of a line simply by passing the mouse pointer over it. Moving the mouse pointer away from the line returns it to its original text color and weight. Figure 11-1 shows the document in a Web browser when the mouse pointer passes over the third line.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>World's Largest Cities by Population</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
<link rel="stylesheet" href="js_styles.css"
    type="text/css" />
</head>
<body>
<h1>World's Largest Cities by Population</h1>
<p><strong>Place your mouse over any line to change its
color and weight.</strong></p><hr />
<p onmouseover="this.style.color = 'blue'; ↵
    this.style.fontWeight = 'bold'"
    onmouseout="this.style.color = 'black'; ↵
    this.style.fontWeight = 'normal'">
    Mumbai, India / 13,922,12</p>
<p onmouseover="this.style.color = 'blue'; ↵
    this.style.fontWeight = 'bold'"
    onmouseout="this.style.color = 'black'; ↵
    this.style.fontWeight = 'normal'">
    Shanghai, China / 13,831,900</p>
<p onmouseover="this.style.color = 'blue'; ↵
    this.style.fontWeight = 'bold'"
    onmouseout="this.style.color = 'black'; ↵
    this.style.fontWeight = 'normal'">
    Karachi, Pakistan / 12,991,000</p>
```

```
<p onmouseover="this.style.color = 'blue'; ↵
    this.style.fontWeight = 'bold'"
    onmouseout="this.style.color = 'black'; ↵
    this.style.fontWeight = 'normal'">
    Delhi, India / 12,259,230</p>
<p onmouseover="this.style.color = 'blue'; ↵
    this.style.fontWeight = 'bold'"
    onmouseout="this.style.color = 'black'; ↵
    this.style.fontWeight = 'normal'">
    Istanbul, Turkey / 11,372,613</p>
</body>
</html>
```

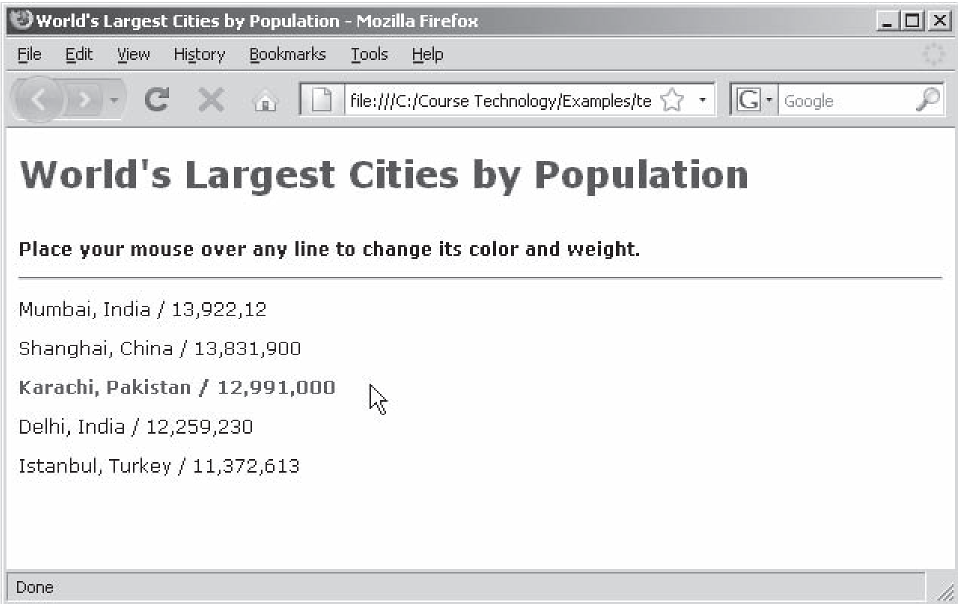


Figure 11-1 Web page with `onmouseover` and `onmouseout` event handlers that change text display

In this chapter, you work on the same DRG Aviation Web pages with which you worked in Chapter 10. You will start by replacing the menu links with button images. When the mouse passes over each menu image, `onmouseover` and `onmouseout` events will swap the displayed image with a more vivid one and then change back to the original image when the mouse pointer is removed.

Be sure to work with a copy of the folder so you don't overwrite the original source files.

To modify the menus in the DRG Aviation Web pages:

1. Copy the DRGAviation folder from your Chapter folder for Chapter 10 to your Chapter folder for Chapter 11.
2. Start your text editor and open the home page for DRG Aviation, **index.html**.

3. Locate the Home, Flight Training, and Instrument Training links and replace the text within the anchor elements with image elements that display the homeup.png, flightup.png, and instrumentup.png images located in the images folder within the DRGAviation folder. Also, delete the image elements that display the arrow2.gif image after each link. Include `onmouseover` and `onmouseout` event handlers for each link, which swap the default images with the homeover.png, flightover.png, and instrumentover.png images (also located in the images folder within the DRGAviation folder) and then change back to the original image when the mouse pointer is removed. The modified statements should appear as follows:

```
<a href="index.html"><img src="images/homeup.png"
    height="28" width="164"
    alt="Button that links to index.html"
    onmouseover="this.src='images/homeover.png'"
    onmouseout="this.src='images/homeup.png'" /></a>
<a href="flighttraining.html">
    <img src="images/flightup.png"
    height="28" width="164"
    alt="Button that links to flighttraining.html"
    onmouseover="this.src='images/flightover.png'"
    onmouseout="this.src='images/flightup.png'" />
</a>
<a href="instruments.html">
    <img src="images/instrumentup.png"
    height="28" width="164"
    alt="Button that links to instruments.html"
    onmouseover="this.src='images/ ↵
    instrumentover.png'"
    onmouseout="this.src='images/ ↵
    instrumentup.png'" />
</a>
```

4. Open the **index.html** document in your Web browser, and test the `onmouseover` and `onmouseout` event handlers in the links. Figure 11-2 shows how the Instrument Training link appears when the mouse pointer passes over it.

Figure 11-2 Instrument Training link when the mouse pointer passes over it

5. Close your Web browser window.

You can also pass the `this` reference as an argument to a function. The `onclick` event handler in the following paragraph element calls a function named `changeColor()` and passes to it the `this` reference. When the `this` reference is passed to the function, it becomes the `curElement` variable, which is defined within the function definition's parentheses. The single statement within the function then uses the `curElement` variable to change the element to red.

```
function changeColor(curElement) {
     curElement.style.color = "red";
}
<p onclick="changeColor(this)">
Red paragraph.</p>
```

The following code shows a modified version of the world's largest cities Web page. This time, however, `this` references are passed to functions that change the display of each line.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
```

```
<head>
<title>World's Largest Cities by Population</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
<link rel="stylesheet" href="js_styles.css"
type="text/css" />
<script type="text/javascript">
/* <![CDATA[ */
function changeDisplay(curLine) {
     curLine.style.color = "blue";
     curLine.style.fontWeight = "bold";
}
function restoreDisplay(curLine) {
     curLine.style.color = "black";
     curLine.style.fontWeight = "normal";
}
/* ]]> */
</script>
</head>
<body>
<h1>World's Largest Cities by Population</h1>
<p><strong>Place your mouse over any line to change
its color and weight.</strong></p><hr />
<p onmouseover="changeDisplay(this)"
    onmouseout="restoreDisplay(this)">
    Mumbai, India / 13,922,12</p>
<p onmouseover="changeDisplay(this)"
    onmouseout="restoreDisplay(this)">
    Shanghai, China / 13,831,900</p>
<p onmouseover="changeDisplay(this)"
    onmouseout="restoreDisplay(this)">
    Karachi, Pakistan / 12,991,000</p>
<p onmouseover="changeDisplay(this)"
    onmouseout="restoreDisplay(this)">
    Delhi, India / 12,259,230</p>
<p onmouseover="changeDisplay(this)"
    onmouseout="restoreDisplay(this)">
    Istanbul, Turkey / 11,372,613</p>
</body>
</html>
```

Modifying Styles with Methods of the Document Object

In order to modify CSS properties without using the `this` reference, you must first gain access to the styles by using the `getElementById()`, `getElementsByName()`, or `getElementsByTagName()` methods of the `Document` object. The statements in the following function show how to use the `getElementById()`method to access the element with an `ID` attribute of `ff1` and modify its `color` and `font-size` properties. Notice that the `ID` attribute is passed to the `changeStyle()` function by passing `this.id` as the argument.

```
function changeStyle(curID) {
    var curElement = document
        .getElementById(curID);
     curElement.style.color = "red";
     curElement.style.fontSize = "18pt";
}
<h1 id="ff1" onclick="changeStyle(this.id)">
Sunshine Deli</h1>
```

The following code is from the world's largest cities page you saw earlier. This time, however, the styles for each line are accessed by using `getElementById()` methods.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<title>World's Largest Cities by Population</title>
<meta http-equiv="content-type"
    content="text/html; charset=iso-8859-1" />
<link rel="stylesheet" href="js_styles.css"
    type="text/css" />
<script type="text/javascript">
/* <![CDATA[ */
function changeDisplay(curLine) {
    var changeElement = document
        .getElementById(curLine);
    changeElement.style.color = "blue";
    changeElement.style.fontWeight = "bold";
}
function restoreDisplay(curLine) {
    var changeElement = document
        .getElementById(curLine);
    changeElement.style.color = "black";
    changeElement.style.fontWeight = "normal";
}
/* ]]> */
</script>
</head>
<body>
<h1>World's Largest Cities by Population</h1>
<p><strong>Place your mouse over any line to change its
color and weight.</strong></p><hr />
<p id="p1" onmouseover="changeDisplay(this.id)"
    onmouseout="restoreDisplay(this.id)">
    Mumbai, India / 13,922,12</p>
<p id="p2" onmouseover="changeDisplay(this.id)"
    onmouseout="restoreDisplay(this.id)">
    Shanghai, China / 13,831,900</p>
<p id="p3" onmouseover="changeDisplay(this.id)"
    onmouseout="restoreDisplay(this.id)">
    Karachi, Pakistan / 12,991,000</p>
```

```
<p id="p4" onmouseover="changeDisplay(this.id)"
    onmouseout="restoreDisplay(this.id)">
    Delhi, India / 12,259,230</p>
<p id="p5" onmouseover="changeDisplay(this.id)"
    onmouseout="restoreDisplay(this.id)">
    Istanbul, Turkey / 11,372,613</p>
</body>
</html>
```


Next, you modify the functions in the DRG Aviation home page so that they modify the style of the anchor elements by using the `getElementById()`method instead of the `this` reference.

To modify the functions in the DRG Aviation home page so that they use the `getElementById()` method instead of the `this` reference:

1. Return to the **index.html** document in your text editor.
2. Modify the links so that they include `id` attributes. Also, modify the `onmouseover` and `onmouseout` event handler functions in the menu links so that they use the `getElementById()`function. Your modified anchor elements should appear as follows:

```
<a href="index.html"><img src="images/homeup.png"
    id="home" height="28" width="164"
    alt="Button that links to index.html"
    onmouseover="document.getElementById( ↵
        this.id).src='images/homeover.png'"
    onmouseout="document.getElementById( ↵
        this.id).src='images/homeup.png'" /></a>
<a href="flighttraining.html">
    <img src="images/flightup.png"
    id="pilot" height="28" width="164"
    alt="Button that links to flighttraining.html"
    onmouseover="document.getElementById( ↵
        this.id).src='images/flightover.png'"
    onmouseout="document.getElementById( ↵
        this.id).src='images/flightup.png'" />
</a><a href="instruments.html">
    <img src="images/instrumentup.png"
    id="inst" height="28" width="164"
    alt="Button that links to instruments.html"
    onmouseover="document.getElementById(
        this.id).src='images/instrumentover.png'"
    onmouseout="document.getElementById( ↵
        this.id).src='images/instrumentup.png'" />
</a>
```

3. Open the **index.html** document in your Web browser, and test the `onmouseover` and `onmouseout` event handlers in the

links. The Web pages should work and appear the same as they did before you added the `getElementById()` methods.

4. Close your Web browser window.

Checking Browser Compatibility

If you anticipate that your script may run in a browser that is not compatible with the W3C's standardized version of DHTML, you should write code that checks whether the browser is compliant with the W3C DOM. If the browser is not compliant with the W3C DOM, your script should open an alternate Web page that does not include DHTML, or your script should display a message advising the user to upgrade his or her browser.

A JavaScript program that checks which type of browser is running is commonly called a **browser sniffer**. Although there are several ways to write a browser sniffer, including using properties of the `Navigator` object, the easiest way to test whether a Web browser is compatible with the W3C DOM is to check whether the browser includes the `getElementById()` method. You can check whether a browser includes the `getElementById()` method by using a statement similar to `if (document.getElementById)`. If the method is available in the browser, then a value of true is returned, meaning that the browser is compatible with the W3C DOM.

The browser sniffer script in the following code opens a DHTML version of a butterfly animation script only if the browser is compatible with the W3C DOM. If the browser is not compatible with the W3C DOM, then a non-DHTML version of the Web page opens.

```
...
<script type="text/javascript">
/* <![CDATA[ */
function checkBrowser() {
    if (document.getElementById)
         document.location.href
              = "ButterflyDHTML.html";
     else
         document.location.href
              = "ButterflyNoDHTML.html";
}
/* ]]> */
</script>
</head>
<body onload="checkBrowser();">
</body>
</html>
```

Short Quiz 1

1. How do you modify styles with methods of the `Document` object?
2. Why doesn't this book use code that checks whether the browser is compliant with the W3C DOM?
3. Explain how to use a browser sniffer.

Understanding CSS Positioning

Although you have used the `<img>` element to create simple animations with JavaScript, you can only use it to create stationary animations. That is, an animation created with the `<img>` element does not travel across the screen. Actually, there is no way to reposition an image on a Web page unless you use **CSS positioning**, which is used to position or lay out elements on a Web page. Table 11-1 lists common CSS positioning properties.

Property	Description
`clip`	Determines the region of an element that is displayed
`display`	Specifies whether to display an element
`height, width`	Determines an image's height and width
`top, left`	Determines the position of an element's upper-left corner in relation to the upper-left corner of the document window
`overflow`	Determines how to handle an image that is bigger than its assigned space
`position`	Specifies the type of CSS positioning
`bottom, right`	Determines the position of an element's lower-right corner in relation to the upper-left corner of the document window
`visibility`	Specifies whether an element is visible
`z-index`	Determines the order in which dynamically positioned elements are layered

Table 11-1 CSS positioning properties

CSS positioning is a lengthy topic; this chapter touches only on the basics.

The most critical CSS positioning property is the `position` property, which determines the type of positioning applied to an element. Table 11-2 lists the values that can be assigned to the `position` property.

Positioning Type	Description
`absolute`	Positions an element in a specific location on a Web page
`fixed`	Positions an element in relation to the browser window
`relative`	Positions an element in relation to other elements on a Web page
`static`	Positions an element according to the normal flow of other elements and text on a Web page; elements that include this positioning type cannot be moved with CSS positioning

Table 11-2 CSS positioning values

A value of "static" essentially means that you cannot use CSS positioning with an element. In order to use CSS positioning, you must use one of the other three values.

Dynamic Positioning

The easiest way to dynamically position an element with CSS is to use the `left` and `top` properties. The `left` property specifies an element's horizontal distance from the upper-left corner of the window, whereas the `top` property specifies an element's vertical distance from the upper-left corner of the window. Both property values are assigned in pixels. For example, the following code dynamically positions three images of a bird on a Web page. Figure 11-3 shows how the images appear in a Web browser.

```
<body>
    <p>
        <img src="up.gif"
        style="position: absolute; left: 40px; ↵
            top: 200px" alt="Image of a bird"
            height="218" width="200" />
    </p>
    <p>
        <img src="down.gif"
        style="position: absolute; left: 250px; ↵
            top: 80px" alt="Image of a bird"
            height="218" width="200" />
    </p>
    <p>
        <img src="up.gif"
        style="position: absolute; left: 480px;
            top: 10px" alt="Image of a bird"
            height="218" width="200" />
    </p>
</body>
```

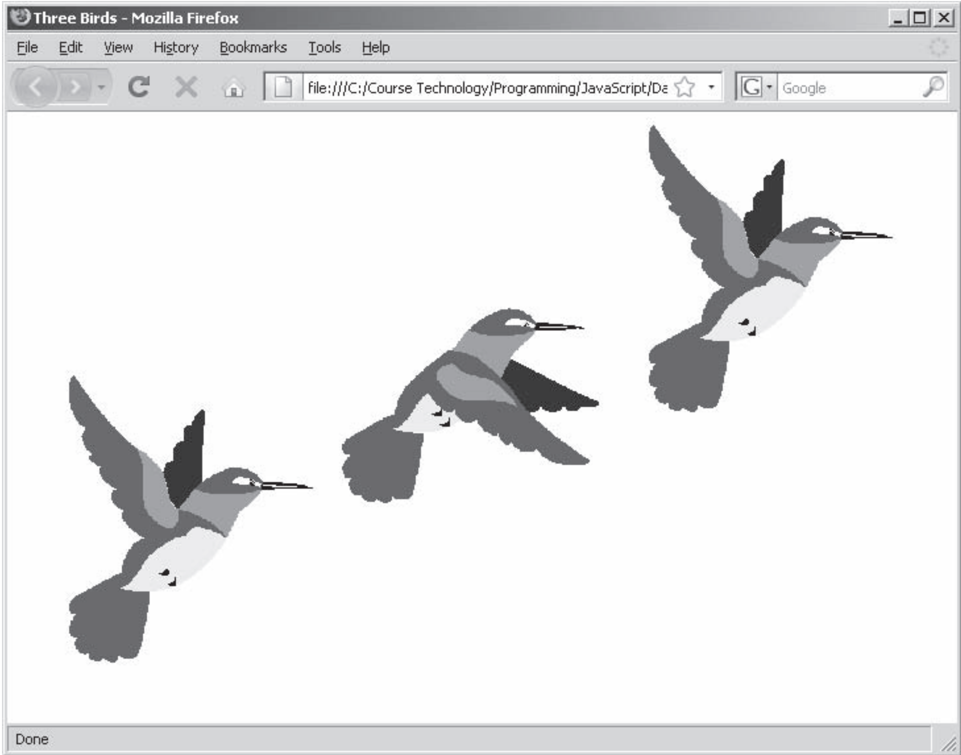


Figure 11-3 Dynamically positioned images

You can find a copy of the ThreeBirds.html document and the images it displays in your Chapter folder for Chapter 11.

Next, you dynamically position an image on the Instruments page of the DRG Aviation site. The images folder in the DRGAviation folder contains a GIF image named airplane.gif that you can use for this exercise.

To dynamically position an image on the Instruments page of the DRG Aviation site:

1. In your text editor, open the **instruments.html** document, which is located in the DRGAviation folder in your Chapter folder for Chapter 11.

2. Add the following CSS-positioned `<img>` elements immediately after the closing `</div>` tag in the first cell of the first table. The CSS properties position the same image in different locations on the screen.

```
<p><img src="images/airplane.gif"
    style="position: absolute; left: 440px; ↵
    top: 140px" alt="Image of an airplane"
    height="38" width="128" /></p>
```

```
<p><img src="images/airplane.gif"
    style="position: absolute; left: 540px; ↵
    top: 100px" alt="Image of an airplane"
    height="38" width="128" /></p>
<p><img src="images/airplane.gif"
    style="position: absolute; left: 590px; ↵
    top: 160px" alt="Image of an airplane"
    height="38" width="128" /></p>
```


3. Save the **instruments.html** document, and then open it in your Web browser. Figure 11-4 shows how the images appear.

Figure 11-4 Images positioned with CSS in instruments.html

4. Close your Web browser window.

Traveling Animation

The animations you have seen so far have been simple stationary animations that are created by swapping the image files assigned to an `<img>` element's `src` attribute. With DHTML, you can use dynamic positioning to create traveling animation—that is, images that appear to travel across the screen. The following code demonstrates how to create traveling animation with an animated GIF image of a butterfly. The butterfly travels from the lower-left side of the screen, over the paragraph, to the upper-right corner. The global `topPosition` and `leftPosition` variables define the initial starting position of the image. An `onload` event handler in the opening `<body>` tag uses the `setInterval()` function to execute the `flyButterfly()` function, which handles the animation. The first statement in the function gets the element ID of the butterfly image, while the second and third statements assign values to the element's `left` and `top` properties. By default, the `style` attribute in the image element uses the `visibility` style to hide the image, so the fourth statement in the `flyButterfly()` function displays the image. The remaining statements modify the values assigned to the `topPosition` and `leftPosition` variables, which the function uses to dynamically position the butterfly image. Figure 11-5 shows how the Web page appears in a browser.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
    <title>Central Valley Floral Design</title>
    <meta http-equiv="Content-Type"
       content="text/html; charset=windows-1251" />
    <link href="css.css" type="text/css"
       rel="stylesheet" />
    <script type="text/javascript">
    /* <![CDATA[ */
        var topPosition = 250;
        var leftPosition = -100;
        function flyButterfly() {
            var butterfly = document.getElementById(
                "butterfly");
            butterfly.style.left = leftPosition
                + "px";
            butterfly.style.top = topPosition
                + "px";
            butterfly.style.visibility = "visible";
            topPosition -= 2;
            leftPosition += 10;
            if (leftPosition >= screen.availWidth
               - 300) {
               topPosition = 250;
               leftPosition = -100;
            }
        }
    /* ]]> */
    </script>
</head>
<body onload="setInterval('flyButterfly()', 100);">
    <p>
        <img src="butterfly.gif" id="butterfly"
            style="position: absolute; ↵
            left: -100px; top: 250px; ↵
```

```
            visibility: hidden"
            alt="Image of a butterfly" height="120"
            width="150" />
    </p>
...
</body>
</html>
```

Figure 11-5 Butterfly animation Web page

Next, you will animate the airplane image you added to the Instruments page of the DRG Aviation site so that it appears to fly across the screen from left to right. The starting horizontal position of the airplane will be -122 pixels, so it appears to fly from off-screen onto the document area. You will use the `Math.random()` function to randomly generate the vertical position, in pixels, where the airplane will begin each time it flies across the screen. To ensure that the starting position is within the top and bottom boundaries of the document area, you need to set the minimum and maximum values that the `Math.random()` function will generate by using the following formula:

> You can find a copy of the butterfly animation document in the FloralDesign folder, located in your Chapter folder for Chapter 11.

```
var randomNumber = Math.floor(Math.random()
    * (maximum - minimum + 1)) + minimum);
```

The value you assign to the *minimum* variable will be 70 (pixels), while the value you assign to the *maximum* variable will be the available screen height minus 200 (again, in pixels). To determine the available screen height, you will use the `availHeight` property of the `Screen` object.

To animate the airplane image you added to the Instruments page of the DRG Aviation site so that it appears to fly across the screen:

1. Return to the **instruments.html** document in your text editor, and add a script section to the document head. Then, add the following global variables to the script section. The `leftPosition` variable sets the initial left position at -122 pixels, the `minVertical` variable sets the minimum vertical position to 70 pixels, and the `maxVertical` variables use the `screen.availHeight` property to set the maximum vertical position to the available screen height, minus 200. The statement that initializes the `topPosition` variable uses the formula for generating random values to dynamically return a vertical starting position that is between the values assigned to the `minVertical` and `maxVertical` variables. The randomly generated value is also assigned to the `topCeiling` variable, which is used to determine the top and bottom positions of the airplane in its flight path. The last variable, `verticalDirection`, determines whether the plane is ascending or descending in its flight path.

```
var leftPosition = -122;
var minVertical = 70;
var maxVertical = screen.availHeight - 200;
var topPosition = Math.floor(Math.random()
    * (maxVertical - (minVertical + 1))
    + minVertical);
var topCeiling = topPosition;
var verticalDirection = "up";
```

2. Add the following `flightCoordinates()` function, which handles the dynamic positioning of the airplane image. The first statement in the function gets the image element's ID, while the second and third statements assign values to the element's `left` and `top` properties. The `if...else` statements then change the values assigned to the global variables in order to set the position of the plane when the `flightCoordinates()` function is called next. The horizontal position of the plane cycles between -122 pixels (the starting point) and the available screen width, minus 200 pixels. The `verticalDirection` variable determines whether to increment or decrement the

value of the `topPosition` variable. The `flightCoordinates()` function is called using a `setInterval()` method from the `onload` event handler of the <body> element.

```
function flightCoordinates() {
    var flight = document.getElementById(
        "airplane");
    flight.style.left = leftPosition + "px";
    flight.style.top = topPosition + "px";
    if (verticalDirection == "up")
        --topPosition;
    else if (verticalDirection == "down")
        ++topPosition;
    if (topPosition == topCeiling - 60)
        verticalDirection = "down";
    else if (topPosition == topCeiling + 60)
        verticalDirection = "up";
    ++leftPosition;
    if (leftPosition == screen.availWidth - 200) {
        leftPosition = -122;
        topPosition = Math.floor(Math.random()
            * (maxVertical - (minVertical + 1))
            + minVertical);
        topCeiling = topPosition;
        verticalDirection = "up";
    }
}
```

3. Replace the three <img> elements you added in the last exercise with the following single <img> element. Be sure that the element includes an `id` attribute that is assigned a value of "airplane".

```
<p><img src="images/airplane.gif" id="airplane"
style="position:absolute; left: -122px; top: 200px"
alt="Image of an airplane" height="38"
width="128" /></p>
```

4. Finally, add an `onload` event handler to the opening <body> tag that calls the `setInterval()` function, as follows:

```
<body onload="setInterval( ↵
    'flightCoordinates()', 25);">
```

5. Save the **instruments.html** document, and open it in your Web browser. The airplane image should appear to fly across the screen from random starting vertical positions, as shown in the composite screenshot in Figure 11-6.

Figure 11-6 Composite screenshot showing airplane image as it appears to move across screen

6. Close your Web browser window.

Short Quiz 2

1. What is the most critical CSS positioning property, and what are the values you can assign to it?
2. What is the easiest way to dynamically position Web page elements?
3. How do you create traveling animation?

Creating DHTML Menus

One of the more popular uses of DHTML is to create menus. The three types of menus discussed in this chapter are expandable menus, navigation menus, and sliding menus. DHTML menus are most often used for organizing navigational links to other Web pages, although they are also useful for displaying and hiding information. As you work through this section, keep in mind that these techniques are only for browsers that are compatible with the W3C DOM. Older browsers that do not support the W3C DOM require different DHTML techniques to achieve the menu effects that are described here.

Expandable Menus

The **`display` property** specifies whether to display an element on a Web page. You can use the `display` property to simulate expandable and collapsible menus on a Web page. You typically use the `display` property with a **block-level element**, which gives a Web page its structure. Most Web browsers render block-level elements so that they appear on their own line. Block-level elements can contain other block-level elements or inline elements. The `<p>` element and heading elements (`<h1>`, `<h2>`, and so on) are examples of common block-level elements that you have worked with. **Inline elements**, or **text-level elements**, describe the text that appears on a Web page. Unlike block-level elements, inline elements do not appear on their own lines; instead, they appear within the line of the block-level element that contains them. Examples of inline elements include the `<b>` (bold) and `<br />` (line break) elements. One block-level element you may be familiar with is the **`<div>` element**, which formats a group of block-level and inline elements with styles. By placing elements and text within a `<div>` element, you can use the `display` property to simulate expandable and collapsible menus.

If you assign a block-level element's `display` property a value of "none", the associated element is not displayed. In fact, the Web page does not even allocate space for the element on the page. However, if you use JavaScript to assign a value of "block" to a block-level element's `display` property, the Web page is reformatted to allocate sufficient space for the element and its contents, which are then displayed.

The following code shows a Web page that displays the hall of fame players for a pro football league. The style section defines a class selector named `collapsed` for the `<div>` element. You should already be familiar with the concept, but, to refresh your memory, a class selector defines different groups of styles for the same element. You create a class selector within a <style> element by appending a name for the class to a selector with a period. You then assign the class name to the class attribute of elements in the document that you want to format with the class's style definitions. The collapsed class selector includes the display property, which turns off the display of each <div> element when the Web page is first rendered. Anchor elements within the document body then use onmouseover and onmouseout event handlers to show and hide the <div> elements. Figure 11-7 shows the document in a Web browser when the mouse pointer passes over the Cleveland Browns link.

```
<!DOCTYPE html
PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
    <title>Pro Football League Hall of Fame
        Players</title>
    <meta http-equiv="content-type"
       content="text/html; charset=iso-8859-1" />
    <link rel="stylesheet" href="js_styles.css"
       type="text/css" />
    <style type="text/css">
        div.collapsed
        {
            display: none;
        }
    </style>
</head>
<body>
    <h1>
        Pro Football League</h1>
    <h2>
        Hall of Fame Players</h2>
    <p>
        <a href="" onmouseover="document ↵
            .getElementById('bills') ↵
            .style.display='block';"
            onmouseout="document ↵
            .getElementById('bills') ↵
            .style.display='none';">
            Buffalo Bills</a></p>
    <div id="bills" class="collapsed">
        <p>
            Joe DeLamielleure '03, Jim Kelly '02,
            Marv Levy '01 (coach), James Lofton '03,
            Billy Shaw '99, O.J. Simpson '99,
            Thurman Thomas '07</p>
    </div>
```

```
    <p>
        <a href="" onmouseover="document ↵
            .getElementById('browns') ↵
            .style.display='block';"
            onmouseout="document ↵
            .getElementById('browns') ↵
            .style.display='none';">
            Cleveland Browns</a></p>
    <div id="browns" class="collapsed">
        <p>
            Doug Atkins '82, Jim Brown '71,
            Paul Brown '67 (coach/owner),
            Willie Davis '81, Len Dawson '87,
            Joe DeLamielleure '03, Len Ford '76,
            Frank Gatski '85, Otto Graham '65,
            Lou Groza '74, Gene Hickerson '07,
            Henry Jordan '95, Leroy Kelly '94, Dante
            Lavelli '75, Mike McCormack '84,
            Tommy McDonald '98, Bobby Mitchell '83,
            Marion Motley '68, Ozzie Newsome '99,
            Paul Warfield '83, Bill Willis '77</p>
    </div>
...
</body>
</html>
```

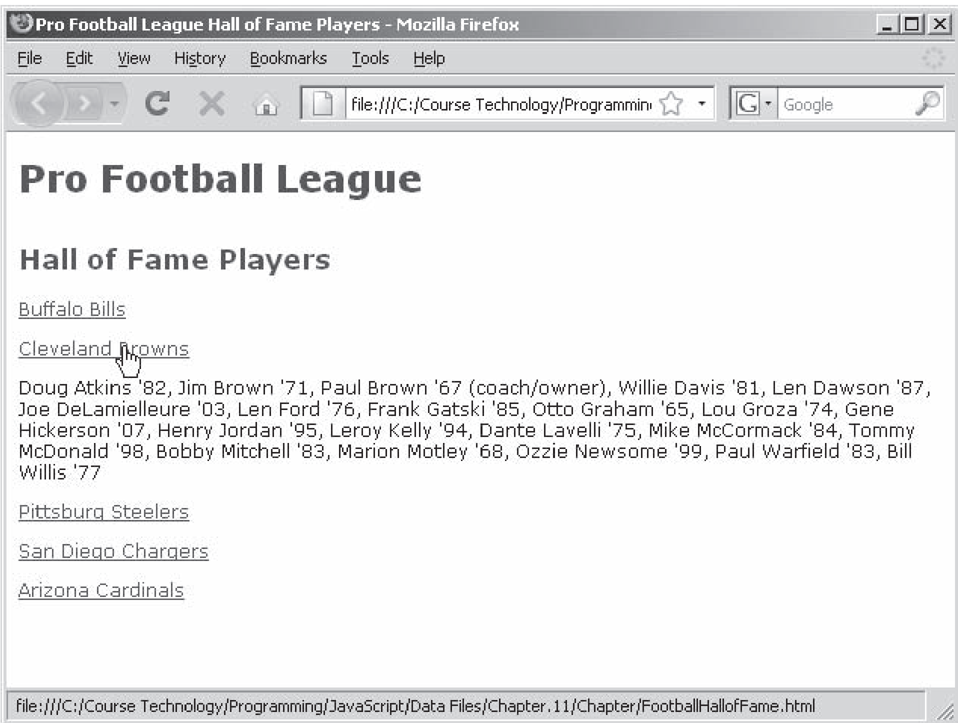


Figure 11-7 Web page with expandable menus

You can find a copy of the FootballHallofFame.html file in your Chapter folder for Chapter 11.

Next, you modify the right frame of the Instrument Training Web page so that the content beneath each heading is contained within expandable menus.

To add expandable menus to the Instrument Training Web page:

1. Return to the **instruments.html** document in your text editor.

2. Add the following style section above the closing </head> tag. The style section contains a single class selector that hides the content of any <div> elements to which it is applied when the Web page first opens.

```
<style type="text/css">
div.collapseInfo { display: none }
</style>
```

3. Place the elements and text beneath the Flight Experience heading within a <div> element, as follows. The <div> element has an id attribute of "experience" and is assigned the collapseInfo class selector.

```
<div id="experience" class="collapseInfo">
<p>An applicant for an Instrument rating must have
40 hours of &quot;instrument&quot; time. Fifteen
hours of this requirement can be accomplished in
an approved Flight Training Device. Students must
also log 50 hours of pilot-in-command cross-country
time.</p>
</div>
```

4. Modify the Flight Experience heading so that the text is contained within an anchor element. Also, add a style attribute along with onclick, onmouseover, and onmouseout event handlers to the anchor element. The style attribute turns off the underline beneath the link. The onclick event handler calls a function named showInfo(), which displays and hides the information in the <div> element. You add the showInfo() function next. The onmouseover and onmouseout event handlers show and hide the underline beneath the anchor element.

```
<h2>
    <a href="" style="font-size: 11px; ↵
        color: #9B0B0B; text-decoration: none"
        onclick="return showInfo('experience');"
        onmouseover="this.style.textDecoration ↵
            ='underline'"
        onmouseout="this.style.textDecoration ↵
            ='none'">
        Flight Experience</a>
</h2>
```

5. Add the following `showInfo()` function to the end of the script section in the document head. The `showInfo()` function displays and hides the content of the `<div>` element.

```
function showInfo(heading) {
     var curHeading = document
        .getElementById(heading);
        if (curHeading.style.display == "block")
              curHeading.style.display = "none";
        else
            curHeading.style.display = "block";
     return false;
}
```

6. Add similar elements and event handlers to the remaining headings and information on the page.

7. Save the **instruments.html** document, and then validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor, and then open it in your Web browser. Click each of the headings to see if they expand and collapse. Figure 11-8 shows how the Web page appears after clicking the Syllabus heading.

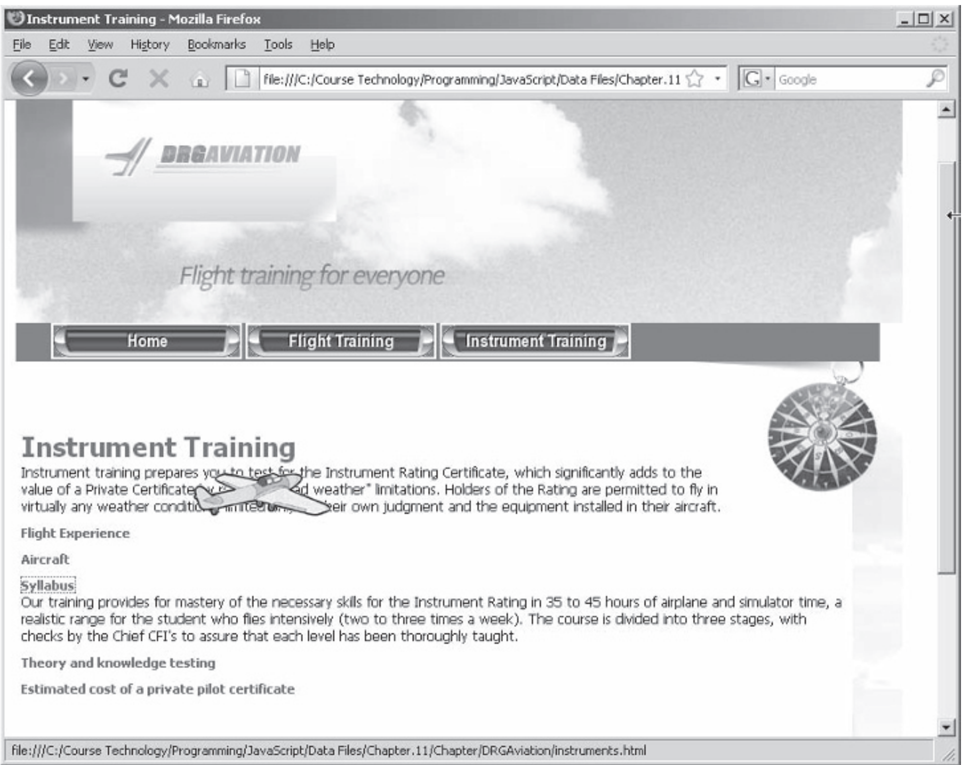


Figure 11-8 Instrument Training Web page after adding expandable menus

8. Close your Web browser window.

Navigation Menus

You are probably already familiar with drop-down, or pull-down, menus similar to the ones you find in a Windows application, such as a File menu or an Edit menu. Menus can greatly improve the design of your Web page and are very useful in helping visitors navigate through your Web site. In Chapter 4, you saw some Web pages from the Woodland Park Zoo. The Photo Gallery Web page, shown in Figure 11-9, contains a navigation menu that assists users in locating the Web page for a particular animal.

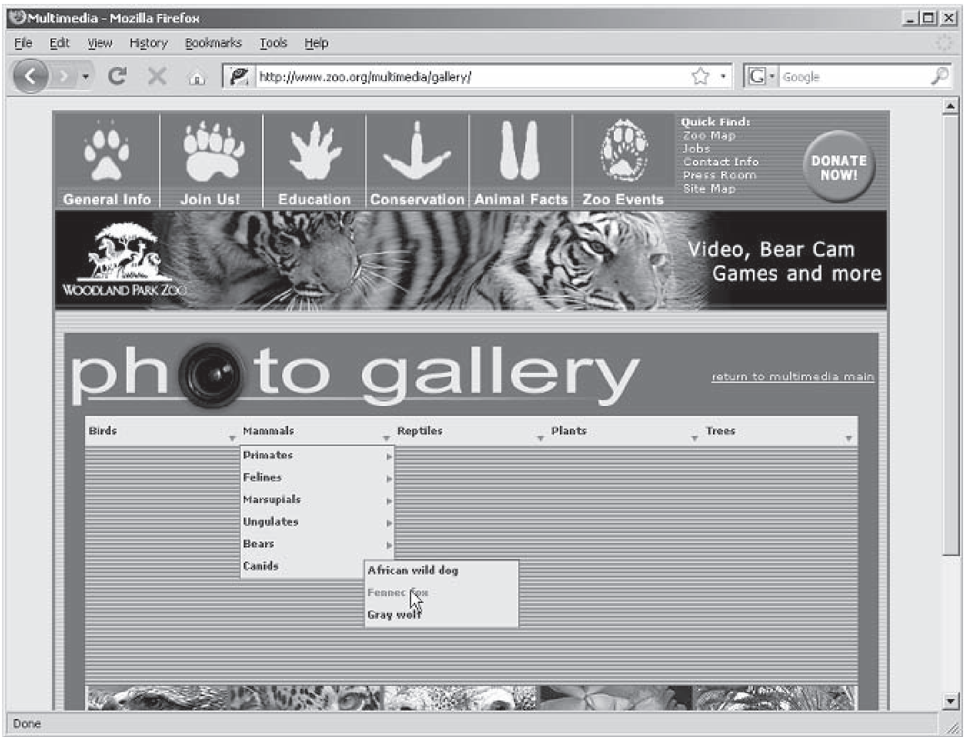


Figure 11-9 Navigation menu for the Woodland Park Zoo Photo Gallery Web page

Although there are several ways to create a navigation menu, the easiest way is to use a table to contain your menu items. First, you create a master table whose purpose is to contain nested tables for each individual menu. The following code shows the beginnings of a table that will create a navigation menu for an electronics store. Figure 11-10 shows the document in a Web browser.

```
<body>
    <table>
        <tr align="left">
            <td onmouseover="document ↵
                .getElementById('b1').src ↵
                ='button1over.png'"
                onmouseout="document ↵
                .getElementById('b1').src ↵
                ='button1up.png'"><a href="">
                <img src="button1up.png" id="b1"
                    border="0" vspace="1"
                    hspace="1" />
                </a></td>
            <td onmouseover="document ↵
                 .getElementById('b2').src
                 ='button2over.png'"
                 onmouseout="document
                 .getElementById('b2').src
                ='button2up.png'"><a href="">
                <img src="button2up.png" id="b2"
                    border="0" vspace="1"
                    hspace="1" /></a>
            </td>
            <td onmouseover="document ↵
                .getElementById('b3').src ↵
                ='button3over.png'"
                onmouseout="document ↵
                .getElementById('b3').src ↵
                ='button3up.png'"><a href="">
                <img src="button3up.png" id="b3"
                    border="0" vspace="1"
                    hspace="1" /></a>
            </td>
            <td onmouseover="document ↵
               .getElementById('b4').src ↵
               ='button4over.png'"
               onmouseout="document
               .getElementById('b4').src
               ='button4up.png'"><a href="">
               <img src="button4up.png" id="b4"
                    border="0" vspace="1"
                    hspace="1" /></a>
            </td>
        </tr>
    </table>
    <h1>
        DRG Electronics</h1>
    <p>
        Use the menu to help find what you
        are looking for.</p>
</body>
```

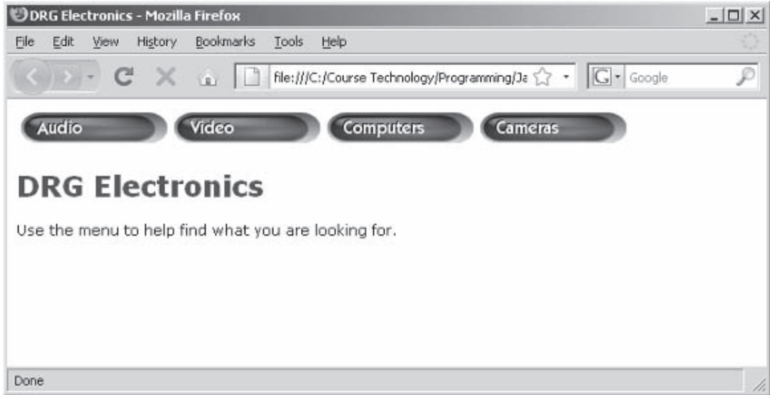


Figure 11-10 Document with a top navigation menu

You nest the contents of a navigation menu within the same cell as the top navigation menu heading. The following code shows a `<div>` element containing the menu items for the Audio menu nested within the same cell as the Audio menu:

```
...
<td
    onmouseover="document.getElementById( ↵
    'b1').src='button1over.png'"
    onmouseout="document.getElementById( ↵
    'b1').src='button1up.png'"><a href=""><br />
    <img src="button1up.png" id="b1" border="0"
        vspace="1" hspace="1" /></a>
    <div class="dropmenu">
        <ul>
            <li><a href="audiosys.html">
                Audio Systems</a></li>
            <li><a href="hometheater.html">
                Home Theater Systems</a></li>
            <li><a href="players.html">
                iPods and MP3 Players</a></li>
            <li><a href="headphones.html">
                Headphones</a></li>
        </ul>
    </div>
</td>
...
```

To show and hide each menu, you use the **`visibility` property**, which determines whether an element is visible. The `visibility` property differs from the `display` property in that it allocates space for an element on a Web page. Recall that a Web browser does not allocate space for an element with a value of "none" assigned to its `display` property. If you assign a value of "hidden" to an element's `visibility` property, space is allocated for the element, but it is not displayed. You display a hidden element by assigning a value of "visible" to the `visibility` property. The following code shows another version of the table elements for the Audio menu. This time, the `<div>` element containing the menu includes a `style` property that hides the element and sets its position to absolute. In the following code, the `onmouseover` and `onmouseout` event handlers for the table cells include statements that use the `visibility` property to show and hide the menu. Figure 11-11 shows the Web page in a browser with the mouse pointer over the Audio menu.

```
<td
    onmouseover="document.getElementById( ↵
    'b1').src='button1over.png'; ↵
    document.getElementById( ↵
    'audio').style.visibility='visible'"
    onmouseout="document.getElementById( ↵
    'b1').src='button1up.png'; ↵
    document.getElementById( ↵
    'audio').style.visibility='hidden'"><a href="">
    <img src="button1up.png" id="b1" border="0"
        vspace="1" hspace="1" /></a><br />
    <div id="audio" class="dropmenu"
        style="visibility:hidden; ↵
           position:absolute">
        <ul>
            <li><a href="audiosys.html">
            Audio Systems</a></li>
            <li><a href="audioplayers.html">
            iPods and MP3 Players</a></li>
            <li><a href="headphones.html">
            Headphones</a></li>
        </ul>
    </div>
</td>
```

Figure 11-11 Audio menu in the top navigation menu

You can find a copy of the ElectronicsMenuTop.html document in your Chapter folder for Chapter 11.

Next, you will add a navigation menu to the index.html document.

To add a navigation menu to the index.html document:

1. Return to the **index.html** document in your text editor.
2. Locate the table cell that contains the three <a> elements that provide links to each of the DRG Aviation Web pages. Replace this cell with the following <td> element, which displays a single button named Navigation. This creates a single menu that contains the three links for each of the DRG Aviation Web pages.

```
<td id="menu" onmouseover="document ↵
    .getElementById(this.id).src ↵
    ='images/navigationover.png'; ↵
    document.getElementById('navigation') ↵
    .style.visibility='visible'"
    onmouseout="document.getElementById( ↵
    this.id).src='images/navigationup.png'; ↵
    document.getElementById('navigation') ↵
    .style.visibility='hidden'"><a href=""><br />
    <img src="images/navigationup.png"
        alt="Visual navigation image"
        id="b1" border="0" vspace="1"
        hspace="1" /></a>
</td>
```

3. Above the closing </td> tag that you added in the last step, add the following nested <div> element, which contains the links to the DRG Aviation Web pages:

```
<div id="navigation" class="dropmenu"
    style="visibility:hidden; position:absolute">
    <ul>
        <li><a href="index.html">Home</a></li>
        <li><a href="flighttraining.html">
            Flight Training</a></li>
        <li><a href="instruments.html">
            Instrument Training</a></li>
    </ul>
</div>
```

4. Save the **index.html** document, and then open it in your Web browser. Figure 11-12 shows how the document appears with the navigation menu open and the mouse held over the Flight Training link.

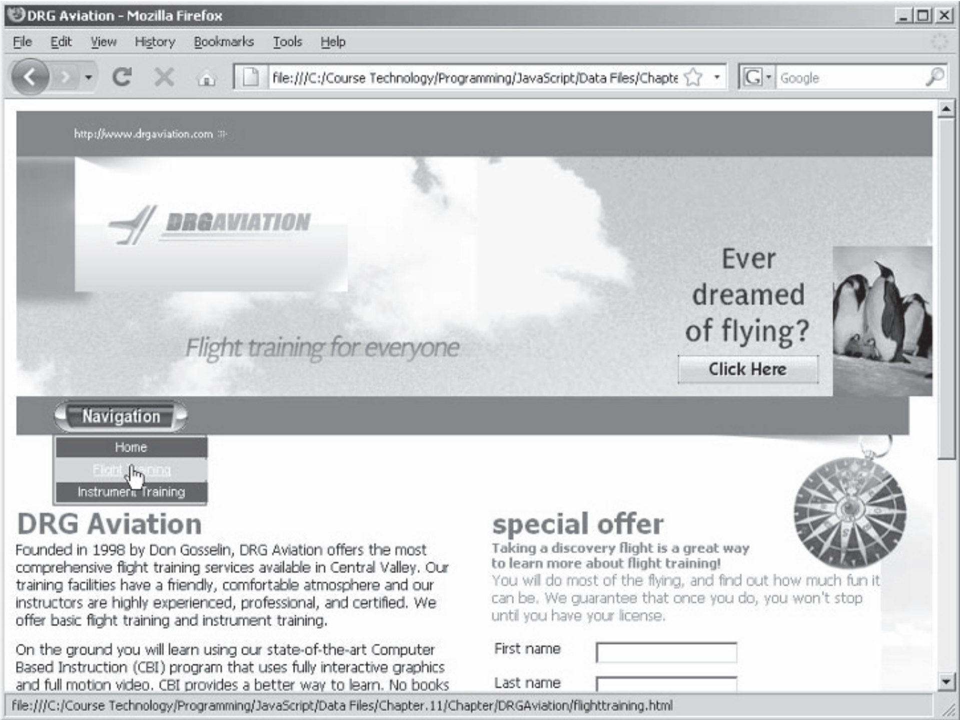


Figure 11-12 DRG Aviation home page with a navigation menu

5. Close your Web browser window.

The following code shows a modified version of the Audio menu for the electronics store Web page. This time, the table is formatted so the menus appear on the left side of the screen. The code also uses the `display` property instead of the `visibility` property in order to allow the nested tables to expand and contract beneath each menu heading. Notice that the `position` property in the `<div>` elements is assigned a value of "relative" instead of "absolute". This forces the `<div>` elements to expand and contract to display the nested tables. Figure 11-13 shows the Web page in a browser with the Video menu expanded.

```
...
<tr align="left">
    <td onmouseover="document.getElementById( ↵
        'b1').src='button1over.png'; ↵
        document.getElementById('audio') ↵
        .style.display='block'"
        onmouseout="document.getElementById( ↵
        'b1').src='button1up.png'; ↵
        document.getElementById('audio') ↵
        .style.display='none'">
```

```
        <a href="">
            <img src="button1up.png" id="b1"
                border="0" vspace="1"
                hspace="1" /></a>
        <div id="audio" class="dropmenu"
            style="display: none; ↵
                position: relative">
            <ul>
                <li><a href="audiosys.html">
                    Audio Systems</a></li>
                <li><a href="audioplayers.html">
                    iPods and MP3 Players</a></li>
                <li><a href="headphones.html">
                    Headphones</a></li>
            </ul>
        </div>
    </td>
</tr>
...
```

You can find a copy of the ElectronicsMenuSide.html document in your Chapter folder for Chapter 11.

Figure 11-13 Left navigation menu

Sliding Menus

As their name implies, **sliding menus** are menus that appear to slide open and closed. Although the `visibility` and `display` properties are quite effective in showing and hiding menus, they simply display their associated elements without any sort of effect. In order to simulate a sliding effect, you must use the `left` and `top` properties (depending on whether you are creating a horizontal or vertical menu) along with simple animation techniques. In order to "hide" the contents of a horizontal navigation menu, you must assign a negative value to the table's `left` property. In order to hide the contents of a vertical navigation menu, you must assign a negative value to the table's `top` property.

For example, consider the following version of the Audio menu from the vertical menu version of the script that you saw earlier. Notice the values that are assigned to the style attribute of the `<div>` element. The `position` property is set to "absolute", and the value assigned to the `top` property is -76px. These settings hide the menu at the top of the screen. The `z-index` property is assigned a value of -1, which forces the `<div>` element to render behind the Audio menu button.

```
<td valign="top"
onmouseover="document.getElementById('b1').src ↵
    ='button1over.png'; showAudio()"
    onmouseout="document.getElementById('b1').src ↵
    ='button1up.png'; hideAudio()"><a href="">
    <img src="button1up.png" id="b1" border="0"
        vspace="1" hspace="1" /></a><br />
    <div id="audio" class="dropmenu"
        style="position: absolute; top: -76px; ↵
            z-index: -1">
        <ul>
            <li><a href="audiosys.html">
            Audio Systems</a></li>
            <li><a href="audioplayers.html">
            iPods and MP3 Players</a></li>
            <li><a href="headphones.html">
            Headphones</a></li>
        </ul>
    </div>
</td>
```

The `onmouseover` event handler for the `<td>` element calls a function named `showAudio()`, which uses a `setInterval()` method to call a function named `showAudioMenu()`, which, in turn, makes each menu visible. The `showAudioMenu()` function continuously changes the `top` property of the `<div>` element until it is equal to 36px, which aligns the top of the menu just below the Audio button. The `onmouseout` event handlers in each `<table>` element call a function named `hideAudio()`. This function uses a `setInterval()` method to call a function named `hideAudioMenu()`, which hides the Audio menu. The code in the `hideAudio()` function is very similar to the code in the `showAudio()` function, except that it continuously decreases the `top` property of the `<div>` element until it is equal to -75px, which hides the menu at the top of the document window. The following code displays the `showAudio()`, `showAudioMenu()`, `hideAudio()`, and `hideAudioMenu()` functions. The first statement declares a variable named `audioPosition`, which tracks the position of the Audio menu as it slides up and down. Note that it's assigned an initial value of -76px, which hides the menu at the top of the document window. The second statement declares a variable named `audioSlider`, which is the variable that represents the `setInterval()` method that is called by the Audio menu.


```
var audioPosition = -76;
var audioSlider;
function showAudio() {
    clearInterval(audioSlider);
    audioSlider = setInterval("showAudioMenu()",
        10);
}
function showAudioMenu() {
    if (audioPosition <= 36) {
        audioPosition = audioPosition + 2;
        document.getElementById("audio").style.top
            = audioPosition + "px";
    }
    else
        document.getElementById("audio").style
            .zIndex = 1;
}
function hideAudio() {
    clearInterval(audioSlider);
    audioSlider = setInterval("hideAudioMenu()",
        10);
}
function hideAudioMenu() {
    if (audioPosition > -75) {
        audioPosition = audioPosition - 2;
        document.getElementById("audio").style.top
            = audioPosition + "px";
    }
    document.getElementById("audio").style
        .zIndex = -1;
}
```

The Video, Computers, and Cameras menus use similar functions to handle their sliding functionality. You can find a completed version of the sliding electronics store menus, named ElectronicsMenuSlide.html, in your Chapter folder for Chapter 11. Open the file and hold your mouse over the menus to test their sliding functionality.

Next, you will modify the navigation menu for the index.html page of the DRG Aviation Web site so that it includes sliding functionality.

To add sliding functionality to the Navigation menu of the DRG Aviation home page:

1. Return to the **index.html** document in your text editor.

2. Locate the `style` attribute for the `<div>` element that displays the Navigation menu. Remove the `visibility` property, and then set the `top` property to 220px and the `z-index` property to -1; these settings hide the menu behind the table cell that contains the Navigation menu button.

3. Replace the second statement that is assigned to the `onmouseover` event handler for the table cell that displays the Navigation button so that it calls a function named `showNavigation()`. Also, replace the second statement that is assigned to the `onmouseout` event handler for the table cell, which displays the Navigation button, so that it calls a function named `hideNavigation()`. (You will create the `showNavigation()` and `hideNavigation()` functions in Step 5.) The modified `<td>` tag should appear as follows:

```
<td id="menu"
    onmouseover="document.getElementById( ↵
        this.id).src ='images/navigationover.png'; ↵
        showNavigation();" onmouseout="document ↵
        .getElementById(this.id).src ↵
        ='images/navigationup.png'; ↵
        hideNavigation()">
```

4. Add a new script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add to the new script section the following code, which gives the sliding menu its functionality. These statements are virtually identical to the statements that give the sliding menus version of the Electronics menu its functionality.

```
var navigationPosition = 220;
var navigationSlider;
function showNavigation() {
    clearInterval(navigationSlider);
    navigationSlider
        = setInterval("showNavigationMenu()", 10);
}
function showNavigationMenu() {
    if (navigationPosition <= 285) {
        navigationPosition = navigationPosition + 2;
        document.getElementById("navigation").style
            .top = navigationPosition + "px";
    }
    else
        document.getElementById("navigation").style
            .zIndex = 1;
}
```

```
function hideNavigation() {
    clearInterval(navigationSlider);
    navigationSlider = setInterval(
        "hideNavigationMenu()", 10);
}
function hideNavigationMenu() {
    if (navigationPosition > 220) {
        navigationPosition = navigationPosition - 2;
        document.getElementById("navigation").style
            .top = navigationPosition + "px";
    }
    document.getElementById("navigation").style
        .zIndex = -1;
}
```

6. Save the **index.html** document, and then validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor, and then open it in your Web browser. Test the sliding functionality of the Navigation menu.

7. Close your Web browser window and text editor.

Short Quiz 3

1. Explain how to create expandable menus.
2. Explain how to create navigation menus.
3. Explain how to create sliding menus.

Summing Up

- The easiest way to refer to a CSS style in JavaScript is to use the `this` reference and the `style` property in an event handler within the element itself.
- You use the `style` property to modify an element's CSS properties with JavaScript.
- A JavaScript program that checks which type of browser is running is commonly called a browser sniffer.
- CSS positioning is used to position or lay out elements on a Web page.

- The most critical CSS positioning property is the `position` property, which determines the type of positioning applied to an element.
- The easiest way to dynamically position an element with CSS is to use the `left` and `top` properties.
- With DHTML, you can use dynamic positioning to create animations that "travel" across the screen by modifying the global `topPosition` and `leftPosition` variables that define an image's position.
- DHTML menus are most often used for organizing navigational links to other Web pages, although they are also useful for displaying and hiding information.
- The `display` property specifies whether to display an element on a Web page. You can use the `display` property to simulate expandable and collapsible menus on a Web page. You typically use the `display` property with a block-level element, which gives a Web page its structure.
- Inline, or text-level, elements describe the text that appears on a Web page.
- One block-level element you may be familiar with is the `<div>` element, which formats a group of block-level and inline elements with styles. By placing elements and text within a `<div>` element, you can use the `display` property to simulate expandable and collapsible menus.
- A class selector defines different groups of styles for the same element.
- To show and hide each menu, you use the `visibility` property, which determines whether an element is visible.
- Sliding menus are menus that appear to slide open and closed.
- In order to simulate a sliding effect, you must use the `left` and `top` properties (depending on whether you are creating a horizontal or vertical menu) along with simple animation techniques.

Comprehension Check

1. Prior to the release of the W3C standardized version of the DOM, no DHTML standard worked with both Internet Explorer and Mozilla-based browsers. If you want to use JavaScript code to manipulate CSS in older browsers, what options do you have?

2. What is the correct syntax for using the `style` property with an `onmouseover` event handler to display an underline beneath a link?

   a. `onmouseover.this="style.textDecoration=underline"`

   b. `onmouseover(this.style.textDecoration="underline")`

   c. `onmouseover="this.style: textDecoration; underline"`

   d. `onmouseover="this.style.textDecoration= 'underline'"`

3. If you pass the `this` reference to a function as a parameter named `linkTarget`, which of the following statements change the element's text color to blue?

   a. `linkTarget.style.color = "blue";`

   b. `linkTarget.style.textColor = "blue";`

   c. `this.style.color = "blue";`

   d. `this.style = "textColor: blue";`

4. Which of the following statements changes the value of the `font-family` style to Arial for an element with an `id` value of `salesTotal`?

   a. `document.getElementById("salesTotal") .style.font-family = "Arial";`

   b. `document.getElementById("salesTotal") .style.FontFamily = "Arial";`

   c. `document.getElementById("salesTotal") .style(font-family) = "Arial";`

   d. `document.getElementById("salesTotal") .style.fontFamily = "Arial";`

5. How do you use DHTML to show and hide an underline beneath an <a> element when the user places the mouse pointer over a link?

6. To determine whether a Web browser is compatible with the W3C DOM, you check if the browser includes the _______________.

   a. `display` property

   b. `position` property

c. `setInterval()` or `setTimeout()` methods

d. `getElementById()` method

7. Which of the following CSS properties can you use to dynamically position an element? (Choose all that apply.)

a. `right`

b. `left`

c. `bottom`

d. `top`

8. Which of the following values (which can be applied to the `position` property) prevents you from using CSS positioning with an element?

a. relative

b. absolute

c. fixed

d. static

9. Explain the difference between the `display` and `visibility` properties.

10. What value do you assign to the `display` property to prevent an element from displaying?

a. false

b. hidden

c. hide

d. none

11. What value do you assign to the `visibility` property to prevent an element from being visible?

a. hidden

b. none

c. false

d. hide

12. Which of the following `style` attributes prevents an element from being moved with CSS positioning?

    a. `style="position: absolute; left: 100px; top: 120px"`

    b. `style="position: relative; left: 100px; top: 120px"`

    c. `style="position: static; left: 100px; top: 120px"`

    d. `style="position: fixed; left: 100px; top: 120px"`

13. The `bottom` and `right` properties determine the position of an element's lower-right corner in relation to the ________________.

    a. lower-right corner of the document window

    b. upper-left corner of the document window

    c. lower-right corner of the visible screen area

    d. upper-left corner of the browser window

14. The ________________ determines the order in which dynamically positioned elements are layered.

    a. `ordering`

    b. `z-index`

    c. `visibility`

    d. `layer`

15. Explain how to create traveling animation with DHTML.

16. What determines an element's starting position when creating traveling animation with DHTML?

    a. The values assigned to the global `topPosition` and `leftPosition` variables

    b. The values assigned to the `left` and `top` style properties in the opening `<body>` tag

    c. The values assigned to an element's `left` and `top` style properties

    d. You cannot determine an element's initial starting position when creating traveling animation with DHTML; the element's position is randomly generated for each animation sequence.

17. You can use the ______________ property to simulate expandable and collapsible menus on a Web page.

    a. `display`

    b. `slide`

    c. `static`

    d. `z-order`

18. To allocate sufficient space for a sliding menu, you must use the ______________ along with simple animation techniques.

    a. `slide` property

    b. `top` and `bottom` properties

    c. `left` and `top` properties

    d. `z-order` property

19. If you assign a value of "hidden" to an element's `visibility` property, space is allocated for the element, but it is not displayed. True or false?

20. Explain how to use tables to create a navigation menu.

Reinforcement Exercises

Exercise 11-1

In this chapter, you learned how to use CSS positioning to set and return the position of elements on a Web page. However, you can only use CSS positioning to set and return the position of elements that include properties such as the `position`, `left`, and `top` properties. To find the position of an element that does not include CSS positioning properties, you can use the `offsetLeft` and `offsetTop` properties. Similarly, you can use the `offsetWidth` and `offsetHeight` properties to return the size of an element on a Web page. The `offsetLeft`, `offsetTop`, `offsetWidth`, and `offsetHeight` properties are available to most current Web browsers. In this project, you will create a document that uses the `offsetTop` and `offsetWidth` properties to display context-sensitive help for the fields on a form. The project will also use the CSS `cursor` property to dynamically change the cursor to a help cursor when the mouse pointer passes over a form element that contains context-sensitive help.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the strict DTD and "Form Help" as the content of the <title> element.

3. Add the following elements and text to the document body. The form contains four text boxes for a username, password, password confirmation, and challenge question. Each text box contains an onmouseover event that changes the cursor to a help cursor and an onclick event that passes the element's id attribute to a function named showHelp(), which you will create shortly. The <div> element will be used to display the context-sensitive help information for each field. Note that the <div> element is initially hidden by assigning a value of "hidden" to the visibility property.

```
<h1>Form Help</h1>
<form action="" method="get"
enctype="application/x-www-form-urlencoded">
<p><strong>User name</strong><br />
<input type="text" id="username" size="50"
onmouseover="this.style.cursor='help'"
    onclick="showHelp(this.id)" /></p>
<p><strong>Password</strong><br />
<input type="password" id="password" size="50"
onmouseover="this.style.cursor='help'"
    onclick="showHelp(this.id)" /></p>
<p><strong>Confirm password</strong><br />
<input type="password" id="password_confirm"
size="50" onmouseover="this.style.cursor='help'"
    onclick="showHelp(this.id)" /></p>
<p><strong>What is your mother's maiden
name?</strong><br />
<input type="password" id="challenge" size="50"
onmouseover="this.style.cursor='help'"
    onclick="showHelp(this.id)" /></p>
</form>
<div id="box" style="position: absolute; ↵
    visibility: hidden; width: 250px; ↵
    background-color:#FFFFC0; font: Comic Sans MS; ↵
    color: #A00000;border:1px dashed #D00000"></div>
```

4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Create the following showHelp() function in the script section. The first two statements use the getElementById()

methods to retrieve the form element represented by the `elementId` parameter and the `<div>` element that is assigned an `id` attribute value of "box".

```
function showHelp(elementId) {
    var curElement = document.getElementById(
        elementId);
    var helpElement = document.getElementById(
        "box");
}
```

6. Add the following `switch` statement to the end of the `showHelp()` function. The statement evaluates the `elementId` parameter and then uses the `innerHTML` property to assign the appropriate help text to the `<div>` element. Be sure to enter each text string on a single line.

```
switch (elementId) {
    case "username":
        helpElement.innerHTML = "Enter a ↵
            unique user name that is between ↵
            5 and 12 characters.";
        break;
    case "password":
        helpElement.innerHTML = "Enter a ↵
            password between 6 and 10 ↵
            characters that contains both ↵
            upper and lowercase letters and ↵
            at least one numeric character. ";
        break;
    case "password_confirm":
        helpElement.innerHTML
           = "Confirm your selected password. ";
        break;
    case "challenge":
        helpElement.innerHTML
            = "Enter your mother's maiden ↵
            name. This value will be used ↵
            to confirm your identity in ↵
            the event that you forget ↵
            your password. ";
        break;
}
```

7. Finally, add the following statements to the end of the `showHelp()` function. The first statement adds an anchor element to the `innerHTML` property of the `<div>` element that users can click to hide the context-sensitive help box. The second statement displays the `<div>` element by assigning a value of "visible" to the visibility property. The third statement obtains the width of the current form field using the `offsetWidth` property, adds 20 pixels to better position the

help box, and then assigns the result to the `left` property of the `<div>` element. The fourth statement obtains the top position of the current form field by using the `offsetTop` property and assigns the result to the `top` property of the `<div>` element.

```
helpElement.innerHTML += "<a href='' ↵
    onclick=\"document.getElementById('box') ↵
    .style.visibility='hidden';return false;\">
    Close</a>";
document.getElementById("box").style.visibility
    = "visible";
document.getElementById("box").style.left
    = curElement.offsetWidth + 20 + "px";
document.getElementById("box").style.top
    = curElement.offsetTop + "px";
```

8. Save the document as **FormHelp.html** in your Exercises folder for Chapter 11 and validate it with the W3C Markup Validation Service. Once the document is valid, open it in your Web browser and test the context-sensitive help functionality.

9. Close your Web browser window.

Exercise 11-2

In this project, you will create a document with a link that appears to shake when you move your cursor over it.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, document head, and `<body>` element. Use the strict DTD and “Shaking Link” as the content of the `<title>` element.

3. Add a script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

4. Add the following link to the document body. The link includes an `onmouseover` event handler that uses the `setInterval()` method to call a function named `shakeLink()`, which you will add next. The `onmouseout` event handler clears the `setInterval()` method.

```
<p><a id="earthquake" style="position: relative"
    href="http://www.earthquake.com"
    onmouseover="shakeVar=setInterval( ↵
        'shakeLink()', 10);"
    onmouseout="clearTimeout(shakeVar);">
    Global Earthquake Response Center</a></p>
```

5. Add the following code to the script section. The `shakeLink()` function, which is called by the `onmouseover` event handler in the link, gives the script its functionality.

```
var shakeVar;
var direction = "left";
function shakeLink() {
     if (direction == "left") {
          document.getElementById("earthquake")
                .style.left="3px";
          direction = "right";
     }
    else {
        document.getElementById("earthquake")
            .style.left="0px";
        direction = "left";
     }
}
```

6. Save the document as **ShakingLink.html** in your Exercises folder for Chapter 11 and validate it with the W3C Markup Validation Service. Once the document is valid, open it in your Web browser. Place your mouse pointer over the link and verify that the link starts to shake. Move your mouse pointer off the link and verify that it stops shaking.

7. Close your Web browser window.

Exercise 11-3

In your Web travels, you have probably encountered "mouse trails"—that is, some sort of image or stylistic element that follows the cursor as it moves around a Web page. You create mouse trails by using DHTML along with the `onmousemove` event and the `screenX` and `screenY` properties of the `Event` object of the HTML DOM. The `screenX` property returns the horizontal coordinate of the cursor when an event occurs, and the `screenY` property returns the vertical coordinate of the cursor when an event occurs. In this project, you will create a Web page that contains a definition and image of comet. When the mouse is moved over a `<div>` element containing the page's text and elements, a mouse trail will display that resembles a comet's tail. Your Exercises folder for Chapter 11 contains an image named comet.jpg that you can use for this exercise.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and " Mouse Trail" as the content of the <title> element.

3. Add the following style section to the document head:

```
<style type="text/css">
h1 { font-family: arial; color: navy; }
p, td { font-family: arial; font-size: 12px; color:
black; }
</style>
```

4. Create the following <div> element in the document body. The element's onmousemove event calls an event handler named moveMouse(). The event handler function is passed an argument named event, which is an object that contains information about the event that occurred. You will use the event argument to access the screenX and screenY properties.

```
<div onmousemove="moveMouse(event)">
</div>
```

5. Add the following text and elements as the content of the <div> element. The content contains a heading element, a description of the comet from Wikipedia, and an image of a comet.

```
<h1>Comet</h1>
<p><a href="http://en.wikipedia.org/wiki/Comet">
Wikipedia</a>
defines a comet as follows:</p>
<table border="1" cellpadding="5">
<colgroup span="1" width="275" />
<colgroup span="1" width="200" />
<tr><td valign="top">A comet is a small body in
the solar system that orbits the Sun and (at least
occasionally) exhibits a coma (or atmosphere)
and/or a tail - both primarily from the effects of
solar radiation upon the comet's nucleus, which
itself is a minor body composed of rock, dust, and
ice. Comets' orbits are constantly changing: their
origins are in the outer solar system, and they
have a propensity to be highly affected (or
perturbed) by relatively close approaches to the
major planets. Some are moved into sun grazing
orbits that destroy the comets when they near the
Sun, while others are thrown out of the solar
system forever.</td>
<td><img src="comet.jpg" alt="Image of a comet"
height="200" width="250" /></td>
</tr></table>
```

6. Add the following script section and global variables to the document head. The `trailInterval` variable determines the length of the "trail" that follows the mouse. The `xPosition` and `yPosition` variables will store the horizontal and vertical mouse coordinates. The `animationStarted` variable determines whether the animation that controls the mouse trail has been started. Note that the `xPosition` and `yPosition` variables are assigned an initial value of -10. Each portion of the trail will be created with an empty `<div>` element that is assigned a background color of blue. In this manner, each portion of the trail will appear as a blue square. This allows you to create a mouse trail without any image files. The initial values of -10 that are assigned to the `xPosition` and `yPosition` variables hide the blue squares that are initially displayed when the Web page first loads.

```
<script type="text/javascript">
/* <![CDATA[ */
var trailInterval = 12;
var xPosition = -10;
var yPosition = -10;
var animationStarted = false;
/* ]]> */
</script>
```

7. Add the following `for` loop to the end of the script section. The `for` loop contains a single `document.write()` statement that creates the number of `<div>` elements that will make up the mouse trail according to the value assigned to the `trailInterval` variable. Each `<div>` element is assigned a unique `id` value of "trail" + *i* (the *i* represents the current counter). Because the `trailInterval` variable is assigned a value of 12, the `for` loop creates 12 `<div>` elements with `id` values of "trail0" through "trail11". You will use each `id` value to control the display of the mouse trail. Each `<div>` element's `position` property is assigned a value of "absolute" so that it can be dynamically positioned and the `background-color` property is assigned a value of "blue". The `top` and `left` properties are assigned the values of the `xPosition` and `yPosition` variables, respectively. (Recall that the initial value assigned to these variables is -10, a setting that hides the `<div>` elements when the Web page first loads.) Notice the values that are assigned to the `width`, `height`, and `font-size` properties. Each of these properties is assigned a value of `i` (the `for` loop counter variable) divided by 2. This creates twelve `<div>` elements, starting with a very small element consisting of a width, height, and font size of .5 and ending with a final element consisting of a width, height, and font size of 6.

These elements will appear as a series of gradually diminishing blue squares that will make up the mouse trail.

```
for (i = 1; i <= trailInterval; i++) {
     document.write("<div id='trail" + i
          + "' style='position:absolute; ↵
          background-color:blue;top:"
          + yPosition + "px;left:" + xPosition
          + "px;width:" + i/2 + "px;height:" + i/2
          + "px; font-size:" + i/2 + "px'></div>");
}
```

8. Add the following mouseMove() function to the end of the script section. The function assigns the horizontal and vertical mouse coordinates to the xPosition and yPosition variables using the screenX and screenY properties of the Event object. Because Firefox and Internet Explorer use different mappings for the vertical mouse coordinates, the if...else statement uses the appName property of the Navigator object to determine the name of the browser and assign the appropriate value to the yPosition variable. The last if statement checks the value of the animationStarted variable to determine whether the animation that controls the mouse trail has started. If the variable contains a value of false, it is assigned a value of true and the animate() function is called. The animate() function will contain the code that causes the <div> elements to “follow” the cursor to create the mouse trail. You will create the animate() function in Step 9.

```
function moveMouse(e) {
    xPosition = e.screenX + 10;
    if (navigator.appName
        == "Microsoft Internet Explorer") {
        yPosition = e.screenY - 122;
    }
    else if (navigator.appName == "Netscape") {
        yPosition = e.screenY - 65;
    }
    if (!animationStarted) {
        animationStarted = true;
        animate();
    }
}
```

9. To the end of the script section, add the following animate() function. The function declares two local variables, div1 and div2. The for loop iterates through each <div> element and changes its value to the value of the previous <div> element. This causes each <div> element to replace the previous <div>, which creates the mouse trail. The last statement in

the function uses the `setTimeout()` method to execute the function every 40 milliseconds.

```
function animate(){
    var div1, div2;
    for (i = 1; i <= trailInterval; i++){
        div1 = document.getElementById(
            "trail"+i);
        if (i < trailInterval){
            div2 = document.getElementById(
                "trail"+(i+1));
            div1.style.top = div2.style.top;
            div1.style.left = div2.style.left;
        }
        else {
            div1.style.top = yPosition + "px";
            div1.style.left = xPosition
                + "px";
        }
    }
    setTimeout("animate()",40);
}
```

10. Save the document as **MouseTrail.html** in your Exercises folder for Chapter 11, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

11. Open the **MouseTrail.html** document in your Web browser, and move your mouse over the text and elements to test the mouse trail.

12. Close your Web browser window.

Exercise 11-4

In this project, you will create a Web page with a ball that bounces randomly within the document area of the Web browser. To create the calculation that causes the ball to bounce randomly, you need to determine the width and height of the document portion of the browser window. With the exception of Internet Explorer, the `Window` object for most current Web browsers includes `innerWidth` and `innerHeight` properties. These properties return the width and height, respectively, of the document displayed in a Web browser. To return the width and height of the document displayed in Internet Explorer, you must use the `clientWidth` and `clientHeight` properties of the `document.documentElement` object. Your Exercises folder for Chapter 11 contains an image named ball.gif that you can use for this exercise.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the strict DTD and “Bounce” as the content of the <title> element.

3. Add to the document body the following <div> element, which will dynamically position the ball.gif image:

```
<div id="ballElement"
style="position:absolute; left:0px;top:0px">
<img id="ballImage" src="ball.gif"
alt="Image of a ball"
height="48" width="48" /></div>
```

4. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add to the script section the following global variables, which will store information about the speed, document, position, and direction of the bouncing ball. The last variable will represent a setTimeout() method.

```
var bounceSpeed = 5;
var widthMax = 0;
var heightMax = 0;
var xPosition = 0;
var yPosition = 0;
var xDirection = "right";
var yDirection = "down";
var ballBounce;
```

6. Add to the end of the script section the following setBall() function, which contains an if...else statement to determine the width of the document portion of the window according to the browser type. The last statement uses the setTimeout() method to call a function named bounceBall(), which performs the task of dynamically moving the ball image. You will create the bounceBall() function next.

```
function setBall() {
    if (navigator.appName
        == "Microsoft Internet Explorer") {
        widthMax = document.documentElement
            .clientWidth;
        heightMax = document.documentElement
            .clientHeight;
    }
```

```
        else {
            widthMax = window.innerWidth-14;
            heightMax = window.innerHeight;
        }
        clearTimeout(ballBounce);
        bounceBall();
    }
```


7. Create the following `bounceBall()` function at the end of the script section:

```
function bounceBall() {
}
```

8. Add the following statements to the `bounceBall()` function. These statements calculate the path and direction of the bouncing ball.

```
if (xDirection == "right" && xPosition > (widthMax
    - document.getElementById("ballImage").width
    - bounceSpeed))
    xDirection = "left";
else if (xDirection == "left" && xPosition < (0
    + bounceSpeed))
    xDirection = "right";
if (yDirection == "down" && yPosition > (heightMax
    - document.getElementById("ballImage").height
    - bounceSpeed))
    yDirection = "up";
else if (yDirection == "up" && yPosition < (0
    + bounceSpeed))
    yDirection = "down";
if (xDirection == "right")
    xPosition = xPosition + bounceSpeed;
else if (xDirection == "left")
    xPosition = xPosition - bounceSpeed;
else
    xPosition = xPosition;
if (yDirection == "down")
    yPosition = yPosition + bounceSpeed;
else if (yDirection == "up")
    yPosition = yPosition - bounceSpeed;
else
    yPosition = yPosition;
```

9. Add the following statements to the end of the `bounceBall()` function. These statements use the values that were assigned to the `xPosition` and `yPosition` variables in the preceding `if...else` statements to dynamically position the ball. The last statement uses a `setTimeout()` method to call the function again in 30 milliseconds.

```
document.getElementById("ballElement").style
    .left = xPosition + "px";
document.getElementById("ballElement").style
    .top = yPosition + "px";
clearTimeout(ballBounce);
setTimeout('bounceBall()',30);
```

10. Add the following statement to the end of the script section. If the window is resized, this statement restarts the animation by calling the `setBall()` method, which retrieves the new dimensions of the document and restarts the `bounceBall()` function.

    ```
    window.onresize = setBall;
    ```

11. Finally, add the following `onload` event to the opening `<body>` tag to call the `setBall()` function when the document first loads:

    ```
    <body onload="setBall()">
    ```

12. Save the document as **Bounce.html** in your Exercises folder for Chapter 11, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

13. Open the **Bounce.html** document in your Web browser. The ball should start bouncing as soon as the page finishes loading. Try resizing the window to see if the animation adjusts to the new document size.

14. Close your Web browser window.

Exercise 11-5

The `clip` CSS position property determines the region of an element that is displayed. To determine the portions of an element to be displayed, you assign to the `clip` property a value of "rect(*top right bottom left*)". The *top*, *right*, *bottom*, and *left* parameters specify values, in pixels, of the amount of space to clip around the element. Be sure not to separate the parameters in the `rect()` value with commas, as you would with the arguments you pass to a method or function. For example, to clip 10 pixels from all sides of an element, you assign a value of "rect(10px 10px 10px 10px)" to the `clip` property. In this project, you will use the `clip` property to create a screen transition effect of a shrinking box that covers an entire Web page when it first loads but then shrinks and disappears.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, document head, and <body> element. Use the strict DTD and "Boxed In" as the content of the <title> element.

3. Add to the document body the following <div> element, which will be used to create the shrinking box:

```
<div id="i1" style="position: absolute; ↵
    background-color: blue"></div>
```

4. Add the following script section to the document body:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

5. Add to the script section the following global variables, which will store information about the shrinking box:

```
var clipSpeed=5;
var clipRight = 0;
var clipLeft = 0;
var clipTop = 0;
var boxSize;
var stopShrinking;
var clipBottom = 0;
var clipBox=document.getElementById("i1").style;
```

6. Add to the end of the script section the following startShrinking() function, which contains an if...else statement to determine the width of the document portion of the window according to the browser type. The last statement uses the setInterval() method to call a function named shrinkBox(), which performs the task of dynamically shrinking the box. You will create the shrinkBox() function next.

```
function startShrinking() {
    if (navigator.appName
        == "Microsoft Internet Explorer") {
        boxSize  = document.documentElement
            .clientWidth / document.documentElement
            .clientHeight;
        clipRight=document.documentElement
            .clientWidth;
        clipBox.width = clipRight + "px";
            clipBottom=document.documentElement
            .clientHeight;
        clipBox.height=clipBottom + "px";
    }
```

```
        else {
                boxSize = window.innerWidth/
                window.innerHeight;
                clipRight=window.innerWidth;
                clipBox.width = clipRight + "px";
                clipBottom=window.innerHeight;
                clipBox.height=clipBottom + "px";
        }
        stopShrinking=setInterval("shrinkBox()",100);
}
```

7. Add the following `shrinkBox()` function to the end of the script section. The statements in this function dynamically shrink the box until it disappears.

```
function shrinkBox(){
    if (navigator.appName
        == "Microsoft Internet Explorer")
        minBoxSize=document.documentElement
            .clientWidth/2;
    else
        minBoxSize=window.innerWidth/2
        if (clipLeft > minBoxSize){
            clearInterval(stopShrinking);
            clipBox.display="none";
        }
        clipBox.clip="rect(" + clipTop + "px "
            + clipRight + "px "
            + clipBottom + "px " + clipLeft + "px)"
        clipLeft += boxSize * clipSpeed;
        clipTop += clipSpeed;
        clipRight -= boxSize*clipSpeed;
        clipBottom -= clipSpeed;
}
```

8. Add an `onload` event to the opening <body> tag that calls the `startShrinking()` function, as follows:

```
<body onload="startShrinking()">
```

9. Save the document as **BoxedIn.html** in your Exercises folder for Chapter 11, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

10. Open the **BoxedIn.html** document in your Web browser. As soon as the page finishes loading, the document portion of the window should be filled with a blue rectangle that gradually shrinks until it disappears.

11. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 11. Be sure to validate the documents you create with the W3C Markup Validation Service.

Project 11-1

Your Projects folder for Chapter 11 contains six images of leaves: leaf1.gif through leaf6.gif. Use each image as many times as you like to create a Web page with falling leaves. Use image caching to ensure that all the images are loaded before the animation begins. Include code that randomly selects which leaf image to display. The formula for randomly selecting a leaf is `Math.floor(Math.random() * numImages)`. Because there are six leaf images, the *numImages* argument should be 6. Also, use the `Math.random()` method to randomly select how fast each leaf falls and the position where it will begin falling. You will need to determine the height and width of the document area by using the `document.documentElement.clientHeight` and `document.documentElement.clientWidth` properties in Internet Explorer or the `window.innerWidth` and `window.innerHeight` for all other browsers. Save the document as **Autumn.html**.

Project 11-2

Your Projects folder for Chapter 11 contains an image file of a mosquito named bug.gif. Use the same coding techniques that you saw in Reinforcement Exercise 11-4, which created a bouncing ball Web page, to dynamically animate the image so the mosquito appears to fly randomly around the page and bounce off the boundaries of the document portion of the window. However, instead of animating a single image, create at least five animated images that move along different paths in the window. To ensure that each image moves along a different path, you only need to set a unique vertical position for each image's starting point. Use a separate `<div>` element for each image. All images should appear to "fly in" from the left side of the screen, so the starting horizontal value for each `<div>` element must be negative. Make sure that some of the images begin traveling in an upward direction and that some of the images begin traveling in a downward direction. You will need to store information about the speed, document, position, and direction of each image in arrays. Use a separate `setInterval()` or `setTimeout()` method to begin animating each image. Save the document as **Buzz.html**.

Project 11-3

In Reinforcement Exercise 11-5, you used the `clip` property to create a screen transition effect of a shrinking box that covers an entire Web page when it first loads but then shrinks and disappears. Use the same technique to create a box that covers an entire Web page but gradually opens from right to left like a curtain. Remember that you will need to determine the height and width of the document area by using the `document.documentElement.clientHeight` and `document.documentElement.clientWidth` properties in Internet Explorer or the `window.innerWidth` and `window.innerHeight` for all other browsers. Save the document as **Curtain.html**.

Project 11-4

Create a Web page that contains a drop-down menu with menu items for five types of sports, such as football or baseball. Each menu should display at least three links to Web sites that contain information about each particular sport. For example, the Football menu may contain links to NFL.com (*http://www.nfl.com*), ESPN's NFL page (*http://sports.espn.go.com/nfl/index*), and Yahoo! Sports NFL page (*http://sports.yahoo.com/nfl;_ylt=AsRakGSbKIS7qaEoSsk90ls5nYcB*). Save the document as **SportsNews.html**.

Project 11-5

You have probably seen the "warp" or "starfield" animation effect that simulates flying through space. With the warp animation, stars usually begin as small points of light in the middle of the computer screen, and then gradually grow large and eventually fly off the screen. Use the DHTML techniques that you learned in this chapter to simulate this type of warp animation. This is an advanced exercise that requires a strong understanding of JavaScript's mathematical functions in order to properly calculate the trajectory of each star and gradually increase its size as it approaches the edge of the screen. If you do not have a strong math background, then do your best to create a simple warp animation with a few stars that begin in the middle of the screen and eventually fly off the edge of the screen. Save the document as **Warp.html**.

CHAPTER 12

Updating Web Pages with AJAX

In this chapter, you will:

- Study AJAX concepts
- Work with HTTP
- Use AJAX to request and receive server data

The most recent version of the JavaScript language is ECMAScript Edition 3, which was first released in December of 1999. The next major edition of the JavaScript language will be ECMAScript Edition 4, although at the time of this writing, the developers of the language have not made significant progress on the new version, and it is not known when it will be complete. While there have been numerous browser enhancements since Edition 3 was released in 1999, the core JavaScript language has remained essentially unchanged for almost a decade. This is unusual with software development technologies, because the Web developers who use these technologies are constantly looking for new and better tools for writing their programs. Unwilling to simply await the arrival of Edition 4, JavaScript programmers have managed to accommodate their own demand for increased JavaScript functionality by combining JavaScript with other technologies.

One such technology is DHTML, which makes Web pages dynamic by combining JavaScript, XHTML, CSS, and the Document Object Model (DOM). DHTML does a great job of making Web pages more dynamic and will continue to be a vital Web page development technique. The fact that DHTML runs entirely within a user's Web browser formerly was considered an advantage because it made external resources, such as server data, unnecessary. However, as the Internet matured and broadband access became commonplace, Web developers began demanding a way to make their Web pages interact more dynamically with a Web server. For example, consider a Web browser's request for a Web page. In response, the Web server returns the requested page. If the user wants to refresh the Web page, the Web server returns the entire page again—not just the changed portions of the page. For Web page data that must always be up to date, such as stock prices, continuously reloading the entire page is too slow, even at broadband speeds. As you will learn in this chapter, the solution is to use AJAX.

Introduction to AJAX

Asynchronous JavaScript and XML (AJAX) refers to a combination of technologies that allows Web pages displayed on a client computer to quickly interact and exchange data with a Web server without reloading the entire Web page. Although its name implies a combination of JavaScript and XML, AJAX primarily relies on JavaScript and HTTP requests to exchange data between a client computer and a Web server. AJAX gets its name from the fact that XML is often the format used for exchanging data between a client computer and a Web server (although it can also exchange data using standard text strings). The other technologies that compose AJAX include XHTML, CSS, and the Document Object Model. However, these technologies primarily handle the display and presentation of data within the Web browser (the same as with DHTML), while HTTP and XML are responsible for data exchange. JavaScript ties everything together.

It's important to note that Garrett and Adaptive Path did not invent anything new. Rather, they improved Web page interactivity by combining JavaScript, XML, XHTML, CSS, and the DOM with the key component of AJAX, the `XMLHttpRequest` object, which is available in modern Web browsers. The **`XMLHttpRequest` object** uses HTTP to exchange data between a client computer and a Web server. Unlike standard HTTP requests, which usually replace the entire page in a Web browser, the `XMLHttpRequest` object can be used to request and receive data without reloading a Web page. By combining the `XMLHttpRequest` object with DHTML techniques, you can update and modify individual portions of your Web page with data received from a Web server. The `XMLHttpRequest` object has been available in most modern Web browsers since around 2001. However, Garrett's article was the first to clearly document the techniques for combining the `XMLHttpRequest` object with other techniques in order to exchange data between a client computer and a Web server.

The term AJAX was first used in an article written in 2005 by Jesse James Garrett, entitled *Ajax: A New Approach to Web Applications* (*http://adaptivepath.com/publications/essays/archives/000385.php*). The article discussed how Garrett's company, Adaptive Path, was using a combination of technologies, which they collectively referred to as AJAX, to add richness and responsiveness to Web pages. Since then, AJAX has become hugely popular among JavaScript developers.

Another factor contributing to AJAX's popularity was the release in 2005 of Google Suggest search functionality, making Google one of the first commercial Web sites to implement an AJAX application. As you type a search item in the Google Web site, Google Suggest lists additional search suggestions based on the text you type. For example, if you type "JavaScript", the search suggestions shown in Figure 12-1 appear. The important thing to understand about Google Suggest is that as you type each letter, JavaScript code uses the `XMLHttpRequest` object to send the string in the text box to the Google server, which attempts to match the typed characters with matching suggestions. The Google server then returns the suggestions to the client computer (without reloading the Web page), and JavaScript code populates the suggestion list with the response text.

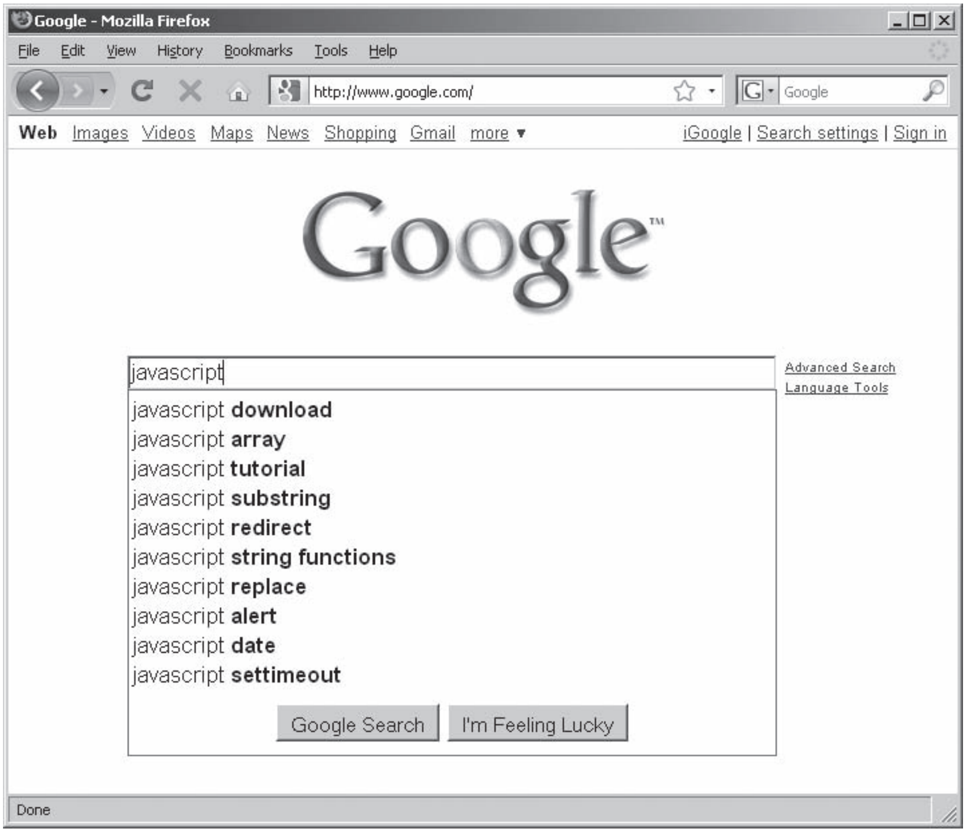


Figure 12-1 Google Suggest list box

You can also use frames (created with `<frame>` elements) and inline frames (created with `<iframe>` elements) to change portions of a Web page. However, frames are deprecated and although inline frames are not formally deprecated, they are not included with the XHTML Strict DTD, so you should avoid using them. A better choice is to use the node manipulation techniques that you studied in Chapter 10, along with the AJAX techniques presented in this chapter.

Figures 12-2 and 12-3 conceptually illustrate the difference between a standard HTTP request and an HTTP request with the `XMLHttpRequest` object. In Figure 12-2, the client makes a standard HTTP request for the *http://www.google.com* Web page, which is returned from the server and displayed in the client's Web browser. Figure 12-3 illustrates the request process with Google when a user types the text "Kona Hawaii vacation" into the text box. Instead of requesting an entire Web page, the `XMLHttpRequest` object only requests recommended search terms for the "Kona Hawaii vacation" string. The server returns recommended search terms to the client, which in turn uses JavaScript to display the terms in the suggestion list.

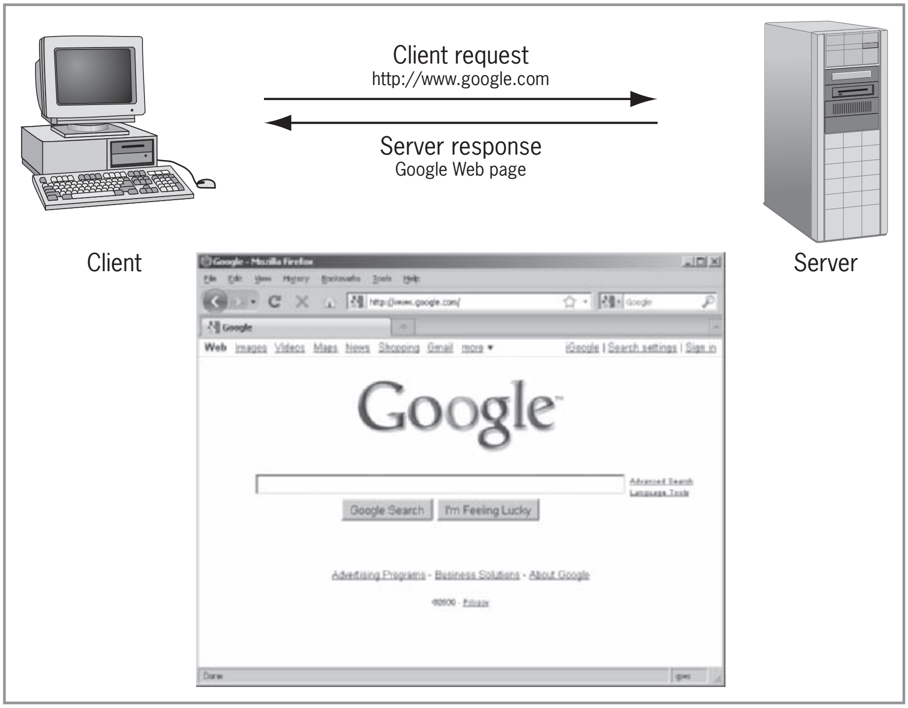


Figure 12-2 Standard HTTP request

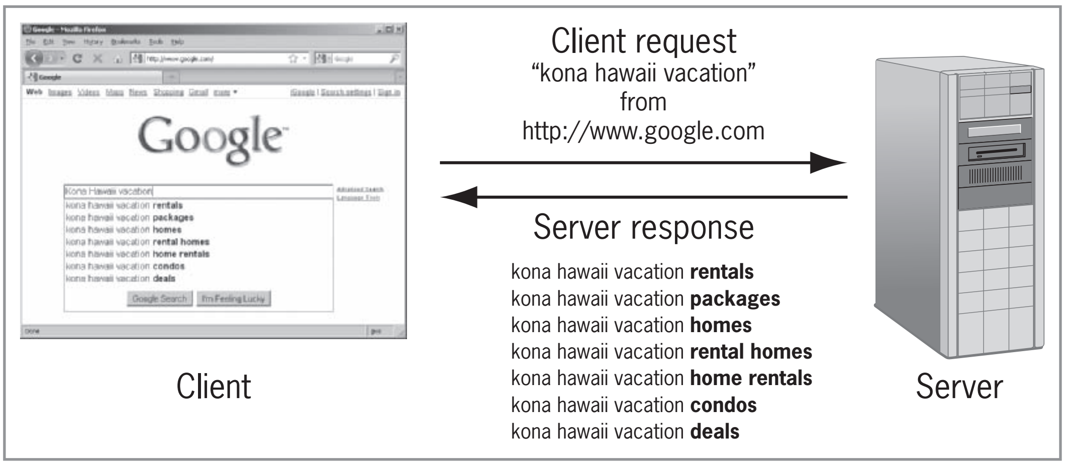


Figure 12-3 HTTP request with the `XMLHttpRequest` object

In this chapter, you will create an AJAX application that retrieves the top stories from a selected news agency using RSS feeds. **RSS** (for **RDF Site Summary** or **Rich Site Summary**) is an XML format that allows Web sites to publish content that can be read by other Web sites. Typical types of data that are published with RSS feeds include

There are countless RSS feeds available on the Internet that you can find by searching for "RSS feeds" in any search engine.

news listings, blogs, and digital content such as podcasts. For example, much of the content on MSNBC's Web site at *http://www.msnbc.msn.com* is delivered through RSS feeds. You'll find a prewritten Web page, TopStories.html, in your Chapter folder for Chapter 12. You will add a heading and form to the body of the Web page.

To add a heading and form to the body of the TopStories.html page:

1. Open in your text editor the **TopStories.html** file from your Chapter folder for Chapter 12.

2. Locate <!-- [Add form here] --> and replace it with the following text and elements. The form will contain radio buttons that represent a list of news agencies from which you can choose to display the selected agency's top stories. The form will be submitted to a PHP script named TopStories, which you will create later in this chapter.

```
<h1>Top Stories</h1>
<form method="get" action="TopStories.php">
</form>
```

3. Add the following table to the form. The table creates the radio buttons that represent the news agencies:

```
<table border="1" width="100%">
<tr><td valign="top">
<input type="radio" name="agency" value="http://
my.abcnews.go.com/rsspublic/ ↵
    fp_rss20.xml" checked="checked" />
ABC News<br />
<input type="radio" name="agency"
value="http://newsrss.bbc.co.uk/rss/ ↵
    newsonline_uk_edition/front_page/rss.xml" />
BBC<br />
<input type="radio" name="agency"
value="http://www.cbsnews.com/feeds/rss/main.rss" />
CBS News<br />
<input type="radio" name="agency"
value="http://rss.cnn.com/rss/cnn_topstories.rss" />
CNN<br />
<input type="radio" name="agency"
value="http://rss.msnbc.msn.com/id/ ↵
    3032091/device/rss/rss.xml" /> MSNBC<br />
<input type="radio" name="agency"
value="http://rss.news.yahoo.com/rss/topstories" />
Yahoo! News
</td><td id="newsCell" valign="top"></td>
</tr>
</table>
```

4. Finally, add the following submit button to the end of the form:

```
<p><input type="submit" value="Get Headlines" /></p>
```

5. Save the **TopStories.html** file, and then open it in your Web browser. Figure 12-4 shows how the document appears in a Web browser. Do not click the submit button yet because you still need to create the PHP script.

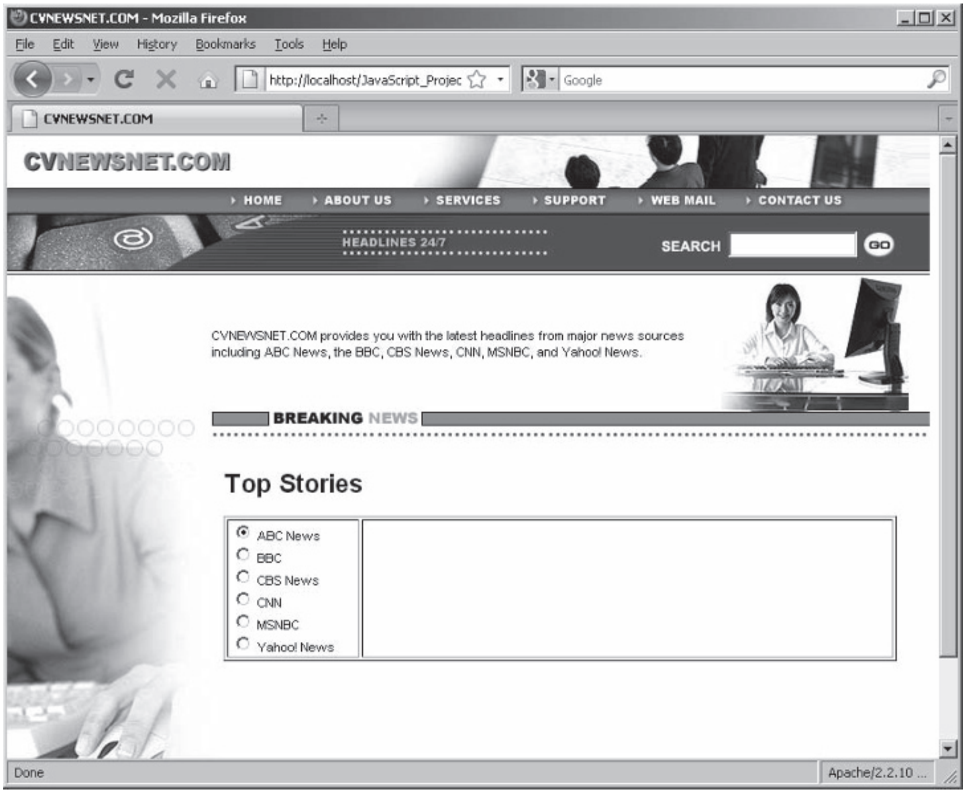


Figure 12-4 Top stories Web page

6. Close your Web browser window.

Understanding AJAX's Limitations

Recall from Chapter 9 that the same origin policy restricts how JavaScript code in one window or frame accesses a Web page in another window or frame on a client computer. For windows and frames to view and modify the elements and properties of documents displayed in other windows and frames, they must have the same protocol (such as HTTP) and exist on the same Web server.

Because JavaScript is the basis of AJAX programming, you cannot use the `XMLHttpRequest` object to directly access content on another domain's server; the data you request with the `XMLHttpRequest` object must be located on the Web server where your JavaScript program is running. In other words, you cannot directly bypass your own Web server and grab data off someone else's Web server. However, the same origin policy only applies to JavaScript and not to any other programs running on your Web server. This means that you can use a server-side script as a proxy to access data from another domain. The term **proxy** refers to someone or something that acts or performs a request for another thing or person. The server-side proxy script can then return the data to the client computer as it is requested with the `XMLHttpRequest` object.

Accessing Content on a Separate Domain

The purpose of the same origin policy is to prevent malicious scripts from modifying the content of other windows and frames, and prevent the theft of private browser information and information displayed on secure Web pages. However, the ability for one Web server to access Web pages and data on another Web server is the foundation of the World Wide Web. Although you should never attempt to pass off the content from another Web site as your own, there are legitimate reasons why you would use a server-side script to access data from another domain, particularly when it comes to accessing Web services and RSS feeds. A **Web service**, or **XML Web service**, is a software component that resides on a Web server. Web services do not contain any sort of graphical user interface or even a command line interface. Instead, they simply provide services and data in the form of methods and properties; it is up to the client accessing a Web service to provide an implementation for a program that calls a Web service.

As an example of a Web service, consider a Web page that displays the prices of commodities that you want to track, such as crude oil, natural gas, gold, or silver. The Web page may periodically call methods of a Web service that return the most recent trading price for each type of commodity. The developer of a server-side script only needs to know which method of the Web service to call for each type of commodity (such as a `getSilverPrice()` method that returns the current price of silver). The Web service itself does not care what you do with the data once you receive it; it is up to you to display it on a Web page, store it in a database, or use it in some other way in your application. In the case of AJAX, you might pass the data to a JavaScript program running on a client.

To find the methods and properties that are available for a particular Web service, visit the Web site of the Web service provider.

This chapter includes an AJAX example that displays streaming stock quote information from Yahoo! Finance. When you enter a stock quote into Yahoo! Finance, the returned results include a link that allows you to download a CSV (comma-separated values) file containing the basic stock quote information such as opening price and average volume. The default URL format for a CSV file downloaded from Yahoo! Finance is as follows:

```
http://finance.yahoo.com/d/quotes.csv?
    s={ticker symbols separated by+}
    &f={data format tags}&e=.csv
```

By default, the CSV file is named quotes.csv, and it is assigned three name=value pairs: *s* for ticker symbols, *f* for data formats, and *e* for file extension (`.csv`). You separate the ticker symbols assigned to the name=value pair for the ticker symbols with plus signs (+). The data that is downloaded from Yahoo! Finance to a CSV file is determined by the special tags that are assigned to the data formats name=value pair. By default, the values sl1d1t1c1ohgv are assigned to the data formats name=value pair and represent the ticker symbol (s), last price (l1), date (d1), time (t1), change (c1), open price (o), daily high (h), daily low (g), and volume (v). Notice that the data format symbols are not separated by spaces or any other symbols. For example, the URL for a CSV file downloaded from Yahoo! Finance for Oracle Corp. (ORCL) is as follows:

```
http://finance.yahoo.com/d/quotes.csv?
    s=ORCL&f=sl1d1t1c1ohgv&e=.csv
```

Because the returned CSV file from Yahoo! Finance is a simple text file, with each entry separated by commas, you can use a script to parse the file and use the values in your Web pages. You will study the stock quote Web page throughout this chapter. For now, you need to understand that the Web page relies on a server-side PHP script to retrieve and parse stock information from Yahoo! Finance. The PHP script executes when it is passed a stock ticker with the `XMLHttpRequest` object. After the PHP script retrieves the information for the specified stock, it returns the data to the JavaScript code that called it. When you first open the stock quote Web page, it defaults to the quote data for the NASDAQ Composite Index (^IXIC), as shown in Figure 12-5.

Although the download data link from Yahoo! Finance returns the ticker symbol, last price, date, time, change, open price, daily high, daily low, and volume by default, you can compose your own URL that downloads additional data for the specific ticker symbols. See *http://www.dividend-growth.org/FundamentalAnalysis/YahooData.htm* for a complete list of data format symbols that you can use when downloading a CSV file from Yahoo! Finance.

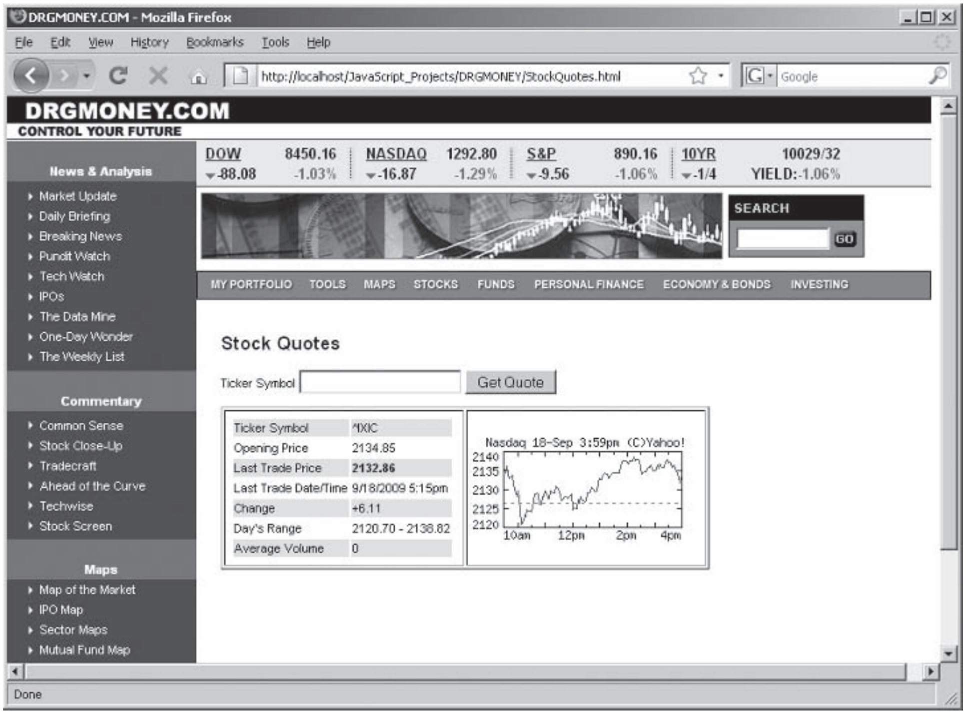


Figure 12-5 Stock quote page displaying the default NASDAQ Composite Index quote data

Entering a new ticker symbol and clicking the Get Quote button automatically retrieves the quote data for the specified stock from the Yahoo! Finance page. Figure 12-6 displays the updated stock quotes page after entering the ticker symbol for Oracle Corporation, ORCL.

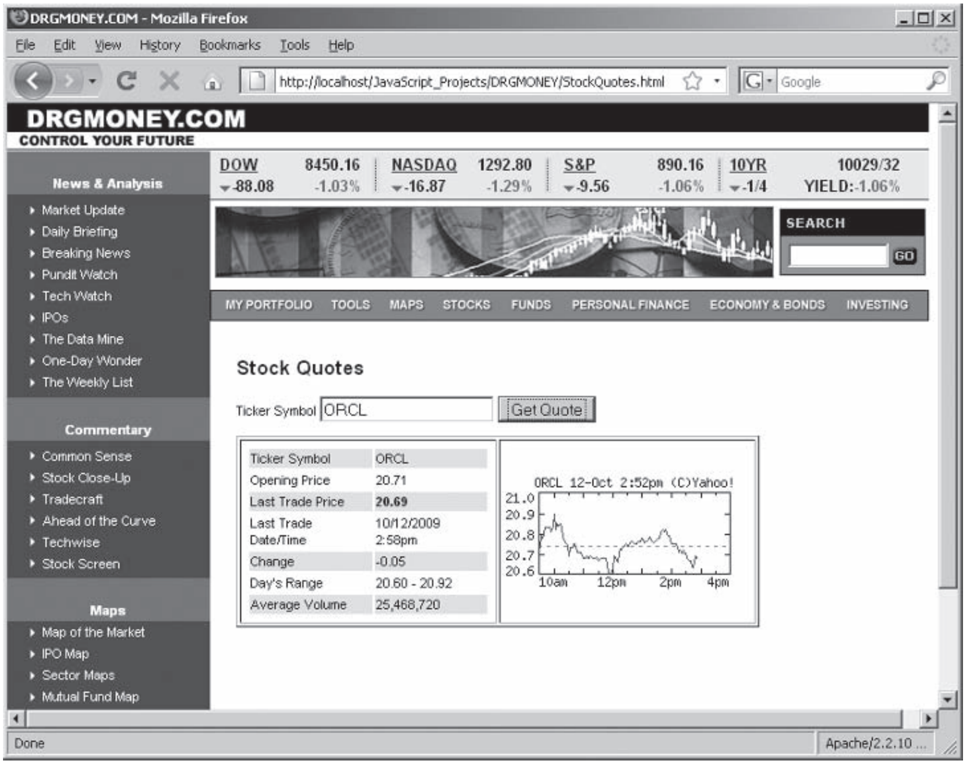


Figure 12-6 Stock quote page displaying quote data for Oracle Corporation

The stock quote page relies on the following PHP script to retrieve data from the Yahoo! Finance page. The script downloads a CSV (comma-separated values) file from the Yahoo! Finance page that displays the quote data. Then, the script builds an XML tree from the CSV file and returns the result to the client with an `echo` statement, which is similar to JavaScript's `document.write()` statement. The focus of this book is JavaScript programming, not PHP programming, so you will not analyze the following code any further. However, PHP shares a lot of similarities with JavaScript, so you can probably figure out most of the statements in the following code on your own.

```
<?php
header("Content-Type: text/xml");
$QuoteXML = "<?xml version='1.0' ↵
    encoding='iso-8859-1' standalone='yes' ?>\n";
$TickerSymbol = $_GET["checkQuote"];
$Quote = fopen("http://finance.yahoo.com/d/quotes.csv?s ↵
    =$TickerSymbol&f=sl1d1t1c1p2ohgv&e=.csv", "r");
$QuoteString = fread($Quote, 2000);
fclose($Quote);
```

```
$QuoteString = str_replace("\"", "", $QuoteString);
$QuoteArray = explode(",", $QuoteString);
$QuoteXML .= "<quote>\n";
$QuoteXML .= "<ticker>{$QuoteArray[0]}</ticker>\n";
$QuoteXML .= "<lastTrade>{$QuoteArray[1]}</lastTrade>\n";
$QuoteXML .= "<lastTradeDate>{$QuoteArray[2]}</
lastTradeDate>\n";
$QuoteXML .= "<lastTradeTime>{$QuoteArray[3]}</
lastTradeTime>\n";
$QuoteXML .= "<change>{$QuoteArray[4]}</change>\n";
$QuoteXML .= "<changePercent>{$QuoteArray[5]}</
changePercent>\n";
$QuoteXML .= "<open>{$QuoteArray[6]}</open>\n";
$QuoteXML .= "<rangeHigh>{$QuoteArray[7]}</rangeHigh>\n";
$QuoteXML .= "<rangeLow>{$QuoteArray[8]}</rangeLow>\n";
$QuoteXML .= "<volume>{$QuoteArray[9]}</volume>\n";
$QuoteXML .= "<chart>http://ichart.yahoo.com/t?s ↵
    =$TickerSymbol</chart>\n";
$QuoteXML .= "</quote>";
header("Content-Length: " . strlen($QuoteXML));
header("Cache-Control: no-cache");
echo $QuoteXML;
?>
```

When you run the preceding PHP script, it builds an XML tree containing the data for the stock ticker symbol that is passed to it. Then, the AJAX code in your JavaScript program uses node manipulation techniques to parse the data. (You will learn how to do this as you progress through this chapter.) Following is an example of the XML tree that the PHP script generates when you pass the ticker symbol ORCL (for Oracle Corporation) to it:

```
<quote>
    <ticker>ORCL</ticker>
    <lastTrade>21.81</lastTrade>
    <lastTradeDate>10/16/2009</lastTradeDate>
    <lastTradeTime>4:00pm</lastTradeTime>
    <change>+0.49</change>
    <changePercent>+2.30%</changePercent>
    <open>21.23</open>
    <rangeHigh>22.03</rangeHigh>
    <rangeLow>21.18</rangeLow>
    <volume>65051668</volume>
    <chart>http://ichart.yahoo.com/t?s=</chart>
</quote>
```

One lesson you should take away from the code is that PHP, like JavaScript, is not rocket science. Given the JavaScript skills you have learned in this book, and with a little additional study, you can easily learn PHP or any other server-side language. For now, keep in mind that any PHP scripts you see in this chapter are server-side scripting programs; they serve as a counterpoint to JavaScript programs, which are client-side scripting programs. In fact, client-side and server-side scripting languages share much of the same syntax and functionality, although server-side scripting languages can usually do quite a bit more than JavaScript. The exercises in this chapter require you to write some simple PHP scripts. For information on the basics of PHP, refer to Appendix B, "Introduction to PHP."

To learn more about PHP programming, refer to *PHP Programming with MySQL* by Don Gosselin (the author of this book) and published by Course Technology/ Cengage Learning.

Running AJAX from a Web Server

Throughout this book, you have opened Web pages directly from your local computer or network with your Web browser. However, in this chapter, you will open files from a Web server. Opening a local file in a Web browser requires the use of the file:/// protocol. Because AJAX relies on the `XMLHttpRequest` object to retrieve data, you must open your AJAX files from a Web server with the HTTP (http://) or HTTPS (https://) protocols. You can turn a computer into a Web server by installing Web server software on it. The most popular Web server software used on the Internet is Apache HTTP Server (typically referred to as Apache), which is used by more than half of today's Web sites. The second most popular Web server is Microsoft Internet Information Services (IIS) for Windows operating systems, which is used on about one-third of today's Web sites. If you do not have access to a Web server that can run PHP, follow the instructions in Appendix A, "Building a Web Development Environment," to install and configure either Apache or IIS and the PHP software on your local computer.

In the following steps, you will open the stock quotes Web page from your Web server. After opening the Web page, you will test it.

To open and test the stock quotes Web page:

1. Follow the instructions in Appendix A, "Building a Web Development Environment," to install and configure a Web server and PHP. Be sure to follow the instructions for creating an Alias directive for Apache (or a virtual directory in IIS) that points to the location of your data files.
2. Open your Web browser and enter the following URL to load the stock quotes Web page:

```
http://localhost/JavaScript_Projects/Chapter.12/ ↵
Chapter/DRGMONEY/StockQuotes.html
```

Remember that you cannot open an AJAX file from your local file system; you must open your AJAX files from a Web server with the HTTP protocol (http://).

3. By default, the stock quotes Web page displays quote data for the NASDAQ Composite Index (^IXIC). Enter another stock symbol, such as MSFT (for Microsoft) or CSCO (for Cisco), and click **Get Quote**. The Web page should automatically update the stock data for the symbol you entered. Figure 12-7 shows how the Web page appears after entering the stock symbol for Microsoft.

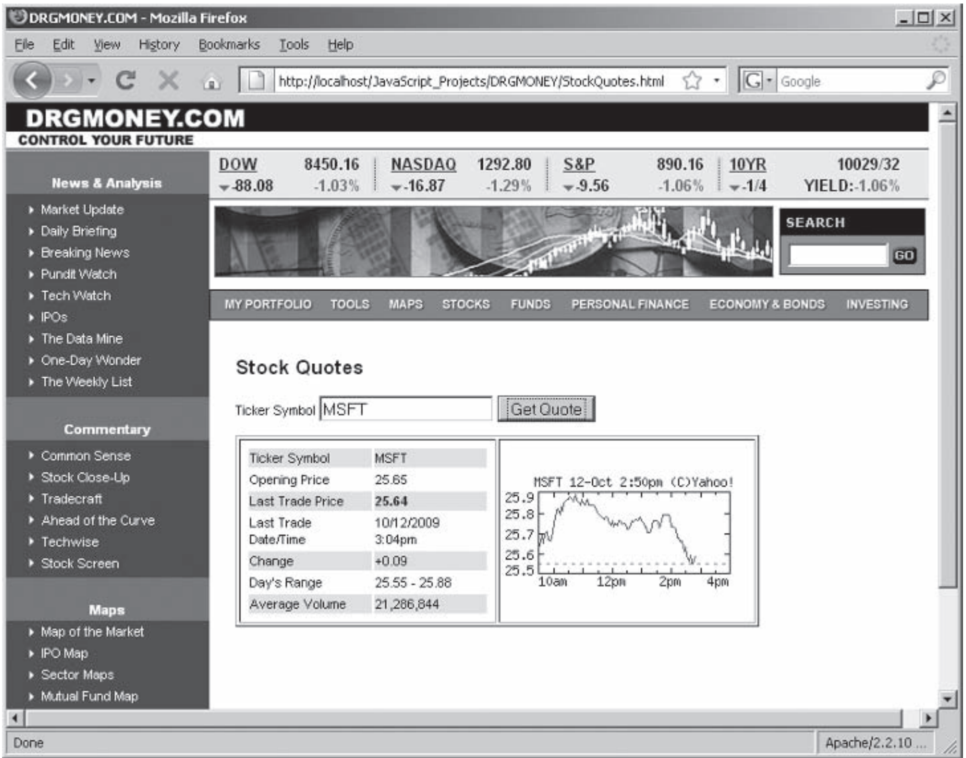


Figure 12-7 Stock quotes Web page displaying Microsoft stock data

4. Close your Web browser window.

Overview of Creating an AJAX Script

After you have installed and configured your Web server, you perform the following steps to create an AJAX script:

- Instantiate an `XMLHttpRequest` object for the Web browser where the script will run.
- Use the `XMLHttpRequest` object to send a request to the server.
- Read and process the data returned from the server.

Before you can write an AJAX script, you need to know a little more about HTTP to understand how AJAX exchanges data between client computers and Web servers.

Short Quiz 1

1. How do you access content on a separate domain?
2. How do you run AJAX from a Web server?
3. What are the primary steps for creating an AJAX script?

Working with HTTP

When discussing HTTP, it's helpful to start by reviewing basic terminology. As you know, when a user attempts to access a Web page, either by entering its URL in a browser's Address box or by clicking a link, the user's Web browser asks a Web server for the Web page. The process of asking for a Web page from a Web server is known as a **request**. The Web server's reply (which might consist of the requested Web page or a message about that Web page) is known as the **response**. Every Web page is identified by a unique address called the Uniform Resource Locator, or **URL**. A Web page's URL is similar to a telephone number in that each URL is unique and refers to a specific Web page. A URL consists of two basic parts: a protocol (usually HTTP) and either the domain name for a Web server or a Web server's Internet Protocol address. **Hypertext Transfer Protocol (HTTP)** is a set of rules that defines how requests are made by an HTTP client to an HTTP server, and how responses are returned from an HTTP server to an HTTP client. The term **HTTP client** refers to the application, usually a Web browser, which makes the request. The term **HTTP server** is another name for a Web server and refers to a computer that receives HTTP requests and returns responses to HTTP clients. A colon, two forward slashes, and a domain name follow the protocol portion of a URL. The term **host** refers to a computer system that is being accessed by a remote computer. In a URL, a specific filename, or a combination of directories and a filename, can follow the domain name or IP address. If the URL does not specify a filename, the requesting Web server looks for a default Web page located in the root or specified directory. Default Web pages usually have names similar to index.html or default.html. For instance, if you enter *http://www.oracle.com/technology/documentation/* in

An Internet Protocol, or IP address, is another way to uniquely identify computers or devices connected to the Internet. An IP address consists of a series of four groups of numbers separated by periods. Each Internet domain name is associated with a unique IP address.

Although HTTP is probably the most widely used protocol on the Internet, it is not the only one. HTTP is a component of Transmission Control Protocol/Internet Protocol (TCP/IP), a large collection of communication protocols used on the Internet. Other common protocols include: Hypertext Transfer Protocol Secure (HTTPS), which provides secure Internet connections that are used in Web-based financial transactions and other types of communication that require security and privacy; and File Transfer Protocol (FTP), which is used for transferring files across the Internet.

your browser's Address box, the Web server automatically opens a file named index html.

The W3C and the Internet Engineering Task Force jointly develop HTTP. The Internet Engineering Task Force (IETF) is a volunteer organization devoted to the development and promotion of Internet Standards, most notably TCP/IP. Recall that the W3C does not actually release a version of a particular technology. Instead, it issues a formal recommendation for a technology, which essentially means that the technology is (or will be) a recognized industry standard. The most recent version of HTTP that is commonly used today is 1.1, which is defined by RFC 2616 and recommendations. You can find the HTTP recommendations on the W3C Web site at *http://www.w3.org/Protocols*.

Understanding HTTP Messages

Most people who use the Web don't realize that there is more going on behind the scenes when it comes to requesting a Web page and receiving a response from a Web server. HTTP client requests and server responses are both known as **HTTP messages**. When you submit a request for a Web page, the HTTP client opens a connection to the server and submits a request message. The Web server then returns a response message that is appropriate to the type of request. Both request and response messages are in the following format:

```
Start line containing the request method for requests or
status line for responses
Header lines (zero or more)
Blank line
Message body (optional)
```

The specific contents of each line depend on whether it is a request or a response message. The first line either identifies the method (such as "get" or "post") for requests or the status returned from a response. Following the first line, each message can include zero or more lines containing **headers**, which define information about the request or response message and about the contents of the message body. The RFC2616 recommendation defines 46 HTTP 1.1 headers, categorized by generic headers that can be used in request or response messages and headers that are specific to a request, a response, or the message body. The format for using a header is *header*: *value*.

For example, the following lines define two generic headers that can be used in either request or response messages: `Connection` and `Date`. The `Connection` header specifies that the HTTP connection should close after the Web client receives a response from the Web server. The `Date` header identifies the date and time in Greenwich Mean Time format when a message was originated.

```
Connection: close
Date: Fri, 27 June 2008 18:32:07 GMT
```


One generic header that requires special mention for AJAX applications is the `Cache-Control` header, which specifies how a Web browser should cache any server content it receives. Most Web browsers try to reduce the amount of data that needs to be retrieved from a server by caching retrieved data on a local computer. **Caching** refers to the temporary storage of data for faster access. If caching is enabled in a Web browser, the Web browser will attempt to locate any necessary data in its cache before making a request from a Web server. For example, assume that caching is turned on when you open the stock quotes Web page. If you enter the same stock symbol more than once and click the Get Quotes button, the browser will retrieve the stock data stored in its cache, not the most recent data from the server. While this technique improves Web browser performance, it goes against the reason for using AJAX, which is to dynamically update portions of a Web page with the most recent data from a server. For this reason, you should always include in your AJAX programs the `Cache-Control` header, assigned a value of "no-cache", as follows:

See RFC 2616 for complete listings and descriptions of the available HTTP 1.1 headers.

The HTTP headers are case insensitive.

```
Cache-Control: no-cache
```

A blank line always follows the last header line. Optionally, a message body can follow the blank line in the messages. In most cases, the message body contains form data for "post" requests or some type of document (such as a Web page or XML page) or other type of content (such as an image file) that is returned with a server response. However, message bodies are not required for either request or response messages. For example, with a "get" request, no message body is necessary because any form data that is part of the request is appended to the URL. Response messages are also not required to include a message body. This may seem a little strange because, if a server doesn't return a Web page, then what is returned? What's the point in sending a request to a Web server if it doesn't return anything? Although "get" and "post" requests are by far the two most common types of HTTP requests, there are five other methods that can be used with an HTTP request: `HEAD`, `DELETE`, `OPTIONS`, `PUT`, and `TRACE`. The `DELETE`, `OPTIONS`, `PUT`, and `TRACE` methods are rarely used. However, the `HEAD` method is commonly used for returning information about a document, but not the document itself. For example, you may use the `HEAD` method to determine the last modification date of a Web page before requesting it from the Web server.

Later in this chapter, you will learn more about how to manage the response messages that are returned from a server. But first, you will learn about what's involved when sending a request message.

Sending HTTP Requests

Without a scripting language such as JavaScript, most Web browsers are usually limited to using the "get" and "post" methods with an HTTP request. The "get" method is used for standard Web page requests but can have a query string or form data appended to the URL. For example, if you enter the address for the United States Postal Service Web site (*http://www.usps.com*) in your Web browser, the browser creates a request message that begins with the following start line:

```
GET / HTTP/1.1
```

The preceding line identifies the method as "get" and 1.1 as the HTTP version. Also, notice the forward slash after "get", which identifies the root directory on the Web server as the location of the requested file. Because no HTML document was specified in the URL, the request looks in the Web server's root directory for a default Web page such as index.htm. However, if the URL contains a specific directory or file name, it is included in the start line. For example, a URL request that contains a directory and filename, such as *http://www.usps.com/business/welcome.htm*, generates the following start line in a request message:

```
GET /business/welcome.htm HTTP/1.1
```

When requesting a URL, most Web browsers include the headers listed in Table 12-1 in generated request messages.

Header	Description
`Host`	Identifies the host portion of a requested URL
`Accept-Encoding`	Defines the encoding formats that the HTTP client accepts
`Accept`	Defines the MIME types that the HTTP client accepts
`Accept-Language`	Lists the languages that the HTTP client accepts in a response
`Accept-Charset`	Defines the character sets that the HTTP client accepts
`User-Agent`	Identifies the user agent, such as a Web browser, that submitted the request
`Referer`	Identifies the referring URL from which the request was made

Table 12-1 Common request headers

The following shows an example of a request header. When you search for "ebay" on Google and click the eBay link (*www.ebay.com/*) that is returned in the search results, the following request message is generated in Firefox:

```
GET /12/!!e!75i!!(U~$(KGrHgoOKiYEjlLmep38BKss!
RMNOw~~_0.JPG HTTP/1.1
Host: i.ebayimg.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1;
en-US; rv:1.9.0.14) Gecko/2009082707 Firefox/3.0.14
(.NET CLR 3.5.30729)
Accept: text/html,application/xhtml+xml,application/
xml;q=0.9,*/*;q=0.8
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Referer: http://www.ebay.com/
blank line
```

A "post" request is similar to a "get" request, except that any submitted data is included in the message body, immediately following the blank line after the last header. To provide more information about the message body, requests made with the "post" method also usually include some of the headers listed in Table 12-2.

Header	Description
`Content-Encoding`	Defines the encoding format of the message body
`Content-Language`	Identifies the language of the message body
`Content-Length`	Identifies the size of the message body
`Content-Location`	Specifies the location of the message body contents
`Content-Type`	Identifies the MIME type of the message body
`Expires`	Defines the expiration date of the message body contents
`Last-Modified`	Identifies the last modification date of the message body contents

Table 12-2 Common message body headers

Next, you will learn about the HTTP responses that the user's browser receives from a Web server.

The message body headers listed in Table 12-2 are used for response messages as well as request messages.

Receiving HTTP Responses

HTTP response messages take the same format as request messages, except for the contents of the start line and the headers. Instead of containing a request method, the start line (also known as the status line), returns the protocol and version of the HTTP server (such as HTTP/1.1) along with a status code and descriptive text. The status codes returned from an HTTP server consist of three digits. The codes that begin with 1 (101, 102, etc.) are purely informational, indicating, for instance, that the request was received. The codes that begin with 2 indicate a successful request. The following list summarizes the types of messages provided by the three-digit codes that begin with 1 through 5. Table 12-3 lists the most common response codes.

- 1*xx* (informational)—Request was received
- 2*xx*: (success)—Request was successful
- 3*xx*: (redirection)—Request cannot be completed without further action
- 4*xx*: (client error)—Request cannot be fulfilled due to a client error
- 5*xx*: (server error)— Request cannot be fulfilled due to a server error

Code	Text	Description
200	OK	The request was successful.
301	Moved Permanently	The requested URL has been permanently moved.
302	Moved Temporarily	The requested URL has been temporarily moved.
404	Not Found	The requested URL was not found.
500	Internal Server Error	The request could not be completed due to an internal server error.

Table 12-3 Common response codes

For successful requests with HTTP 1.1, the start line in the response message consists of the following status line:

```
HTTP/1.1 200 OK
```

Zero or more response headers follow the status line. Table 12-4 lists the most common response codes.

Header	Description
`Vary`	Determines whether the server can respond to subsequent requests with the same response
`Server`	Returns information about the server software that processed the request
`Location`	Redirects clients to a different URI

Table 12-4 Common response headers

Because responses return documents (such as an XHTML document) or other types of files (such as image files), response messages usually include one or more of the message body headers listed in Table 12-4.

The response returned from a server can be much more involved than the original request that generated it. The initial request from an HTTP client for a Web page often results in the server issuing multiple other requests for resources that are required by the requested URL, such as style sheets, images, and so on. As a simplified example, the following statements represent the basic response that is returned for a request for the United States Postal Service Web site, although keep in mind that additional requests may be issued for resources that are required by the URL:

```
HTTP/1.x 200 OK
Server: Netscape-Enterprise/6.0
Content-Type: text/html
Content-Encoding: gzip
Cache-Control: no-cache, must-revalidate
Date: Sun, 20 Sep 2009 23:00:05 GMT
Content-Length: 15174
Connection: keep-alive
Vary: Accept-Encoding
blank line
<!DOCTYPE HTML PUBLIC
"-//W3C//DTD HTML 4.01 Transitional//EN">
<html><head>
<title>USPS - The United States Postal Service (U.S.
Postal Service)</title>
...
```

Next, you will create a PHP script that returns the RSS feeds for the selected news agency in the top stories program. The response returned from the PHP script will include the `Content-Type`, `Content-Length`, and `Cache-Control` headers.

To create a PHP script that returns the RSS feeds for a selected news agency:

1. Create a new document in your text editor.
2. Add the following PHP script section to the document:

   ```
   <?php
   ?>
   ```

3. Add the following statement to the script section. This statement retrieves the value of the `agency` field that was passed in the "get" request from the TopStories.html page and assigns it to a variable named `$NewsSource`.

   ```
   $NewsSource=$_GET["agency"];
   ```

4. Add to the end of the script section the following `header()` functions. PHP uses the `header()` function to define a header that will be returned with a response. The first statement creates the `Content-Type` header and assigns it a value of "text/xml". The second statement creates the `Content-Length` header and assigns it the length of the RSS feed by using the `file_get_contents()` method to retrieve the file and the `strlen()` function to obtain the file length. The second statement creates the `Cache-Control` header and assigns it a value of "no-cache".

```
header("Content-Type: text/xml");
header("Content-Length: " .
strlen(file_get_contents($NewsSource)));
header("Cache-Control: no-cache");
```

5. Add to the end of the script section the following statement, which uses the `readfile()` function to return the contents of the RSS feed as a response:

```
readfile($NewsSource);
```

6. Save the document as **TopStories.php** in your Chapter folder for Chapter 12, and then close it in your text editor.

7. Open your Web browser, and enter the following URL to load the top stories Web page:

```
http://localhost/JavaScript_Projects/Chapter.12/ ↵
    Chapter/TopStories.html
```

8. Select a news agency on the top stories Web page, and click **Get Headlines**. Most current Web browsers have built-in readers that can automatically read and display RSS feeds. Figure 12-8 displays the RSS feed that appears for the BBC.

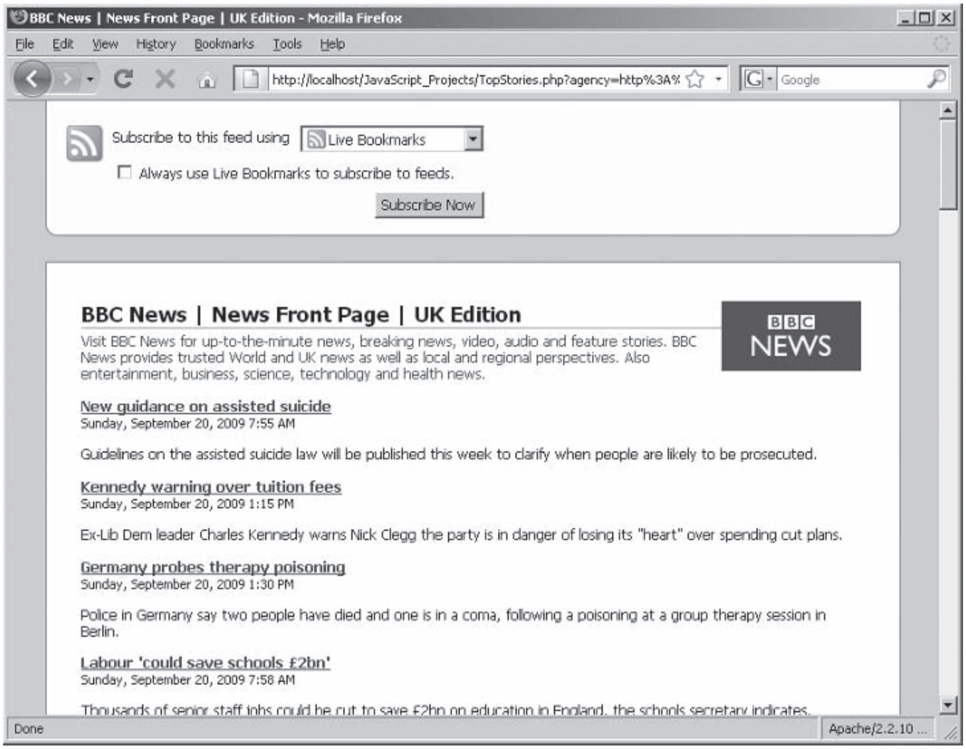


Figure 12-8 RSS feed for the BBC

9. Close your Web browser window.

Now that you understand the basics of HTTP requests and responses, you can begin learning about how to use these operations with JavaScript to exchange data between a client computer and a Web server.

Short Quiz 2

1. What are HTTP messages and headers?

2. Explain how caching is used with Web pages and why you should avoid using it with AJAX.

3. List and explain the response codes returned from an HTTP server.

Requesting Server Data

The `XMLHttpRequest` object is the key to turning your JavaScript script into an AJAX program because it allows you to use JavaScript and HTTP to exchange data between a Web browser and a Web server. More specifically, you use the methods and properties of an instantiated `XMLHttpRequest` object with JavaScript to build and send request messages and to receive and process response messages. The `XMLHttpRequest` object contains the methods listed in Table 12-5 and the properties listed in Table 12-6.

Method	Description
`abort()`	Cancels the current HTTP request
`getAllResponseHeaders()`	Returns a text string containing all of the headers that were returned with a response in *header*: *value* format, separated by line breaks
`getResponseHeader(`*`header_name`*`)`	Returns a text string containing the value assigned to the specified header
`open(`*`method`*`,`*`URL`*`[,`*`async`*`,`*`user`*`,` *`password`*`])`	Specifies the method and URL for an HTTP request; assigning a value of true to the *`async`* argument performs the request asynchronously, while a value of false performs the request synchronously; the default is true
`send([`*`content`*`])`	Submits an HTTP request using the information assigned with the `open()` method; the optional `content` argument contains the message body
`setRequestHeader(`*`header_name`*`,` *`value`*`)`	Creates an HTTP header using the *header_name* and *value* arguments

Table 12-5 `XMLHttpRequest` object methods

Property	Description
`onreadystatechange`	Specifies the name of the event handler function that executes whenever the value changes that is assigned to the `readyState` property
`readyState`	Contains one of the following values, which represent the state of the HTTP request: 0 (uninitialized), 1 (open), 2 (sent), 3 (receiving), or 4 (loaded)
`responseText`	Contains the HTTP response as a text string
`responseXML`	Contains the HTTP response as an XML document
`status`	Contains the HTTP status code (such as 200 for “OK” or 404 for “Not Found”) that was returned with the response
`statusText`	Contains the HTTP status text (such as “OK” or “Not Found”) that was returned with the response

Table 12-6 `XMLHttpRequest` object properties

Before you can use any of the methods and properties listed in Tables 12-5 and 12-6, you must first learn how to instantiate an `XMLHttpRequest` object.

Instantiating an XMLHttpRequest Object

The first step for using AJAX to exchange data between an HTTP client and a Web server is to instantiate an `XMLHttpRequest` object. For Mozilla-based browsers, such as Firefox, and for Internet Explorer 7 and higher, you instantiate an `XMLHttpRequest` object with the `XMLHttpRequest` constructor, as follows:

```
var httpRequest = new XMLHttpRequest();
```

Unfortunately, although the `XMLHttpRequest` object is available in most modern Web browsers, it is not standardized by the W3C or any other standards organization. Thankfully, Internet Explorer 7 and higher now uses the same syntax for instantiating an `XMLHttpRequest` object that Mozilla-based browsers use. However, for older versions of Internet Explorer, to instantiate an `XMLHttpRequest` object in Internet Explorer, you must instantiate the `XMLHttpRequest` object as an ActiveX object. **ActiveX** is a technology that allows programming objects to be easily reused with any programming language that supports Microsoft's Component Object Model. (The **Component Object Model (COM)** is an architecture for cross-platform development of client/server applications.) For Internet Explorer 6, you use the following syntax to instantiate an `XMLHttpRequest` object by passing a value of "Msxml2.XMLHTTP" to the ActiveX object constructor:

```
var httpRequest = new ActiveXObject(
    "Msxml2.XMLHTTP");
```

To make things even more confusing, Internet Explorer 5.5 requires the following slightly different syntax to instantiate an `XMLHttpRequest` object by passing a value of "Microsoft.XMLHTTP" instead of "Msxml2.XMLHTTP" to the ActiveX object constructor:

```
var httpRequest = new ActiveXObject(
    "Microsoft.XMLHTTP");
```

As of October 2009, Internet Explorer 6 and 5.5 are still used by a small percentage of the browser market. Because these versions of Internet Explorer are still in use, you should include the appropriate syntax to instantiate an `XMLHttpRequest` object for each browser. Essentially, your code should test for and instantiate an `XMLHttpRequest` object according to the following rules:

1. For Mozilla-based browsers or Internet Explorer 7 and higher, use the `XMLHttpRequest` constructor.

2. For Internet Explorer 6, pass a value of "Msxml2.XMLHTTP" to the ActiveX object constructor.
3. For Internet Explorer 5.5, pass a value of "Microsoft. XMLHTTP" to the ActiveX object constructor.
4. For all other browsers, inform the user that his or her browser does not support AJAX.

Most JavaScript programmers use a series of nested `try...catch` statements to instantiate an `XMLHttpRequest` object according to the Web browser that is running the script. For example, the following code declares a variable named `httpRequest` and then attempts to use the `XMLHttpRequest` constructor in the `try` statement to declare an `XMLHttpRequest` object. If the Web browser running the code does not contain an `XMLHttpRequest` constructor, then it is neither a Mozilla-based browser nor Internet Explorer 7 or higher. If this is the case, then the `try` statement throws an exception to the `catch` statement. Notice that the `catch` statement contains a nested `try...catch` statement. The nested `try` statement attempts to declare an `XMLHttpRequest` object by passing a value of "Msxml2. XMLHTTP" to the ActiveX object constructor. If the Web browser running the code does not support a value of "Msxml2.XMLHTTP" with the ActiveX object constructor, then it is not Internet Explorer. If this is the case, then the `try` statement throws an exception to the nested `catch` statement. Finally, if the nested `try` statement cannot instantiate an `XMLHttpRequest` object with the ActiveX object constructor, the nested `catch` statement prints "Your browser does not support AJAX!".

```
var httpRequest;
// instantiate an object for Mozilla-based browsers
// and Internet Explorer 7 and higher
try {
     httpRequest = new XMLHttpRequest();
}
// instantiate an ActiveX object for
// Internet Explorer 6
catch (requestError) {
     try {
          httpRequest = new ActiveXObject(
               "Msxml2.XMLHTTP");
     }
     catch (requestError) {
          document.write("<p>Your browser does ↵
               not support AJAX!</p>");
          return false;
     }
}
```

If you only need to support Internet Explorer 6 and higher, then the preceding code is sufficient. However, to support Internet Explorer 5.5, you must include another `try...catch` statement within the nested `catch` statement that attempts to pass a value of "Microsoft.XMLHTTP" (the value that is required for Internet Explorer 5.5) to the ActiveX object constructor. The following code demonstrates how to use two nested `try...catch` statements within a main `try...catch` statement to instantiate an `XMLHttpRequest` object for the appropriate Web browser. If none of the three `try` statements is able to instantiate an `XMLHttpRequest` object, then the final `catch` statement prints "Your browser does not support AJAX!".

```
var httpRequest;
// instantiate an object for Mozilla-based browsers
// and Internet Explorer 7 and higher
try {
     httpRequest = new XMLHttpRequest();
}
catch (requestError) {
// instantiate an ActiveX object for
// Internet Explorer 6
     try {
          httpRequest = new ActiveXObject(
                "Msxml2.XMLHTTP");
     }
     catch (requestError) {
// instantiate an ActiveX object for
//  Internet Explorer 5.5
          try {
               httpRequest = new ActiveXObject(
                      "Microsoft.XMLHTTP");
          }
          catch (requestError) {
               document.write(
                      "<p>Your browser does not ↵
                      support AJAX!</p>");
               return false;
          }
     }
}
```

Opening and closing HTTP connections takes up a lot of computer memory and processing time. To improve performance between client requests and server responses, HTTP/1.1 automatically keeps the client-server connection open until it is specifically closed by the client or server. It does this by assigning a value of "close" to the `Connection` header. This means that you can make your AJAX programs faster by reusing an instantiated `XMLHttpRequest` object instead of recreating it each time you send a server request. The following code demonstrates how to create a global variable named `curRequest`, which is assigned an instantiated `XMLHttpRequest` object in a function named `getRequestObject()`. The `getRequestObject()` function is only called once, when the Web page first loads. After the `getRequestObject()`function creates the appropriate `XMLHttpRequest` object, the last statement in the function returns the `curRequest` variable to a calling statement. Notice the `if` statement that follows the `getRequestObject()`function. If the `curRequest` variable is equal to false, then it has not been instantiated with the `XMLHttpRequest` object and the `getRequestObject()`function is called. The `return` statement in the `getRequestObject()` function returns the `httpRequest` variable, which represents the `XMLHttpRequest` object. The statement that called the `getRequestObject()` function then assigns the `XMLHttpRequest` object to the `curRequest` variable. However, if the `curRequest` variable is *not* equal to false (meaning that the Web page has already been loaded), then the `getRequestObject()`function is bypassed because the `XMLHttpRequest` object already exists.


```
var curRequest = false;
function getRequestObject() {
     try {
          httpRequest = new XMLHttpRequest();
     }
     catch (requestError) {
          try {
               httpRequest = new ActiveXObject(
                       "Msxml2.XMLHTTP");
          }
          catch (requestError) {
               try {
                    httpRequest = new
                       ActiveXObject(
                       "Microsoft.XMLHTTP");
               }
               catch (requestError) {
                    window.alert("Your browser ↵
                    does not support AJAX!");
                    return false;
               }
          }
     }
     return httpRequest;
}
```

```
if (!curRequest)
     curRequest = getRequestObject();
```

Next, you will add code to the top stories Web page that instantiates an XMLHttpRequest object.

To add code to the top stories Web page that instantiates an XMLHttpRequest object:

1. Return to the **TopStories.html** document in your text editor.
2. Add the following script section above the closing </head> tag:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

3. Add to the script section the following global declaration for the newsRequest variable and the getRequestObject() function:

```
var newsRequest = false;
function getRequestObject() {
     try {
          httpRequest = new XMLHttpRequest();
     }
     catch (requestError) {
          try {
               httpRequest = new ActiveXObject(
                   "Msxml2.XMLHTTP");
          }
          catch (requestError) {
               try {
                    httpRequest = new
                       ActiveXObject(
                       "Microsoft.XMLHTTP");
               }
               catch (requestError) {
                    window.alert("Your browser ↵
                    does not support AJAX!");
                    return false;
               }
          }
     }
     return httpRequest;
}
```

4. Save the **TopStories.html** document.

Opening and Sending a Request

After you instantiate an XMLHttpRequest object, you use the open() method with the instantiated XMLHttpRequest object to specify the request method (such as “get” or “post”) and URL.

The following statement is the `open()` method used by the stock quotes Web page. The statement specifies the "get" method and a URL named StockCheck.php, which is the PHP script that retrieves the stock information from Yahoo! Finance. The requested stock is appended to the URL as a query string in the format `checkQuote=tickerSymbol`. The value assigned to the `tickerSymbol` variable is passed with the Get Quote button's `onclick` event to a function containing the `XMLHttpRequest` code.

```
stockRequest.open("get","StockCheck.php?"
    + "checkQuote=" + tickerSymbol);
```

The `open()` method also accepts three optional arguments. The first optional argument, the *async* argument, can be assigned a value of true or false to determine whether the request will be handled synchronously or asynchronously. The second and third optional arguments— a username and password—are only necessary if the Web server requires authentication. Assigning a value of true to the *async* argument performs the request asynchronously, while a value of false performs the request synchronously. If you omit the *async* argument, it defaults to a value of true, which performs the request asynchronously. The following statement demonstrates how to specify that the request will be handled synchronously and how to pass a username ("dongosselin") and password ("rosebud") to the `open()` method:

```
stockRequest.open("get","StockCheck.php?"
    + "checkQuote=" + tickerSymbol, false,
    "dongosselin", "rosebud");
```

In the last section, you learned how to reuse an instantiated `XMLHttpRequest` object instead of recreating it each time you send a server request. When you reuse an existing `XMLHttpRequest` object, it is possible that the object may already have been in the process of sending a request to the server. To improve performance, you should call the `abort()` method of the `XMLHttpRequest` object to cancel any existing HTTP requests before beginning a new one. Append the `abort()` method to an instantiated `XMLHttpRequest` object and call the method before calling the `open()` method, as follows:

```
stockRequest.abort();
stockRequest.open("get","StockCheck.php?"
    + "checkQuote=" + tickerSymbol, false,
    "dongosselin", "rosebud");
```

After you have defined the basic request criteria with the `open()` method, you use the `send()` method with the instantiated `XMLHttpRequest` object to submit the request to the server. The `send()` method accepts a single argument containing the message body. If "get" is specified with the `open()` method, you must pass a value of `null` to the `send()` method, as follows:

```
stockRequest.send(null);
```

Recall that when a Web browser submits an HTTP request, it usually includes various response and message body headers. When running basic "get" requests with the `XMLHttpRequest` object, you do not usually need to specify any additional HTTP headers. For example, the following statements are all you need to open and send a request with the stock quotes Web page:

```
stockRequest.abort();
stockRequest.open("get","StockCheck.php?"
    + "checkQuote=" + tickerSymbol);
stockRequest.send(null);
```

"Post" requests are a little more involved. With form data, a Web browser automatically handles the task of creating name=value pairs from form element `name` attributes and field values. When submitting form data as the message body with the `XMLHttpRequest` object, you must manually build the name=value pairs that will be submitted to the server. The first statement in the following code creates a variable named `requestBody` that is assigned the value "checkQuote=" and the URI-encoded value assigned to the `tickerSymbol` variable. The last statement then passes the `requestBody` variable as an argument to the `send()` method.

```
var requestBody = "checkQuote="
    + encodeURIComponent(tickerSymbol);
stockRequest.send(requestBody);
```

With "post" requests, you must at least submit the `Content-Type` header before executing the `send()` method to identify the MIME type of the message body. You should also submit the `Content-Length` header to specify the size of the message body and the `Connection` header to specify that the connection with the server be closed after the response is received. You use the `setRequestHeader()` method to specify HTTP headers and values to submit with the HTTP request. You pass two arguments to the `setRequestHeader()` method: the name of the header and its value. For example, the following code uses the `setRequestHeader()` method to define the `Content-Type`, `Content-Length`, and `Connection` headers before submitting the request for the stock quotes Web page:

```
stockRequest.abort();
stockRequest.open("post","StockCheck.php");
```

```
var requestBody = "checkQuote="
    + encodeURIComponent(tickerSymbol);
stockRequest.setRequestHeader("Content-Type",
    "application/x-www-form-urlencoded");
stockRequest.setRequestHeader("Content-Length",
    requestBody.length);
stockRequest.setRequestHeader("Connection",
    "close");
stockRequest.send(requestBody);
```

Next, you will add a function that instantiates, opens, and submits an `XMLHttpRequest` object.

To add a function that instantiates, opens, and submits an XMLHttpRequest object:

1. Return to the **TopStories.html** document in your text editor.
2. Add the following `newsUpdate()` function to the end of the script section. The `if` statement at the beginning of the function calls the `getRequestObject()` function to instantiate the `newsRequest` object if it does not already exist. The `for` loop iterates through the radio buttons on the form to determine which one is checked, and then copies the checked item's URL (which is stored in the `value` attribute) to a variable named `agency`. The last three statements then abort an existing process (if one is running), and open and send the new request. Notice that the value of the `agency` variable is appended to the URL in the `open()` function as a query string.

```
function newsUpdate() {
     if (!newsRequest)
          newsRequest = getRequestObject();
     for (var i=0; i<6; ++i) {
          if (document.forms[0].agency[i].checked
                == true) {
                var agency = document.forms[0]
                    .agency[i].value;
                    break;
          }
     }
     newsRequest.abort();
     newsRequest.open("get","TopStories.php?"
          + "agency=" + agency);
     newsRequest.send(null);
}
```

3. Save the **TopStories.html** document.

Short Quiz 3

1. Why is the XMLHttpRequest object the key to turning your JavaScript script into an AJAX program?
2. Explain how to instantiate an XMLHttpRequest object for different browsers.
3. Explain how to open and send a request with an XMLHttpRequest object.

Receiving Server Data

After you submit a request with the XMLHttpRequest object, the message body in the server response is assigned to the XMLHttpRequest object's responseXML or responseText properties. The responseXML property contains the HTTP response as an XML document, while the responseText property contains the HTTP response as a text string. Note that the message body is only assigned to the responseXML property if the server response includes the Content-Type header, assigned a MIME type value of "text/xml". You can process the contents of the responseXML property by using the same node-manipulating techniques that you learned in Chapter 10. For example, the following statements demonstrate how to manipulate the value assigned to the responseXML property for the stock quotes Web page. The first statement assigns the value of the returned responseXML property to a variable named stockValues. The remaining statements then use the innerHTML() method and node properties to assign the values of the XML document stored in the stockValues variable to the appropriate element.

```
var stockValues = stockRequest.responseXML;
document.getElementById("ticker").innerHTML
    = stockValues.getElementsByTagName("ticker")[0]
    .childNodes[0].nodeValue;
document.getElementById("openingPrice")
    .innerHTML = stockValues.getElementsByTagName(
    "open")[0].childNodes[0].nodeValue;
document.getElementById("lastTrade").innerHTML
    = "<strong>" + stockValues.getElementsByTagName(
    "lastTrade")[0].childNodes[0].nodeValue
    + "</strong>";
```

```
document.getElementById("lastTradeDT").innerHTML
    = stockValues.getElementsByTagName(
    "lastTradeDate")[0].childNodes[0].nodeValue
    + " " + stockValues.getElementsByTagName(
    "lastTradeTime")[0].childNodes[0].nodeValue;
document.getElementById("change").innerHTML
    = stockValues.getElementsByTagName(
    "change")[0].childNodes[0].nodeValue;
document.getElementById("range").innerHTML
    = stockValues.getElementsByTagName(
    "rangeLow")[0].childNodes[0]
    .nodeValue + " - "
    + stockValues.getElementsByTagName(
    "rangeHigh")[0].childNodes[0].nodeValue;
var volume = parseInt(stockValues
    .getElementsByTagName(
    "volume")[0].childNodes[0].nodeValue);
document.getElementById("volume").innerHTML
    = volume.toLocaleString();
document.getElementById("chart").innerHTML
    = "<img src=" + stockValues
    .getElementsByTagName("chart")[0]
    .childNodes[0].nodeValue
    + " alt='Stock line chart from Yahoo.com.' />";
```

To use the `responseText` property, consider the following simplified version of the PHP script you saw earlier, which retrieves data from the Yahoo! Finance page:

```
<?php
header("Content-Type: text/html");
$TickerSymbol = $_GET["checkQuote"];
$Quote = fopen("http://finance.yahoo.com/d/ ↵
    quotes.csv?s=$TickerSymbol&f=sl1d1t1c1p2ohgv ↵
    &e=.csv", "r");
$QuoteString = fread($Quote, 2000);
fclose($Quote);
echo $QuoteString;
?>
```

Don't worry about understanding the PHP script—the only thing you need to know about the script is that this version returns a text string instead of an XML document.

The second statement in the preceding code assigns a value of "text/html" to the `Content-Type` header, and instead of building an XML tree, the code simply returns a text string similar to the following text that is returned for the NASDAQ Composite Index (^IXIC):

```
"^IXIC",2421.64,"3/30/2009","5:16pm",
    +3.76,2419.91,2432.20,2403.01,0
```

The following statements demonstrate how to use the returned response string with JavaScript. The first statement uses the `split()` method of the `String` object to split the string at each of the commas into an array named `responseArray`. The remaining statements then use the `innerHTML()` method to assign the values in `responseArray` to the appropriate elements.


```
var responseArray
    = stockRequest.responseText.split(",");
document.getElementById('ticker').innerHTML
    = responseArray[0].slice(1,
    responseArray[0].length-1);
document.getElementById('openingPrice').innerHTML
    = responseArray[5];
document.getElementById('lastTradeDT').innerHTML
    = responseArray[2].slice(1,
    responseArray[2].length-1) + " "
    + responseArray[3].slice(1,
    responseArray[3].length-1);
document.getElementById('lastTrade').innerHTML
    = "<strong>" +  responseArray[1] + "</strong>";
document.getElementById('change').innerHTML
    = responseArray[4];
document.getElementById('range').innerHTML
    = responseArray[7]
    + " - " + responseArray[6];
var volume = parseInt(responseArray[8]);
document.getElementById('volume').innerHTML
    = volume.toLocaleString();
document.getElementById('chart').innerHTML
    = "<img src=http://ichart.yahoo.com/t?s="
    + tickerSymbol
    + " alt='Stock line chart from Yahoo.com.' />";
```

The specific procedures for accessing the values of the `responseText` and `responseXML` properties with JavaScript depend on whether you submitted a synchronous or asynchronous request.

Sending and Receiving Synchronous Requests and Responses

The value of the `open()` method's third argument determines whether the HTTP request is performed synchronously or asynchronously. A **synchronous request** stops the processing of the JavaScript code until a response is returned from the server. To create a synchronous request, you should check the value of the XMLHttpRequest object's status property, which contains the HTTP status code (such as 200 for "OK" or 404 for "Not Found") that was returned with the response, to ensure that the response was received successfully.

The following statements demonstrate how to use the returned status code and response string. The second statement passes a value of false as the third argument of the open() method to create a synchronous request. The if statement then determines whether the value assigned to the status property is 200. If so, the response was successful and the statements within the if statement execute. Note that the statements within the if statement are the same statements you saw previously for manipulating the value assigned to the responseXML property for the stock quotes Web page. If any other status code is returned, the else statement prints a message with the status code and text.

```
stockRequest.abort();
stockRequest.open("get", "StockCheck.php?"
    + "checkQuote=" + tickerSymbol, false);
if (stockRequest.status == 200) {
    stockRequest.send(null);
    var stockValues = stockRequest.responseXML;
    document.getElementById("ticker").innerHTML
        = stockValues.getElementsByTagName(
        "ticker")[0].childNodes[0].nodeValue;
...
}
else {
    document.write("<p>HTTP response error "
        + stockRequest.status + ": "
        + stockRequest.statusText + "</p>");
}
```

Next, you will modify the top stories Web page so that it sends and receives synchronous requests and responses using RSS feeds. RSS documents are in a standardized XML format contained within a root element named <channel>. The <channel> root element contains four required elements: <title>, <link>, <description>, and <item>. Multiple <item> elements can be included, each of which contains an article or other type of content that is being published as part of the feed. Each <item> element also requires nested <title>, <link>, and <description> elements. There are numerous other optional elements that can be included in an RSS feed. One optional element, the <pubDate> element, which contains an article's publication date, is often used within the <item> elements in the RSS feeds from news agencies. The following is a simplified example of a portion of an RSS feed from CNN.

```
<?xml version="1.0" encoding="ISO-8859-1" ?>
<rss version="2.0">
    <channel>
        <title>CNN.com</title>
       <link>http://www.cnn.com/?eref
           =rss_topstories</link>
        <description>CNN.com delivers
            up-to-the-minute news and information
            on the latest top stories, weather,
            entertainment, politics and
             more.</description>
        <language>en-us</language>
        <copyright>© 2009 Cable News Network LP,
            LLLP.</copyright>
        <pubDate>Sun, 20 Sep 2009 19:20:10
            EDT</pubDate>
        <item>
            <title>What to watch for at the Emmys
                tonight</title>
            <link>http://rss.cnn.com/~r/rss/
                cnn_topstories/~3/0t3Qtqv-08o/
                index.html</link>
            <description>
                The red carpet is under way in Los
                Angeles for the Emmy Awards, which
                begins at 8 p.m. ET.
             </description>
            <pubDate>Sun, 20 Sep 2009 19:09:57
                 EDT</pubDate>
        </item>
        <item>
            <title>Schwarzenegger signs bill
                honoring Harvey Milk</title>
            <link> http://rss.cnn.com/%7Er/rss/
                cnn_topstories/%7E3/YfP1joUkwzs/
                index.html</link>
            <description>
                California Gov. Arnold
                Schwarzenegger has signed a bill
                commemorating Harvey Milk ...
             </description>
            <pubDate>Mon, 12 Oct 2009 12:16:27
```

```
                EDT</pubDate>
        </item>
...
</channel>
</rss>
```


To retrieve all of the `<item>` elements, you can use a statement similar to the following:

```
var newsItems=news.getElementsByTagName("item");
```

You can then use the `newsItems` variable with the `getElementsByTagName()` method, the `firstChild` property, and the `lastChild` property to retrieve the values for each news item's title, publication date, link, and description. For example, the following statement assigns the value of the first `<item>` element's `<title>` element ("What to watch for at the Emmys tonight") to a variable named `curHeadline`.

```
var curHeadline = newsItems[0].getElementsByTagName(
    "title")[0].firstChild.nodeValue;
```

Next, you will modify the top stories Web page so that it sends and receives synchronous requests and responses.

To modify the top stories Web page so that it sends and receives synchronous requests and responses:

1. Return to the **TopStories.html** document in your text editor, and add a value of false as the third argument of the `open()` method as follows so that it sends the request synchronously:

   ```
   newsRequest.open("get","TopStories.php?" + "agency="
       + agency, false);
   ```

2. Add the following statements to the end of the `newsUpdate()` function to handle the server response. The first statement assigns the value of the `responseXML` property to a variable named `news`. The news stories will be displayed in a cell with an `id` attribute of `newsCell`. Each time you select a different news agency, the second statement deletes the cell's existing content by assigning an empty string to the `innerHTML` property of the cell.

   ```
   var news = newsRequest.responseXML;
   document.getElementById("newsCell").innerHTML = "";
   ```

3. Add to the end of the `newsUpdate()` function the following statement, which returns a collection of all `<item>` elements in the response and assigns it to a variable named `newsItems`.

   ```
   var newsItems=news.getElementsByTagName("item");
   ```

4. Start creating the following `for` statement at the end of the `newsUpdate()` function. The `for` statement is contained within an `if` statement that first determines whether the RSS feed contains any items. The `for` statement will use the response in the `news` variable to build the cell containing each news item's title, publication date, link, and description.

```
if (newsItems.length > 0) {
for (var i=0; i<newsItems.length; ++i) {
}
}
else
    document.getElementById("newsCell").innerHTML
        = "RSS feed does not contain any items.";
```

5. Add the following statements to the `for` loop. These statements use the `getElementsByTagName()` method, the `firstChild` property, and the `nodeValue` property to retrieve the values for each news item's title, publication date, link, and description.

```
var curHeadline = newsItems[i].getElementsByTagName(
    "title")[0].firstChild.nodeValue;
var curLink = newsItems[i].getElementsByTagName(
    "link")[0].firstChild.nodeValue;
var curPubDate = newsItems[i].getElementsByTagName(
    "pubDate")[0].firstChild.nodeValue;
var curDesc = newsItems[i].getElementsByTagName(
    "description")[0].firstChild.nodeValue;
```

6. Add the following statements to the end of the `for` loop to build the cell containing the stories:

```
var curStory = "<a href='" + curLink + "'>"
    + curHeadline + "</a><br />";
curStory += "<span style='color: gray'>"
    + curPubDate + "</span><br />";
curStory += curDesc + "<br />";
document.getElementById("newsCell").innerHTML
    += curStory;
```

7. Add the following `onload` event handler to the opening <body> tag. This event handler calls the `newsUpdate()` function when the Web page first loads.

```
onload="newsUpdate()"
```

8. Add the following `onclick` event handler to each of the radio buttons. This event handler calls the `newsUpdate()` function whenever a radio button is selected.

```
onclick="newsUpdate()"
```

9. Delete the following paragraph and input element:

```
<p><input type="submit" value="Get Headlines" /></p>
```

10. Add the following elements immediately after the opening <table> tag that contains the links to the news agencies to handle the display of the table columns:

```
<colgroup span="1" width="20%" />
<colgroup span="1" width="80%" />
```

11. Save the **TopStories.html** document, and then open it in your Web browser by entering the following URL. After the Web page loads, the top stories for ABC News should appear in the right column of the table, as shown in Figure 12-9.

```
http://localhost/JavaScript_Projects/Chapter.12/ ↵
    Chapter/TopStories.html
```

Figure 12-9 Top stories Web page displaying default ABC News stories

12. Select a different news agency. The stories for the selected agency should display. Figure 12-10 displays the results for CBS News.

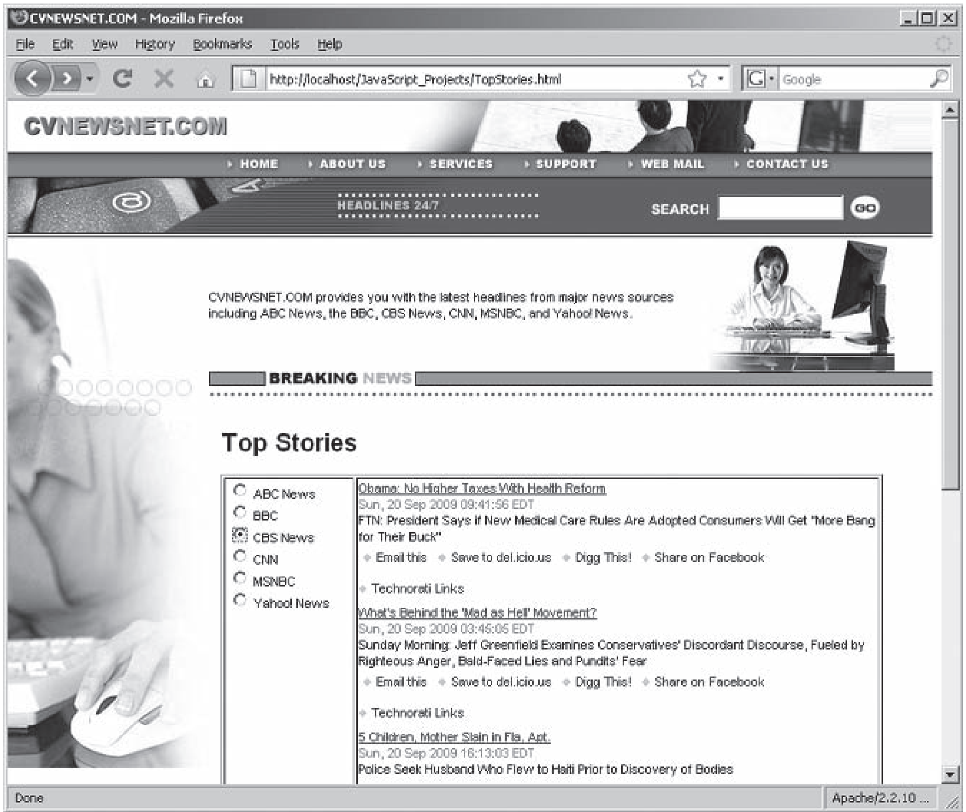


Figure 12-10 Top stories Web page displaying default CBS News stories

13. Close your Web browser window.

Although synchronous responses are easier to handle, they have a major drawback in that a script will not continue processing until the response is received. This means that if the server doesn't respond for some reason (perhaps because it is running slowly due to high traffic or maintenance requirements), your Web page will appear to be dead in the water. Users can stop the script by clicking the browser's Stop button. However, a synchronous request with the `send()` method does not contain any sort of mechanism for specifying the length of time that is allowed for receiving a response. To ensure that your script continues running in the event of a server problem, you should use asynchronous requests with the `send()` method.

Sending and Receiving Asynchronous Requests and Responses

Compared to a synchronous request, an **asynchronous request** allows JavaScript to continue processing while it waits for a server response. To create an asynchronous request, you pass a value of true as the third argument of the open() method or omit the argument altogether. To receive a response for an asynchronous request, you must use the XMLHttpRequest object's readyState property and onreadystatechange event. The readyState property contains one of the following values, which represents the state of the HTTP request: 0 (uninitialized), 1 (open), 2 (sent), 3 (receiving), or 4 (loaded). The onreadystatechange event is triggered whenever the value assigned to the readyState property changes. You assign to the onreadystatechange event the name of a function that will execute whenever the readyState property changes. For example, the open() method in the following code defines an asynchronous request because it includes a value of true as the method's third argument. (Recall that you can also simply omit the third argument to define an asynchronous request.) The fourth statement assigns a function named fillStockInfo() as the event handler function for the onreadystatechange event.

```
stockRequest.abort();
stockRequest.open("get","StockCheck.php?"
    + "checkQuote=" + tickerSymbol);
stockRequest.send(null);
stockRequest.onreadystatechange=fillStockInfo;
```

The value assigned to the readyState property is updated automatically according to the current statement of the HTTP request. However, you cannot process the response until the readyState property is assigned a value of 4, meaning that the response is finished loading. For this reason, you include an if statement in the fillStockInfo() function that checks the value assigned to the readyState property. As shown in the following example, once the readyState property is assigned a value of 4 and the status property is assigned a value of 200, the statements in the body of the if statement process the response:

```
function fillStockInfo() {
    if (stockRequest.readyState==4
        && stockRequest.status == 200) {
        var stockValues = stockRequest.responseXML;
        document.getElementById("ticker").innerHTML
            = stockValues.getElementsByTagName(
            "ticker")[0].childNodes[0].nodeValue;
    ...
    }
}
```

Next, you will modify the top stories Web page so that it sends and receives asynchronous requests and responses.

To modify the top stories Web page so that it sends and receives asynchronous requests and responses:

1. Return to the **TopStories.html** document in your text editor, and change the value of the third argument of the `open()` method in the `newsUpdate()` function from false to true as follows so that it sends the request asynchronously:

```
newsRequest.open("get","TopStories.php?" + "agency="
    + agency, true);
```

2. Add the following `fillNewsInfo()` function definition to the end of the script section. The statements in the body of the `if` statement (which you will add next) will process the response once the `readyState` property is assigned a value of 4 and the `status` property is assigned a value of 200.

```
function fillNewsInfo() {
    if (newsRequest.readyState==4
        && newsRequest.status == 200) {
    }
}
```

3. Move the following statements from the end of the `newsUpdate()` function to the `if` statement in the `fillNewsInfo()` function:

```
var news = newsRequest.responseXML;
document.getElementById("newsCell").innerHTML = ""
var newsItems=news.getElementsByTagName("item");
if (newsItems.length > 0) {
     for (var i=0; i<newsItems.length; ++i) {
          var curHeadline = newsItems[i]
                .getElementsByTagName("title")[0]
                .firstChild.nodeValue;
          var curLink = newsItems[i]
                .getElementsByTagName("link")[0]
                .firstChild.nodeValue;
          var curPubDate = newsItems[i]
                .getElementsByTagName("pubDate")[0]
                    .firstChild.nodeValue;
          var curDesc = newsItems[i]
                     .getElementsByTagName(
                     "description")[0].firstChild
                     .nodeValue;
          var curStory = "<a href='" + curLink
                + "'>"  + curHeadline
                + "</a><br />";
          curStory += "<span style='color: gray'>"
                + curPubDate + "</span><br />";
          curStory += curDesc + "<br />";
                document.getElementById("newsCell")
                .innerHTML += curStory;
     }
```

```
}
else
    document.getElementById("newsCell").innerHTML
        = "RSS feed does not contain any items.";
```

4. Add the following statement to the end of the `newsUpdate()` function. This statement assigns the `fillNewsInfo()` function as the event handler function for the `onreadystatechange` event.


```
newsRequest.onreadystatechange=fillNewsInfo;
```

5. Save the **TopStories.html** document, and then open it in your Web browser by entering the following URL. The Web page should function the same as it did before you changed it to perform asynchronous requests.

```
http://localhost/JavaScript_Projects/Chapter.12/ ↵
    Chapter/TopStories.html
```

6. Close your Web browser window.

Refreshing Server Data Automatically

To automatically refresh data that is obtained from an HTTP server, you use JavaScript's `setTimeout()` or `setInterval()` methods to send a request to the server, and read and process the data returned from the server. As an example, the following code contains a completed version of the JavaScript section that gives the stock quotes Web page its functionality. A global variable named `tickerSymbol` is declared at the beginning of the script section and assigned a default value of ^IXIC, which is the ticker symbol for the NASDAQ Composite Index. The `getStockQuote()` function, which calls the `getRequestObject()` function and also opens and submits the HTTP request, is initially called from an `onload` event in the `<body>` tag and is subsequently called each time a user clicks the Get Quote button. The last statement in the `getStockQuote()` function uses a `setTimeout()` method to call the `getStockQuote()` function every 10,000 milliseconds (or every 10 seconds). The `setTimeout()` method reinitializes each time the `getStockQuote()` function executes.

```
<script type="text/javascript">
/* <![CDATA[ */
var stockRequest = false;
var tickerSymbol = "^IXIC";
function getRequestObject() {
    try {
        httpRequest = new XMLHttpRequest();
    }
```

```
    catch (requestError) {
        try {
            httpRequest = new ActiveXObject(
            "Msxml2.XMLHTTP");
        }
        catch (requestError) {
            try {
                httpRequest = new ActiveXObject(
                    "Microsoft.XMLHTTP");
            }
            catch (requestError) {
                window.alert("Your browser ↵
                    does not support AJAX!");
                return false;
            }
        }
    }
    return httpRequest;
}
function getStockQuote(newTicker) {
    if (!stockRequest)
        stockRequest = getRequestObject();
    if (newTicker)
        tickerSymbol = newTicker;
    stockRequest.abort();
    stockRequest.open("get","StockCheck.php?"
        + "checkQuote=" + tickerSymbol, true);
    stockRequest.send(null);
    stockRequest.onreadystatechange=fillStockInfo;
    clearTimeout(updateQuote);
    var updateQuote = setTimeout(
        'getStockQuote()', 10000);
}
function fillStockInfo() {
    if (stockRequest.readyState==4
        && stockRequest.status == 200) {
        var stockValues = stockRequest.responseXML;
    document.getElementById("ticker").innerHTML
        = stockValues.getElementsByTagName(
        "ticker")[0].childNodes[0].nodeValue;
    document.getElementById("openingPrice")
        .innerHTML = stockValues
        .getElementsByTagName("open")[0]
        .childNodes[0].nodeValue;
```

```
    document.getElementById("lastTrade").innerHTML
          = "<strong>" + stockValues
          .getElementsByTagName(
          "lastTrade")[0].childNodes[0].nodeValue
          + "</strong>";
    document.getElementById("lastTradeDT")
         .innerHTML = stockValues
         .getElementsByTagName("lastTradeDate")[0]
         .childNodes[0].nodeValue + " "
         + stockValues.getElementsByTagName(
         "lastTradeTime")[0].childNodes[0]
         .nodeValue;
    document.getElementById("change").innerHTML
          = stockValues.getElementsByTagName(
          "change")[0].childNodes[0].nodeValue;
    document.getElementById("range").innerHTML
          = stockValues.getElementsByTagName(
          "rangeLow")[0].childNodes[0].nodeValue
          + " - " + stockValues
          .getElementsByTagName("rangeHigh")[0]
          .childNodes[0].nodeValue;
    var volume = parseInt(stockValues
          .getElementsByTagName(
          "volume")[0].childNodes[0].nodeValue);
    document.getElementById("volume").innerHTML
          = volume.toLocaleString();
    document.getElementById("chart").innerHTML
          = "<img src=" + stockValues
          .getElementsByTagName("chart")[0]
          .childNodes[0].nodeValue
          + " alt='Stock line chart from ↵
          Yahoo.com.' />";
    }
}
/* ]]> */
</script>
```

Next, you add a `setTimeout()` statement to the top stories Web page that refreshes the currently displayed news stories every 300,000 milliseconds (or five minutes).

To add a `setTimeout()` statement to the top stories Web page that refreshes the currently displayed news stories every five minutes:

1. Return to the **TopStories.html** document in your text editor, and add the following statements to the end of the `newsUpdate()` function:

```
clearTimeout(recentNews);
var recentNews = setTimeout('newsUpdate()', 300000);
```

2. Save the **TopStories.html** file, close it in your text editor, and then validate it with the W3C Markup Validation Service. Once the file is valid, open it in your Web browser by entering the following URL. If you wait five minutes, the most recent stories should refresh for the selected news agency.

```
http://localhost/JavaScript_Projects/Chapter.12/ ↵
    Chapter/TopStories.html
```

3. Close your Web browser window.

Short Quiz 4

1. Explain how to send and receive synchronous responses.

2. Explain how to send and receive asynchronous responses.

3. Explain how to refresh server data automatically.

Conclusion

Your goal in the study of JavaScript programming, or any technology subject for that matter, should not be memorizing facts and syntax. Instead, your goal should be to understand how things work. If you forget everything else you learned in this book, remember this: The best programmers in the world do not necessarily know all the answers. Rather, they know where to *find* the answers. Build yourself a library of reference books that you can use to find the answers you need. Best of luck in your career!

Summing Up

- Asynchronous JavaScript and XML (or AJAX) refers to a combination of technologies that allows a Web page displayed on a client computer to quickly interact and exchange data with a Web server without reloading the entire Web page.
- The `XMLHttpRequest` object uses HTTP to exchange data between a client computer and a Web server.
- RSS (for RDF Site Summary or Rich Site Summary) is an XML format that allows Web sites to publish content that can be read by other Web sites.
- You cannot use the `XMLHttpRequest` object to directly access content on another domain's server; the data you request with the `XMLHttpRequest` object must be located on the Web server where your JavaScript program is running.
- Because AJAX relies on the `XMLHttpRequest` object to retrieve data, you must open AJAX files from a Web server with the HTTP protocol (http://).
- Hypertext Transfer Protocol (HTTP) is a set of rules that defines how requests are made by an HTTP client to an HTTP server, and how responses are returned from an HTTP server to an HTTP client. The term "HTTP client" refers to the application, usually a Web browser, which makes the request. "HTTP server" is another name for a Web server and refers to a computer that receives HTTP requests and returns responses to HTTP clients.
- HTTP client requests and server responses are both known as HTTP messages.
- You use the methods and properties of an instantiated `XMLHttpRequest` object with JavaScript to build and send request messages, and to receive and process response messages.
- The first step for using AJAX to exchange data between an HTTP client and a Web server is to instantiate an `XMLHttpRequest` object.
- After you instantiate an `XMLHttpRequest` object, you use the `open()` method with the instantiated `XMLHttpRequest` object to specify the request method (such as "get" or "post") method and URL.

- To improve performance, you should call the `abort()` method of the `XMLHttpRequest` object to cancel any existing HTTP requests before beginning a new one.
- After you have defined the basic request criteria with the `open()` method, you use the `send()` method with the instantiated `XMLHttpRequest` object to submit the request to the server.
- After you submit a request with the `XMLHttpRequest` object, the message body in the server response is assigned to the `XMLHttpRequest` object's `responseXML` or `responseText` properties.
- A synchronous request stops the processing of the JavaScript code until a response is returned from the server; an asynchronous request allows JavaScript to continue processing while it waits for a server response.
- To automatically refresh data that is obtained from an HTTP server, you use JavaScript's `setTimeout()` or `setInterval()` methods to periodically execute the statements that instantiate an `XMLHttpRequest` object, send a request to the server, and read and process the data returned from the server.

Comprehension Check

1. Explain the difference between AJAX and DHTML.
2. You can use the `XMLHttpRequest` object to directly access content on another domain's server. True or false?
3. The term ________________ refers to someone or something that acts or performs a request for another person.
   a. intermediary
   b. firewall
   c. deputy
   d. proxy
4. Explain how JavaScript's same origin policy affects AJAX applications. How can you get around the restrictions imposed by the same origin policy?

5. Which of the following protocols cannot be used to open and run an AJAX Web page? (Choose all that apply.)

   a. file:///

   b. ftp://

   c. http://

   d. https://

6. Which of the following steps is not required for creating an AJAX application?

   a. instantiate an `XMLHttpRequest` object for the Web browser where the script will run

   b. use the `XMLHttpRequest` object's `open()` method to find the request information

   c. use the `XMLHttpRequest` object to send a request to the server

   d. close the `XMLHttpRequest` object after parsing the response data

7. A(n) ______________ is another name for a Web server.

   a. HTTP server

   b. client-side scripting engine

   c. server-side scripting engine

   d. `XMLHttpRequest` server

8. What is the most recent version of HTTP?

   a. 1.0

   b. 1.1

   c. 1.5

   d. 2.0

9. HTTP requests and responses must define at least one header. True or false?

10. Why you should always include the `Cache-Control` header in your AJAX programs? What value should you assign to it?

11. An HTTP message that does not contain a message body must end with a(n) ______________.

    a. non-breaking space character (` `)

    b. closing `</http>` tag

    c. `EOF` statement

    d. blank line

12. Which of the following HTTP request methods returns information about a document but not the document itself?

    a. `HEAD`

    b. `OPTIONS`

    c. `PUT`

    d. `TRACE`

13. Which of the following start lines is returned for a "get" request with HTTP 1.1 to *http://movies.go.com/reviews*?

    a. `GET HTTP/1.1 movies.go.com/reviews`

    b. `GET / HTTP/1.1`

    c. `GET movies.go.com/reviews HTTP/1.1`

    d. `GET /reviews HTTP/1.1`

14. Which of the following response codes is returned with a successful HTTP request?

    a. 100

    b. 200

    c. 404

    d. 500

15. The `XMLHttpRequest` object is compatible with all known Web browsers. True or false?

16. What value do you pass as an argument to the `XMLHttpRequest` object's `send()` method if the request does not include a message body?

    a. null

    b. 0

    c. 1

    d. The `send()` method does not require an argument if the request does not include a message body.

17. What is the difference between synchronous and asynchronous HTTP requests? Which is the preferred method and why?

18. Which of the following headers should be included with HTTP requests that contain message bodies?

    a. `Connection`

    b. `Content-Type`

    c. `Content-Length`

    d. `Last-Modified`

19. An HTTP response has been received from a Web server when the `readyState` property contains which of the following values?

    a. 1

    b. 2

    c. 3

    d. 4

20. Which event is triggered whenever the value assigned to the `readyState` property changes?

    a. `onstatechange`

    b. `onrefresh`

    c. `onreadystate`

    d. `onreadystatechange`

Reinforcement Exercises

Exercise 12-1

In this exercise, you will create an AJAX program that looks up city and state names based on a Zip code entered by a user. Your Exercises folder for Chapter 12 contains an XML file named zips.xml that you can use for this exercise. Note that the zips.xml file only contains information for the states of Florida and Georgia. This is because the XML file containing information for all U.S. Zip codes would be approximately five megabytes in size, which is too large to successfully manipulate with JavaScript. Note that the purpose of this exercise is to demonstrate how to use AJAX to look up information on a server. In reality, a better solution for retrieving individual records from such a large collection of data is to use a server-side script to retrieve it from a relational database.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "City and State Lookup" as the content of the `<title>` element.

3. Add the following style section to the document head:

```
<style type="text/css">
h1 {
font-family:arial; color:navy;
}
p, td {
font-family:arial; font-size:11px; color:black;
}
</style>
```

4. Add the following text and elements to the document body. The form contains three text boxes for Zip code, city, and state. When a user enters a value into the Zip code box and leaves the field, the `onblur` event calls the `updateCityState()` function, which you will create shortly.

```
<h1>City and State Lookup</h1>
<form action="">
<p>Zip code <input type="text" size="5" name="zip"
id="zip" onblur="updateCityState()" /></p>
<p>City <input type="text" name="city" />
State <input type="text" size="2"
name="state" /></p>
</form>
```

5. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

6. Add to the script section the following global `cityStateRequest` variable definition and `getRequestObject()` function, which instantiates the `XMLHttpRequest` object:

```
var cityStateRequest = false;
function getRequestObject() {
     try {
          httpRequest = new XMLHttpRequest();
     }
     catch (requestError) {
          try {
               httpRequest = new ActiveXObject(
                    "Msxml2.XMLHTTP");
          }
          catch (requestError) {
               try {
                    httpRequest = new
                    ActiveXObject(
                    "Microsoft.XMLHTTP");
               }
               catch (requestError) {
                    window.alert(
                    "Your browser does not ↵
                    support AJAX!");
                    return false;
               }
          }
     }
     return httpRequest;
}
```

7. Add to the end of the script section the following `updateCityState()` function, which handles the tasks of instantiating, opening, and sending the HTTP request. The `onreadystatechange` event is assigned `getZipInfo()` as the event handler function. You will create the `getZipInfo()` function next.

```
function updateCityState() {
    if (!cityStateRequest)
         cityStateRequest = getRequestObject();
    cityStateRequest.abort();
    cityStateRequest.open("get","zips.xml");
    cityStateRequest.send(null);
    cityStateRequest.onreadystatechange=getZipInfo;
}
```

8. Add to the end of the script section the following `getZipInfo()` function, which retrieves the city and state from the XML file and adds them to the form fields in the document body after the response is received from the server.

```
function getZipInfo() {
    if (cityStateRequest.readyState==4
        && cityStateRequest.status == 200) {
    var zips = cityStateRequest.responseXML;
    var locations = zips.getElementsByTagName(
        "Row");
    var notFound = true;
    for (var i=0; i<locations.length; ++i) {
        if (document.forms[0].zip.value
            == zips.getElementsByTagName(
            "ZIP_Code")[i].childNodes[0]
            .nodeValue) {
            document.forms[0].city.value
                = zips.getElementsByTagName(
                "City")[i].childNodes[0].nodeValue;
            document.forms[0].state.value
                = zips.getElementsByTagName(
                "State_Abbreviation")[i]
                .childNodes[0].nodeValue;
            notFound = false;
            break;
      }
    }
    if (notFound) {
        window.alert("Invalid ZIP code!");
        document.forms[0].city.value = "";
        document.forms[0].state.value = "";
    }
  }
}
```

9. Save the document as **CityStateLookup.html** in your Exercises folder for Chapter 12, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

10. Open the **CityStateLookup.html** document in your Web browser by entering the following URL: *http://localhost/JavaScript_Projects/Chapter.12/Exercises/CityStateLookup.html*. Enter a Zip code for a city in Florida or Georgia, such as 34136 for Bonita Springs, Florida. The city and state names should automatically be added to the form fields.

11. Close your Web browser window.

Exercise 12-2

Yahoo! Weather includes an RSS feed that allows you to retrieve a locale's current weather conditions according to its Zip code. In this exercise, you will create an AJAX program that allows users to enter a Zip code to retrieve current weather conditions.

1. Create a new document in your text editor.

2. Type the <!DOCTYPE> declaration, <html> element, header information, and the <body> element. Use the strict DTD and "Weather Report" as the content of the <title> element.

3. Add the following style section to the document head:

```
<style type="text/css">
h1 {
font-family:arial; color:navy;
}
p, td {
font-family:arial; font-size:11px; color:black;
}
</style>
```

4. Add the following text and elements to the document body. The form contains a text box and button that includes an `onclick` event, which calls a function named `weatherUpdate()` when clicked. The text box contains a default value of 94558, which is the Zip code for Napa, California.

```
<h1>Weather Report</h1>
<form method="get" action="" >
<p>ZIP code <input type="text" name="zip"
value="94558" /> <input type="button"
value="Check Weather"
onclick="weatherUpdate()" /></p>
</form>
<p id="weatherPara"></p>
```

5. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

6. Add to the script section the following global `weatherRequest` variable definition and `getRequestObject()` function, which instantiates the `XMLHttpRequest` object:

```
var weatherRequest = false;
function getRequestObject() {
     try {
          httpRequest = new XMLHttpRequest();
     }
     catch (requestError) {
          try {
               httpRequest = new ActiveXObject(
                       "Msxml2.XMLHTTP");
          }
          catch (requestError) {
               try {
                    httpRequest = new
                            ActiveXObject(
                            "Microsoft.XMLHTTP");
               }
               catch (requestError) {
                    window.alert("Your browser ↵
                            does not support AJAX!");
                    return false;
               }
          }
     }
     return httpRequest;
}
```


7. Add to the end of the script section the following `weatherUpdate()` function, which handles the tasks of instantiating, opening, and sending the HTTP request. The `onreadystatechange` event is assigned `fillWeatherInfo()` as the event handler function. You will create the `fillWeatherInfo()` function next.

```
function weatherUpdate() {
    if (!weatherRequest)
        weatherRequest = getRequestObject();
    var zip = document.forms[0].zip.value;
    weatherRequest.abort();
    weatherRequest.open("get",
        "WeatherReport.php?zip=" + zip, true);
    weatherRequest.send(null);
    weatherRequest.onreadystatechange
        =fillWeatherInfo;
}
```

8. Add to the end of the script section the following `fillWeatherInfo()` function, which adds the weather information to the empty paragraph element in the document body after the response is received from the server.

```
function fillWeatherInfo() {
    if (weatherRequest.readyState==4
        && weatherRequest.status == 200) {
    var weather = weatherRequest.responseXML;
```

```
        var weatherItems=weather
            .getElementsByTagName("item");
        if (weatherItems.length > 0) {
            for (var i=0; i<weatherItems.length; ++i) {
            var curHeadline = weatherItems[i]
                .getElementsByTagName(
                "title")[0].childNodes[0].nodeValue;
            var curLink = weatherItems[i]
                .getElementsByTagName(
                "link")[0].childNodes[0].nodeValue;
            var curPubDate = weatherItems[i]
                .getElementsByTagName(
                "pubDate")[0].childNodes[0].nodeValue;
            var curDesc = weatherItems[i]
                .getElementsByTagName(
                "description")[0].childNodes[0].nodeValue;
            var weatherSpot = document
                .getElementById('weatherPara');
            var curStory = "<a href='" + curLink + "'>"
                + curHeadline + "</a><br />";
            curStory += "<span style='color: gray'>"
                + curPubDate + "</span><br />";
            curStory += curDesc + "<br />";
            weatherSpot.innerHTML= curStory;
          }
        }
        else
          window.alert("Invalid ZIP code.");
    }
}
```

9. Add an `onload` event to the opening <body> tag so it runs the `weatherUpdate()` function as soon as the Web page finishes loading, as follows:

```
<body onload="weatherUpdate()">
```

10. Save the document as **WeatherReport.html** in your Exercises folder for Chapter 12, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

11. Create a new document in your text editor and add the following PHP code, which opens the RSS feed and returns the XML document to the WeatherReport.html document:

```
<?php
$Zip = $_GET["zip"];
$WeatherURL
    = "http://weather.yahooapis.com/forecastrss?p="
    . $Zip;
header("Content-Type: text/xml");
header("Content-Length: " .
strlen(file_get_contents($WeatherURL)));
```

```
header("Cache-Control: no-cache");
readfile($WeatherURL);
?>
```

12. Save the document as **WeatherReport.php** in your Exercises folder for Chapter 12, close it in your text editor, and then open the **WeatherReport.html** document in your Web browser by entering the following URL: *http://localhost/JavaScript_Projects/Chapter.12/Exercises/WeatherReport.html*. When the Web page first opens, it displays the weather for Napa, California.

13. Enter a different Zip code in the text box, and click the **Check Weather** button. The page should update with the weather conditions for the Zip code you entered.

14. Close your Web browser window.

Exercise 12-3

ESPN.com publishes separate RSS feeds for various sports, such as football, baseball, and golf. In this exercise, you will create an AJAX program that allows users to view current news for a selected sport.

1. Create a new document in your text editor.

2. Type the `<!DOCTYPE>` declaration, `<html>` element, header information, and the `<body>` element. Use the strict DTD and "Sporting News" as the content of the `<title>` element.

3. Add the following style section to the document head:

```
<style type="text/css">
h1 {
font-family:arial; color:navy;
}
p, td {
font-family:arial; font-size:11px; color:black;
}
</style>
```

4. Add the following text and elements to the document body. This content is very similar to the text and elements you added to the document body for the top stories Web page. Instead of containing information for different news agencies, the radio buttons represent different sports, and their values are the URL for the associated ESPN.com RSS feed. The last cell at the end of the table will contain the sports stories.

```
<h1>Sporting News</h1>
<form method="get" action="">
<table border="1">
<colgroup span="1" width="125" />
<colgroup span="1" width="350" />
<tr><td valign="top">
<input type="radio" name="sport"
value="http://sports.espn.go.com/espn/rss/nfl/news"
checked="checked" onclick="sportsUpdate()" />
NFL<br />
<input type="radio" name="sport"
value="http://sports.espn.go.com/espn/rss/nba/news"
onclick="sportsUpdate()" />NBA<br />
<input type="radio" name="sport"
value="http://sports.espn.go.com/espn/rss/mlb/news"
onclick="sportsUpdate()" />MLB<br />
<input type="radio" name="sport"
value="http://sports.espn.go.com/espn/rss/rpm/news"
onclick="sportsUpdate()" />NASCAR<br />
<input type="radio" name="sport"
value="http://sports.espn.go.com/espn/rss/nhl/news"
onclick="sportsUpdate()" />NHL<br />
<input type="radio" name="sport" value
="http://sports.espn.go.com/espn/rss/boxing/news"
onclick="sportsUpdate()" />Boxing
</td>
<td id="newsCell" valign="top"></td></tr>
</table>
</form>
```

5. Add the following script section to the document head:

```
<script type="text/javascript">
/* <![CDATA[ */
/* ]]> */
</script>
```

6. Add to the script section the following global `sportsRequest` variable definition and `getRequestObject()` function, which instantiates the `XMLHttpRequest` object:

```
var sportsRequest = false;
function getRequestObject() {
     try {
          httpRequest = new XMLHttpRequest();
     }
     catch (requestError) {
          try {
               httpRequest = new ActiveXObject(
                    "Msxml2.XMLHTTP");
          }
          catch (requestError) {
               try {
```

```
                    httpRequest = new
                          ActiveXObject(
                         "Microsoft.XMLHTTP");
               }
               catch (requestError) {
                    window.alert("Your browser ↵
                    does not support AJAX!");
                    return false;
               }
          }
     }
     return httpRequest;
}
```

7. Add to the end of the script section the following `sportsUpdate()` function, which handles the tasks of instantiating, opening, and sending the HTTP request. The `onreadystatechange` event is assigned `getSportsNews()` as the event handler function. You will create the `getSportsNews()` function next.

```
function sportsUpdate() {
     if (!sportsRequest)
          sportsRequest = getRequestObject();
     for (var i=0; i<6; ++i) {
          if (document.forms[0].sport[i].checked
               == true) {
          var sport = document.forms[0].sport[i]
               .value;
          break;
     }
}
sportsRequest.abort();
sportsRequest.open("get","SportingNews.php?"
    + "sport=" + sport, true);
    sportsRequest.send(null);
    sportsRequest.onreadystatechange=getSportsNews;
    clearTimeout(recentNews);
    var recentNews = setTimeout('sportsUpdate()',
        5000);
}
```

8. Add to the end of the script section the following `getSportsNews()` function, which adds the sports information to the nested table in the document body after the response is received from the server.

```
function getSportsNews() {
    if(sportsRequest.readyState==4 && sportsRequest
        .status == 200) {
        var news = sportsRequest.responseXML;
        document.getElementById("newsCell")
            .innerHTML = ""
```

```
        var newsItems=news.getElementsByTagName(
            "item");
        if (newsItems.length > 0) {
            for (var i=0; i<newsItems.length; ++i) {
                var curHeadline = newsItems[i]
                    .getElementsByTagName(
                    "title")[0].childNodes[0]
                    .nodeValue;
                var curLink = newsItems[i]
                   .getElementsByTagName(
                   "link")[0].childNodes[0].nodeValue;
                var curPubDate = newsItems[i]
                    .getElementsByTagName(
                    "pubDate")[0].childNodes[0]
                    .nodeValue;
                var curDesc = newsItems[i]
                    .getElementsByTagName(
                    "description")[0].childNodes[0]
                    .nodeValue;
                var curStory = "<a href='" + curLink
                    + "'>" + curHeadline
                    + "</a><br />";
                 curStory
                     += "<span style='color: gray'>"
                     + curPubDate + "</span><br />";
                 curStory += curDesc + "<br />";
                 document.getElementById("newsCell")
                     .innerHTML += curStory;
            }
       }
       else
           document.getElementById("newsCell")
               .innerHTML = "RSS feed does not ↵
               contain any items.";
      }
}
```

9. Add an `onload` event to the opening `<body>` tag so it runs the `sportsUpdate()` function as soon as the Web page finishes loading, as follows:

```
<body onload="sportsUpdate()">
```

10. Save the document as **SportingNews.html** in your Exercises folder for Chapter 12, and then validate the document with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

11. Create a new document in your text editor and add the following PHP code, which opens the RSS feed and returns the XML document to the SportingNews.html document:

```
<?php
$SportsLeague=$_GET["sport"];
header("Content-Type: text/xml");
header("Content-Length: " .
strlen(file_get_contents($SportsLeague)));
header("Cache-Control: no-cache");
readfile($SportsLeague);
?>
```

12. Save the document as **SportingNews.php** in your Exercises folder for Chapter 12, close it in your text editor, and then open the **SportingNews.html** document in your Web browser by entering the following URL: *http://localhost/JavaScript_Projects/Chapter.12/Exercises/SportingNews.html*. When the Web page first opens, it displays news for the NFL.

13. Select a radio button for a different sport. The page should be updated with the news for the sport you selected.

14. Close your Web browser window.

Exercise 12-4

In this exercise, you will modify the stock quotes Web page that was used as the chapter example so that it also lists RSS news information for a selected stock.

1. Copy the **DRGMONEY** folder from your Chapter folder for Chapter 12 to your Exercises folder for Chapter 12.

2. Open the **StockQuotes.html** document from the DRGMONEY folder in your Exercises folder for Chapter 12.

3. First, add the following text and elements immediately above the closing </table> tag for the last table in the form. This content creates a cell that will display the news information for the selected stock.

```
<tr><td id="stockNews" colspan="2"> </td></tr>
```

4. Next, add the following code to the end of the script section. The first statement declares a global variable named `newsRequest` that will represent an `XMLHttpRequest` object. The `getStockNews()` function creates a new `XMLHttpRequest` object and assigns it to the newsRequest variable. The `open()` statement opens a PHP file named StockNews.php and passes the stock symbol to it. The `onreadystatechange` event is

assigned `fillStockNews()` as the event handler function. You will create the `fillStockNews()` function next.

```
var newsRequest = false;
function getStockNews() {
    if (!newsRequest)
        newsRequest = getRequestObject();
    newsRequest.abort();
    newsRequest.open("get",
        "StockNews.php?stockFeed="
            + tickerSymbol, true);
    newsRequest.send(null);
    newsRequest.onreadystatechange = fillStockNews;
}
```

5. Add the following function call to the end of the `if` statement in the `fillStockInfo()` function; the stock's news information will be retrieved after the stock quote information:

```
getStockNews();
```

6. Add to the end of the script section the following `fillStockNews()` function, which adds the title, link, and publication date for each stock news item to the last table cell in the document body after the response is received from the server.

```
function fillStockNews() {
    if (newsRequest.readyState == 4
        && newsRequest.status == 200) {
        var news = newsRequest.responseXML;
        document.getElementById("stockNews")
            .innerHTML = "";
        var newsItems = news.getElementsByTagName(
            "item");
        if (newsItems.length > 0) {
            for (var i = 0; i < newsItems.length;
                ++i) {
                var curHeadline = newsItems[i]
                   .getElementsByTagName("title")[0]
                   .firstChild.nodeValue;
                var curLink = newsItems[i]
                   .getElementsByTagName("link")[0]
                   .firstChild.nodeValue;
                var curPubDate = newsItems[i]
                   .getElementsByTagName(
                   "pubDate")[0].firstChild
                   .nodeValue;
                var curStory = "<a href='" + curLink
                    + "'>" + curHeadline
                    + "</a><br />";
                curStory
                    += "<span style='color: gray'>"
                    + curPubDate + "</span><br />";
```

```
                document.getElementById(
                    "stockNews").innerHTML
                    += curStory;
            }
        }
        else
            document.getElementById(
                "stockNews").innerHTML
                = "RSS feed does not contain ↵
                any items.";
    }
}
```

7. Save the **StockQuotes.html** document, and validate it with the W3C Markup Validation Service.

8. Create a new document in your text editor and add the following PHP code, which opens the Yahoo! Finance RSS feed for the stock and returns the XML document to the StockQuotes.html document. The value assigned to the `$NewsSource` variable is the URL for the Yahoo! Finance news RSS feed, *http://finance.yahoo.com/rss/headline*, combined with a name=value pair consisting of s=*ticker*. (The "s" portion of the name=value pair is required by the Yahoo! Finance RSS news feed.)

```
<?php
$NewsSource
    = "http://finance.yahoo.com/rss/headline?s="
    . $_GET["stockFeed"];
header("Content-Type: text/xml");
header("Content-Length: " .
strlen(file_get_contents($NewsSource)));
header("Cache-Control: no-cache");
readfile($NewsSource);
?>
```

9. Save the document as **StockNews.php** in the DRGMONEY folder in your Exercises folder for Chapter 12, close it in your text editor, and then open the **StockQuotes.html** document in your Web browser by entering the following URL: *http://localhost/JavaScript_Projects/Chapter.12/Exercises/DRGMONEY/StockQuotes.html*. When the Web page first opens, it should display quote information and news for the NASDAQ Composite Index (^IXIC). Enter another stock symbol (such as ORCL for Oracle), and click **Get Quote**. The stock quote and news should change to display Oracle information.

10. Close your Web browser window.

Exercise 12-5

You may have noticed that the ticker at the top of the stock quotes Web page, which displays data for the DOW, NASDAQ, and S&P, is static. In this exercise, you will modify the stock quotes Web page so that this information is dynamic. The displayed values are stored in `<span>` elements with assigned `id` attributes. For example, the `<span>` elements for the DOW are assigned `id` attributes of `dowLastTrade`, `dowChange`, and `dowPercentChange`. Each section also contains an arrow image indicating whether the price is moving up or down. You will dynamically change the displayed image to a green arrow pointing up if the price is going up or a red arrow pointing down if the price is going down.

1. Return to the StockQuotes.html document in your text editor.

2. Add the following function for the DOW to the end of the script section. The function creates and opens a unique `XMLHttpRequest` object for the DOW.

```
function getDow() {
     var dowRequest = false;
     if (!dowRequest)
          dowRequest = getRequestObject();
     dowRequest.abort();
     dowRequest.open("get",
          "StockCheck.php?checkQuote=^DJI", true);
     dowRequest.send(null);
}
```

3. Next, add to the end of the `getDOW()` function the following function literal, which is very similar to the `fillStockNews()` function. In this case, the function literal only retrieves the value, price change, and percent change. Notice that the function literal also includes an `if` statement that changes the arrow image, depending on whether the price is up or down.

```
dowRequest.onreadystatechange = function() {
     if (dowRequest.readyState == 4
          && dowRequest.status == 200) {
          var dowValues = dowRequest.responseXML;
          document.getElementById("dowLastTrade")
               .innerHTML = dowValues
               .getElementsByTagName("lastTrade")[0]
               .childNodes[0].nodeValue;
          document.getElementById("dowChange")
               .innerHTML = dowValues
               .getElementsByTagName("change")[0]
               .childNodes[0].nodeValue;
```

```
        document.getElementById("dowPercentChange")
            .innerHTML = dowValues
            .getElementsByTagName(
            "changePercent")[0].childNodes[0]
            .nodeValue;
        if (dowValues.getElementsByTagName(
            "dowChange")[0].childNodes[0]
            .nodeValue < 0)
            document.getElementById("dowDirection")
                .src = "images/red.gif";
        else
            document.getElementById("dowDirection")
                .src = "images/green.gif";
    }
}
```

4. Finally, add to the end of the `getDOW()` function the following statements, which set and retrieve a timeout that updates the DOW values every 10 seconds:

```
clearTimeout(dowQuote);
var dowQuote = setTimeout('getDow()', 10000);
```

5. Add the following function to retrieve the NASDAQ information:

```
function getNASDAQ() {
    var nasdaqRequest = false;
    if (!nasdaqRequest)
        nasdaqRequest = getRequestObject();
    nasdaqRequest.abort();
    nasdaqRequest.open("get",
        "StockCheck.php?checkQuote=^IXIC", true);
    nasdaqRequest.send(null);
    nasdaqRequest.onreadystatechange = function() {
        if (nasdaqRequest.readyState == 4
            && nasdaqRequest.status == 200) {
            var nasdaqValues
                = nasdaqRequest.responseXML;
            document.getElementById(
                "nasdaqLastTrade")
                .innerHTML = nasdaqValues
                .getElementsByTagName(
                "lastTrade")[0].childNodes[0]
                .nodeValue;
            document.getElementById(
                "nasdaqChange")
                .innerHTML = nasdaqValues
                .getElementsByTagName("change")[0]
                .childNodes[0].nodeValue;
            document.getElementById(
                "nasdaqPercentChange")
                .innerHTML = nasdaqValues
                .getElementsByTagName(
                "changePercent")[0].childNodes[0]
                .nodeValue;
```

```
                if (nasdaqValues.getElementsByTagName(
                    "nasdaqChange")[0].childNodes[0]
                    .nodeValue < 0)
                    document.getElementById(
                        "nasdaqDirection")
                        .src = "images/red.gif";
                else
                    document.getElementById(
                        "nasdaqDirection").src
                        = "images/green.gif";
            }
        }
        clearInterval(nasdaqQuote);
        var nasdaqQuote = setTimeout('getNASDAQ()',
            10000);
    }
```

6. Add the following function to retrieve the S&P information:

```
function getSP() {
    var spRequest = false;
    if (!spRequest)
        spRequest = getRequestObject();
    spRequest.abort();
    spRequest.open("get",
        "StockCheck.php?checkQuote=^GSPC", true);
    spRequest.send(null);
    spRequest.onreadystatechange = function() {
        if (spRequest.readyState == 4
            && spRequest.status == 200) {
            var spValues
                = spRequest.responseXML;
            document.getElementById(
                "spLastTrade")
                .innerHTML = spValues
                .getElementsByTagName(
                "lastTrade")[0].childNodes[0]
                .nodeValue;
            document.getElementById(
                "spChange")
                .innerHTML = spValues
                .getElementsByTagName("change")[0]
                .childNodes[0].nodeValue;
            document.getElementById(
                "spPercentChange")
                .innerHTML = spValues
                .getElementsByTagName(
                "changePercent")[0].childNodes[0]
                .nodeValue;
            if (spValues.getElementsByTagName(
                "spChange")[0].childNodes[0]
                .nodeValue < 0)
                document.getElementById(
                    "spDirection")
                    .src = "images/red.gif";
```

```
                else
                    document.getElementById(
                        "spDirection").src
                        = "images/green.gif";
            }
        }
        clearInterval(spQuote);
        var spQuote = setTimeout('getSP()',
            10000);
    }
```

7. Modify the opening `<body>` tag as follows so it also calls the `getDOW()`, `getNASDAQ()`, and `getSP()` functions:

```
<body onload="getStockQuote(); getDow();↵
    getNASDAQ(); getSP()">
```

8. Save the **StockQuotes.html** document and validate it with the W3C Markup Validation Service. Once the document is valid, close it in your text editor.

9. Open the **StockQuotes.html** document in your Web browser by entering the following URL: *http://localhost/JavaScript_Projects/Chapter.12/Exercises/DRGMONEY/StockQuotes.html*. The DOW, NASDAQ, and S&P information at the top of the page should begin updating automatically.

10. Close your Web browser window.

Discovery Projects

For the following projects, save the documents you create in your Projects folder for Chapter 12. Be sure to validate the HTML documents you create with the W3C Markup Validation Service.

Project 12-1

Movies.com publishes RSS feeds for current movies, including what's in theaters, upcoming movies, reviews, and so on. The available RSS feeds are listed on the following URL: *http://movies.go.com/rss*. Create an AJAX application that is similar to the top stories application you created in this chapter. Allow users to display news information using the available RSS feeds on Movies.com. Save the HTML document as MovieNews.html and the PHP document as MovieNews.php.

Project 12-2

Online travel sites such as Orbitz.com publish RSS feeds with travel deals. Create an AJAX application that retrieves RSS feeds for travel deals from at least three online travel sites. Design the application using the same techniques that you used to create the top stories application in this chapter. Save the HTML document as TravelDeals.html and the PHP document as TravelDeals.php.

Project 12-3

The traffic.com Web site (*http://www.traffic.com*), which contains free, real-time traffic information, publishes RSS feeds for traffic conditions in numerous American cities. The RSS traffic feeds page on traffic.com (*http://bhelp.traffic.com/features-rss-feeds*) lists the RSS feeds for the available cities. Create an AJAX program containing a Web page with a text box into which users can enter the name of a city to retrieve its traffic results. The URLs for each of the RSS feeds are in the format *http://cityrss.traffic.com/feeds/rss_*city. For example, the RSS traffic feed for Boston is *http://cityrss.traffic.com/feeds/rss_boston*. Note that spaces are removed from city names with multiple words. For example, the RSS traffic feed for San Diego is *http://cityrss.traffic.com/feeds/rss_sandiego*. You will need to build the string that is passed to the server by appending the city name to the URL. Use the `toLowerCase()` and `replace()` methods of the `String` object to ensure that the city name is lowercase and does not contain any spaces. When the page first opens, it should default to the traffic information for Albany, New York. Include functionality that displays the message “Invalid city or there are no reported traffic incidents” if the user enters an invalid city name or if the selected feed does not contain any traffic incidents. Save the Web page as TrafficReport.html and the PHP page as TrafficReport.php.

Project 12-4

In Chapter 7, you created a Web page that displayed scrolling text in the status bar. Use a similar technique to add scrolling headlines to the top stories Web page. First, copy the TopStories.html and TopStories.php documents from your Chapter folder for Chapter 12 to your Projects folder for Chapter 12. Add a text box above the table that displays the list of news organizations and stories. Add functionality to the `fillNewsInfo()` function that assigns the values from each `<title>` element in the RSS feed to a global array, and then convert the array to a single string separated by three periods (. . .). Add a function named `scrollHeadlines()` that scrolls the headlines in the text box. The scrolling text should start with the first headline displayed in the headlines list and change to each subsequent headline. Once the last headline is displayed, start over with the first headline.

APPENDIX A

Building a Web Development Environment

Understanding how to install and configure the software required for creating and delivering PHP scripts is considered a critical skill for Web developers. Even if you have an Internet service provider (ISP) hosting your Web site, you will still need to develop your PHP scripts on your local computer before uploading them to your ISP. In this appendix, you build a Web development environment consisting of a Web server and PHP. After you have finished installing and testing your Web development environment, you study the basics of how to create PHP scripts.

Even if you already have access to the necessary software for creating and delivering PHP scripts, or if you install the software in some other manner, be certain to follow the instructions in the Configuring Apache or Configuring Internet Information Services sections later in this appendix (depending on which Web server you install). These sections contain procedures you need to perform to configure your Web server to work with Chapter 12's data files.

Building a Web Development Environment

Before you can write PHP scripts, you need the following:

- A Web browser
- A Web server
- The PHP software

You should already have a Web browser installed on your computer. Be sure to use a recent Web browser such as Firefox 2 or Internet Explorer 8. You can use almost any version of the UNIX/ Linux operating system to develop PHP scripts, including Red Hat Linux and Mac OS X. To develop PHP scripts with the Windows operating systems, the version of Windows you can use depends primarily on the Web server software you decide to install. Although you could install the Apache Web server on Windows platforms as far back as Windows 95, the Apache Foundation does not recommend installing Apache on Windows 95, Windows 98, or Windows Me. Internet Information Services (IIS) is only available on Windows 2000 and newer versions.

If you have an account with an ISP, you may already have access to a PHP installation on your ISP's Web server. Check with your ISP for more information. Even if you do have an account with an ISP, you should install the necessary software on your local computer so that you can develop your Web pages and scripts before transferring them to your ISP.

Understanding Binary and Source Code Installations

You can install open source software from binary format or from source code. **Binary format** (or **binaries**) are compiled files, such as executable installation programs. **Source code** is the original programming code in which an application was written. Before you can use source code, it must be **compiled**, or processed and assembled into an executable format. On Windows platforms, your best bet is to install the open source applications discussed in this section using binaries that are available on each application's Web site. Although you can also compile Windows versions of each program, you must use Microsoft Visual Studio, which is a line of development tools for Windows platforms.

The difference between interpreting and compiling is that, while interpreted programs (such as JavaScript and PHP) are processed and assembled into an executable format each time they execute, compiled programs only need to be recompiled when their code changes.

For UNIX and Linux operating systems, you can also install Apache and PHP from either binary or source code format, although the open source organizations that develop these applications do not usually make binary versions available on their Web sites. However, Apache and PHP come preinstalled on many UNIX- and Linux-based operating systems. If they are not preinstalled on your system, then you can

The instructions in this appendix assume that you are familiar with basic commands for your operating system.

Keep in mind that the Web development environment you install in this section should only be used for development and testing purposes, not for hosting a live Web site. Until you understand the security and maintenance issues involved with hosting a Web site, your best bet is to go through an ISP.

A number of companies offer free and commercial installation kits that automatically install and configure a Web server and PHP. However, the PHP Group (the open source organization that develops PHP) does not endorse any installation kits and recommends that you perform a manual installation for best results.

Because so many UNIX/Linux operating systems are available, specific instructions cannot be listed here for determining whether an application is installed or for locating and installing binary packages on each platform. You should be able to find detailed instructions on your platform vendor's Web site.

Source code for many UNIX/Linux programs is written in the C programming language. To compile C code on UNIX/Linux systems, you must use the make utility with an ANSI C compiler. Even if you already have an ANSI C compiler installed on your system, it is recommended that you install the most recent version of the GNU C compiler, which is freely available at *http://gcc.gnu.org/*.

probably find binaries in the form of "packages" that can be installed with special programs. For example, various Linux platforms allow you to use an application called the Red Hat Package Manager (RPM) to install binary packages (or "RPMs"). You can probably find binary package versions of Apache and PHP with your UNIX/Linux installation files or on your platform vendor's Web site or another third-party Web site. For example, you can download a binary package of PHP for Mac OS X at *http://www.entropy.ch/software/macosx/php/*.

Although a binary format can be easier to install, it may not contain the most recent version of an open source application, and you may not be able to customize your installation and configuration. To be successful with this book, you do not necessarily need the latest and greatest version of each application, nor do you need to perform advanced installations and configurations. Yet, the ability to install and compile programs from source code is a skill you must possess in order to be a successful Web developer, especially if you work with UNIX/Linux systems for which binary installations do not exist. For this reason, the instructions in this appendix describe how to install each open source application from source code. The instructions use generic steps that are similar for most UNIX-based systems, including Linux platforms and Mac OS X. For detailed instructions on installing each open source application with specific platforms, see the installation documentation on each application's Web site.

Getting Help

You have probably grown to expect a certain level of help and support from vendors of commercial software. For instance, Microsoft provides a great deal of help and support for IIS. The first line of support is the online help that is installed with IIS. Figure A-1 shows the Web page that should appear in your browser for IIS 5.1.

If you cannot find the answers you need with the online help that is installed with IIS, you can obtain more information as well as professional technical support on Microsoft's Web site at *http://www.microsoft.com*.

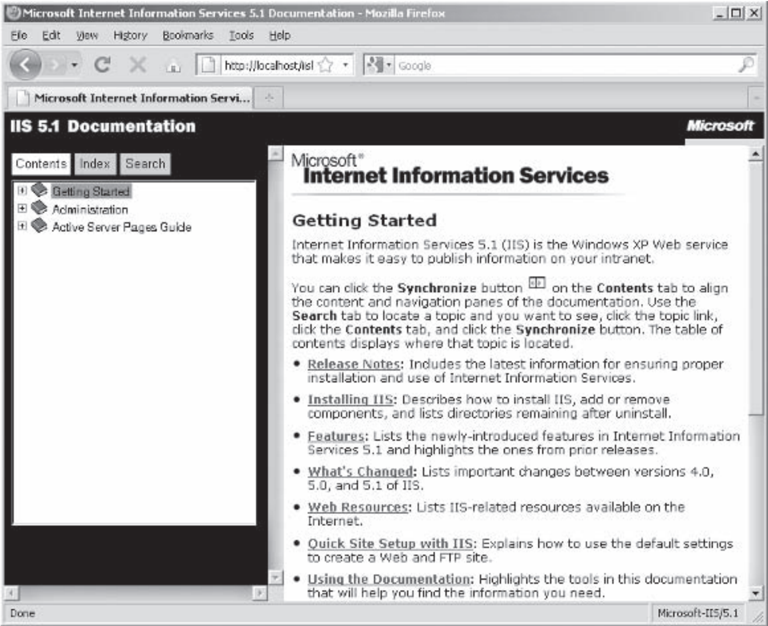


Figure A-1 Help page for IIS

Of the three applications discussed in this section, IIS is the only commercial offering; Apache and PHP are all open source software. One of the downsides to using open source software is the lack of official support from a commercial software company such as Microsoft to help you through difficulties. Instead, you must rely on online documentation that is maintained by volunteers. You can access the official online documentation for Apache and PHP at the following URLs:

- **Apache documentation**: *http://httpd.apache.org/docs/*
- **PHP documentation**: *http://www.php.net/docs.php*

If you cannot find your answers in the online documentation, then you can also post a message to various mailing lists that are available for each application. In most cases, other users who monitor the lists will be delighted to help you figure out a problem. You can find mailing lists and other support resources for each product at the following URLs:

- **Apache support resources**: *http://httpd.apache.org/lists.html*
- **PHP support resources**: *http://www.php.net/support.php*

Course Technology and the author of this book are more than happy to help with any problems you may have with this book. However, when it comes to installing or running any of the applications discussed in this book, they cannot help you find the answers to your problems as quickly as the open source community can.

Installing and Configuring a Web Server

As you learned earlier, Apache is the most popular Web server software used on the Internet. Apache is developed as open source software by the Apache Software Foundation (*http://apache.org/*) and runs on most platforms, including Windows and Linux.

Microsoft's commercial IIS for Windows operating systems is the second most popular Web server and is used on about a third of today's Web sites. IIS is available as a component of the following Windows platforms:

- Windows 2000 (Professional, Server, and Advanced Server)
- Windows XP Professional
- Windows Server 2003 family for both client and server applications
- Windows Vista
- Windows 7

IIS can only be installed on Windows platforms.

When you install Apache on UNIX and Linux operating systems, you must start and stop the application manually. When you install Apache or IIS on Windows, each Web server is installed as a service. The term **service** is used in Windows operating systems to refer to a program that performs a specific function to support other programs. Services are usually launched automatically when Windows first starts, so you do not normally need to start Apache or IIS yourself. Yet, there will be times when you will need to restart your Web server, especially after you modify your configuration settings. For this reason, instructions for starting and stopping Apache and IIS are listed in the following sections.

Other Microsoft Web servers that support PHP are available for older versions of Windows, including Peer Web Services on Windows NT Workstation 4.0 and Personal Web Server for Windows 95/98/ME. However, because these Web servers have been discontinued by Microsoft, this book only includes instructions for IIS.

PHP scripts are supported by almost every Web server out there. You can use whatever Web server you like with this book, provided that it supports PHP. But because Apache and IIS are two of the most popular Web server applications, the installation and configuration instructions in this book focus on Apache and IIS. If you decide to use a Web server other than Apache or IIS, refer to the documentation that came with the Web server for installation and configuration instructions.

Before installing Apache on UNIX and Linux systems, you may need to log in as the root user to ensure that you have the necessary permissions to perform administration tasks.

Installing and Running Apache on UNIX and Linux

This section explains how to install and configure Apache from source code on UNIX and Linux systems. For more detailed installation instructions, refer to the Apache documentation at *http://httpd.apache.org/docs/install.html*.

To install Apache from source code on UNIX and Linux systems:

1. Start your Web browser, and enter the Web address for the Apache HTTP Server download page: **http://httpd.apache.org/download.cgi**. Download the compressed UNIX source file containing the Apache version that the Apache Foundation recommends as the best available. At the time of this writing, the best available version is Apache 2.2.14, and the compressed UNIX source file is named httpd-2.2.14.tar.gz. Save the file to a temporary location such as your usr/src directory or another directory of your choice.
2. Run the following `gunzip` command in the directory where you downloaded the compressed file. This command decompresses the httpd-2.2.14.tar.gz file into a tar file named httpd-2.2.14.tar within the same directory.

   ```
   gunzip httpd-2.2.14.tar.gz
   ```
3. Run the following `tar` command, which extracts the files in the httpd-2.2.14.tar to a directory named httpd-2.2.14 within the current directory:

   ```
   tar xvf httpd-2.2.14.tar
   ```
4. Change to the httpd-2.2.14 directory:

   ```
   cd httpd-2.2.14
   ```
5. The httpd-2.2.14 directory contains a `configure` command that prepares your system for installation of Apache. You can specify several parameters when you run the `configure` command. One parameter that you should be aware of is the `--prefix` parameter, which specifies the location to install Apache. By default, Apache is installed in the /usr/local/apache2 directory. Run the `configure` command using default options, including the default installation location, then run the following command:

   ```
   ./configure
   ```

   If you want to install Apache in a location other than the default, run the `configure` command as follows:

   ```
   ./configure --prefix=installation directory
   ```
6. After the configuration script finishes, compile the Apache source code by running the `make` command in the httpd-2.2.14 directory.
7. Finally, perform the installation by running the `make install` command in the httpd-2.2.14 directory.

For a complete listing of parameters and syntax for the `configure` command, type `./configure --help`.

You start, stop, and restart Apache using the `apachectl` control script, located in the bin directory beneath the directory where you installed Apache. The following examples assume that Apache is installed in the /usr/local/apache2 directory.

To start Apache, use the `start` option with the `apachectl` control script, as follows:

```
/usr/local/apache2/bin/apachectl start
```

To stop Apache, use the `stop` option of the `apachectl` control script, as follows:

```
/usr/local/apache2/bin/apachectl stop
```

To restart Apache, use the `restart` option of the `apachectl` control script, as follows:

```
/usr/local/apache2/bin/apachectl restart
```

Installing and Running Apache on Windows

This section explains how to install and configure Apache from binary format on Windows operating systems. For more detailed installation instructions, refer to the Apache documentation at *http://httpd.apache.org/docs/*.

To install Apache from binary format on Windows operating systems:

1. Start your Web browser, and enter the Web address for the Apache HTTP Server download page: **http://httpd.apache.org/download.cgi**. Download the Win32 Binary (MSI Installer) file containing the Apache version that the Apache Foundation recommends as the best available. At the time of this writing, the best available version is Apache 2.2.14 and the Win32 Binary (MSI Installer) file is named apache_2.2.14-win32-x86-no_ssl.msi. Save the file to a temporary folder on your computer.
2. Open **Windows Explorer** or **My Computer**, and navigate to the folder where you downloaded the apache_2.2.14-win32-x86-no_ssl.msi installation file. Double-click the file to start the installation program. The Welcome screen of the Installation Wizard appears.
3. In the Welcome screen, click the **Next** button to proceed with installation. The License Agreement screen appears.
4. On the License Agreement screen, click the button that accepts the terms of the license agreement, and then click the **Next** button. The Read This First screen appears.

5. Read through the contents of the Read This First screen, and then click the **Next** button. The Server Information screen appears.

6. The Server Information screen asks you for information about your Web server, including the network domain, the server name, and the administrator's e-mail address. If you have registered a domain name and already configured your computer as a Web server, enter this information. However, you are probably only using the current computer to perform the exercises in this book. If that is the case, accept the default values that were entered for your system. In the section of the screen that asks for whom to install Apache, accept the default value of **for All Users, on Port 80, as a Service -- Recommended**. Click the **Next** button to continue. The Setup Type screen appears.

7. The Setup Type screen allows you to select whether to perform a typical or custom installation. Accept the default value of **Typical**, and click the **Next** button. The Destination Folder screen appears.

8. The Destination Folder screen allows you to change the folder where Apache will be installed. Change the destination folder if you need to, although in most cases you should accept the default value. Click the **Next** button to continue. The Ready to Install the Program screen appears.

9. The Ready to Install the Program screen is the final screen that appears before Apache is installed. If you want to change any of the installation options you selected, click the **Back** button. Otherwise, click the **Install** button. When the installation is complete, the Installation Wizard Complete screen appears.

10. Click the **Finish** button to close the Installation Wizard Complete screen.

The preceding steps install Apache as a service, so you do not normally need to start Apache yourself. To control Apache manually, click your Start menu and point to All Programs; you should see an Apache HTTP Server 2.2 folder, which in turn contains a Control Apache Server folder. The Control Apache Server folder contains Stop, Start, and Restart commands that you can use if you need to control the service manually. The Control Apache Server folder also contains a Monitor Apache Servers command, which places an icon in the notification area to the right of the Windows taskbar. You can also use the Monitor Apache Services icon to stop, start, and restart Apache. The Monitor Apache Services command should start automatically when you first start Windows.

If Apache is running, the Monitor Apache Services icon appears as an arrow. If Apache is not running, the Monitor Apache Services icon appears as a square.

Installing and Running Internet Information Services on Windows Operating Systems

This section explains how to install and configure IIS on Windows 2000, Windows XP, Windows Server 2003, Windows Vista and Windows 7 operating systems. Note that the steps for installing IIS on Windows Vista differ from the steps for installing IIS on the other Windows operations systems.

Do not perform these steps if you have already installed Apache as your Web server.

To install IIS on Windows 2000, Windows XP, or Windows Server 2003:

1. Open **Control Panel** from the **Start** menu.
2. Select the **Add or Remove Programs** icon. The Add or Remove Programs window opens.
3. In the Add or Remove Programs window, click **Add/Remove Windows Components**. The Windows Components Wizard window opens. The window lists components that can be installed with the Windows operating system. A selected check box indicates that a component will be installed, whereas a shaded check box indicates that only part of a component will be installed.
4. Scroll down the Components list, and click the check box next to Internet Information Services (IIS). By default, IIS is only installed with the most common options, so the check box is shaded. If you want to select additional options for IIS, click the Details button. However, the default IIS installation options are all you need for this book, so click the **Next** button to begin installation.
5. During the installation process, you might be prompted for the location of your original Windows installation CD-ROM. The Windows Components Wizard displays a message when installation is complete. After installation is complete, click the **Finish** button to close the Windows Components Wizard.
6. If prompted, restart Windows.
7. Close the Add or Remove Programs window and Control Panel if you do not need to restart Windows.

The preceding steps install IIS as a service, so normally you do not need to start IIS yourself. To manually control the default Web site that is managed by IIS, you use the Internet Information Services window in Control Panel.

To manually control the default Web site with the Internet Information Services window:

1. Open **Control Panel** from the **Start** menu, and switch to Classic view if necessary.
2. Use the **Administrative Tools** icon to open the Administrative Tools window.
3. Double-click **Internet Information Services**. The Internet Information Services window opens.
4. Click the plus sign next to the icon that represents your computer, and then click the plus sign next to the Web Sites folder, if necessary.
5. Click the **Default Web Site** icon. If the Default Web site is not currently running, the name of the icon changes to Default Web Site (Stopped).
6. Perform one of the following tasks to manually control the default Web site:
   - To start the default Web site, select **Start** from the **Action** menu.
   - To stop the default Web site, select **Stop** from the **Action** menu.
   - To temporarily pause the default Web site, select **Pause** from the **Action** menu.

You can also use buttons on the IIS toolbar to start, stop, and pause a Web site.

Installing and Controlling IIS on Windows Vista and Windows 7

Perform the following steps to install IIS on Windows Vista and Windows 7:

To install IIS on Windows Vista and Windows 7:

1. Open **Control Panel** from the **Start** menu.
2. In Windows Vista, display the Control Panel home page. In Windows 7, click **Programs and Features**. The Programs window opens.
3. In Windows Vista, under Programs and Features, click **Turn Windows features on or off**. In Windows 7, under Control Panel Home, click **Turn Windows features on or off**. If you see a warning dialog box, click **Continue**. If necessary, provide your administrator password and then click Yes. The Windows Features dialog box opens. The window

lists components that can be installed with the Windows operating system. (You might have to wait briefly before the list appears in the dialog box.) A selected check box indicates that a component is turned on, whereas a shaded check box indicates that only part of a component will be installed.

4. Scroll down the list, and click the check box next to Internet Information Services. By default, IIS is only installed with the most common options, so the check box is shaded. If you want to select additional options for IIS, expand the features beneath Internet Information Services. However, the default IIS installation options are all you need for this book, so click the **OK** button to begin the installation.

5. During the installation process, you might be prompted for the location of your original Windows installation CD-ROM. When installation is complete, the Windows Features dialog box closes and you return to Control Panel.

6. If prompted, restart Windows.

7. Close Control Panel if you do not need to restart Windows.

The preceding steps install IIS as a service on Windows Vista and Windows 7, so you do not normally need to start IIS yourself. Perform the following steps to manually control the default Web site that is managed by IIS on Windows Vista.

To manually control the default Web site with the Internet Information Services window in Windows Vista and Windows 7:

1. Open the **Start** menu, right-click **Computer**, and then click **Manage**. Click **Continue** in Windows Vista, if necessary. In Windows 7, provide a password and click **Yes** if necessary. The Computer Management window opens.

2. In the Computer Management window, expand **Services and Applications**, and then expand **Internet Information Services (IIS) Manager**.

3. Expand the icon that represents your computer, and then expand the Sites folder, if necessary.

4. Select the **Default Web Site** icon, and then select **Start**, **Stop**, or **Restart** from the Actions panel.

Testing Your Web Server

For the typical user, the computer running the Web server and the local computer are two different computers. In that case, you open a file on the Web server by entering the domain name or IP address of a Web site in the local computer's browser. However, when developing a Web site, you need to be able to open your Web pages from a Web server that is running on your local computer. You can do this using *localhost*, which is the name that a local computer uses to refer to itself. Alternatively, you can access a Web server with *127.0.0.1*, which is the IP address that a local computer uses to refer to itself. For example, you can access a default Web page named index.html on your local computer by entering a URL of *http://localhost/index.html* or *http://localhost/*. You can access the same Web page by entering a URL of *http://127.0.0.1/index.html* or *http://127.0.0.1/*.

By default, Apache serves Web pages from the /usr/local/apache2.2/htdocs directory on UNIX/Linux, and from the C:\Program Files\Apache Group\Apache2.2\htdocs directory on Windows. This directory contains files that generate a default Web page based on your language. You can access Apache's default Web page with either *http://localhost/* or *http://127.0.0.1/*. The default directory from where IIS serves Web pages is C:\Inetpub\wwwroot. IIS does not create a default Web page. However, if you do not create a default Web page yourself, whenever you access *http://localhost/* or *http://127.0.0.1/*, IIS displays one Web page informing you that IIS is running and another Web page opened to the IIS online documentation page.

In the next exercise, you test your Web server with the *http://localhost/* and *http://127.0.0.1/* URLs.

To test your Web server:

1. Open your Web browser.
2. Type **http://localhost/** in the Address box and press **Enter**. You should see the default Web page for your server. If you installed IIS, you should see another Web page opened to the IIS online documentation page.
3. Now type **http://127.0.0.1/** in the Address box, and press **Enter**. You should see the same page you saw in Step 2.
4. Close your Web browser window.

In TCP/IP, a **port** represents the endpoint of a connection between a client and a server. Clients use a port number to identify a specific application on a Web server. Port numbers range from 0 to 65536, with ports 0 to 1024 being reserved for special purposes or well-known protocols. For example, port 80 is reserved for HTTP communications. This means that whenever you access a Web page, such as http://www.yahoo.com/, you are really accessing it through port 80 on Yahoo's Web server. Although they are assigned by default to port 80, Apache and IIS can be configured to use any nonreserved port. If you do assign a Web server to a different port, you need to specify the port number in the URL by appending the port number with a colon to

If you are using Firefox and cannot open the default Web page for your server by typing http://localhost/, then type about:config in the Address box and press Enter. A list of configuration settings appears along with a Filter box. Type ntlm in the Filter box, and then double-click the network.automatic-ntlm-auth.trusted-uris entry that appears in the list of configuration settings. In the Enter string value dialog box that appears, type localhost and click OK. Finally, restart Firefox.

The instructions in this appendix primarily use *http://localhost/*.

Two Web servers cannot share the same port. If you do have two Web servers configured to use the same port, the Web server that starts running first has exclusive access to the port. This means that if you install Apache and IIS on the same computer, you must configure one of the Web servers to use a port other than port 80.

Although directives are case insensitive, keep in mind that the values you assign to them might be case sensitive. For example, in UNIX/Linux, directory names are case sensitive. This means that if you assign a directory name to a directive, it must use the correct letter case.

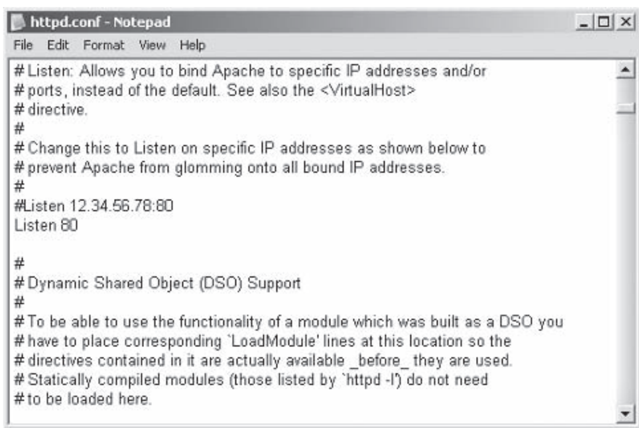
localhost or *127.0.0.1*. For example, to open the default Web page for a Web server that is configured to use port 8083, you can use either of the following URLs:

```
http://localhost:8083/
http://127.0.0.1:8083/
```

Configuring Apache

To configure ports and other settings for Apache after installation, you must edit the httpd.conf file, located in the conf directory beneath the directory where you installed Apache. By default, this file is located in the /usr/local/apache2.2/conf directory for UNIX/Linux and in the C:\Program Files\Apache Group\Apache2.2\conf directory for Windows. In UNIX/Linux, you can edit the httpd.conf file with a text editor such as GNU Emacs. In Windows, you can quickly edit the httpd.conf file in Notepad or your default text editor by selecting the Edit the Apache httpd.conf Configuration File command, located in the Configure Apache Server folder in your Apache HTTP Server 2.2.4 folder under All Programs in your Start menu. Figure A-2 shows a portion of the httpd.conf file. The first lines shown in Figure A-2 configure Apache for the ports that it will use. Lines that begin with the pound sign (#) are informational comments, which do not affect Apache's configuration. The lines without pound signs contain **directives**, which define information about how a program should be configured. The Listen directive in Figure A-2 configures Apache to use port 80.

After you edit and save the httpd.conf file, you must restart Apache for the changes to take effect.


httpd.conf - Notepad

File Edit Format View Help

```
# Listen: Allows you to bind Apache to specific IP addresses and/or
# ports, instead of the default. See also the <VirtualHost>
# directive.
#
# Change this to Listen on specific IP addresses as shown below to
# prevent Apache from glomming onto all bound IP addresses.
#
#Listen 12.34.56.78:80
Listen 80

#
# Dynamic Shared Object (DSO) Support
#
# To be able to use the functionality of a module which was built as a DSO you
# have to place corresponding `LoadModule' lines at this location so the
# directives contained in it are actually available _before_ they are used.
# Statically compiled modules (those listed by `httpd -l') do not need
# to be loaded here.
```

Figure A-2 httpd.conf

The `DocumentRoot` directive identifies the default directory from where Apache serves Web pages. The default document root is /usr/local/apache2.2/htdocs on UNIX/Linux systems, and C:\Program Files\Apache Group\Apache2.2\htdocs on Windows systems. You can also use the `Alias` directive to identify other directories that Apache can use to serve Web pages. The syntax for the `Alias` directive is `Alias` *`URL-path directory-path`*. The *`URL-path`* identifies the alias that you will use to access the directory with your Web site's URL. For example, the following UNIX example defines an alias named specials for the /usr/local/WebPages/specials directory:

```
Alias /specials /usr/local/WebPages/specials
```

Here is a Windows example of the preceding `Alias` directive. Notice that the alias and the directory name include an ending forward slash and that the directory name is surrounded by quotation marks. Also notice that, even though this is a Windows example, it uses forward slashes (/). (Windows directories are usually referenced using backslashes.)

```
Alias /specials/ "C:/WebPages/specials/"
```

The directory you specify for an alias must exist on your server.

The preceding `Alias` directives allow you to open files from the specials directory by appending the alias name to *localhost* or *127.0.0.1*. For example, to open a file named sales.html from the specials directory, you can use the URL *http://localhost/specials/sales.html* or *http://127.0.0.1/specials/sales.html*.

Next, you add to the Apache httpd.conf file an `Alias` directive that points to the main directory where you will store the files you create with this book.

To modify the Apache httpd.conf file on UNIX/Linux systems:

1. Open the **httpd.conf** file from the **/usr/local/apache2/conf** directory or other directory where you installed Apache. Use any text editor such as GNU Emacs.

2. Add the following `Alias` directive to the end of the httpd.conf file. The new directive creates an alias for the /usr/local/course/programming/javascript/data_files directory.

   ```
   Alias /JavaScript_Projects / ↵
   usr/local/course/programming/ ↵
       javascript/data_files
   ```

3. Add the following `<Directory>` section to the end of the httpd.conf file. The statements in the `<Directory>` section allow users to open the files in the directory represented by the alias.

   ```
   <Directory "usr/local/course/programming/ ↵
       javascript/data_files">
       Allow from all
   </Directory>
   ```

4. Save and close the **httpd.conf** file.

5. Use the following command to restart Apache (you might need to specify a different directory if you installed Apache in a location other than the default):

```
/usr/local/apache2/bin/apachectl restart
```

To modify the Apache httpd.conf file on Windows systems:

1. Click **Start** and point to **All Programs**. Select the **Apache HTTP Server 2.2** folder, select the **Configure Apache Server** subfolder, and then select **Edit the Apache httpd.conf configuration file**. The httpd.confi file opens in your default text editor, which is usually Notepad.

2. Scroll to the end of the file and add the following Alias directive. The new directive creates an alias for the C:\Course Technology\Programming\JavaScript\Data Files directory.

```
Alias /JavaScript_Projects/
"C:/Course Technology/Programming/JavaScript/Data Files/"
```

3. Add the following Directory directive, which assigns the necessary permissions to the alias directory:

```
<Directory "C:/Course Technology/Programming/
JavaScript/Data Files/">
    AllowOverride None
    Options None
    Order allow,deny
    Allow from all
</Directory>
```

4. Save and close the **httpd.conf file**.

5. To restart Apache, click **Start**, point to **All Programs**, point to the **Apache HTTP Server 2.2** folder, point to the **Control Apache Server** folder, and then click the **Restart** command.

After you modify the httpd.conf file for your operating system and restart Apache, perform the following steps to test the new alias by opening in your Web server the menu.html file you created in Chapter 1.

To test the `Alias` directive:

1. Open your Web browser.

2. Type the **http://localhost/JavaScript_Projects/Chapter.01/Chapter/DonsPizza/menu.html** in the Address box, and press **Enter**. The Web page should open correctly in your

Web browser. Note that the Web page opens from your Web server and not as a local file.

3. Close your Web browser window.

Configuring Internet Information Services

You configure IIS with the Internet Information Services window. To open the Internet Information Services window in Windows 2000 or XP, open Control Panel and switch to Classic View, if necessary. Select Administrative Tools, and then select Internet Information Services to display the Internet Information Services window. Within the Internet Information Services window, expand your computer name and the Web Sites folder. Then, click the Default Web Site icon, click the Action menu, and then click Properties. The Default Web Site Properties dialog box opens. This dialog box contains several tabs with various configuration options. The Web Site tab, shown in Figure A-3, allows you to select the default TCP/IP port.

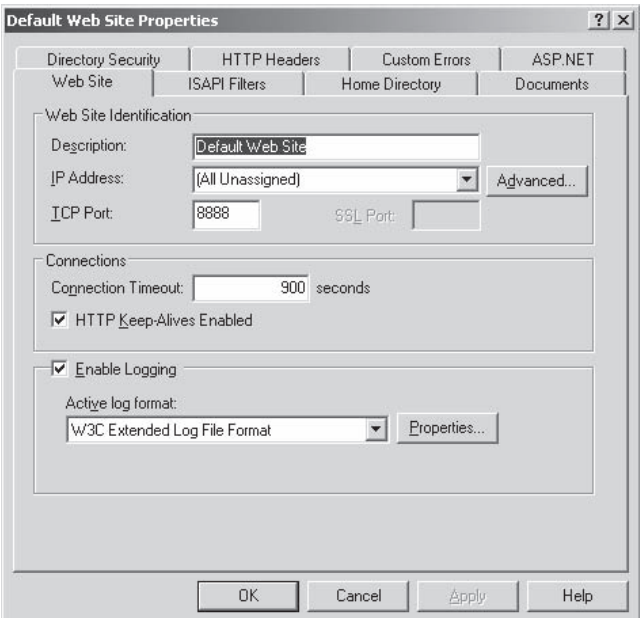


Figure A-3 Default Web Site Properties dialog box

To open the Internet Information Services window in Windows Vista or Windows 7, open Control Panel, select System and Maintenance (or System and Security in Windows 7), select Administrative Tools, and then select Internet Information Services (IIS) Manager. Within the Internet Information Services (IIS) Manager window, expand

Depending on the options you selected during installation of IIS, your version of the Default Web Site Properties dialog box may not contain the same tabs and options shown in Figure A-3.

If you read the previous section on Apache configuration, you should recognize a virtual directory as being the IIS equivalent to an alias in Apache.

your computer name and the Sites folder. Next, click the Default Web Site icon, and then click Bindings under "Edit Site" in the Actions column. The Site Bindings dialog box allows you to edit the default TCP/IP port, similar to the Default Web Site Properties dialog box in Windows 2000 and Windows XP.

The Home Directory tab in the Default Web Site Properties dialog box allows you to specify the directory from where IIS serves Web pages. (The default directory is C:\Inetpub\wwwroot.) You can also specify a virtual directory that IIS can use to serve Web pages. After you create a virtual directory in IIS, you can use a Web browser to open any file in the virtual directory. The URL you type in the browser should follow this syntax: `http://localhost/directory/file` or `http://127.0.0.1/directory/file`. For example, if you create a virtual directory named *interests*, you can open a document named index.html by typing the following URL in a Web browser's Address box: *http://localhost/interests/index.html*.

Next, you create a virtual directory in IIS that points to the main directory where you will store the files you create with this book.

To create a virtual directory in IIS:

1. Open the Internet Information Services Window (or, in Windows Vista or Windows 7, the Internet Information Services (IIS) Manager window).
2. Expand the icon that represents your computer, and then expand the Web Sites (or Sites) folder, if necessary.
3. In Windows 2000 or Windows XP, click the **Default Web Site** icon, click **Action** on the menu bar, point to **New**, and then click **Virtual Directory**. The Virtual Directory Creation Wizard opens. (In Windows Vista or Windows 7, right-click the **Default Web Site** icon, and then click **Add Virtual Directory** to open the Add Virtual Directory dialog box instead.)
4. In the introductory dialog box of the Virtual Directory Creation Wizard for Windows XP or Windows 2000, click the **Next** button to display the Virtual Directory Alias dialog box. (In Windows Vista and Windows 7, this step is not necessary.)
5. Type **JavaScript Projects** in the Alias textbox. Then, in Windows 2000 or XP, click the **Next** button to open the Web Site Content Directory dialog box. In Windows Vista or Windows 7, simply proceed to step 6 after entering the alias.

6. Type the path where you store your PHP projects. By default, this should be the C:\Course Technology\Programming\JavaScript\Data Files directory. In Windows 2000 or Windows XP, click the **Next** button when you are finished to open the Access Permissions dialog box. In Windows 7 or Windows Vista, click the **OK** button to return to the Internet Information Services Manager window.
7. In Windows 2000 or XP, leave the options in the Access Permissions dialog box set to their default values, and click the **Next** button to display the final Virtual Directory Creation Wizard dialog box. In Windows Vista and Windows 7, this step is not necessary.
8. In Windows 2000 or Windows XP, click **Finish**. In Windows Vista or Windows 7, this step is not necessary.
9. In all versions of Windows, close the Internet Information Services window and Control Panel.
10. Open your Web browser to test the virtual directory. Type **http://localhost/JavaScript_Projects/Chapter.01/Chapter/DonsPizza/menu.html** in the Address box, and press **Enter**. The Web page should open correctly in your Web browser. Note that the Web page opens from your Web server and not as a local file.
11. Close your Web browser window.

Installing PHP

This section explains how to install PHP on UNIX/Linux systems running Apache and Windows systems running either Apache or IIS. Before you install PHP, be certain to install and configure a Web server, as described in the previous section.

For more information on how to install PHP, refer to the installation instructions in the online PHP manual at *http://www.php.net/manual/en/install.php*.

Installing PHP on UNIX and Linux Systems Running Apache

This section explains how to install and configure PHP from source code on UNIX and Linux systems running Apache.

Before installing PHP on UNIX and Linux systems, you might need to log in as the root user to ensure that you have the necessary permissions to perform administration tasks.

To install PHP from source code on UNIX and Linux systems running Apache:

1. Start your Web browser, and enter the Web address for the PHP download page: **http://www.php.net/downloads.php**. Download the compressed UNIX source file containing the most recent version of PHP. At the time of writing, the most

If you download a different version of PHP, be sure to replace the "5.3.0" in the following steps with the correct version number.

recent version is PHP 5.3.0 and the compressed UNIX source file is named php-5.3.0.tar.gz. Save the file to a temporary location such as your usr/src directory or another directory of your choice.

2. Run the following `gunzip` command in the directory where you downloaded the compressed file. This command decompresses the php-5.3.0.tar.gz file into a tar file named php-5.3.0.tar within the same directory:

```
gunzip php-5.3.0.tar.gz
```

3. Run the following `tar` command, which extracts the files in the php-5.3.0.tar to a directory named php-5.3.0 within the current directory:

```
tar -xvf php-5.3.0.tar
```

4. Change to the php-5.3.0 directory:

```
cd php-5.3.0
```

5. The php-5.3.0 directory contains a `configure` command that prepares your system for installation of PHP. You can specify a number of parameters when you run the `configure` command, including the `--prefix` parameter, which specifies the location in which to install PHP. One of the most common parameters is the `--apxs2=`*directory* parameter, which identifies the location of the Apache Extension Tool, which is necessary to associate PHP with Apache. You assign to the `--apxs2=`*directory* parameter the directory path containing the Apache Extension Tool, which is usually /usr/local/apache2/bin/apxs if you installed Apache in the default location. To run the `configure` command with the `apxs2=`*directory* parameter, enter the following, but be certain to enter the correct directory for the Apache Extension Tool if you installed Apache in another location:

```
./configure --with-apxs2=/usr/local/apache2/bin/apxs
```

For a complete list of parameters and syntax for the `configure` command, type `./configure --help`.

6. After the configuration script finishes, compile the PHP source code by running the `make` command in the php-5.3.0 directory.

7. Perform the installation by running the `make install` command in the php-5.3.0 directory.

8. When installation is complete, you need to specify which configuration file you want to use with PHP. The PHP configuration file is named php.ini. The installation process creates two sample configuration files: php.ini-dist and php.

ini-recommended. You need to copy one of these files to the usr/local/lib directory and rename it php.ini. The php.ini-dist file is intended for development environments, whereas the php.ini-recommended file is intended for production environments. Because you are using this book to learn how to develop Web sites with PHP, you will primarily use the php.ini-dist file. Run the following command to copy the php.ini-dist file to your usr/local/lib directory and rename it php.ini:

```
cp php.ini-dist /usr/local/lib/php.ini
```

Be sure that you understand the settings in the php.ini-recommended file before using it as your PHP configuration file in a production environment.

Installing PHP on Windows Running Apache or IIS

This section explains how to install PHP from binary format on Windows systems running either Apache or IIS.

To install PHP from binary format on Windows operating systems:

1. Start your Web browser, and enter the Web address for the PHP download page: **http://windows.php.net/download/**. Download the most recent Windows binary installer. At the time of this writing, the most recent version is the PHP 5.3.0 installer; the binary file for this installer is named php-5.3.0-nts-Win32-VC9-x86.msi. Save the file to a temporary folder on your computer.

The specific installation instructions may differ with other PHP versions.

2. Open **Windows Explorer** and navigate to the folder where you downloaded the php-5.3.0-nts-Win32-VC9-x86.msi installation file. Double-click the file to start the installation program. The Welcome screen of the Installation Wizard appears.
3. In the Welcome screen, click the **Next** button to proceed with installation. The License Agreement screen appears.
4. In the License Agreement screen, click the **I accept the terms in the License Agreement** button, and then click the **Next** button. The Destination Folder screen appears.
5. The Destination Folder screen allows you to change the folder where PHP will be installed. Change the destination folder if you need to, although in most cases you should accept the default value. Click the **Next** button to continue. The Web Server Setup screen appears.
6. In the Web Server Type screen, select the type of Web server that you want to use with PHP. You should select an Apache

or IIS Web server. If you are using an Apache Web server, select the correct module for the version of Apache that you installed. For example, if you installed Apache 2.2.4, you should select **Apache 2.2.x Module**. If you are using an IIS Web server, then select **IIS ISAPI module** for Windows XP and earlier or **IIS FastCGI** for Windows Vista and Windows 7. Click the **Next** button to continue.

7. If you chose an Apache Web server, then the Apache Configuration Directory screen appears. If you did not select an Apache Web server, then skip to the next step. If you did select an Apache Web server, then in the Apache Configuration Directory screen, click the **Browse** button and select the folder where the httpd.conf file is stored (usually in a directory named \conf beneath the Apache installation directory). Click the **Next** button to continue. The Choose Items to Install screen appears.
8. In the Choose Items to Install screen, accept the default options and click the **Next** button to continue. The Ready to install PHP screen appears.
9. In the Ready to install PHP screen, click the **Install** button to begin installation. At the end of the installation process, you see a dialog box announcing that PHP was successfully installed. Click the last **Finish** button to exit installation.
10. Restart your Apache Web server. On Windows systems, restart Apache by clicking the **Start** button and pointing to **All Programs**. Select the **Restart** command, located in the **Control Apache Server** folder in the **Apache HTTP Server 2.2** folder.

Configuring Apache for PHP on UNIX/Linux Platforms

You do not need to perform any additional steps if you installed PHP in a Windows environment.

After you install PHP on UNIX/Linux platforms, you need to configure Apache to use it.

To configure Apache for PHP on UNIX/Linux platforms:

1. Open the **httpd.conf** file from the **/usr/local/apache2/conf** directory or other directory where you installed Apache. Use any text editor such as GNU Emacs.
2. Search for the following `LoadModule` directive. If it does not exist, add it to the end of the file.

```
LoadModule php5_module libexec/libphp5.so
```

3. Add the following `AddType` directive to the end of the file. This line configures Apache to use PHP to process files with an extension of .php.

   ```
   AddType application/x-httpd-php .php
   ```

4. Save and close the **httpd.conf** file.
5. Use the following command to restart Apache (although you might need to specify a different directory if you installed Apache in a location other than the default):

   ```
   /usr/local/apache2/bin/apachectl restart
   ```

Configuring PHP

You configure PHP by modifying the php.ini configuration file. For UNIX/Linux systems, you should have installed this file in the /usr/local/lib directory. On Windows systems, this file is installed automatically in your Program Files directory. You can edit the php.ini file with a text editor such as GNU Emacs for UNIX/Linux and Notepad in Windows. Figure A-4 shows a portion of the php.ini file that is used to configure resource limits and error handling and logging. Lines that begin with a semicolon (;) are informational comments, which do not affect PHP's configuration. The lines without semicolons contain **directives**, which define information about how a program should be configured.

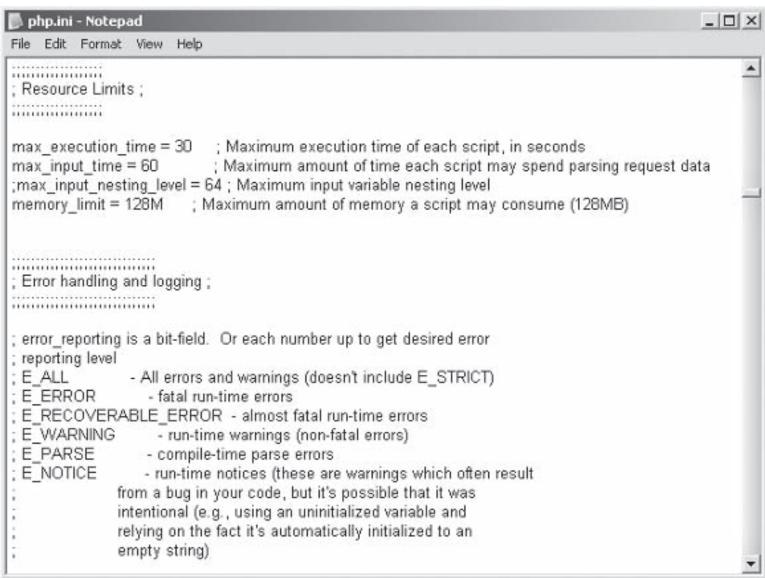


Figure A-4 The php.ini configuration file

PHP reads the php.ini configuration file each time it processes a script. For this reason, you do not need to restart your Web server after modifying the configuration file.

APPENDIX B

Introduction to PHP

Creating Basic PHP Scripts

JavaScript and PHP are both referred to as **embedded scripting languages** because code for both languages is embedded within a Web page (either an HTML or XHTML document). You type this code directly into a Web page as a separate section. Although JavaScript code can be added to standard Web page documents that have an extension of .html, a Web page document containing PHP code must have an extension of .php. Whenever a request is made for a document with an extension of .php, the Web server sends the file to the scripting engine for processing. The scripting engine then processes any PHP code it encounters. Although PHP files use an extension of .php, they can contain the same HTML or XHTML elements you would find in a static Web page. The scripting engine ignores any non-PHP code and only processes any PHP code it finds within PHP code blocks. The Web server then returns the results of the PHP script along with any HTML or XHTML elements found in the PHP file to the client, where it is rendered by the client's Web browser. In most cases, the results returned from a PHP script, such as database records, are formatted with HTML or XHTML elements. This means that PHP code is never sent to a client's Web browser; only the resulting Web page that is generated from the PHP code and HTML or XHTML elements found within the PHP file are returned to the client. Later in this appendix, you will see an example of a Web page that is returned to a client from a PHP file that contains both PHP code and XHTML elements. First, you need to learn about PHP code blocks.

A PHP file does not need to contain any PHP code whatsoever. However, if this is the case with a file you are working on, you should name the file with an extension of .html to avoid the extra step of having the file processed by the scripting engine.

Creating PHP Code Blocks

You write PHP scripts within **code declaration blocks**, which are separate sections within a Web page that are interpreted by the scripting engine. You can include as many code declaration blocks as you want within a document. The standard method of writing PHP code declaration blocks is to use the `<?php` and `?>` script delimiters. A **delimiter** is a character or sequence of characters used to mark the beginning and end of a code segment. When the scripting engine encounters the `<?php` and `?>` script delimiters, it processes any code between the delimiters as PHP. You need to use the following syntax in a document to tell the Web server that the statements that follow must be interpreted by the scripting engine:

```
<?php
statements;
?>
```

The following script contains a single statement that writes the text "Explore Africa!" to a Web browser window, using an `echo()` statement, which you will study shortly:

```
<?php
echo "Explore Africa!";
?>
```

Notice that the preceding statement ends in a semicolon. PHP, unlike JavaScript, requires you to end all statements with a semicolon.

You can use whichever extension you want for your PHP scripts, provided that your Web server is configured to process the extensions you use with the scripting engine. However, .php is the default extension that most Web servers use to process PHP scripts.

Displaying Script Results

When you write a PHP script, you will often want to display the results of the script in the Web page that is returned as a response to a client. For example, you might want the Web page to display database records that the client requested or the result of a calculation that was processed by the PHP script. Recall that the scripting engine ignores any non-PHP code and only processes any PHP code it finds within PHP code blocks. The Web server then returns the results of the PHP script along with any HTML or XHTML elements found in the PHP file to the client, where it is rendered by the client's Web browser. To return to the client the results of any processing that occurs within a PHP code block, you must use an `echo()` statement, which you've already seen, or the `print()` statement. The **`echo()`** and **`print()` statements** create new text on a Web page that is returned as a response to a client.

You might be thinking that the `echo()` and `print()` statements resemble functions because function names are usually followed by a set of parentheses. Actually, they are not functions, but language constructs of the PHP programming language. A **programming language construct** is a built-in feature of a programming language. The `echo()` and `print()` statements are virtually identical, although the `print()` statement returns a value of 1 if it was successful or a value of 0 if it was not successful. Keep in mind that you can use the exact same syntax with the `print()` statement that you use with the `echo()` statement.

You should understand that the only reason to use the `echo()` and `print()` statements is to include the results of a PHP script within a Web page that is returned to a client. For example, you might want to return a new Web page based on information a user enters into a form for an online transaction and submits to a Web server. You can use a PHP script to process the submitted information and return a new Web page to the client that displays the sales total, order confirmation, and so on. If you simply want to display text in a Web page that is returned to the client, there is no need to use anything but standard XHTML elements.

If you want to pass multiple arguments to the `echo()` and `print()` statements, separate them with commas, just as with arguments passed to a function. In the following example, three text string arguments are passed to the `echo()` statement:

```
<?php echo "Explore Africa, ",
    "South America, ", " and Australia!"; ?>
```

You can also use parentheses with the `echo()` and `print()` statements, in the same manner that you use them with functions, as follows:

```
<?php echo("Explore Africa, ",
    "South America, ", " and Australia!";); ?>
```

Case Sensitivity in PHP

Unlike XHTML and JavaScript, programming language constructs in PHP are mostly case insensitive, although there are some exceptions. This means that you can use any of the following versions of the `echo()` statement without receiving an error message:

```
<?php
echo "<p>Explore <strong>Africa</strong>, ↵
    <br />";
Echo "<strong>South America</strong>, ↵
    <br />";
ECHO " and <strong>Australia</strong>!</p>";
?>
```

Exceptions to PHP's case insensitivity include variable and constant names, which *are* case sensitive. You study variables and constants later in this appendix.

Adding Comments to a PHP Script

PHP supports the same block comments as JavaScript: line comments and block comments. However, with PHP line comments, you can use either two slashes // or the pound symbol # before the text you want to use as a comment. The following code shows a PHP code block containing line and block comments. If a client requests a Web page containing the following script in a Web browser, the scripting engine ignores the text marked with comments.

```
<?php
/*
This line is part of the block comment.
This line is also part of the block comment.
*/
echo "<h1>Comments Example</h1>";  // Line ↵
comments can follow code statements
// This line comment takes up an entire line.
# This is another way of creating a line comment.
/* This is another way of creating
a block comment. */
?>
```

Using Variables

You must observe the following rules and conventions when naming a variable in PHP:

- Identifiers must begin with a dollar sign ($).
- You can use numbers or an underscore (_) in an identifier, but not as the first character after the dollar sign.
- You cannot include spaces in an identifier.
- Identifiers are case sensitive.

Unlike other types of PHP code, variable names are case sensitive. Therefore, the variable name `$MyVariable` is a completely different variable than one named `$Myvariable`, `$myVariable`, or `$MYVARIABLE`. If you receive an error when running a script, be sure that you are using the correct case when referring to any variables in your code.

When working with variables in PHP, you follow the same conventions that are used with JavaScript variables, with one important exception: in PHP, you must declare and initialize a variable in the same statement, using the following syntax:

If you attempt to declare a variable without initializing it, you will receive an error.

```
$variable_name = value;
```

PHP also supports a "resource" data type, which is a special variable that holds a reference to an external resource, such as a database or XML file.

The term NULL refers to a data type as well as a value that can be assigned to a variable. Assigning the value `NULL` to a variable indicates the variable does not contain a usable value. A variable with a value of `NULL` has a value assigned to it—null is really the value "no value." You assign the `NULL` value to a variable when you want to ensure that the variable does not contain any data.

Like JavaScript, PHP is a loosely typed programming language.

The value you assign to a variable can be a literal string or a numeric value. For example, the following statement assigns the literal string "Don" to the variable `$MyName`:

```
$MyName = "Don";
```

Working with Data Types

PHP supports the five primitive data types described in Table B-1.

Data Type	Description
Integer numbers	Positive or negative numbers with no decimal places
Floating-point numbers	Positive or negative numbers with decimal places or numbers written using exponential notation
Boolean	A logical value of true or false
String	Text such as "Hello World"
NULL	An empty value, also referred to as a `NULL` value

Table B-1 Primitive PHP data types

The PHP language also supports **reference**, or **composite**, data types, which can contain multiple values or complex types of information, as opposed to the single values stored in primitive data types. The two reference data types supported by the PHP language are arrays and objects.

Understanding Variable Scope

A variable's scope in PHP can be either global or local. A global variable is one that is declared outside a function and is available to all parts of your program. A local variable is declared inside a function and is only available within the function in which it is declared. Local variables cease to exist when the function ends. If you attempt to use a local variable outside the function in which it is declared, you receive an error message. With many programming languages, global variables are automatically available to all parts of your program, including functions. However, this is not the case in PHP. As an example, the output statement in the following script generates an error because `$GlobalVariable` is not recognized within the scope of the `scopeExample()` function.

```
<?php
$GlobalVariable = "Global variable";
function scopeExample() {
     echo "<p>$GlobalVariable</p>"; // error
}
scopeExample();
?>
```

In PHP, you must declare a global variable with the `global` keyword inside of a function definition for the variable to be available within the scope of that function. When you declare a global variable with the `global` keyword, you do not need to assign the variable a value, as you do when you declare a standard variable. Instead, within the declaration statement you only need to include the `global` keyword along with the name of the variable. The correct syntax for this is: `global $variable_name;`. The following code shows a modified version of the preceding script. This time, the code declares the global variable within the function, which allows the output message to print successfully.

```
<?php
$GlobalVariable = "Global variable";
function scopeExample() {
     global $GlobalVariable;
     echo "<p>$GlobalVariable</p>";
}
scopeExample();
?>
```

Working with Operators, Functions, and Control Structures

The syntax for working with operators, functions, and control structures in PHP is virtually identical to JavaScript. To use operators, functions, and control structures in your PHP scripts, use the same syntax that is listed in Chapters 2 and 3.

Working with PHP Strings

Working with strings in PHP is very similar to working with strings in JavaScript, but with a few important differences, as described in this section.

Using String Operators

Up to this point, to print values from multiple literal strings and variables, you have sent them to the `echo()` and `print()` statements as multiple arguments separated by commas. For example, the following passes two literal strings and a variable to the `echo()` statement:

```
$Explorer = "Henry M. Stanley";
echo '<p>"Dr. Livingstone, I presume?", ↵
    asked ', $Explorer, ".</p>";
```

In PHP, you can also use two operators to combine strings. The first of these operators is the **concatenation operator** (`.`). The following code uses the concatenation operator to combine several string variables and literal strings, and assigns the new value to another variable:

```
$Destination = "Paris";
$Location = "France";
$Destination = "<p>" . $Destination
    . " is in " . $Location . ".</p>";
echo $Destination;
```

The combined value of the `$Location` variable and the literal strings that are assigned to the `$Destination` variable is `"<p>Paris is in France.</p>"`.

You can also combine strings by using the **concatenation assignment operator** (`.=`) to combine two strings. The following code combines two text strings, but without using the `$Location` variable:

```
$Destination = "<p>Paris";
$Destination .= " is in France.</p>";
echo $Destination;
```

Understanding Simple and Complex String Syntax

Values and variables can be combined in a literal string using simple or complex syntax. **Simple string syntax** allows you to use the value of a variable within a string by including the variable name inside a text string with double quotation marks. For example, the following code prints the text "Do you have any broccoli?" to the Web browser.

```
$Vegetable = "broccoli";
echo "<p>Do you have any $Vegetable?</p>";
```

Also, recall that if you surround a variable name inside a text string with single quotation marks, the name of the variable prints.

When the PHP interpreter encounters a dollar sign with a text string, it attempts to evaluate any characters that follow the dollar sign as part of the variable name until it comes to a character that is not allowed in an identifier, such as a space. In the preceding example, the `$Vegetable` variable is interpreted correctly because the question mark is not a legal character for an identifier. However, consider the following version of the preceding code:

```
$Vegetable = "tomato";
echo "<p>Do you have any $Vegetables?</p>";
```

Because an "s" is appended to the `$Vegetable` variable name, the preceding `echo()` statement causes an error. This is because the PHP interpreter is attempting to locate a variable named `$Vegetables` (plural), which has not been declared. To make the preceding code work, you need to surround the variable name with curly braces `{ }`, as shown in the following example. This type of structure, in which variables are placed within curly braces inside of a string, is called **complex string syntax**.

```
$Vegetable = "carrot";
echo "<p>Do you have any {$Vegetable}s?</p>";
```

The preceding `echo()` statement prints the text string "Do you have any carrots?" Complex string syntax is only recognized if the opening brace is immediately before or after a variable's dollar sign. The following version of the preceding code also works:

```
$Vegetable = "carrot";
echo "<p>Do you have any ${Vegetable}s?</p>";
```

However, if you place any characters between the opening brace and the dollar sign, the contents of the string are interpreted as literal values. For example, because the following code includes a space between the dollar sign and the opening brace, the `echo()` statement prints the text string "Do you have any { $Vegetable}s?":

```
$Vegetable = "carrot";
echo "<p>Do you have any { $Vegetable}s?</p>";
```

Parsing Strings

Table B-2 lists the functions you can use to count characters and words in a string.

Function	Description
`str_word_count(`*string*`[, `*format*`])`	Returns the number of words in a string
`strcspn(`*string1*`, `*string2*`)`	Returns the initial number of characters in one string that do not have matching values in another string
`strlen(`*string*`)`	Returns the number of characters in a string
`strspn(`*string1*`, `*string2*`)`	Returns the initial number of characters in one string that have matching values in another string
`substr_count(`*string*`, `*search_string*`)`	Returns the number of occurrences of a substring

Table B-2 PHP string counting functions

Finding and Extracting Characters and Substrings

To search for and extract characters and substrings in PHP, you use the functions listed in Table B-3.

Function	Description
`stripos(string, search_string [, start_position])`	Performs a case-insensitive search and returns the position of the first occurrence of one string in another string
`stristr(string, search_string)`	Performs a case-insensitive search for specified characters in a string and returns a substring from the first occurrence of the specified characters to the end of the string
`strpos(string, search_string [, start_position])`	Performs a case-sensitive search and returns the position of the first occurrence of one string in another string
`strrchr(string, character)`	Performs a case-sensitive search for specified characters in a string and returns a substring from the last occurrence of the specified characters to the end of the string
`strripos(string, search_string [, start_position])`	Performs a case-insensitive search and returns the position of the last occurrence of one string in another string
`strrpos(string, search_string [, start_position])`	Performs a case-sensitive search and returns the position of the last occurrence of one string in another string
`strstr(string, search_string)` or `strchr(string, search_string)`	Performs a case-sensitive search for specified characters in a string and returns a substring from the first occurrence of the specified characters to the end of the string
`substr(string, start_position [, length])`	Returns a portion of a string

Table B-3 PHP string search and extraction functions

There are two types of string search and extraction functions: functions that return a numeric position in a text string and functions that return a character or substring. With the exception of the `substr()` function, all of the functions in Table B-3 return a value of false if the search string is not found. To use functions that return the numeric position in a text string, you need to understand that the position of characters in a text string begins with a value of 0, the same as with indexed array elements. For example, the `strpos()` function performs a case-sensitive search and returns the position of the first occurrence of one string in another string. You pass two arguments to the `strpos()` function: The first argument is the string you want to search, and the second argument contains the characters for which you want to search. If the search string is not found, the `strpos()` function returns a Boolean value of false. The following code uses the `strpos()` function to determine whether the `$Email` variable contains an @ character. Because the position of text strings begin with 0, the `echo()` statement returns a value of 9, even though the @ character is the tenth character in the string:

```
$Email = "president@whitehouse.gov";
echo strpos($Email, '@'); // returns 9
```

If you simply want to determine whether a character exists in a string, you need to keep in mind that PHP converts the Boolean values true and false to 1 and 0, respectively. However, these values are character positions within a string. For example, the following statement returns a value of 0 because "p" is the first character in the string:

```
$Email = "president@whitehouse.gov";
echo strpos($Email, 'p'); // returns 0
```

To determine whether the `strpos()` function (and other string functions) actually returns a Boolean false value, not a 0 representing the first character in a string, you must use the strict not equal operator (`!==`). The following example uses the `strpos()` function and the strict not equal operator to determine whether the `$Email` variable contains an `@` character.

```
$Email = "president@whitehouse.gov";
if (strpos($Email, '@') !== FALSE)
    echo "<p>The e-mail address contains ↵
        an @ character.</p>";
else
    echo "<p>The e-mail address does ↵
        not contain an @ character.</p>";
```

Replacing Characters and Substrings

You can use the functions listed in Table B-4 to replace characters and substrings in PHP.

Function	Description
`str_ireplace(`*search_string*`,` *replacement_string*`,` *string*`)`	Performs a case-insensitive replacement of all occurrences of specified characters in a string
`str_replace(`*search_string*`,` *replacement_string*`,` *string*`)`	Performs a case-sensitive replacement of all occurrences of specified characters in a string
`substr_replace(`*string*`,` *replacement_string*`,` *start_position*`[,` *length*`])`	Replaces characters within a specified portion of a string

Table B-4 PHP string replacement functions

Comparing Strings

In addition to comparison operators, you can also use the functions listed in Table B-5 to compare strings in PHP.

Function	Description
`strcasecmp(string1, string2)`	Performs a case-insensitive comparison of two strings
`strcmp(string1, string2)`	Performs a case-sensitive comparison of two strings
`strnatcasecmp(string1, string2)`	Performs a case-insensitive natural order comparison of two strings, so that, for example, a set of strings would be ordered as Purchase1, Purchase2, Purchase3, Purchase4, Purchase5, Purchase6, Purchase7, Purchase8, Purchase9, Purchase10, Purchase11 (the way a human would naturally sort them); and not as Purchase1, Purchase10, Purchase11, Purchase2, Purchase3, Purchase4, Purchase5, Purchase6, Purchase7, Purchase8, Purchase9 (the way a computer would otherwise normally sort them)
`strnatcmp(string1, string2)`	Performs a case-sensitive natural order comparison of two strings
`strncasecmp(string1, string2, length)`	Performs a case-insensitive comparison of a specified number of characters within two strings
`strncmp(string1, string2, length)`	Performs a case-sensitive comparison of a specified number of characters within two strings
`levenshtein(string1, string2)`	Returns the number of characters you need to change to make two strings the same
`metaphone(string)`	Determines a string's value as calculated by metaphone, which is an algorithm for indexing words by their sound, when pronounced in English
`similar_text(string1, string2[, float_percent])`	Returns the number of characters that two strings have in common
`soundex()`	Determines a string's value as calculated by soundex, which is an algorithm for indexing words by their sound, when pronounced in English

Table B-5 PHP string comparison functions

Working with Arrays

The identifiers you use for an array name must follow the same rules as identifiers for variables: They must begin with a dollar sign, can include numbers or an underscore (but not as the first character after the dollar sign), cannot include spaces, and are case sensitive.

In PHP, you can create numerically indexed arrays and associative arrays. You create an indexed array using the `array()` construct or by using the array name and brackets. The `array()` construct uses the following syntax:

```
$array_name = array(values);
```

The following code uses the `array()` construct to create the `$Provinces[]` array:

```
$Provinces = array(
    "Newfoundland and Labrador",
    "Prince Edward Island", "Nova Scotia",
    "New Brunswick", "Quebec", "Ontario",
    "Manitoba", "Saskatchewan", "Alberta",
    "British Columbia");
```

You access and modify values in a PHP array the same way you access and modify arrays in JavaScript. The following code assigns values to the first three elements in an array named `$HospitalDepts[]`:

```
$HospitalDepts = array(
    "Anesthesia", // first element (0)
    "Molecular Biology", // second element (1)
    "Neurology"); // third element (2)
```

After you have assigned a value to an array element, you can change it, just as you can change other variables in a script. To change the first array element in the `$HospitalDepts[]` array from "Anesthesia" to "Anesthesiology," you use the following statement:

```
$HospitalDepts[0] = "Anesthesiology";
```

Manipulating Elements

This section describes the techniques for manipulating array elements.

Adding and Removing Elements to and from the Beginning of an Array

To add or remove elements to or from the beginning of an array, you need to use the `array_shift()` and `array_unshift()` functions. The `array_shift()` function removes the first element from the beginning of an array, whereas the `array_unshift()` function adds one or more elements to the beginning of an array. You pass to the `array_shift()` function the name of the array whose first element you want to remove. You pass to the `array_unshift()` function the name of an array followed by comma-separated values for each element you want to add. For example, the following code declares and initializes an array containing the names of the world's top-ranked golfers in 2005. The `array_shift()` function removes the first golfer, Ernie Els, from the top of the array and the `array_unshift()` function adds the two highest-ranked players, Tiger Woods and Vijay Singh, to the top of the array.

```
$TopGolfers = array(
     "Ernie Els",
     "Phil Mickelson",
     "Retief Goosen",
     "Padraig Harrington",
     "David Toms",
     "Sergio Garcia",
     "Adam Scott",
     "Stewart Cink");
array_shift($TopGolfers);
array_unshift($TopGolfers, "Tiger Woods",
    "Vijay Singh");
```


Adding and Removing Elements from the End of an Array

The easiest way to add additional elements to the end of an array is to simply use the array name and brackets syntax that you first saw in Chapter 3. For example, the first statement in the following code uses the `array()` construct to create the initial `$HospitalDepts[]` array. The second statement then adds a new value, "Pediatrics," as the fourth element of the array.

```
$HospitalDepts = array(
     "Anesthesia",
     "Molecular Biology",
     "Neurology");
$HospitalDepts[] = "Pediatrics";
```

You can also add and remove elements to and from the end of an array by using the `array_pop()` and `array_push()` functions. The `array_pop()` function removes the last element from the end of an array, whereas the `array_push()` function adds one or more elements to the end of an array. You pass to the `array_pop()` function the name of the array whose last element you want to remove. You pass to the `array_push()` function the name of an array followed by comma-separated values for each element you want to add. In the following example, the `array_pop()` function removes the last department, "Pediatrics," from the end of the array; and the `array_push()` function adds the two additional departments, "Psychiatry" and "Pulmonary Diseases," to the end of the array.

```
$HospitalDepts = array(
    "Anesthesia",
    "Molecular Biology",
    "Neurology",
    "Pediatrics");
array_pop($HospitalDepts);
array_push($HospitalDepts, "Psychiatry",
    "Pulmonary Diseases");
```

Adding and Removing Elements Within an Array

To add or remove elements anywhere else in an array, you need to use an array function. PHP includes numerous functions for working with arrays, including the `array_splice()` function, which adds or removes array elements. After adding or removing array elements, the `array_splice()` function also renumbers the indexes in the array. The syntax for the `array_splice()` function is `array_splice(array_name, start, characters_to_delete, values_to_insert);`. The *array_name* argument indicates the name of the array you want to modify. The *start* argument indicates the element within the array, at which point elements should be added or removed. The *characters_to_delete* argument is an integer value that indicates the number of elements to remove from the array, starting with the element indicated by the *start* argument. The *values_to_insert* argument represents the values you want to add as new elements to an array.

Removing Duplicate Elements

You might find it necessary to ensure that an array in a script does not contain duplicate values. For example, your script may use arrays of e-mail addresses, customer names, or sales items, each of which should contain unique elements. You can use the `array_unique()` function to remove duplicate elements from an array. You pass to the `array_unique()` function the name of the array from which you want to remove duplicate elements. The `array_unique()` function does not operate directly on an array. Instead, it returns a new array with the renumbered indexes. For this reason, you need to write a statement that assigns the array that is returned from the `array_unique()` function to a new variable name or to the original array.

Manipulating Arrays

This section discusses how to sort, combine, and compare arrays.

Sorting Arrays

You sort arrays using the functions listed in Table B-6.

Function	Description
`array_multisort(array[, array, ...])`	Sorts multiple arrays or multidimensional arrays
`arsort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Performs a reverse sort of values in an associative array and maintains the existing keys
`asort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Sorts an associative array by value and maintains the existing keys
`krsort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Performs a reverse sort of an associative array by key
`ksort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Sorts an associative array by key
`natcasesort(array)`	Performs a case-sensitive natural order sort by value and maintains the existing indexes or keys
`natsort(array)`	Performs a natural order sort by value and maintains the existing indexes or keys
`rsort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Performs a reverse sort of values in an indexed array and renumbers the indexes
`sort(array[, SORT_REGULAR | SORT_NUMERIC | SORT_STRING])`	Sorts an indexed array by value and renumbers the indexes
`uk_sort(array[, comparison_function])`	Uses a comparison expression to sort an associative array by keys, maintaining the existing keys
`usort(array[, comparison_function])`	Uses a comparison expression to sort an indexed array by values, renumbering the indexes

Table B-6 Array-sorting functions

Combining Arrays

If you want to combine arrays, you have two options. You can either append one array to another or merge the two arrays. To append one array to another, you use the addition (+) or the compound assignment operator (+=). Instead of appending one array to another, you can merge two or more arrays with the `array_merge()` function. The syntax for the `array_merge()` function is *`new_array`* `= array_merge($`*`array1`*`, $`*`array2`*`, $`*`array3`*`, ...);`. The `$`*`array2`* array is appended to the `$`*`array1`* array, the `$`*`array3`* array is appended to the `$`*`array2`* array, and so on. If you use the `array_merge()` function with associative arrays, the keys in the array you are appending overwrite any duplicate keys in the array to which you are appending. With indexed arrays, all elements in one array are appended to another array and renumbered. The following statement demonstrates how to combine the associative `$ProvincialCapitals[]` and the `$TerritorialCapitals[]` arrays.

```
$CanadianCapitals = array_merge(
    $ProvincialCapitals,
    $TerritorialCapitals);
```

Comparing Arrays

PHP includes several functions for comparing the contents of two or more arrays. Two of the most basic comparison functions are `array_diff()` and `array_intersect()`. The `array_diff()` function returns an array of elements that exist in one array but not in any other arrays to which it is compared. The syntax for the `array_diff()` function is *`new_array`* `= array_diff($`*`array1`*`, $`*`array2`*`, $`*`array3`*`, ...);`. A new array is returned, containing elements that occur in `$`*`array1`* but not in any of the other array arguments. Indexes are not renumbered in the new array.

The `array_intersect()` function returns an array of elements that exists in all of the arrays that are compared. The syntax for the `array_intersect()` function is *`new_array`* `= array_intersect($`*`array1`*`, $`*`array2`*`, $`*`array3`*`, ...);`. As with the `array_diff()` function, keys and indexes are not renumbered in the new array, so you must use the `array_values()` function to renumber an indexed array.

Converting Between Strings and Arrays

You use the `str_split()` or `explode()` function to split a string into an indexed array. The `str_split()` function splits each character in a string into an array element, using the syntax `$`*`array`* `= str_split(`*`string`*`[, `*`length`*`]);`. The *`length`* argument represents the number of characters you want assigned to each array element. The `explode()` function splits a string into an indexed array at a specified separator. The syntax for the `explode()` function is

`$array = explode(separator, string);`. The following code demonstrates how to split the `$Presidents` string into an array named `$PresidentArray`:

```
$Presidents = "George W. Bush; ↵
    William Clinton;George H. W. Bush; ↵
    Ronald Reagan;Jimmy Carter";
$PresidentArray = explode(";", $Presidents);
foreach ($PresidentArray as $President) {
     echo "$President<br />";
}
```

If the string does not contain the specified separators, the entire string is assigned to the first element of the array. The `explode()` function evaluates the characters in the *separator* argument as a substring. For example, a semicolon and a space separate each president's name in the following example. Therefore, the `explode()` function includes a semicolon and a space as the *separator* argument.

If you pass to the `explode()` function an empty string as the *separator* argument, the function returns a value of false.

```
$Presidents = "George W. Bush; ↵
    William Clinton; George H.W. Bush; ↵
    Ronald Reagan; Jimmy Carter";
$PresidentArray = explode("; ", $Presidents);
foreach ($PresidentArray as $President) {
     echo "$President<br />";
}
```

The opposite of the `explode()` function is the `implode()` function, which combines an array's elements into a single string, separated by specified characters. The syntax for the `implode()` function is `$variable = implode(separators, array);`. The following example first creates an array named `$PresidentsArray`, then uses the `implode()` function to combine the array elements into the `$Presidents` variable, separated by a comma and a space.

```
$PresidentsArray = array("George W. Bush",
    "William Clinton", "George H.W. Bush",
    "Ronald Reagan", "Jimmy Carter");
$Presidents = implode(", ", $PresidentsArray);
echo $Presidents;
```

Handling Form Submissions

This section describes how to handle form submissions to a PHP script.

Using Autoglobals

PHP includes various predefined global arrays, called **autoglobals** or **superglobals**, which contain client, server, and environment information that you can use in your scripts. Table B-7 lists the PHP autoglobals.

Array	Description
$_COOKIE	An array of values passed to the current script as HTTP cookies
$_ENV	An array of environment information
$_FILES	An array of information about uploaded files
$_GET	An array of values from a form submitted with the GET method
$_POST	An array of values from a form submitted with the POST method
$_REQUEST	An array of all the elements found in the $_COOKIE, $_GET, and $_POST arrays
$_SERVER	An array of information about the Web server that served the current script
$_SESSION	An array of session variables that are available to the current script
$GLOBALS	An array of references to all variables that are defined with global scope

Table B-7 PHP autoglobals

The following statements print three elements of the $_SERVER autoglobal. The $_SERVER["PHP_SELF"] element prints the path and name of the current script, the $_SERVER["SERVER_SOFTWARE"] element prints the name of the server software that executed the script, and the $_SERVER["SERVER_PROTOCOL"] element prints the server protocol that was used to request the script.

```
echo "<p>The name of the current script is ",
    $_SERVER["PHP_SELF"], "<br />";
echo "This script was executed with the ↵
    following server software: ",
$_SERVER["SERVER_SOFTWARE"], "<br />";
echo "This script was requested with ↵
    the following server protocol: ",
$_SERVER["SERVER_PROTOCOL"], "</p>";
```

The elements that are available with the $_SERVER autoglobal depend on the Web server that executes the PHP script. For more information on the $_SERVER autoglobal, see the online PHP documentation at *http://www.php.net/docs.php*.

Two of the most commonly used autoglobals are $_GET and $_POST, which allow you to access the values of forms that are submitted to a PHP script. The $_GET autoglobal contains values of forms that are submitted with the “get” method while the $_POST autoglobal contains values of forms that are submitted with the “post” method. Which autoglobal you use depends on the value you assign to a <form> element’s method attribute. The following code contains a typical form that uses the “get” method to submit the form to a script named ProcessOrder.php.

```
<form method="get" action="ProcessOrder.php">
<p>Name<br />
<input type="text" name="name"
size="50" /><br />
Address<br />
<input type="text" name="address"
size="50" /><br />
City, State, Zip<br />
<input type="text" name="city" size="38" />
```

```
<input type="text" name="state" size="2" maxlength="2" />
<input type="text" name="zip" size="5"
    maxlength="5" /><br />E-Mail<br />
<input type="text" name="email"
size="50" /></p>
<p><input type="reset" />
<input type="submit" /></p>
</form>
```

When you click a form's Submit button, each field on the form is submitted to the server as a name=value pair. When the "get" method is specified, the name portion of the name=value pair becomes the key of an element in the `$_GET` autoglobal, and the value portion is assigned as the value of the element. Similarly, when the "post" method is specified, the name portion of the name=value pair becomes the key of an element in the `$_POST` autoglobal, and the value portion is assigned as the value of the element. Upon submitting the preceding form to the ProcessOrder.php script, you can access the form fields with the following statements:

```
$_GET["name"]
$_GET["address"]
$_GET["city"]
$_GET["state"]
$_GET["zip"]
$_GET["email"]
```

Validating Submitted Data

You can validate data that is submitted from a form to a PHP script in essentially three ways:

- Use the `isset()` function to ensure that a variable contains a value.
- Use the `empty()` function to ensure that a variable contains a value.
- Use the `is_numeric()` function to test whether a variable contains a numeric string.

Determining if Form Variables Contain Values

Both the `isset()` function and the `empty()` function can be used to determine if form variables contain values, but they do this in different ways. The `isset()` function determines whether a variable has been declared and initialized (or "set"), whereas the `empty()` function determines whether a variable is empty. You pass to both functions the name of the variable you want to check.

In the following example, the first script section uses the `isset()` function to determine whether the `$_GET['height']` and

$_GET['weight'] variables are set. If both variables are set, the script performs a body mass index calculation. In the form section of the example, if statements use the empty() function to determine whether the variables are empty. If they are not empty, their values are displayed in the text boxes. If the variables are empty, only the form is displayed.

```
<h1>Body Mass Index</h1><hr />
<?php
if (isset($_GET['height']) && isset($_GET['weight'])) {
     $BodyMass = $_GET['weight'] / ($_GET['height']
          * $_GET['height']) * 703;
     printf("<p>Your body mass index is %d.</p>",
$BodyMass);
}
?>
<form action="BodyMassIndex.php" method="get"
enctype="application/x-www-form-urlencoded">
<p>Height: <input type="text" name="height"
size="30" value="<?php if
(!empty($_GET['height'])) echo $_GET['height']
?>" /> (Enter a height in inches)</p>
<p>Weight: <input type="text" name="weight"
size="30" value="<?php if (!empty($_GET['weight']))
echo $_GET['weight']
?>" /> (Enter a weight in pounds)</p>
<p><input type="submit" value="Calculate" />
<input type="reset" value="Reset Form" /></p>
</form><hr />
```

Testing if Form Variables Contain Numeric Values

Even though the data that a PHP script receives from a form submission is usually in the form of a text string, the PHP scripting engine can usually perform the necessary type casting. This means that you do not need to explicitly convert form data to a specific data type. This is especially important when your script expects a numeric value that will be used in a calculation. For example, with the Body Mass Index script, PHP converts any numbers that are submitted from the form to a numeric format. However, you cannot be sure that a user will always enter a number into each text box. If a submitted form value must be numeric data, you should use an is_numeric() function to test the variable. The following example contains a modified version of the first script section from the previous example. This version contains a nested if statement that tests whether the $_GET['height'] and $_GET['weight'] variables are numeric after the first if statement checks to see whether they are set.

You cannot use any other `is_*()` functions to test the data type of a form variable. If you want to ensure that a form variable is of a specific numeric data type, such as an integer, you should first use the `is_numeric()` function to test whether the variable is numeric, then cast the variable to the required data type.

```
if (isset($_GET['height'])
    && isset($_GET['weight'])) {
    if (is_numeric($_GET['weight'])
    && is_numeric($_GET['height'])) {
    $BodyMass = $_GET['weight']
        / ($_GET['height'] * $_GET['height'])
        * 703;
    printf("<p>Your body mass index is ↵
        %d.</p>",
    $BodyMass);
    }
    else
        echo "<p>You must enter numeric ↵
            values!</p>";
}
```

Working with Files

In this section, you will learn how to read and store data in text files.

Opening and Closing File Streams

PHP includes several functions for reading data from a file. But before any of these functions can do their jobs, you must create a stream. A **stream** is a channel that is used for accessing a resource that you can read from and write to. For example, you might use a stream to access a file. The **input stream** reads data from a resource (such as a file), whereas the **output stream** writes data to a resource (again, such as a file). Using a file stream involves the following steps:

1. Open the file stream with the `fopen()` function.
2. Write data to or read data from the file stream.
3. Close the file stream with the `fclose()` function.

In the following sections, you first learn how to open and close file streams, and then you learn how to write and read data.

Opening a File Stream

When you use the `echo()` or `print()` functions to send data to an output stream, you only need to call each function for the data to be sent to the stream. With external files, such as text files, you must write code that opens and closes a handle to a file. A **handle** is a special type of variable that PHP uses to represent a resource such as a file. You use the `fopen()` function to open a handle to a file stream. The syntax for the `fopen()` function is `$open_file = fopen("text file", "mode");`. The `$open_file` variable is the handle that you can use to read and write data from and to the file. The *mode* argument can be one of several values that determines what you can do with the file after you open it.

Table B-8 lists the *mode* arguments that you can use with the `fopen()` function. Among other things, these arguments control the position of the file pointer. A **file pointer** is a special type of variable that refers to the currently selected line or character in a file. The file pointer is a way of keeping track of where you are in a file.

Argument	Description
`a`	Opens the specified file for writing only and places the file pointer at the end of the file; attempts to create the file if it doesn't exist
`a+`	Opens the specified file for reading and writing and places the file pointer at the end of the file; attempts to create the file if it doesn't exist
`r`	Opens the specified file for reading only and places the file pointer at the beginning of the file
`r+`	Opens the specified file for reading and writing and places the file pointer at the beginning of the file
`w`	Opens the specified file for writing only and deletes any existing content in the file; attempts to create the file if it doesn't exist
`w+`	Opens the specified file for reading and writing and deletes any existing content in the file; attempts to create the file if it doesn't exist
`x`	Creates and opens the specified file for writing only; returns false if the file already exists
`x+`	Creates and opens the specified file for reading and writing; returns false if the file already exists

Table B-8 Mode arguments of the `fopen()` function

The following statement shows how to use the `fopen()` function to open a handle to a file stream:

```
$BowlersFile = fopen("bowlers.txt", "r+");
```

Assume that the preceding statement opens a file that contains a list of people who have signed up for a bowling tournament. The `fopen()` function assigns the file to a handle named `$BowlersFile`. Notice that the function uses a *mode* argument of "r+", which opens the specified file for reading and writing and places the file pointer at the beginning of the file, before the first record. If you want to open a file and place the file pointer at the end of the file, you use a *mode* argument of *"a+"*, as shown in the following statement:

```
$BowlersFile = fopen("bowlers.txt", "a+");
```

Closing a File Stream

When you are finished working with a file stream, you use the statement `fclose($handle);` to ensure that the file doesn't keep taking up space in your computer's memory. The following code includes an `fclose()` statement:

```
$BowlersFile = fopen("bowlers.txt", "a");
$NewBowler = "Gosselin, Don\n";
fwrite($BowlersFile, $NewBowler);
fclose($BowlersFile);
```

Notice that the `fopen()` function in the preceding statement uses *"a"* as the *mode* argument. The *mode* argument of *"a"* opens the bowlers.txt file for writing only (or attempts to create it if it doesn't exist) and places the file pointer at the end of the file. The code also includes the `fwrite()` function, which writes a line to the open file.

Writing Data to Files

PHP supports two basic functions for writing data to text files: the `file_put_contents()` function and the `fwrite()` function. But before you learn how to write data to text files, you need to understand how line breaks vary by operating systems.

Different operating systems use different escape sequences to identify the end of a line. UNIX/Linux platforms use the `\n` carriage return escape sequence to identify the end of a line, Macintosh platforms use `\r` to identify the end of a line, and Windows operating systems use both the `\r` carriage return escape sequence and the `\n` newline escape sequence to identify the end of a line. For example, to identify the end of a line on UNIX/Linux platforms, you append the `\n` carriage return escape sequence to the end of a line, as follows:

```
This is how you end a line on UNIX/Linux platforms.\n
```

The following statement demonstrates how to use both the `\r` carriage return escape sequence and the `\n` newline escape sequence to identify the end of a line on Windows operating systems:

```
This is how you end a line on Windows operating systems.\r\n
```

If you do not use the correct end-of-line escape sequence, you may experience problems when working with text files on different platforms. For example, the following names of people registered for the bowling tournament end with the `\n` newline escape sequence, as required for UNIX/Linux operating systems:

```
Blair, Dennis\n
Hernandez, Louis\n
Miller, Erica\n
Morinaga, Scott\n
Picard, Raymond\n
```


The PHP file functions that you study in this chapter can usually accommodate any of these escape sequences and end lines in a text file appropriately, regardless of the operating system. For this reason, although the examples in this book use the `\n` newline escape sequence that is supported by UNIX/Linux operating systems, the PHP scripts you write will function correctly on any platform.

Writing an Entire File

The `file_put_contents()` function writes or appends a text string to a file. The syntax for the `file_put_contents()` function is `file_put_contents(filename, string[, options])` function. If the specified filename does not exist, it is created. However, if the specified filename does exist, any data it contains is overwritten. With the `file_put_contents()` function, you do not need to use the `fopen()` and `fclose()` function. Instead, you simply call the `file_put_contents()` function and pass to it the name of the file to which you want to write data, along with a text string containing the data you want to write. For example, the following code builds a variable named `$TournamentBowlers` that contains the names of bowlers in the tournament separated by line breaks, along with a variable named `$BowlersFile` that contains the filename where the bowler names will be stored. The last statement passes the `$BowlersFile` and the `$TournamentBowlers` variables to the `file_put_contents()` function.

```
$TournamentBowlers = "Blair, Dennis\n";
$TournamentBowlers .= "Hernandez, Louis\n";
$TournamentBowlers .= "Miller, Erica\n";
$TournamentBowlers .= "Morinaga, Scott\n";
$TournamentBowlers .= "Picard, Raymond\n";
$BowlersFile = "bowlers.txt";
file_put_contents($BowlersFile, $TournamentBowlers);
```

The `file_put_contents()` function returns the number of bytes that were written to the file. If no data was written to the file, the function returns a value of 0. You can use the return value to determine whether data was successfully written to the file, as follows:

```
if (file_put_contents($BowlersFile,
    $TournamentBowlers) > 0)
    echo "<p>Data was successfully written ↵
        to the $BowlersFile file.</p>";
```

You can use an absolute or relative path with the filename you pass to the `file_put_contents()` function. However, even though the function will create a filename that does not exist, it will not create any directories that do not exist. If you specify a nonexistent directory, you receive an error.

```
else
    echo "<p>No data was written to the ↵
        $BowlersFile file.</p>";
```

In addition to the filename and text string arguments, you can pass a third argument to the `file_put_contents()` function that contains the `FILE_USE_INCLUDE_PATH` or the `FILE_APPEND` constant. The `FILE_USE_INCLUDE_PATH` constant instructs PHP to search for the specified filename in the path that is assigned to the `include_path` directive in your php.ini configuration file. The `FILE_APPEND` constant instructs PHP to append data to any existing contents in the specified filename instead of overwriting it.

Reading Data from Files

PHP includes a number of different functions for reading data from text files. These functions can be generally classified as functions that read an entire file or functions that read the contents of a file incrementally. You study the functions that read an entire file first.

You do not need to use the `fopen()` and `fclose()` functions with the functions listed in Table B-9.

Reading an Entire File

Table B-9 lists the PHP functions that you can use to read the entire contents of a text file.

Function	Description
`file(filename[, use_include_path])`	Reads the contents of a file into an indexed array
`file_get_contents(filename[, use_include_path])`	Reads the contents of a file into a string
`fread($handle, length)`	Reads the contents of a file into a string up to a maximum number of bytes
`readfile(filename[, use_include_path])`	Prints the contents of a file

Table B-9 PHP functions that read the entire contents of a text file

The `file_get_contents()` function reads the entire contents of a file into a string. If you have a text file containing a single block of data (that is not a collection of individual records), the `file_get_contents()` function can be useful. For example, assume that a weather service uses a text file to store daily weather forecasts. The following code uses the `file_put_contents()` function to write the daily forecast for San Francisco to a text file named sfweather.txt:

```
$DailyForecast = "<p><strong>San Francisco ↵
    daily weather forecast</strong>: Today: ↵
    Partly cloudy. Highs from the 60s to mid ↵
    70s. West winds 5 to 15 mph. Tonight: ↵
    Increasing clouds. Lows in the mid-40s ↵
    to lower 50s. West winds 5 to 10 ↵
    mph.</p>";
file_put_contents("sfweather.txt",
    $DailyForecast);
```

The following example uses the `file_get_contents()` function to read the contents of the sfweather.txt file into a string variable, which is then printed with an `echo()` statement:

```
$SFWeather = file_get_contents(
    "sfweather.txt");
echo $SFWeather;
```

If you only want to print the contents of a text file, you do not need to use the `file_get_contents()` function to assign the contents of a file. Instead, use the `readfile()` function, which prints the contents of a text file along with the file size to a Web browser. For example, the following `readfile()` function accomplishes the same task as the `file_get_contents()` version you saw earlier:

```
readfile("sfweather.txt");
```

APPENDIX C

Working with Well-Formed Web Pages

XHTML Document Type Definitions (DTDs)

When a document conforms to the rules and requirements of XHTML, it is said to be **well formed**. Among other things, a well-formed document must include a `<!DOCTYPE>` declaration and the `<html>`, `<head>`, and `<body>` elements. The **`<!DOCTYPE>` declaration** belongs in the first line of an XHTML document and determines the Document Type Definition with which the document complies. A **Document Type Definition**, or **DTD**, defines the elements and attributes that can be used in a document, along with the rules that a document must follow when it includes them. You can use three types of DTDs with XHTML documents: transitional, strict, and frameset. To understand the differences among the three types of DTDs, you need to understand the concept of deprecated HTML elements. One of the goals of XHTML is to separate the way HTML is structured from the way the parsed Web page is displayed in the browser. To accomplish this goal, the W3C decided that several commonly used HTML elements and attributes for display and formatting would not be used in XHTML 1.0. Instead of using HTML elements and attributes for displaying and formatting Web pages, the W3C recommends you use Cascading Style Sheets (CSS), which are discussed later in this chapter.

Elements and attributes that are considered obsolete and that will eventually be eliminated are said to be **deprecated**. Table C-1 lists the HTML elements that are deprecated in XHTML 1.0.

Element	Description
<applet>	Executes Java applets
<basefont>	Specifies the base font size
<center>	Centers text
<dir>	Defines a directory list
<font>	Specifies a font name, size, and color
<isindex>	Creates automatic document indexing forms
<menu>	Defines a menu list
<s> or <strike>	Formats strikethrough text
<u>	Formats underlined text

Table C-1 HTML elements that are deprecated in XHTML 1.0

The three DTDs are distinguished in part by the degree to which they accept or do not accept deprecated HTML elements. This is explained in more detail in the following sections.

Transitional DTD

The **transitional DTD** allows you to use deprecated style elements in your XHTML documents. The <!DOCTYPE> declaration for the transitional DTD is as follows:

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/ ↵
    xhtml1-transitional.dtd">
```

You should use the transitional DTD only if you need to create Web pages that use the deprecated elements listed in Table C-1.

Frameset DTD

The **frameset DTD** is identical to the transitional DTD, except that it includes the <frameset> and <frame> elements, which allow you to split the browser window into two or more frames.

The <!DOCTYPE> declaration for the frameset DTD is as follows:

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Frameset//EN"
"http://www.w3.org/TR/xhtml1/DTD/ ↵
    xhtml1-frameset.dtd">
```

You should understand that frames have been deprecated in favor of tables. However, frameset documents are still widely used, and you need to be able to recognize and work with them in the event that you need to modify an existing Web page that was created with frames.

Strict DTD

The **strict DTD** eliminates the elements that were deprecated in the transitional DTD and frameset DTD. The <!DOCTYPE> declaration for the strict DTD is as follows:

```
<!DOCTYPE html PUBLIC
"-//W3C//DTD XHTML 1.0 Strict//EN"
"http://www.w3.org/TR/xhtml1/DTD/ ↵
    xhtml1-strict.dtd">
```

As a rule, you should always try to use the strict DTD. This ensures that your Web pages conform to the most current Web page authoring techniques.

Writing Well-Formed Documents

As you learned earlier, a well-formed document must include a <!DOCTYPE> declaration and the <html>, <head>, and <body> elements. The following list describes some other important components of a well-formed document:

- All XHTML documents must use <html> as the root element. The xmlns attribute is required in the <html> element and must be assigned the *http://www.w3.org/1999/xhtml* URI.
- XHTML is case sensitive.
- All XHTML elements must have a closing tag.
- Attribute values must appear within quotation marks.
- Empty elements must be closed.
- XHTML elements must be properly nested.

Most of the preceding rules are self-explanatory. However, the last rule requires further explanation. **Nesting** refers to how elements are placed inside other elements. For example, in the following code, the <i> element is nested within the <b> element, while the <b> element is nested within a <p> element.

```
<p><b><i>Call for a free estimate!</i></b></p>
```

In an HTML document, it makes no difference how the elements are nested. Examine the following modified version of the preceding statement:

```
<p><b><i>Call for a free estimate!</b></p></i>
```

In this version, the opening <i> element is nested within the <b> element, which, in turn, is nested within the <p> element. Notice, however, that the closing </i> tag is outside the closing </p> tag. The <i> is the innermost element. In XHTML, the innermost element in a statement must be closed before another element is closed. In the preceding statement, the <b> and <p> elements are closed before the <i> element. Although the order in which elements are closed makes no difference in HTML, the preceding code would prevent an XHTML document from being well formed.

The second-to-last rule in the list ("Empty elements must be closed.") also requires further explanation. Three of the most common empty elements in HTML are the <hr> element, which inserts a horizontal rule into the document, the
 element, which inserts a line break, and the <img> element, which adds an image to the document. You close an empty element in XHTML by adding a space and a slash before the element's closing bracket. For example, the following code shows how to use the <hr> and
 elements in an XHTML document. Figure C-1 shows how the code appears in a Web browser.

```
<hr />
<p>In 2009, <b>China</b> had 1.3 billion people, <br />
<b>India</b> had 1.2 billion people, <br />
and <b>The United States</b> had 308
million people.</p>
<hr />
```

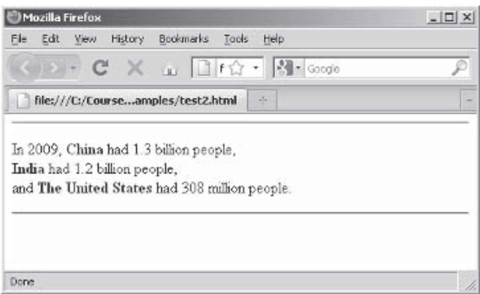


Figure C-1 XHTML document with closed empty elements

You might be wondering why XHTML documents do not use a root element of <xhtml>. The <html> element is necessary for backward compatibility with older browsers that do not recognize the <!DOCTYPE> element, which declares the DTD used by an XHTML element.

Using Phrase Elements

Recall that, early on, Web browser makers began to add their own extensions to HTML in order to provide functionality for displaying and formatting Web pages. These extensions (such as the bold and font elements) did nothing to describe the type of data being presented, but only served to instruct a Web browser how to display and format it. At the time, these extensions were considered a useful improvement. But as user agents become more complex, more nuanced elements became necessary. For example, consider the bold element. Visually, it's a great way to emphasize a word or phrase. However, it's not so useful for a user agent for the visually impaired who reads the contents of a Web page out loud. The Web developer needs some way of telling this type of user agent which text should receive extra, audible emphasis.

To address this type of issue, XHTML uses two types of inline elements for managing the formatting of text in an XHTML document: formatting elements and phrase elements. **Formatting elements** provide specific instructions about how their contents should be displayed. Two of the most commonly used formatting elements are the `<b>` element (for boldface) and the `<i>` element (for italics). **Phrase elements**, on the other hand, primarily identify or describe their contents. For instance, the `<em>` element is an emphasized piece of data, similar to a quotation. How the `<em>` element is rendered is up to each user agent, although most current Web browsers display the contents of the `<em>` element using italics. However, a user agent for the vision impaired may use the `<em>` element to pronounce the text or phrase it contains with more emphasis, in order to get the meaning across to the vision-impaired visitor to the Web site. Although text-formatting elements are commonly used and work perfectly well for displaying text with a specific style of formatting, it's better to format the text on your Web pages using a phrase element that describes its content. Using phrase elements helps ensure that your Web pages are compatible with user agents that may not be capable of handling formatting elements. Generally, you should strive not to use formatting elements at all and use only CSS to manage the display of elements on your Web pages. However, because several of the basic formatting elements are so commonly used, they are not deprecated in XHTML Strict.

Table C-2 lists the phrase elements that are available in XHTML, along with how each element is rendered by most Web browsers.

Element	Description	Renders as
`<abbr>`	`Specifies abbreviated text`	`Default text`
`<acronym>`	`Identifies an acronym`	`Default text`
`<cite>`	`Defines a citation`	`Italics`
`<code>`	`Identifies computer code`	`Monospace font`
`<dfn>`	Marks a definition	Italics
`<em>`	Defines emphasized text	Italics
`<kbd>`	Indicates text that is to be entered by a visitor to a Web site	Monospace font
`<q>`	Defines a quotation	Italics
`<samp>`	Identifies sample computer code	Monospace font
`<strong>`	Defines strongly emphasized text	Bold
`<var>`	Defines a variable	Italics

Table C-2 Phrase elements

Working with Cascading Style Sheets (CSS)

Although you should always strive to create Web pages that are compatible with all user agents, you can also design and format them so they are visually pleasing when rendered in a traditional Web browser. To design and format Web pages for traditional Web browsers, you use CSS, a standard set by the W3C for managing the design and formatting of Web pages in a Web browser. A single piece of CSS formatting information, such as text alignment or font size, is referred to as a **style**. Some of the style capabilities of CSS include the ability to change fonts, backgrounds, and colors, and to modify the layout of elements as they appear in a Web browser.

Entire books are devoted to CSS. This chapter provides only enough information to get you started. To learn more about CSS techniques, refer to Don Gosselin's *XHTML*, also published by Course Technology. For other books that cover CSS more fully, search for "css" on the Course Technology Web site at *http://www.course.com*. You can also find the latest information on CSS at the W3C's Web site: *http:/www.w3.org/style/css/*.

CSS information can be added directly to documents or stored in separate documents and shared among multiple Web pages. The term "cascading" refers to the ability of Web pages to use CSS information from more than one source. When a Web page has access to multiple CSS sources, the styles "cascade," or "fall together." Keep in mind that CSS design and formatting techniques are truly independent of the content of a Web page, unlike text-formatting elements, such as the `<b>` and `<i>` elements. CSS allows you to provide design and formatting specifications for well-formed documents that are compatible with all user agents.

CSS Properties

CSS styles are created with two parts separated by a colon: the **property**, which refers to a specific CSS style, and the value assigned to it, which determines the style's visual characteristics. Together, a CSS property and the value assigned to it are referred to as a **declaration** or **style declaration**. Figure C-2 shows a simple style declaration for the `color` property that changes the color of an element's text to blue.

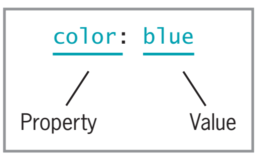


Figure C-2 Style declaration

Inline Styles

When you design a Web page, you often want the elements on your page to share the same formatting. For example, you might want all of the headings to be formatted in a specific font and color. Later in this section, you will learn how to use internal and external style sheets to apply the same formatting to multiple elements on a Web page. However, there might be times when you want to change the style of a single element on a Web page. The most basic method of applying styles is to use **inline styles**, which allows you to add style information to a single element in a document. You use the `style` attribute to assign inline style information to an element. You assign to the `style` attribute a property declaration enclosed in quotation marks. Suppose you want to modify a single paragraph in a document so it uses the Verdana font instead of the browser's default font. You can modify the default font using the following statement, which uses an inline style declaration for the `font-family` property. Figure C-3 shows how the paragraph appears in a Web browser.

```
<p>This paragraph does not use CSS.</p>
<p style="font-family: Verdana">Paragraph formatted
with inline styles.</p>
```

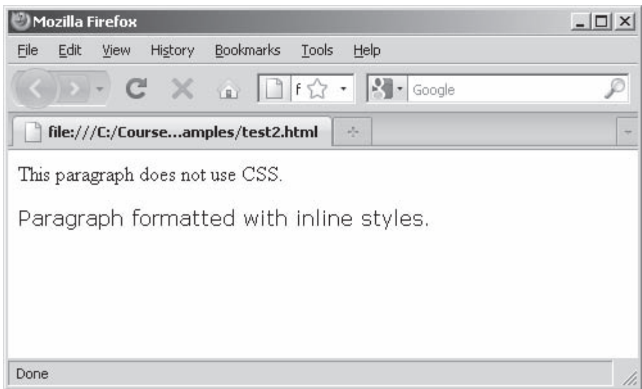


Figure C-3 Paragraph formatted with an inline style declaration

The styles you assign to an element are automatically passed to any nested elements it contains. For example, if you use the `font-family` style to assign a font to a paragraph, that font is automatically assigned to any nested elements the paragraph contains, such as `<strong>` or `<em>` elements.

You can include multiple style declarations in an inline style by separating each declaration with a semicolon. The following statement shows the same paragraph element shown earlier, but this time with two additional style declarations: one for the `color` property, which sets an element's text color to blue, and one for the `text-align` property, which centers the paragraph in the middle of the page. Notice that the `<strong>` element, which is nested in the paragraph element, automatically takes on the paragraph element's style elements. Figure C-4 shows how the paragraph appears in a Web browser.

```
<p style="font-family: Verdana; color: blue; ↵
   text-align: center">Paragraph formatted
with <strong>inline styles</strong>.</p>
```

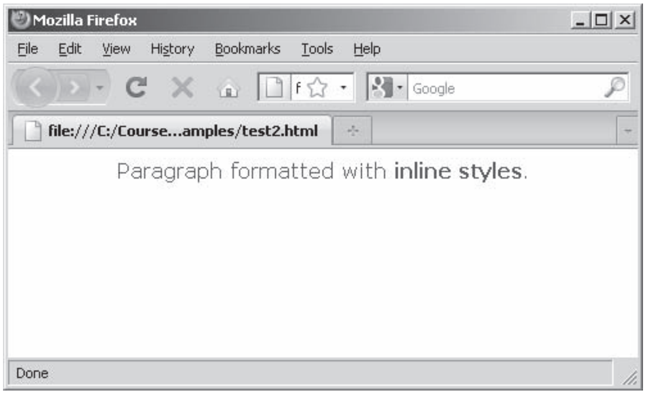


Figure C-4 Paragraph formatted with multiple inline style declarations

One of the great advantages to using CSS is that you can share styles among multiple Web pages, making it easier to create and maintain a common look and feel for an entire Web site. Inline styles, however, cannot be shared by other Web pages or even by other elements on the same page (except by elements that are nested within other elements). Plus, it is extremely time consuming to add inline styles to each and every element on a Web page. Inline styles are only useful if you need to make a one-time change to a single element on a page. If you want to apply the same formatting to multiple elements on a page or share styles with other Web pages, then you need to use internal or external style sheets.

You can also use an optional `media` attribute with the `<style>` element, which you use to select the destination medium for the style information. Valid values you can assign to the `media` attribute are screen, tty, tv, projection, handheld, print, braille, aural, and all.

Internal Style Sheets

You use an **internal style sheet** to create styles that apply to an entire document. You create an internal style sheet within a `<style>` element placed within the document head. The `<style>` element must include a `type` attribute, which is assigned a value of `"text/css"`, as follows:

```
<style type="text/css">
style declarations
</style>
```

Within the `<style>` element, you create any style instructions for a specific element that are applied to all instances of that element contained in the body of the document. The element to which specific style rules in a style sheet apply is called a **selector**. You create a style declaration for a selector in an internal style sheet by placing a list of declarations within a pair of braces `{ }` following the name of the selector. Figure C-5 shows some style declarations for the <p> element (which is the selector), which change the `color` property to blue.

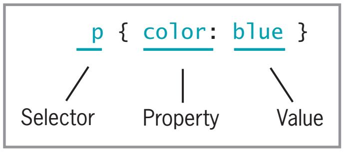


Figure C-5 Selector style declaration

As with inline styles, you separate multiple properties for a selector by semicolons. The following code shows an example of an internal style sheet. A pair of braces containing style instructions follows each selector. All instances of the associated elements in the body of the document are formatted using these style instructions.

```
...
<style type="text/css">
h1 {color: navy; font-size: 2em;
font-family: Arial}
h2 {color: red; font-size: 1.5em;
font-family: Arial}
body {color: blue; font-family: Arial;
font-size: .8em; font-weight: normal}
</style>
</head>
...
```

You can also group selectors so they share the same style declarations by separating each selector with a comma. For example, you use the following single declaration to format all of a document's `<h1>`, `<h2>`, and `<h3>` elements to use the same color:

```
<style type="text/css">
h1, h2, h3 {color: navy}
</style>
```

External Style Sheets

Inline styles are useful if you need to format only a single element; internal style sheets are useful for creating styles that apply to an entire document. However, most companies want all of the documents on a Web site to have the same look and feel. For this reason, it's preferable to use **external style sheets**, which are separate text documents containing style declarations that are used by multiple documents on a Web site. You should create an external style sheet whenever you need to use the same styles on multiple Web pages in the same site.

You create an external style sheet in a text editor, the same as when you create XHTML documents. However, you should save the document with an extension of .css. The style sheet document should not contain XHTML elements, only style declarations. Use the same rules for creating style declarations in an external style sheet as you use in an internal style sheet. The contents of a typical external style sheet may appear as follows. Notice that the code contains no XHTML elements.

```
h1 {color: navy; font-size: 2em;
font-family: serif}
h2 {color: red; font-size: 1.5em;
font-family: Arial}
body {color: blue; font-family: Arial;
font-size: .8em; font-weight: normal}
```

The most popular way to access the styles in an external style sheet is to use the empty `<link>` element to link a document to a style sheet. You place the `<link>` element in the document head. You include three attributes in the `<link>` element: an `href` attribute that is assigned the URL of the style sheet, the `rel` attribute that is assigned a value of `"stylesheet"` to specify that the referenced file is a style sheet, and the `type` attribute, which is assigned the same `"text/css"` value as the `type` attribute used in the `<style>` element. For example, to link a document to a style sheet named corpstyles.css, you include a link element in the document head, as follows:

```
<head>
...
<link rel="stylesheet" href=" corpstyles.css"
type="text/css" />
</head>
```

Next, you will learn about content-type <meta> elements, which the W3C strongly encourages you to use to specify an XHTML document's character set.

MIME is a protocol that was originally developed to allow different file types to be transmitted as attachments to e-mail messages. Now, MIME has become a standard method of exchanging files over the Internet. You specify MIME types with two-part codes separated by a forward slash (/). The first part specifies the MIME type, and the second part specifies the MIME subtype.

The Content-Type <meta> Element

When a user enters a URL for a Web page in a browser's Address box or clicks a link to a Web page, the user's Web browser asks the Web server for the Web page. One part of the response from the Web server is the requested Web page. Another important part of the response is the **response header**, which is sent to the Web browser before the Web page is sent to provide information that the browser needs to render the page. One of the most important pieces of information in the response header is the type of data, or content type, that the server is sending. For Web pages, you create a content-type <meta> element to specify a content type that the document uses. The term **metadata** means information about information. In a Web page, you use the <meta> element to provide information about the information in a Web page. You must place the <meta> element within the <head> element. You can use three primary attributes with the <meta> element: name, content, and http-equiv.

Another important use of the content-type <meta> element is to specify a document's character encoding. This allows a Web server to construct a response header in the appropriate character set. To create a content-type <meta> element, you assign a value of "content-type" to the http-equiv attribute in a <meta> element. You then assign to the <meta> element's content attribute a value of "text/html; charset=iso-8859-1". This specifies that the document's MIME type is "text/html" and that the document uses the iso-8859-1 character set, which represents English and many western European languages. The following statement shows how to construct the content-type <meta> elements:

```
<meta http-equiv="content-type"
content="text/html; charset=iso-8859-1" />
```

The content-type <meta> element is just one of many response headers that you can construct with the http-equiv attribute. Go to *http://vancouver-webpages.com/META/* for a complete list of other response header <meta> elements to use with the http-equiv attribute.

The W3C strongly encourages the use of content-type <meta> elements to specify an XHTML document's character set. However, a content-type <meta> element is not required because most current Web browsers can determine on their own the character set of an XHTML document. For XHTML documents you create in this book, you include the content-type <meta> element in order to comply with the W3C's recommendation.

APPENDIX D

JavaScript Reference

Comment Types

Line Comments

```
<script type="text/javascript">
// Line comments are preceded by two slashes.
</script>
```

Block Comments

```
<script type="text/javascript">
/*
This line is part of the block comment.
This line is also part of the block comment.
*/
/* This is another way of creating a block comment. */
</script>
```

JavaScript Reserved Words

abstract	else	instanceof	switch
boolean	enum	int	synchronized
break	export	interface	this
byte	extends	long	throw
case	false	native	throws
catch	final	new	transient
char	finally	null	true
class	float	package	try
const	for	private	typeof
continue	function	protected	var
debugger	goto	public	void
default	if	return	volatile
delete	implements	short	while
do	import	static	with
double	in	super	

Events

JavaScript Events

Event	Triggered When
abort	The loading of an image is interrupted.
blur	An element, such as a radio button, becomes inactive.
click	The user clicks an element once.
change	The value of an element, such as text box, changes.
error	An error occurs when a document or image is being loaded.
focus	An element, such as a command button, becomes active.
load	A document or image loads.
mouseout	The mouse moves off an element.
mouseover	The mouse moves over an element.
reset	A form's fields are reset to its default values.
select	A user selects a field in a form.
submit	A user submits a form.
unload	A document unloads.

Elements and Associated Events

Element	Description	Event
`<a>`	Anchor	`onfocus, onblur, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<img>`	Image	`onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<body>`	Document body	`onload, onunload, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<form>`	Form	`onsubmit, onreset, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<input>`	Form control	`tabindex, accesskey, onfocus, onblur, onselect, onchange, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<textarea>`	Text area	`onfocus, onblur, onselect, onchange, onclick, ondblclick, onmousedown, onmouseup, onmouseover, onmousemove, onmouseout, onkeypress, onkeydown, onkeyup`
`<select>`	Selection	`onfocus, onblur, onchange`

Primitive Data Types

Data type	Description
Integer numbers	Positive or negative numbers with no decimal places
Floating-point numbers	Positive or negative numbers with decimal places or numbers written using exponential notation
Boolean	A logical value of true or false
String	Text such as “Hello World”
Undefined	A variable that has never had a value assigned to it, has not been declared, or does not exist
Null	An empty value

JavaScript Escape Sequences

Escape Sequence	Character
\\	Backslash
\b	Backspace
\r	Carriage return
\“	Double quotation mark
\f	Form feed
\t	Horizontal tab
\n	New line
\0	Null character
\’	Single quotation mark
\v	Vertical tab
\x *XX*	Latin-1 character specified by the *XX* characters, which represent two hexadecimal digits
\x *XXXX*	Unicode character specified by the *XXXX* characters, which represent four hexadecimal digits

Operators

JavaScript Operator Types

Operator type	Description
Arithmetic	Used for performing mathematical calculations.
Assignment	Assigns values to variables.
Comparison	Compares operands and returns a Boolean value.
Logical	Used for performing Boolean operations on Boolean operands.
String	Performs operations on strings.
Special	Special operators are used for various purposes and do not fit within other operator categories.

Arithmetic Binary Operators

Operator	Name	Description
+	Addition	Adds two operands
-	Subtraction	Subtracts one operand from another operand
*	Multiplication	Multiplies one operand by another operand
/	Division	Divides one operand by another operand
%	Modulus	Divides one operand by another operand and returns the remainder

Arithmetic Unary Operators

Operator	Name	Description
++	Increment	Increases an operand by a value of one
--	Decrement	Decreases an operand by a value of one
-	Negation	Returns the opposite value (negative or positive) of an operand

Assignment Operators

Operator	Name	Description
=	Assignment	Assigns the value of the right operand to the left operand
+=	Compound addition assignment	Combines the value of the right operand with the value of the left operand or adds the value of the right operand to the value of the left operand and assigns the new value to the left operand
-=	Compound subtraction assignment	Subtracts the value of the right operand from the value of the left operand and assigns the new value to the left operand
*=	Compound multiplication assignment	Multiplies the value of the right operand by the value of the left operand and assigns the new value to the left operand
/=	Compound division assignment	Divides the value of the left operand by the value of the right operand and assigns the new value to the left operand
%=	Compound modulus assignment	Divides the value of the left operand by the value of the right operand and assigns the remainder to the left operand (modulus)

Comparison Operators

Operator	Name	Description
==	Equal	Returns true if the operands are equal
===	Strict equal	Returns true if the operands are equal and of the same type
!=	Not equal	Returns true if the operands are not equal
!==	Strict not equal	Returns true if the operands are not equal or not of the same type
>	Greater than	Returns true if the left operand is greater than the right operand
<	Less than	Returns true if the left operand is less than the right operand
>=	Greater than or equal	Returns true if the left operand is greater than or equal to the right operand
<=	Less than or equal	Returns true if the left operand is less than or equal to the right operand

Logical Operators

<table>
<tr><th>Operator</th><th>Name</th><th>Description</th></tr>
<tr><td>&&</td><td>And</td><td>Returns true if both the left operand and right operand return a value of true; otherwise, it returns a value of false.</td></tr>
<tr><td>||</td><td>Or</td><td>Returns true if either the left operand or right operand returns a value of true. If neither operand returns a value of true, then the expression containing the || operator returns a value of false.</td></tr>
<tr><td>!</td><td>Not</td><td>Returns true if an expression is false and returns false if an expression is true.</td></tr>
</table>

Operator Precedence

Operators	Description	Associativity
.	Objects—highest precedence	Left to right
[]	Array elements—highest precedence	Left to right
()	Functions/evaluation—highest precedence	Left to right
new	New object—highest precedence	Right to left
!	Not	Right to left
-	Unary negation	Right to left
++	Increment	Right to left
--	Decrement	Right to left
typeof	Data type	Right to left
void	Void	Right to left
delete	Delete object	Right to left
* / %	Multiplication/division/modulus	Left to right
+ -	Addition/subtraction/concatenation	Left to right
< <= > >=	Comparison	Left to right
instanceof	Object type	Left to right
in	Object property	Left to right
== != === !==	Equality	Left to right
&&	Logical and	Left to right
||	Logical or	Left to right
?:	Conditional	Right to left
= += -= *= /= %=	Compound assignment	Right to left
,	Comma—lowest precedence	Left to right

Control Structures and Statements

if Statements

```
if (conditional expression) {
    statement(s);
}
```

if...else Statements

```
if (conditional expression) {
    statement(s);
}
else {
    statement(s);
}
```

switch Statements

```
switch (expression) {
    case label:
        statement(s);
        break;
    case label:
        statement(s);
        break;
   ...
    default :
        statement(s);
}
```

while Statements

```
while (conditional expression) {
    statement(s);
}
```

do...while Statements

```
do {
    statement(s);
} while (conditional expression);
```

for Statements

```
for (initialization expression; condition; update statement) {
    statement(s);
}
```

for...in Statements

```
for (variable in object) {
    statement(s);
}
```

with Statements

```
with (object) {
    statement(s);
}
```

break Statements

A `break` statement is used to exit `switch` statements and other program control statements such as the `while`, `do...while`, `for`, and `for...in` looping statements. To end a `switch` statement once it performs its required task, you should include a `break` statement within each `case` label.

`continue` Statements

The `continue` statement halts a looping statement and restarts the loop with a new iteration. You use the `continue` statement when you want to stop the loop for the current iteration, but want the loop to continue with a new iteration.

Built-In JavaScript Functions

Function	Description
`eval()`	Evaluates expressions contained within strings
`isFinite()`	Determines whether a number is finite
`isNaN()`	Determines whether a value is the special value `NaN` (Not a Number)
`parseInt()`	Converts string literals to integers
`parseFloat()`	Converts string literals to floating-point numbers
`encodeURI()`	Encodes a text string so that it becomes a valid URI
`encodeURIComponent()`	Encodes a text string so that it becomes a valid URI component
`decodeURI()`	Decodes text strings encoded with `encodeURI()`
`decodeURIComponent()`	Decodes text strings encoded with `encodeURIComponent()`

Built-In JavaScript Classes

`Array` Class

Methods

Method	Description
`Array()`	`Array` object constructor
`concat()`	Combines two arrays into a single array
`join()`	Combines all elements of an array into a string
`pop()`	Removes and returns the last element from an array
`push()`	Adds and returns a new array element
`reverse()`	Transposes elements of an array
`shift()`	Removes and returns the first element from an array
`slice()`	Creates a new array from a section of an existing array
`splice()`	Adds or removes array elements
`sort()`	Sorts elements of an array
`unshift()`	Adds new elements to the start of an array and returns the new array length

Properties

Property	Description
`length`	Returns the number of elements in an array

Date Class

Methods

Method	Description
`Date()`	`Date` object constructor
`getDate()`	Returns the date of a `Date` object
`getDay()`	Returns the day of a `Date` object
`getFullYear()`	Returns the year of a `Date` object in four-digit format
`getHours()`	Returns the hour of a `Date` object
`getMilliseconds()`	Returns the milliseconds of a `Date` object
`getMinutes()`	Returns the minutes of a `Date` object
`getMonth()`	Returns the month of a `Date` object
`getSeconds()`	Returns the seconds of a `Date` object
`getTime()`	Returns the time of a `Date` object
`getTimezoneOffset()`	Returns the time difference between the user's computer and GMT
`getUTCDate()`	Returns the date of a `Date` object in universal time
`getUTCDay()`	Returns the day of a `Date` object in universal time
`getUTCFullYear()`	Returns the four-digit year of a `Date` object in universal time
`getUTCHours()`	Returns the hours of a `Date` object in universal time
`getUTCMilliseconds()`	Returns the milliseconds of a `Date` object in universal time
`getUTCMinutes()`	Returns the minutes of a `Date` object in universal time
`getUTCMonth()`	Returns the month of a `Date` object in universal time
`getUTCSeconds()`	Returns the seconds of a `Date` object in universal time
`getYear()`	Returns the year of a `Date` object
`parse()`	Returns a string containing the number of milliseconds since January 1, 1970
`setDate()`	Sets the date of a `Date` object
`setFullYear()`	Sets the four-digit year of a `Date` object
`setHours()`	Sets the hours of a `Date` object
`setMilliseconds()`	Sets the milliseconds of a `Date` object
`setMinutes()`	Sets the minutes of a `Date` object
`setMonth()`	Sets the month of a `Date` object
`setSeconds()`	Sets the seconds of a `Date` object

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Method	Description
`setTime()`	Sets the time of a `Date` object
`setUTCDate()`	Sets the date of a `Date` object in universal time
`setUTCDay()`	Sets the day of a `Date` object in universal time
`setUTCFullYear()`	Sets the 4-digit year of a `Date` object in universal time
`setUTCHours()`	Sets the hours of a `Date` object in universal time
`setUTCMilliseconds()`	Sets the milliseconds of a `Date` object in universal time
`setUTCMinutes()`	Sets the minutes of a `Date` object in universal time
`setUTCMonth()`	Sets the month of a `Date` object in universal time
`setUTCSeconds()`	Sets the seconds of a `Date` object in universal time
`setYear()`	Sets the two-digit year of a `Date` object
`toGMTString()`	Converts a `Date` object to a string in GMT time zone format
`toLocaleString()`	Converts a `Date` object to a string, set to the current time zone
`toString()`	Converts a `Date` object to a string

Math Class

Methods

Method	Description
`abs(`*x*`)`	Returns the absolute value of *x*
`acos(`*x*`)`	Returns the arc cosine of *x*
`asin(`*x*`)`	Returns the arc sine of *x*
`atan(`*x*`)`	Returns the arc tangent of *x*
`atan2(`*x*`,`*y*`)`	Returns the angle from the *x*-axis
`ceil(`*x*`)`	Returns the value of *x* rounded to the next highest integer
`cos(`*x*`)`	Returns the cosine of *x*
`exp(`*x*`)`	Returns the exponent of *x*
`floor(`*x*`)`	Returns the value of *x* rounded to the next lowest integer
`log(`*x*`)`	Returns the natural logarithm of *x*
`max(`*x*`,`*y*`)`	Returns the larger of two numbers
`min(`*x*`,`*y*`)`	Returns the smaller of two numbers
`pow(`*x*`,`*y*`)`	Returns the value of *x* raised to the *y* power
`random()`	Returns a random number
`round(`*x*`)`	Returns the value of *x* rounded to the nearest integer
`sin(`*x*`)`	Returns the sine of *x*
`sqrt(`*x*`)`	Returns the square root of *x*
`tan(`*x*`)`	Returns the tangent of *x*

Properties

Property	Description
`E`	Euler's constant *e*, which is the base of a natural logarithm; this value is approximately 2.7182818284590452354
`LN10`	The natural logarithm of 10, which is approximately 2.302585092994046
`LN2`	The natural logarithm of 2, which is approximately 0.6931471805599453
`LOG10E`	The base-10 logarithm of *e*, the base of the natural logarithms; this value is approximately 0.4342944819032518
`LOG2E`	The base-2 logarithm of *e*, the base of the natural logarithms; this value is approximately 1.4426950408889634
`PI`	A constant representing the ratio of the circumference of a circle to its diameter, which is approximately 3.1415926535897932
`SQRT1_2`	The square root of 1/2, which is approximately 0.7071067811865476
`SQRT2`	The square root of 2, which is approximately 1.4142135623730951

`Number` Class

Methods

Method	Description
`Number()`	`Number` object constructor
`toExponential()`	Converts a number to a string in exponential notation using a specified number of decimal places
`toFixed()`	Converts a number to a string with a specified number of decimal places
`toLocaleString()`	Converts a number to a string that is formatted with local numeric formatting conventions
`toPrecision()`	Converts a number to a string with a specific number of decimal places, either in exponential notation or in fixed notation
`toString()`	Converts a number to a string using a specified radix

Properties

Property	Description
`MAX_VALUE`	The largest positive number that can be used in JavaScript
`MIN_VALUE`	The smallest positive number that can be used in JavaScript
`NaN`	The value `NaN`, which stands for "Not a Number"
`NEGATIVE_INFINITY`	The value of negative infinity
`POSITIVE_INFINITY`	The value of positive infinity

`String` Class

Methods

Method	Description
`charAt(`*`index`*`)`	Returns the character at the specified position in a text string. Returns an empty string if the specified position is greater than the length of the string.
`charCodeAt(`*`index`*`)`	Returns the Unicode character at the specified position in a text string. Returns `NaN` if the specified position is greater than the length of the string.
`concat(`*`value1`*`, `*`value2`*`, ...)`	Creates a new string by combining the *value* arguments.
`indexOf(`*`text`*`, `*`index`*`)`	Returns the position number in a string of the first character in the *`text`* argument. If the *`index`* argument is included, then the `indexOf()` method starts searching at that position within the string. Returns -1 if the text is not found.
`lastIndexOf(`*`text`*`, `*`index`*`)`	Returns the position number in a string of the last instance of the first character in the *`text`* argument. If the *`index`* argument is included, then the `IndexOf()` method starts searching at that position within the string. Returns -1 if the character or string is not found.
`match(`*`pattern`*`)`	Returns an array containing the results that match the *`pattern`* argument.
`replace(`*`text`*`, `*`pattern`*`)`	Creates a new string with all instances of the *`text`* argument replaced with the value of the *`pattern`* argument.
`search(`*`pattern`*`)`	Returns the position number in a string of the first instance of the first character in the *`text`* argument.
`slice(`*`starting index`*`, `*`ending index`*`)`	Extracts text from a string starting with the position number in the string of the *`starting index`* argument and ending with the position number of the *`ending index`* argument. Allows negative argument values.

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Method	Description
`split(`*`text, limit`*`)`	Separates a string into an array at the character or characters specified by the *`text`* argument. The *`limit`* argument determines the maximum length of the array.
`substring(`*`starting index, ending index`*`)`	Extracts text from a string starting with the position number in the string of the *`starting index`* argument and ending with the position number of the *`ending index`* argument. Does not allow negative argument values.
`toLowerCase()`	Converts a text string to lowercase.
`toString()`	Returns the primitive value of a string.
`toUpperCase()`	Converts a text string to uppercase.
`valueOf()`	Returns the primitive value of a string.

Properties

Method	Description
`Length`	Returns the number of characters in a string

Objects of the Browser Object Model

`Document` Object

Methods

Method	Description
`close()`	Closes a new document that was created with the `open()` method
`getElementById(`*`ID`*`)`	Returns the element represented by *`ID`*
`getElementsByName(`*`name`*`)`	Returns a collection of elements represented by *`name`*
`open()`	Opens a new document in a window or frame
`write(text)`	Writes new text to a document
`writeln(text)`	Writes new text to a document, followed by a line break

Properties

Property	Description
`anchors`	Returns a collection of the document's anchor elements
`applets`	Returns a collection of the document's applets, which are Java programs that run within a Web page
`body`	Returns the document's `<body>` or `<frameset>` element
`cookie`	Returns the current document's cookie string, which contains small pieces of information about a user that are stored by a Web server in text files on the user's computer
`domain`	Returns the domain name of the server where the current document is located
`forms`	Returns a collection of the document's forms
`images`	Returns a collection of the document's images
`links`	Returns a collection of a document's links
`referrer`	Returns the Uniform Resource Locator (URL) of the document that provided a link to the current document
`title`	Returns or sets the title of the document as specified by the `<title>` element in the document `<head>` section
`URL`	Returns the URL of the current document

`History` Object

Methods

Method	Description
`back()`	Produces same result as clicking a Web browser's Back button
`forward()`	Produces same result as clicking a Web browser's Forward button
`go()`	Opens a specific document in the history list

Properties

Property	Description
`length`	Contains the specific number of documents that have been opened during the current browser session

`Location` Object

Methods

Method	Description
`assign()`	Loads a new Web page
`reload()`	Causes the page that currently appears in the Web browser to open again
`replace()`	Replaces the currently loaded URL with a different one

Properties

Property	Description
`assign()`	Loads a new Web page
`hash`	A URL's anchor
`host`	The host and domain name (or IP address) of a network host
`hostname`	A combination of the URL's host name and port sections
`href`	The full URL address
`pathname`	The URL's path
`port`	The URL's port
`protocol`	The URL's protocol
`search`	A URL's search or query portion

`Navigator` Object

Properties

Properties	Description
`appCodeName`	The Web browser code name
`appName`	The Web browser name
`appVersion`	The Web browser version
`platform`	The operating system in use on the client computer
`userAgent`	The string stored in the HTTP user-agent request header, which contains information about the browser, the platform name, and compatibility

`Screen` Object

Properties

Properties	Description
`availHeight`	Returns the available height, in pixels, of the screen that displays the Web browser
`availWidth`	Returns the available width, in pixels, of the screen that displays the Web browser
`colorDepth`	Returns the number of bits that are used for color on the screen
`height`	Returns the total height, in pixels, of the screen that displays the Web browser
`width`	Returns the total width, in pixels, of the screen that displays the Web browser

`Window` Object

Methods

Method	Description
`alert()`	Displays a simple message dialog box with an OK button
`blur()`	Removes focus from a window
`clearInterval()`	Cancels an interval that was set with `setInterval()`
`clearTimeout()`	Cancels a timeout that was set with `setTimeout()`
`close()`	Closes a Web browser window
`Confirm()`	Displays a confirmation dialog box with OK and Cancel buttons
`focus()`	Makes a `Window` object the active window
`moveBy()`	Moves the window relative to the current position
`moveTo()`	Moves the window to an absolute position
`open()`	Opens a new Web browser window
`print()`	Prints the document displayed in the window or frame
`prompt()`	Displays a dialog box prompting a user to enter information
`resizeBy()`	Resizes a window by a specified amount
`resizeTo()`	Resizes a window to a specified size
`scrollBy()`	Scrolls the window by a specified amount
`scrollTo()`	Scrolls the window to a specified position
`setInterval()`	Repeatedly executes a function after a specified number of milliseconds has elapsed
`setTimeout()`	Executes a function once after a specified number of milliseconds has elapsed

Properties

Properties	Description
`closed`	Returns a Boolean value that indicates whether a window has been closed
`defaultStatus`	Sets the default text that is written to the status bar
`document`	Returns a reference to the `Document` object
`frames[]`	Returns an array listing the `Frame` objects in a window
`history`	Returns a reference to the `History` object
`location`	Returns a reference to the `Location` object
`name`	Returns the name of the window
`navigator`	Returns a reference to the `Navigator` object
`opener`	Refers to the window that opened the current window
`parent`	Returns the parent frame that contains the current frame
`self`	Returns a self-reference to the `Window` object; identical to the `window` property
`status`	Specifies temporary text that is written to the status bar
`top`	Returns the topmost `Window` object that contains the current frame
`window`	Returns a self-reference to the `Window` object; identical to the `self` property

Objects of the Document Object Model

Form Object

Methods

Method	Description
`reset()`	Resets a form without the use of a reset button
`submit()`	Submits a form without the use of a submit button

Properties

Property	Description
`action`	Returns the URL to which form data will be submitted
`encoding`	Sets and returns a string representing the MIME type of the data being submitted
`length`	Returns an integer representing the number of elements in the form
`method`	Sets and returns a string representing one of the two options for submitting form data: “get” or ”post”

Events

Event	Description
`reset`	Executes when a form's reset button is clicked
`submit`	Executes when a form's submit button is clicked

`Image` Object

Properties

Property	Description
`border`	A read-only property containing the border width, in pixels, as specified by the `border` attribute of the `<img>` element
`complete`	A Boolean value that returns true when an image is completely loaded
`height`	A read-only property containing the height of the image as specified by the `height` attribute of the `<img>` element
`hspace`	A read-only property containing the amount of horizontal space, in pixels, to the left and right of the image, as specified by the `hspace` attribute of the `<img>` element
`lowsrc`	The URL of an alternate, low-resolution image
`name`	A name assigned to the element
`src`	The URL of the displayed image
`vspace`	A read-only property containing the amount of vertical space, in pixels, above and below the image, as specified by the `vspace` attribute of the `<img>` element
`width`	A read-only property containing the width of the image as specified by the `width` attribute of the `<img>` element

Events

Property	Description
`onabort`	Executes when the user cancels the loading of an image, usually by clicking the Stop button
`onerror`	Executes when an error occurs while an image is loading
`onload`	Executes after an image is loaded

`Input` Object

Methods and Their Associated Form Controls

Method	Description	Form Controls
`blur()`	Removes focus from a form control	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists
`click()`	Activates a form control's click event	Button, check boxes, radio buttons, reset buttons, submit buttons, selection lists
`focus()`	Changes focus to a form control	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists
`select()`	Selects the text in a form control	Text boxes, text areas, password boxes, file boxes

Properties and Their Associated Form Controls

Property	Description	Form Controls
`checked`	Sets and returns the checked status of a check box or radio button	Check boxes, radio buttons
`defaultChecked`	Determines the control that is checked by default in a check box group or radio button group	Check boxes, radio buttons
`defaultValue`	Specifies the default text that will appear in a form control	Text boxes, text areas, password boxes, file boxes
`form`	Returns a reference to the form that contains the control	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists, hidden text boxes
`length`	Returns the number of items within a selection list's `options[]` array	Selection lists
`name`	Returns the value assigned to the element's `name` attribute	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists, hidden text boxes
`selectedIndex`	Returns an integer that represents the element displayed in a selection list, according to its position	Selection lists

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Property	Description	Form Controls
`type`	Returns the type of form element: button, checkbox, file, hidden, password, radio, reset, select-one, select-multiple, submit, text, or textarea	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists, hidden text boxes
`value`	Sets and returns the value of form controls	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, hidden text boxes

Events and Their Associated Form Controls

Event	Description	Form Controls
`blur`	An element, such as a radio button, becomes inactive	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists
`change`	The value of an element, such as text box, changes	Text boxes, text areas, password boxes, file boxes, selection lists
`click`	The user clicks an element once	Button, check boxes, radio buttons, reset buttons, submit buttons
`focus`	An element, such as a command button, becomes active	Button, check boxes, radio buttons, reset buttons, submit buttons, text boxes, text areas, password boxes, file boxes, selection lists

APPENDIX E

Solutions to Short Quizzes

Chapter 1

Short Quiz 1

1. **How and why did the World Wide Web evolve?**

   In 1990 and 1991, Tim Berners-Lee created what would become the World Wide Web, or the Web, at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, as a way to easily access cross-referenced documents that existed on the CERN computer network. When other academics and scientists saw the usefulness of being able to easily access cross-referenced documents using Berners-Lee's system, the Web as we know it today was born. In fact, this method of accessing cross-referenced documents, known as hypertext linking, is probably the most important aspect of the Web because it allows you to open other Web pages quickly. A hypertext link, or hyperlink, contains a reference to a specific Web page that you can click to open that Web page.

2. **What prompted the browser wars?**

   The browser wars began over DHTML, a combination of various technologies including HTML and JavaScript that allows a Web page to change after it has been loaded by a browser. Examples of DHTML include the ability to position text and elements, change document background color, and create effects such as animation. Earlier versions of Internet Explorer and Navigator included DHTML elements that were incompatible. Furthermore, Microsoft and Netscape each wanted its version of DHTML to become the industry standard. To settle the argument, the World Wide Web Consortium set out to create a platform-independent and browser-neutral version of DHTML. The World Wide Web Consortium, or W3C, was established in 1994 at MIT to oversee the development of Web technology standards. While the W3C was drafting a recommendation for DHTML, versions 4 of both Internet Explorer and Navigator added a number of proprietary DHTML elements that were completely incompatible with the other browser. As a result, when working with advanced DHTML techniques such as animation, a programmer had to write a different set of HTML code for each browser type. Unfortunately for Netscape, the W3C adopted as the formal standard the version of DHTML found in version 4 of Internet Explorer, which prompted many loyal Netscape followers to defect to Microsoft.

3. **What are the basic element requirements for all Web pages?**

   All HTML documents must use the `<html>` element as the root element. A root element contains all the other elements in a document. This element tells a Web browser to assemble any instructions between the tags into a Web page. The opening and closing `<html>. . .</html>` tags are required and contain all the text and other elements that make up the HTML document. Two other important HTML elements are the `<head>` element and the `<body>` element. The `<head>` element contains information that is used by the Web browser, and you place it at the beginning of an HTML document, after the opening `<html>` tag. You place several elements within the `<head>` element to help manage a document's content, including the `<title>` element, which contains text that appears in a browser's title bar. A `<head>` element must contain a `<title>` element. With the exception of the <title> element, elements contained in the `<head>` element do not affect the display of the HTML document.

4. **What is a user agent?**

   An application that is capable of retrieving and processing HTML and XHTML documents is called a user agent. A user agent can be a traditional Web browser or a device, such as a mobile phone or PDA, or even an application such as a crawler for a search engine that simply collects and processes data instead of displaying it. Although user agents other than browsers can process HTML, they are not ideally suited to the task, primarily because HTML is more concerned with how data appears than with the data itself. As Web browsers have evolved over the years, they have added extensions (elements and attributes) to HTML to provide functionality for displaying and formatting Web pages. For instance, one extension to the original HTML language is the `<font>` element, which allows you to specify the font for data in an HTML document. The `<font>` element has nothing to do with the type of data in an HTML document. Instead, its sole purpose is to display data in a specific typeface within a Web browser. There is nothing wrong with continuing to author your Web pages using HTML and design elements such as the `<font>` element—provided that your Web pages will be opened only in a Web browser. However, many user agents (such as mobile phones and PDAs) are incapable of processing HTML elements that handle the display and formatting of data. User agents such as these require a language that truly defines data (such as a paragraph or heading) independently of the way it is displayed.

Short Quiz 2

1. **What are the differences among Web page design, Web page authoring, and Web development?**

   Web page design, or Web design, refers to the visual design and creation of the documents that appear on the World Wide Web. Most businesses today—both prominent and small—have Web sites. To attract and retain visitors, and to stand out from the crowd, Web sites must be exciting and visually stimulating. High-quality Web design plays an important role in attracting first-time and repeat visitors. Web page authoring (or Web authoring) refers to the creation and assembly of the tags, attributes, and data that make up a Web page. There is a subtle, but important distinction between Web design and Web page authoring: Web design refers to the visual and graphical design aspects of creating Web pages, whereas Web page authoring refers to the physical task of assembling the Web page tags and attributes. Web development, or Web programming, refers to the design of software applications for a Web site. Generally, a Web developer works "behind the scenes" to develop software applications that access databases and file systems, communicate with other applications, and perform other advanced tasks. The programs created by a Web developer will not necessarily be seen by a visitor to a Web site, although the visitor will certainly use a Web developer's programs, particularly if the Web site writes and reads data to and from a database.

2. **What are the primary roles of the client and the server in two-tier system architecture?**

   One of the primary roles of the client, or front end, in a two-tier system is the presentation of an interface to the user. The user interface gathers information from the user, submits it to a server, or back end, then receives, formats, and presents the results returned from the server. The main responsibility of a server is usually data storage and management. On client/server systems, heavy processing, such as calculations, usually takes place on the server.

3. **What is the purpose of the processing tier in three-tier system architecture?**

   The processing tier, or middle tier, handles the interaction between the Web browser client and the data storage tier. (The processing tier is also sometimes called the processing bridge.) Essentially, the client tier makes a request of a database on a Web server. The processing tier performs any necessary processing or calculations based on the request from the client tier, and then reads information from or writes information to the data storage tier. The processing tier also handles the return of any information to the client tier. Note that the processing tier is not the only place where processing can occur.

4. **Why are scripts written with the JavaScript programming language restricted to executing only within a Web browser?**

   For security reasons, the JavaScript programming language cannot be used outside of the Web browser. For example, to prevent mischievous scripts from stealing information, such as your e-mail address or credit card information you use for an online transaction, or from causing damage by changing or deleting files, JavaScript does not allow any file manipulation whatsoever. Similarly, JavaScript does not include any sort of mechanism for creating a network connection or accessing a database. This limitation prevents JavaScript programs from infiltrating a private network or intranet from which information might be stolen or damaged. Another helpful limitation is the fact that JavaScript cannot run system commands or execute programs on a client. The ability to read and write cookies is the only type of access to a client that JavaScript has. Web browsers, however, strictly govern cookies and do not allow access to cookies from outside the domain that created them. This security also means that you cannot use JavaScript to interact directly with Web servers that operate at the processing tier. Although the programmer can employ a few tricks (such as forms and query strings) to allow JavaScript to interact indirectly with a Web server, if you want true control over what's happening on the server, you need to use a server-side scripting language.

Short Quiz 3

1. **What element do you use to add JavaScript code to a Web page and how is it structured?**

   JavaScript programs contained within a Web page are often referred to as scripts. The `<script>` element tells the Web browser that the scripting engine must interpret the commands it contains. The type attribute of the `<script>` element tells the browser which scripting language and which version of the scripting language is being used. You assign a value of "text/javascript" to the type attribute to indicate that the script is written with JavaScript.

2. **What is an object as the term is used in programming languages?**

   An object is programming code and data that can be treated as an individual unit or component. For example, you might create a CarLoan object that calculates the number of payments required to pay off a car loan. The CarLoan object may also store information such as the principal loan amount and the interest rate. Individual statements used in a computer program are often grouped into logical units called procedures, which are used to perform specific tasks. For example, a procedure may contain a group of statements that calculate the sales tax based on sales total. The procedures associated with an object are called methods. A property is a piece of data, such as a color or a name, that is associated with an object. In the `CarLoan` object example, the programming code that calculates the number of payments required to pay off the loan is a method. The principal loan amount and the interest rate are properties of the `CarLoan` object.

3. **Explain how to include comments in your JavaScript code.**

   A line comment hides a single line of code. To create a line comment, add two slashes // before the text you want to use as a comment. The // characters instruct the JavaScript interpreter to ignore all text from the point immediately following the slashes to the end of the line. You can place a line comment either at the end of a line of code or on its own line. Block comments hide multiple lines of code. You create a block comment by adding /* to the first line that you want included in the block, and you close a comment block by typing */ after the last character in the block. Any text or lines between the opening /* characters and the closing */ characters are ignored by the JavaScript interpreter.

Short Quiz 4

1. **What rules must you observe when naming a variable in JavaScript?**

   - Identifiers must begin with an uppercase or lowercase ASCII letter, dollar sign ($), or underscore (_).
   - You can use numbers in an identifier, but not as the first character.
   - You cannot include spaces in an identifier.
   - You cannot use reserved words for identifiers.

2. **Why should you initialize a variable when you first declare it?**

   Although you can assign a value when a variable is declared, you are not required to do so. Your script may assign the value later, or you may use a variable to store user input. However, your script will not run correctly if it attempts to use a variable that has not been initialized. Therefore, it is good programming practice always to initialize your variables when you declare them.

3. **What is the difference between operands and operators?**

   Operands are variables and literals contained in an expression. Operators, such as the addition operator (+) and multiplication operator (*), are symbols used in expressions to manipulate operands.

4. **What is an event?**

   An event is a specific circumstance (such as an action performed by a user, or an action performed by the browser) that is monitored by JavaScript and that your script can respond to in some way. The most common events are actions that users perform. For example, when a user clicks a form button, a `click` event is generated. You can think of an event as a trigger that fires specific JavaScript code in response to a given situation. User-generated events, however, are not the only kinds of events monitored by JavaScript. Events that are not direct results of user actions, such as the `load` event, are also monitored. The `load` event, which is triggered automatically by a Web browser, occurs when a document finishes loading in a Web browser.

5. **How do you reference Web page elements with JavaScript?**

   You can use JavaScript to reference any element on a Web page by appending the element's name to the name of any elements in which it is nested, starting with the `Document` object. Specific properties of an element can then be appended to the element name. This allows you to retrieve information about an element or change the values assigned to its attributes. For example, form elements such as text boxes have `value` properties that you can use to set or retrieve the value entered into the field. Suppose that you have a form with a `name` attribute that is assigned a value of "invoice", containing a text box with a `name` attribute that is assigned value of "salesTotal". You can change the value of the text box by using a statement similar to `document.invoice.salesTotal.value = ` *`value`*`;`.

Short Quiz 5

1. **Why should you place `<script>` elements in the document head?**

   You can place `<script>` elements in either the document head or document body. Where you place your `<script>`

elements varies, depending on the program you are writing. The statements in a script are rendered in the order in which they appear in the document. As a general rule, it is a good idea to place as much of your JavaScript code as possible in the document head, because the head of a document is rendered before the document body. When placed in the document head, JavaScript code is processed before the main body of the document is displayed. It is especially important to place JavaScript code in the document head when your code performs behind-the-scenes tasks that are required by script sections located in the document body.

2. **Why would you place JavaScript in a separate source file?**

   - Your document will be neater. Lengthy JavaScript code in a document can be confusing. You may not be able to tell at a glance where the XHTML code ends and the JavaScript code begins.
   - The JavaScript code can be shared among multiple Web pages. For example, your Web site may contain pages that allow users to order an item. Each Web page displays a different item but uses the same JavaScript code to gather order information. Instead of recreating the JavaScript order information code within each document, the Web pages can share a central JavaScript source file. Sharing a single source file among multiple documents reduces disk space. In addition, when you share a source file among multiple documents, a Web browser needs to keep only one copy of the file in memory, which reduces system overhead.
   - JavaScript source files hide JavaScript code from incompatible browsers. If your document contains JavaScript code, an incompatible browser displays that code as if it were standard text. By contrast, if you put your code in a source file, incompatible browsers simply ignore it.

3. **How should you format your JavaScript code so that it does not prevent a Web page from being invalid?**

   One option is to move your code into a source file, which prevents the validator from attempting to parse the JavaScript statements. Alternatively, if you prefer to keep the JavaScript code within the document, you can enclose the code within a <script> element within a CDATA section, which marks sections of a document as CDATA. JavaScript is compatible with virtually all current Web browsers. However, it is possible that someone may open a Web page containing JavaScript on an older Web browser, which does not recognize CDATA sections. If a browser does not recognize CDATA sections, any JavaScript contained within a CDATA section will not run. To avoid this problem, you can enclose the opening and closing portions of a CDATA section within block comments.

Chapter 2

Short Quiz 1

1. **What is the difference between arguments and parameters?**

   The variables or values that you place in the parentheses of the function call statement are called arguments or actual parameters. Sending arguments to the parameters of a called function is called passing arguments. When you pass arguments to a function, the value of each argument is then assigned to the value of the corresponding parameter in the function definition. Parameters are placed within the parentheses that follow a function name. A parameter is a variable that is used within a function. Placing a parameter name within the parentheses of a function definition is the equivalent of declaring a new variable. However, you do not need to include the `var` keyword.

2. **How do you execute a function?**

   A function definition does not execute automatically. Creating a function definition only names the function, specifies its parameters, and organizes the statements it will execute. To execute a function, you must invoke, or call, it from elsewhere in your program. The code that calls a function is referred to as a function call and consists of the function name followed by parentheses, which in turn contain any variables or values to be assigned to the function parameters.

3. **Why would you want to return a value from a function?**

   In many instances, you may want your program to receive the results from a called function and then use those results in other code. For instance, consider a function that calculates the average of a series of numbers that are passed to it as arguments. Such a function would be useless if your program could not print or use the result elsewhere. As another example, suppose that you have created a function that simply prints the name of a student. Now suppose that you want to alter the program so that it uses the student name in another section of code. You can return a value from a function to a calling statement by assigning the calling statement to a variable.

4. **What is variable scope?**

   When you use a variable in a JavaScript program, particularly a complex JavaScript program, you need to be aware of the variable's scope—that is, you need to think about where in your program a declared variable can be used. A variable's scope can be either global or local. A global variable is one that is declared outside a function and is available to all parts of your program. A local variable is declared inside a function and is only available within the function in which it is declared. Local variables cease to exist when the function ends. If you attempt to use a local variable outside the function in which it is declared, you will receive an error message.

Short Quiz 2

1. **What is the difference between loosely typed and strongly typed programming languages?**

   Many programming languages require that you declare the type of data that a variable contains. Programming languages that require you to declare the data types of variables are called strongly typed programming languages. Strong typing is also known as static typing, because data types do not change after they have been declared. Programming languages that do not require you to declare the data types of variables are called loosely typed programming languages. Loose typing is also known as dynamic typing because data types can change after they have been declared. JavaScript is a loosely typed programming language. In JavaScript, you are not required to declare the data type of variables and, in fact, are not allowed to do so. Instead, the JavaScript interpreter automatically determines what type of data is stored in a variable and assigns the variable's data type accordingly.

2. **Explain exponential notation.**

   Exponential notation, or scientific notation, is a shortened format for writing very large numbers or numbers with many decimal places. Numbers written in exponential notation are represented by a value between 1 and 10 multiplied by 10 raised to some power. The value of 10 is written with an uppercase or lowercase *E*. For example, the number 200,000,000,000 can be written in exponential notation as 2.0e11, which means "two times ten to the eleventh power." Floating-point values in JavaScript range from approximately $\pm 1.7976931348623157 \times 10^{308}$ to $\pm 5 \times 10^{-324}$.

3. **What are Boolean values and how do you use them?**

   A Boolean value is a logical value of true or false. You can also think of a Boolean value as being yes or no, or on or off. Boolean values are most often used for deciding which parts of a program should execute and for comparing data. In JavaScript programming, you can only use the words true and false to indicate Boolean values. In other programming languages, you can use the integer values of 1 and 0 to indicate Boolean values of true and false—1 indicates true and 0 indicates false. JavaScript converts the values true and false to the integers 1 and 0 when necessary. For example, when you attempt to use a Boolean variable of true in a mathematical operation, JavaScript converts the variable to an integer value of 1.

4. **Explain how to use the concatenation and compound assignment operators with strings.**

   JavaScript has two operators that can be used with strings: + and +=. When used with strings, the plus sign is known as the concatenation operator. The concatenation operator (+) is used to combine two strings. For example, the following code combines a string variable and a literal string, and assigns the new value to another variable:

```
var destination = "Honolulu";
var location = "Hawaii";
destination = destination + " is in " + location;
```

   The combined value of the location variable and the string literal that is assigned to the destination variable is "Honolulu is in Hawaii."

   You can also use the compound assignment operator (+=) to combine two strings. The following code combines the two text strings, but without using the location variable:

```
var destination = "Honolulu";
destination += " is in Hawaii";
```

Note that the same symbol—a plus sign—serves as the concatenation operator and the addition operator. When used with numbers or variables containing numbers, expressions using the concatenation operator return the sum of the two numbers. As you learned earlier in Chapter 3, if you use the concatenation operator with a string value and a number value, the string value and the number value are combined into a new string value, as in the following example:

```
var textString = "The legal voting age is ";
var votingAge = 18;
newString = textString + votingAge;
```

5. **What are escape characters and escape sequences?**

   An escape character tells the compiler or interpreter that the character that follows it has a special purpose. In JavaScript, the escape character is the backslash \. Placing a backslash in front of an apostrophe tells the JavaScript interpreter that the apostrophe is to be treated as a regular keyboard character, such as "a", "b", "1", or "2", and not as part of a single quotation mark pair that encloses a text string. You can also use the escape character in combination with other characters to insert a special character into a string. When you combine the escape character with other characters, the combination is called an escape sequence. The backslash followed by an apostrophe \' and the backslash followed by a double quotation mark \" are both examples of escape sequences.

Short Quiz 3

1. **What is the difference between division (/) operator and the modulus (%) operator?**

   The division operator performs a standard mathematical division operation. For example, dividing 15 by 6 results in a value of 2.5. By contrast, the modulus operator returns the remainder that results from the division of two integers.

2. **How do you use prefix and postfix operators?**

   The increment (++) and decrement (--) unary operators can be used as prefix or postfix operators. A prefix operator is placed before a variable. A postfix operator is placed after a variable. The statements ++count; and count++; both increase the count variable by one. However, the two statements return different values. When you use the increment operator as a prefix operator, the value of the operand is returned *after* it is increased by a value of one. When you use the increment operator as a postfix operator, the value of the operand is returned *before* it is increased by a value of one. Similarly, when you use the decrement operator as a prefix operator, the value of the operand is returned *after* it is decreased by a value of one, and when you use the decrement operator as a postfix operator, the value of the operand is returned *before* it is decreased by a value of one. If you intend to assign the incremented or decremented value to another variable, then whether you use the prefix or postfix operator makes a difference.

3. **Explain how to use the += compound addition assignment operator.**

   You can use the += compound addition assignment operator to combine two strings as well as to add numbers. In the case of strings, the string on the left side of the operator is combined with the string on the right side of the operator, and the new value is assigned to the left operator. Before combining operands, the JavaScript interpreter attempts to convert a nonnumeric operand, such as a string, to a number. If a nonnumeric operand cannot be converted to a number, you receive a value of "NaN". The value "NaN" stands for "Not a Number" and is returned when a mathematical operation does not result in a numerical value.

4. **Explain how the JavaScript interpreter compares nonnumeric values.**

   When two nonnumeric values are used as operands, the JavaScript interpreter compares them in alphabetical order. The statement `arithmeticValue = "b" > "a";` returns true because the letter *b* is alphabetically greater than the letter *a*. When one operand is a number and the other is a string, the JavaScript interpreter attempts to convert the string value to a number. If the string value cannot be converted to a number, a value of false is returned. For example, the statement `arithmeticValue = 10 == "ten";` returns a value of false because the JavaScript interpreter cannot convert the string "ten" to a number.

5. **Explain how to use logical operators.**

   Logical operators are used for comparing two Boolean operands for equality. For example, a script for an automobile insurance company may need to determine whether a customer is male *and* under 21 in order to determine the correct insurance quote. As with comparison operators, a Boolean value of true or false is returned after two operands are compared. The Or (`||`) and the And (&&) operators are binary operators (requiring two operands), whereas the Not (`!`) operator is a unary operator (requiring a single operand). Logical operators are often used with comparison operators to evaluate expressions, allowing you to combine the results of several expressions into a single statement. For example, the And (&&) operator is used for determining whether two operands return an equivalent value. The operands themselves are often expressions. The Not (`!`) operator returns true if an operand evaluates to false and returns false if an operand evaluates to true.

Short Quiz 4

1. **What is associativity and how does it affect operator precedence?**

   Associativity is the order in which operators of equal precedence execute. As an example of how associativity is evaluated, consider the multiplication and division operators. These operators have an associativity of left to right. Thus, the expression 30 / 5 * 2 results in a value of 12. Although the multiplication and division operators have equal precedence, the division operation executes first because of the left to right associativity of both operators.

2. **Which operator has the highest level of associativity?**

   The `.` `[]` `()` and `new` operators have the highest level of precedence.

3. **Which operators have the lowest level of associativity?**

   The comma (`,`) has the lowest level of precedence.

Chapter 3

Short Quiz 1

1. **How do you declare and initialize an array?**

   Arrays are represented in JavaScript by the Array object. The Array object contains a special constructor, named Array(), which is used for creating an array. A constructor is a special type of function that is used as the basis for creating reference variables (that is, variables whose data type is the reference data type). You create new arrays by using the keyword new and the Array() constructor with the following syntax:

```
var arrayName = new Array(number of elements);
```

Within the parentheses of the `Array()` construction, you include an integer that represents the number of elements to be contained in the array. Each piece of data contained in an array is called an element. The following code creates an array named cellPhones that has 10 elements:

```
var cellPhones = new Array(10);
```

2. **How do you access and modify the individual elements in an array?**

   You access an element's value just as you access the value of any other variable, except that you include brackets and the element index. For example, the following code prints the values contained in the first three elements of the `cellPhones` array:

```
document.writeln(cellPhones[0]); //
prints "BlackBerry Storm 9530"
document.writeln(cellPhones[1]); //
prints "LG VX8360"
document.writeln(cellPhones[2]); //
prints "Motorola MOTO W755"
```

3. **How do you determine the number of elements in an array?**

   The `Array` class contains a single property, the length property, which returns the number of elements in an array. You append the `length` property to the name of the array whose length you want to retrieve, using the following syntax: *`array_name`*`.length`;. Remember that property names are not followed by parentheses, as are method names.

Short Quiz 2

1. **When will an `if` statement execute?**

   If the condition being evaluated returns a value of true, then the statement immediately following the conditional expression executes.

2. Why would you use a command block with a decision-making statement?

You can use a command block to construct a decision-making structure using multiple `if` statements. A command block is a set of statements contained within a set of braces, similar to the way function statements are contained within a set of braces. Each command block must have an opening brace (`{`) and a closing brace (`}`). If a command block is missing either the opening or closing brace, an error occurs.

3. Why would you nest decision-making statements?

For instance, you may have a program that uses an `if` statement to ask users if they like sports. If users answer yes, you may want to run another `if` statement that asks users whether they like team sports or individual sports. You can include any code you like within the code block for an `if` statement or an `if...else` statement, and that includes other `if` or `if...else` statements.

4. What type of label represents a specific value and contains one or more statements that execute if its value matches the value of the `switch` statement's expression?

A case label in a `switch statement` represents a specific value and contains one or more statements that execute if the value of the `case` label matches the value of the `switch` statement's expression. For example, your script for an insurance company might include a variable named `customerAge`. A `switch` statement can evaluate the variable and compare it to a `case` label within the `switch` construct. The `switch` statement might contain several `case` labels for different age groups that calculate insurance rates based on a customer's age. If the `customerAge` variable is equal to 25, the statements that are part of the "25" `case` label execute and calculate insurance rates for customers who are 25 or older. Although you could accomplish the same task using `if` or `if...else` statements, a `switch` statement makes it easier to organize the different branches of code that can be executed.

5. Describe how the statements in a `switch` statement execute. When does a `switch` statement end?

When a `switch` statement executes, the value returned by the expression is compared to each `case` label in the order in which it is encountered. Once a matching label is found, its statements execute. Unlike the `if...else` statement, execution of a `switch` statement does not automatically stop after particular `case` label statements execute. Instead, the `switch` statement continues evaluating the rest of the `case` labels in the list. Once a matching `case` label is found, evaluation of additional `case` labels is unnecessary. If you are working with a large `switch` statement with many `case` labels, evaluation of additional `case` labels can potentially slow down your program.

To avoid slow performance, then, you need to give some thought to how and when to end a `switch` statement. A `switch` statement ends automatically after the JavaScript interpreter encounters its closing brace (}). You can, however, use a special kind of statement, called a `break` statement, to end a `switch` statement once it has performed its required task. To end a `switch` statement once it performs its required task, include a `break` statement within each `case` label.

Short Quiz 3

1. **Why is a counter critical to repetition statements?**

   You track the progress of a `while` statement, or any other loop, with a counter. A counter is a variable that increments or decrements with each iteration of a loop statement. To ensure that a looping statement will eventually end, you must include code within the body of the statement that changes the value of the conditional expression. For example, suppose that you have a `while` statement that prints odd numbers between 0 and 100. You need to include code within the body of the `while` statement that ends the loop after the last odd number (99) prints. If you do not include code that changes the value used by the conditional expression, your program will be caught in an infinite loop.

2. **How do you break out of an infinite loop?**

   In most cases, you must force a Web browser that is caught in an infinite loop to close. The method for forcing an application to close varies from one operating system to another. For Windows operating systems, press Ctrl+Alt+Delete, click Task Manager to open the Windows Task Manager, click the Applications tab, click the task containing your browser name, and then click End Task.

3. **Which type of repetition statement always executes its statements once, even if the conditional expression returns a value of false?**

   The `do...while` statement executes a statement or statements once, then repeats the execution as long as a given conditional expression evaluates to true. Unlike the simpler `while` statement, the statements in a `do...while` statement always execute once, before a conditional expression is evaluated.

4. **What are the primary differences between the `while` statement and the `for` statement?**

   One of the primary differences between the `while` statement and the `for` statement is that, in addition to a conditional expression, the `for` statement can also include code that initializes a counter and changes its value with each iteration. This is useful because it provides a specific place for you to declare and initialize a counter, and to update its value, which helps prevent infinite loops.

5. **How do you restart a repetition statement?**

   The `continue` statement restarts a loop with a new iteration. `For` example, suppose that you have a script that uses a `for` statement to loop through the elements of an array containing a list of stocks. For stocks worth more than $10, the script prints information such as purchase price and number of shares on the screen. However, for stocks worth less than $10, you use the `continue` statement to skip that stock and move on to a new iteration.

Chapter 4

Short Quiz 1

1. **Explain what the browser object model is and why it's so important to JavaScript.**

   The browser object model (BOM) (or client-side object model) is a hierarchy of objects, each of which provides programmatic access to a different aspect of the Web browser window or the Web page. You can use the methods and properties of objects in the browser object model to manipulate the window and elements displayed in a Web browser.

2. **What is the top-level object in the browser object model?**

   The top-level object in the browser object model is the `Window` object, which represents a Web browser window. The Web browser automatically creates the `Window` object for you. The `Window` object is called the global object because all other objects in the browser object model are contained within it. For example, the `Window` object contains the `Document` object, just as a Web browser `window` contains a Web page document. You use the methods and properties of the Window object to control the Web browser window while you use the methods and properties of the `Document` object to control the Web page.

3. **Explain how to reference arrays that are part of the browser object model.**

   Some of the objects in the browser object model represent arrays. The arrays contain objects created from the corresponding elements on a Web page. For example, the `images[]` array contains `Image` objects that represent all the `<img>` elements on a Web page. `Image` objects for each `<img>` element are assigned to the elements of the `images[]` array in the order that they appear on the Web page. The first `Image` object is represented by `images[0]`, the second `Image` object is represented by `images[1]`, and so on.

Short Quiz 2

1. **What are the different ways that you can refer to the `Window` object?**

   You can refer to the `Window` object by using the `window` or `self` keywords.

2. **Explain how to override an internal event handler with your own code.**

   To override an internal event handler, you add to an element an event handler that executes custom code. When you override an internal event handler with your own code, your code must return a value of true or false, using the `return` statement. For example, with the `<a>` element, a value of true indicates that you want the Web browser to perform its default event handling operation of opening the URL referenced in the link. A value of false indicates that you do not want the `<a>` element to perform its default event-handling operation.

3. How do you use JavaScript to modify an element's CSS properties?

You use the style property to modify an element's CSS properties with JavaScript. In order to refer to a style with the `this` reference, you use a period to append the `style` property to it, followed by another period and a CSS property. CSS properties without hyphens are referred to in JavaScript with all lowercase letters. However, when you refer to a CSS property containing a hyphen in JavaScript code, you remove the hyphen, convert the first word to lowercase, and convert the first letter of subsequent words to uppercase. For example, the `text-decoration` property is referred to as `textDecoration`, `font-family` is referred to as `fontFamily`, `font-size` is referred to as `fontSize`, and so on.

4. How do you open and close a window, and customize its appearance?

In order to open new windows in the strict DTD, you must use the `open()` method of the `Window` object. When you open a new Web browser window, you can customize its appearance using the `options` argument of the `window.open()` method. When including multiple items in the options string, you must separate the items by commas. If you exclude the options string of the `window.open()` method, then all the standard options are included in the new Web browser window. However, if you include the options string, you must include all the components you want to create for the new window; that is, the new window is created with only the components you explicitly specify. You use the `close()` method to close a Web browser window.

5. Explain how to use timeouts and intervals to execute JavaScript code repeatedly.

The `setTimeout()` method is used in JavaScript to execute code after a specific amount of time has elapsed. Code executed with the `setTimeout()` method executes only once. The syntax for the `setTimeout()` method is `var` *`variable`* `= setTimeout("code", milliseconds);`. This statement declares that the variable will refer to the `setTimeout()` method. The code argument must be enclosed in double or single quotation marks and can be a single JavaScript statement, a series of JavaScript statements, or a function call. The amount of time the Web browser should wait before executing the code argument of the `setTimeout()`

method is expressed in milliseconds. The `clearTimeout()` method is used to cancel a `setTimeout()` method before its code executes. The `clearTimeout()` method receives a single argument, which is the variable that represents a `setTimeout()` method call. The variable that represents a `setTimeout()` method call must be declared as a global variable.

The `setInterval()` method is similar to the `setTimeout()` method, except that it repeatedly executes the same code after being called only once. The `clearInterval()` method is used to clear a `setInterval()` method call in the same fashion that the `clearTimeout()` method clears a `setTimeout()` method call. The `setInterval()` and `clearInterval()` methods are most often used for starting animation code that executes repeatedly. The syntax for the `setInterval()` method is the same as the syntax for the `setTimeout()` method: `var variable = setInterval("code", milliseconds);`. As with the `clearTimeout() method`, the `clearInterval()` method receives a single argument, which is the global variable that represents a `setInterval()` method call.

Short Quiz 3

1. **Explain the security features of the `History` object.**

   Two important security features are associated with the `History` object. First, the `History` object will not actually display the URLs contained in the history list. This is important because individual user information in a Web browser, such as the types of Web sites a user likes to visit, is private information. Preventing others from viewing the URLs in a `History` list is an essential security feature because it keeps people's likes and interests (as evidenced by the types of Web sites a person visits) confidential. This security feature is available in both Firefox and Internet Explorer.

   A second important security feature of the `History` object is specific to Internet Explorer and has to do with the domain in which a Web page exists. As mentioned earlier, you can write a script that uses the history list to navigate to Web pages that have been opened during a Web browser session. In Internet Explorer, you can use JavaScript code to navigate through a history list. However, this is only possible if the currently displayed Web page exists within the same domain as the Web page containing the JavaScript code that is attempting to move through the list. For example, a user may open the home page for a company that sells office supplies. Suppose that the user then clicks on a link on the office supply company's home page that takes them to another Web page in the company's domain, such as an online ordering page. In this case, the office supply company's home page is added to the user's history list. JavaScript code on the online ordering page can use the `History` object to navigate back to the company's home page. If JavaScript code attempts to access the `History` object of a Web browser that contains a URL located in a different domain, the Web browser ignores the JavaScript code. This security feature helps prevent malicious programmers and unscrupulous Web sites from seizing control of your browser or even your computer. As a general rule, you should only use the `History` object to help visitors navigate through your particular Web site.

2. **How do you use the `History` object to navigate backward or forward in a Web browser's history?**

   When you use a method or property of the `History` object, you must include a reference to the `History` object itself. For example, the `back()` and `forward()` methods allow a script to move backward or forward in a Web browser's history. To use the `back()` method, you must use the following: `history.back()`. The `go()` method is used for navigating to a specific Web page that has been previously visited. The argument of the `go()` method is an integer that indicates how many pages in the history list, forward or backward, you want to navigate. For example, `history.go(-2);` opens the Web page that is two pages back in the history list; the statement `history.go(3);` opens the Web page that is three pages forward in the history list. The statement `history.go(-1);` is equivalent to using the `back()` method, and the statement `history.go(1);` is equivalent to using the `forward()` method.

3. **How do you use the `Location` object to change to a new Web page?**

   The properties of the `Location` object allow you to modify individual portions of a URL. When you modify any properties of the `Location` object, you generate a new URL, and the Web browser automatically attempts to open that new URL. Instead of modifying individual portions of a URL, it is usually easier to change the `href` property, which represents the entire URL. For example, the statement `location.href = "http://www.google.com";` opens the Google home page.

4. **What is the `Navigator` object and how do you use it?**

   The `Navigator` object is used to obtain information about the current Web browser. It gets its name from Netscape Navigator but is also supported by Firefox, Internet Explorer, and other current browsers. Some Web browsers, including Internet Explorer, contain unique methods and properties of the `Navigator` object that cannot be used with other browsers. The `Navigator` object is most commonly used to determine which type of Web browser is running. Because of the incompatibilities between Firefox and Internet Explorer, it is important to be able to distinguish which browser is running in order to execute the correct code for a specific browser. The statement `browserType = navigator.appName;` returns the name of the Web browser in which the code is running to the `browserType` variable. You can then use the `browserType` variable to determine which code to run for the specific browser type.

Chapter 5

Short Quiz 1

1. **Explain how to use the Form object to use JavaScript to access form controls and verify form information.**

   To use JavaScript to access form controls and verify form information, you use the Form object, which represents a form on a Web page. The `Form` object is part of the browser object model, which you studied in Chapter 4, and contains properties, methods, and events that you can use to manipulate forms and form controls. Recall from Chapter 4 that some of the objects in the browser object model are arrays of other objects. For instance, the `Document` object includes a `forms[]` array that contains all the forms on a Web page. If a window does not contain any forms, then the `forms[]` array is empty. The first form in a document is referred to as `document.forms[0]`, the second form is referred to as `document.forms[1]`, and so on.

2. **How do you reference forms with the strict DTD?**

   Although you can still use it with the transitional DTD, it is no longer available with the strict DTD. Therefore, if you want your Web pages to be well formed according to the strict DTD, you must avoid using the `name` attribute with your `<form>` elements. Referencing a form by its position in the `forms[]` array is usually not that difficult because most Web pages rarely include more than one form.

3. **How do you use the `elements[]` array to reference elements on a form?**

   Just as the Document object has a `forms[]` array, the `Form` object has an `elements[]` array. You can use it to reference each element on a form. The `elements[]` array contains objects representing each of the controls in a form. Each element on a form is assigned to the `elements[]` array in the order in which it is encountered by the JavaScript interpreter. To refer to an element on a form, you reference the index number of the form in the `forms[]` array, followed by the appropriate element index number from the `elements[]` array.

Short Quiz 2

1. **What is the difference between minimized form and full form when referring to Boolean attributes in XHTML?**

   When a Boolean attribute is not assigned a value, the attribute is said to have a minimized form. However, recall from Chapter 1 that all attribute values must appear within quotation marks. This syntax also means that an attribute must be assigned a value. For this reason, minimized Boolean attributes are illegal in XHTML . You can still use Boolean attributes in XHTML provided that you use their full form. You create the full form of a Boolean attribute by assigning the name of the attribute itself as the attribute's value.

2. **How do you use the `isNaN()` function to determine if the value entered by a user is a number?**

   For any fields that require numeric values you can use JavaScript's built-in `isNaN()` function to determine whether the value entered by the user is a number. Recall from Chapter 3 that the `isNaN()` function determines whether a value is the special value NaN (Not a Number). The `isNaN()` function returns a value of true if the value passed to it is not a number and a value of false if the value passed to it is a number.

3. **What's the point of using a password box?**

   Each character that a user types in a password box appears as an asterisk or bullet, depending on the operating system and

Web browser, in order to hide the password from anyone who may be looking over the user's shoulder.

4. **Why would you use the `name` and `value` attributes with a push button?**

   You can use the `name` and `value` attributes with a push button `<input>` element. The text you assign to a push button's `value` attribute is the text that appears on the button's face. The width of a push button created with the `<input type="button">` element is based on the number of characters in its `value` attribute. You are not required to include the `name` and `value` attributes, because a user cannot change the value of a push button. If you include the `name` and `value` attributes, the default value set with the `value` attribute is transmitted to a Web server along with the rest of the form data.

5. **How do you create a group of radio buttons?**

   To create a group of radio buttons, all radio buttons in the group must have the same `name` attribute. Each radio button requires a `value` attribute that identifies the unique value associated with that button. Only one selected radio button in a group creates a name=value pair when a form is submitted to a Web server. You can also include the `checked` attribute in a radio `<input>` element to set an initial value for a group of radio buttons. For example, you might have a group of radio buttons that lists the cost of journal subscriptions. One button lists the cost of a three-month subscription, another button lists the cost of a six-month subscription, and another lists the cost of a yearly subscription. In order to encourage subscribers to purchase the yearly subscription, you could include the `checked` attribute with the yearly subscription radio button. If the `checked` attribute is not included in any of the <input type="radio"> elements in a radio button group, then none of the buttons in the group is selected when the form loads.

Short Quiz 3

1. **How do you create a selection list with the `<select>` element?**

   The `<select>` element creates a selection list that presents users with fixed lists of options from which to choose.

The options displayed in a selection list are created with `<option>` elements, which you will study next. As with other form elements that create controls, the `<select>` element must appear within a block-level element such as the `<p>` element. The selection list can appear as an actual list of choices or as a drop-down menu. Depending on the number of options in the list, a selection list can also include a scroll bar. Like other form controls, the `<select>` element includes a `name` attribute that is submitted to a Web server. However, the value portion of a `<select>` element's name=value pair is the value assigned to an option that is created with the `<option>` element (which you study next). If a `<select>` element includes the Boolean `multiple` attribute, which specifies whether a user can select more than one option from the list, and a visitor selects more than one option in the list, then multiple name=value pairs for the `<select>` element are submitted with the form. Each instance of a `<select>` element's name=value pair includes a value assigned to one of the selected list options created with the `<option>` element. The `size` attribute designates how many lines of the selection list appear when the form is rendered in a Web browser. If this attribute is excluded or set to 1, and the `<select>` element does not include the `multiple` attribute, then the selection list is a drop-down style menu. For drop-down style menus, the first option element is automatically selected.

2. **How do you use the `Select` object to manipulate selection lists with JavaScript?**

   The `Select` object represents a selection list in a form. The `Select` object includes an `options[]` array containing an `Option` object for each `<option>` element in the selection list. The `Option` object represents an option in a selection list. You use the `Select` and `Option` objects with JavaScript to manipulate the options displayed in a selection.

3. **How do you add options to a selection list with JavaScript?**

   To add a new option to a selection list after a Web page renders it, you must create a new option with the `Option()` constructor. After you create a new `Option` object and assign values to its properties, you assign the object to an empty element in an `options[]` array.

4. **How do you remove options in a selection list with JavaScript?**

   To remove a single option from a selection list, you pass the option's index number in the `options[]` array to the `remove()` method of the `Select` object. You can remove all the options from an options array by appending the `Selection` object's `length` property to the `options[]` array without the brackets and then by assigning the `length` property a value of 0.

5. **How do you change options in a selection with JavaScript?**

   To change an option in a selection list, you simply assign new values to the option's `value` and `text` properties.

Short Quiz 4

1. **How do you validate text and password boxes?**

   To verify that text and password boxes are not empty, you can use an `if` statement in the `onsubmit` event handler that checks whether the field's value property contains a value.

2. **How do you validate radio buttons?**

   Radio buttons share the same name so that a single name=value pair can be submitted to a server-side script. When you have an array that is created from a group of buttons that share the same name, you can use the `checked` property to determine which element in a group is selected. The `checked` property returns a value of true if a check box or radio button is selected, and a value of false if it is not.

3. **How do you validate check boxes?**

   You can use the `checked` property to determine whether an individual check box has been selected. If check boxes are part of a group, then you can validate them using the same functionality as the validation code for radio buttons, because JavaScript creates an array out of elements with the same name.

4. **How do you validate selection lists?**

   You need to test whether the selection list's `selectedIndex` property contains a value of -1. If it does, then no option is selected.

Chapter 6

Short Quiz 1

1. **Why do programmers refer to encapsulation as a black box?**

   Objects are encapsulated, which means that all code and required data are contained within the object itself. In most cases, an encapsulated object consists of a single computer file that contains all code and required data. Encapsulation places code inside what programmers like to call a black box; when an object is encapsulated, you cannot see "inside" it—all internal workings are hidden. The code (methods and statements) and data (variables and constants) contained in an encapsulated object are accessed through an interface. An interface refers to the programmatic elements required for a source program to communicate with an object.

2. **What is instantiation as it relates to classes, objects, and object-oriented programming?**

   In object-oriented programming, the code, methods, attributes, and other information that make up an object are organized into **classes**. Essentially, a class is a template, or blueprint, that serves as the basis for new objects. When you use an object in your program, you actually create an instance of the class of the object. An **instance** is an object that has been created from an existing class. When you create an object from an existing class, you are said to be **instantiating** the object.

3. **Explain how to conceptually instantiate an object from a class.**

   Consider an object named `BankAccount` that contains methods and properties that you might use to record transactions associated with a checking or savings account. The `BankAccount` object is created from a `BankAccount` class. To use the `BankAccount` class, you create an instance of the class. A particular instance of an object **inherits** its methods and properties from a class—that is, it takes on the characteristics of the class on which it is based. The `BankAccount` object, for instance, would inherit all of the methods and properties of the `BankAccount` class. To give another example, when you create a new word processing document, which is a type of object, it usually inherits the properties of a template on which it is based. The template is a type of class. The document inherits characteristics of the template such as font size, line spacing, and boilerplate text. In the same manner, programs that include instances of objects inherit the object's functionality.

Short Quiz 2

1. **How do you refer to the days of the week, dates of the month, and months of the year when working with the `Date` class?**

   If you want to display the full text for days and months (for example, Wednesday, or January), then you can use a conditional statement to check the value returned by the `getDay()` or `getMonth()` method.

2. **What is the primary reason for using any of the "to" methods in the `Number` class?**

   The primary reason for the "to" methods is to convert a number to a string value with a specific number of decimal places that will be displayed to a user. If you don't need to display the number for a user, there is no need to use any of the methods. The most useful `Number` class method is the `toFixed()` method, which you can use to display a numeric value with a specified number of decimal places. For example, you may have a number in your program that represents a dollar value. However, depending on the result of a calculation or a value entered by a user, the number may contain more than the two decimal places that are acceptable in a currency value.

3. **How do you use the `Math` object and one of its methods or properties directly in your code?**

   Unlike the `Array`, `Date`, and `Number` classes, the `Math` class does not contain a constructor. This means that you cannot instantiate a Math object by using a statement such as `var mathCalc = new Math()`. Instead, you use the `Math` object and one of its methods or properties directly in your code.

Short Quiz 3

1. **Why would you create a custom object with the `Object` object?**

   You use the `Object` object to organize properties with a single object.

2. **Explain how to create custom objects using a constructor function.**

   To declare a custom object with the `Object` object, you use the following statement:

   ```
   var objectName = new Object();
   ```

   You can also create a custom object by assigning a pair of empty braces to a variable name, as follows:

   ```
   var objectName = {};
   ```

3. **How do you add properties to a custom object?**

   To add a property to a constructor function, you must add a statement to the function body that uses the this keyword with the following syntax: `this.property_name = value;`. In the case of a custom JavaScript object, the `this` keyword refers to the object that calls the constructor function.

4. **How and why do you enumerate custom object properties?**

   Some custom objects can contain dozens of properties. For example, a script may create new custom object properties that store sales prices for each item a customer wants to purchase. Suppose that you want to discount the individual sales prices by 10% off any items that cost more than $100. Because there is no way to determine in advance which items a customer will purchase, you have no way of knowing which properties have been added to the object for each individual customer. To execute the same statement or command block for all the properties within a custom object, you can use the **for...in statement**, which is a looping statement similar to the for statement.

5. **How do you add methods to a custom object?**

   You can create a function that will be used as an object method by referring to any object properties it contains with the this reference. After a method is created, it must be added to the constructor function, using the syntax `this.methodname = functionname;`. The *methodname* following the `this` reference is the name that is being assigned to the function within the object. Remember not to include the parentheses following the function name, as you would when calling a function in JavaScript. The statement `this.methodname = functionname();` is incorrect, because it includes parentheses. To add the `displayConcertTickets()` function to the `ConcertTickets` function definition as a method named `showOrder()`, you include the statement `this.showOrder = displayConcertTickets;` within the function definition braces.

Chapter 7

Short Quiz 1

1. **Why would you need to count the number of characters in a text string?**

   You will often find it necessary to count characters and words in strings, particularly with strings from form submissions. For example, you might need to count the number of characters in a password to ensure that a user selects a password with a minimum number of characters. Or, you might have a Web page that allows users to submit classified ads that cannot exceed a maximum number of characters. The `String` class contains a single property, the length property, which returns the number of characters in a string. To return the total number of characters in a string, you append the `length` property of the `String` class to a literal string, variable, or object containing text.

2. **Explain how you include special characters within a text string.**

   You learned in Chapter 2 that when you want to include basic types of special characters, such as quotation marks, within a literal string, you must use an escape sequence. The escape sequence for double quotation marks is `\"` and the escape sequence for single quotation marks is `\'`. For other types of special characters, you need to use Unicode, which is a standardized set of characters from many of the world's languages. A number represents each character in the Unicode character set. For instance, the Unicode numbers for the uppercase letters A, B, and C, are 65, 66, and 67, respectively. In most cases, you can use XHTML numeric character references or character entities to represent Unicode characters in text strings. For example, the copyright symbol (©) can be represented in HTML by the numeric character reference `©` and the character entity is `©`.

3. **Explain why you might need to find and extract characters and substrings from a string.**

   In some situations, you will need to find and extract characters and substrings from a string. For example, if your script receives an e-mail address, you may need to extract the name portion of the e-mail address or domain name.

Short Quiz 2

1. **List three types of strings you would validate with regular expressions.**

   You can use a regular expression to ensure that a user enters a date in a specific format, such as *mm/dd/yyyy*, or a telephone number in the format (###) ###-####, or an e-mail address in the format *name@domain.identifier*.

2. **What objects and methods do you use to create a regular expression and to determine whether a particular string matches a regular expression pattern?**

   Regular expression patterns in JavaScript must begin and end with forward slashes. The following statement defines a regular expression pattern for determining whether a text string contains "https" and assigns it to a variable named `urlProtocol`. Notice that the regular expression pattern is not enclosed in quotation marks.

```
var urlProtocol = /https/;
```

   You can use regular expressions with several of the `String` class methods, including the `search()` and `replace()` methods. The value you pass to either of these methods can be either a text string or a regular expression. The following statements pass the `urlProtocol` regular expression to the `search()` method, which then searches the text contained within the `url` variable for "https". Because the `url` variable contains a protocol of "http" instead of "https", the `search()` method returns a value of -1, indicating that the regular expression pattern was not found.

```
var urlProtocol = /https/;
var url = "http://www.dongosselin.com";
document.write("<p>" +
url.search(urlProtocol) + "</p>"); //
returns -1
```

   In addition to assigning a regular expression to a variable, you can also pass the pattern directly to a method that accepts regular expressions. The following example demonstrates how to pass the /https/ regular expression directly to the search() method. Again, notice that the regular expression is not enclosed within quotation marks.

```
var url = "http://www.dongosselin.com";
document.write("<p>" +
url.search(/https/) + "</p>"); //
returns -1
```

A final approach to creating a regular expression is to use the RegExp() constructor. The RegExp() constructor is part of the RegExp object, which contains methods and properties for working with regular expressions in JavaScript. The syntax for creating a regular expression with the RegExp() constructor is as follows:

```
var regExpName = new RegExp("pattern"[,
attributes]);
```

3. **Describe the metacharacters you can use with regular expressions.**

Metacharacters are special characters that define the pattern matching rules in a regular expression. You can use the following metacharacters with JavaScript:

Metacharacter	Description
.	Matches any single character
\	Identifies the next character as a literal value
^	Matches characters at the beginning of a string
$	Matches characters at the end of a string
()	Specifies required characters to include in a pattern match
[]	Specifies alternate characters allowed in a pattern match
[^]	Specifies characters to exclude in a pattern match
-	Identifies a possible range of characters to match
|	Specifies alternate sets of characters to include in a pattern match

4. **What does a period in a regular expression represent?**

You use a period (.) to match any single character in a pattern. A period in a regular expression pattern really specifies that the pattern must contain a value where the period is located. For example, the following code specifies that the zip variable must contain five characters. Because the variable only contains three characters, the test() method returns a value of false.

```
var zipPattern = /...../;
var zip = "015";
document.write(zipPattern.test(zip)); //
returns false
```

5. **Explain how to define a character class with a regular expression.**

   You use character classes in regular expressions to treat multiple characters as a single item. You create a character class by enclosing the characters that make up the class within bracket `[]` metacharacters. Any characters included in a character class represent alternate characters that are allowed in a pattern match. You use a hyphen metacharacter (-) to specify a range of values in a character class. You can include alphabetical or numerical ranges. You specify all lowercase letters as "[a-z]" and all uppercase letters as "[A-Z]". To specify optional characters to exclude in a pattern match, include the ^ metacharacter immediately before the characters in a character class.

Short Quiz 3

1. **Explain how to find and extract elements and values in an array.**

   The primary method for finding a value in an array is to use a looping statement to iterate through the array until you find a particular value. To extract elements and values from an array, you use the `slice()` method to return (copy) a portion of an array and assign it to another array. The syntax for the `slice()` method is `array_name.slice(start, end);`. The *`array_name`* argument indicates the name of the array from which you want to extract elements. The *`start`* argument indicates the start position within the array to begin extracting elements. The *`end`* argument is an integer value that indicates the number of elements to return from the array, starting with the element indicated by the *`start`* argument.

2. **How do you add and remove elements to and from the beginning and end of an array?**

   To add or remove elements to or from the beginning of an array, you need to use the `shift()` and `unshift()` methods. The `shift()` method removes and returns the first element from the beginning of an array, whereas the `unshift()` method adds one or more elements to the beginning of an array. You append the `shift()` method to the name of the array whose first element you want to remove. You append the `unshift()` method to the name of an array and pass to the method a comma-separated list of values for each element you want to add.

3. **How do you add and remove elements within an array?**

To add or remove elements anywhere else in an array, you need to use the `splice()` method. After adding or removing array elements, the `splice()` method also renumbers the indexes in the array. The syntax for the `splice()` method is `array_name.splice(start, characters_to_delete, value1, value2, ...);`. The *`array_name`* argument indicates the name of the array you want to modify. The *`start`* argument indicates the element within the array at which point elements should be added or removed. The *`characters_to_delete`* argument is an integer value that indicates the number of elements to remove from the array, starting with the element indicated by the *`start`* argument. The *`value`* arguments represent the values you want to add as new elements to an array. To add an element within an array, include a value of 0 as the second argument to the `splice()` method. To add more than one element within an array, you must pass them as additional values to the `splice()` method. You can also delete array elements by omitting the third argument from the `splice()` method. After you delete array elements with the `splice()` method, the remaining indexes are renumbered, just as when you add new elements.

4. **Explain how to sort and reverse sort an array.**

To sort elements of an array alphabetically, you use the `sort()` method. You append the `sort()` method to the name of the array you want to sort using the following syntax: `array_name.sort();`.The `reverse()` method simply transposes, or reverses, the order of the elements in an array; it does not perform a reverse sort (Z to A instead of A to Z). If you want to perform a reverse sort on an array, then you first need to execute the `sort()` method to sort the array alphabetically and then call the `reverse()` method to transpose the array elements.

5. **Explain how to convert between strings and arrays.**

Depending on the type of data stored in a string, you may often find it easier to manipulate the data by converting it into an array. You use the `split()` method of the `String` class to split a `string` into an indexed array. The `split()` method splits each character in a string into an array element, using the syntax *`array`* `=` *`string`*`.split(`*`separator`*`[,` *`limit`*`]);`. The *`separator`* argument specifies the character or characters where the string will be separated into array elements, and the *`limit`* argument determines the maximum length of the array. If the string does not contain the specified separators, the entire string is assigned to the first element of the array. To split the individual characters in a string into an array, pass an empty string (`""`) as the *`separator`* argument. The opposite of the `split()` method is the `Array` class's `join()` method, which combines array elements into a string, separated by a comma or specified characters. The syntax for the `join()` method is *`array`*`.join(["`*`separator`*`"]);`. The *`separator`* argument specifies the character or characters that will separate the contents of each array element in the returned string. If you do not include the *`separator`* argument, the `join()` method automatically separates elements with a comma. To prevent the elements from being separated by any characters in the new string, pass an empty string (“”) as the *`separator`* argument.

Chapter 8

Short Quiz 1

1. **What is debugging and where does the term come from?**

   Any error in a program that causes it to function incorrectly, whether because of incorrect syntax or flaws in logic, is called a bug. The term *debugging* refers to the act of tracing and resolving errors in a program. Grace Murray Hopper, a mathematician who was instrumental in developing the Common Business-Oriented Language (COBOL) programming language, is said to have first coined the term “debugging.” As the story from the 1940s goes, a moth short-circuited a primitive computer that Hopper was using. Removing the moth from the computer “debugged” the system and resolved the problem. Today, the term bug refers to any sort of problem in the design and operation of a program.

2. **What is the difference between syntax errors, run-time errors, and logic errors?**

   Syntax errors occur when the interpreter fails to recognize code. The second type of error, a run-time error, occurs when the JavaScript interpreter encounters a problem while a program is executing. Run-time errors differ from syntax errors in that they do not necessarily represent JavaScript language errors. Instead, run-time errors occur when the interpreter encounters code that it cannot execute. The third type of error, logic errors, are flaws in a program's design that prevent the program from running as you anticipate. In this context, the term "logic" refers to the execution of program statements and procedures in the correct order to produce the desired results.

3. **How can you use error messages to help debug your programs?**

   The first line of defense in locating bugs in JavaScript programs are the error messages you receive when the JavaScript interpreter encounters a syntax or run-time error. Two important pieces of information displayed in error message dialog boxes are the line number in the document where the error occurred and a description of the error.

Short Quiz 2

1. **Explain how to trace errors with `window.alert()` statements.**

   The `window.alert()` method provides one of the most useful ways to trace JavaScript code. You place a `window.alert()` method at different points in your program and use it to display the contents of a variable, an array, or the value returned from a function. Using this technique, you can monitor values as they change during program execution.

2. **Explain how to trace errors with `write()` and `writeln()` statements.**

   There may be situations in which you want to trace a bug in your program by analyzing a list of values rather than by trying to interpret the values displayed in alert dialog boxes on a case-by-case basis. You can create such a list by including code that opens a new browser window (called a popup window) and using the `write()` and `writeln()` methods to print values to this separate window.

3. **Explain how to trace errors with comments.**

   Another method of locating bugs in a JavaScript program is to take lines that you think may be causing problems and transform them into comments. In other words, you can "comment out" problematic lines. This technique helps you isolate the statement that is causing the error. In some cases, you may choose to comment out individual lines that may be causing the error, or you may choose to comment out all lines except the lines that you know work. When you first receive an error message, start by commenting out only the statement specified by the line number in the error message. Save the document, and then open it again in your Web browser to see if you receive another error. If you receive additional error messages, comment out those statements as well. Once you eliminate the error messages, examine the commented-out statements for the cause of the bug.

Short Quiz 3

1. **Explain how to use break mode to trace program execution. What commands can you use to enter break mode?**

   Both JavaScript Debugger and JScript debugger include commands that you can use to control program execution after your scripts enter break mode. The term *break mode* refers to the temporary suspension of program execution so that you can monitor values and trace program execution. Entering break mode requires inserting breakpoints into your code. A breakpoint is a statement in the code at which program execution enters break mode. Once a program is paused at a breakpoint, you can use the commands on the JavaScript Debugger or JScript debugger Debug menus to trace program execution. When a program enters break mode, program execution is not stopped—it is only suspended.

2. **Once your program is in break mode, which command do you use to execute all remaining code in the current function?**

   The Step Out command executes all remaining code in the current function. If the current function was called from another function, all remaining code in the current function executes and the debugger stops at the next statement in the calling function.

3. **Explain how to use the Local Variables and Watches views in JavaScript Debugger.**

   JavaScript Debugger includes two views that you can use to trace variables and expressions during the course of program execution: Local Variables and Watches. Local Variables view displays all local variables within the currently executing function, regardless of whether or not they have been initialized. Local Variables view helps you see how different values in the currently executing function affect program execution. You use Local Variables view when you need to be able to see all of a function's variables, regardless of whether they have been assigned a value. You can change the value of a variable in Local Variables view by right-clicking the variable and selecting Change Value from the shortcut menu. Watches view monitors both variables and expressions in break mode. To open Watches view, select Watches from the Show/Hide submenu on the View menu. To display the value of a variable or expression, you right-click Watches view and select Add Watch Expression from the shortcut menu. Enter the variable or expression you want to watch, and click OK. The variable or expression you enter is displayed in Watches view, along with its value.

4. **Explain how to use the Console, Locals, and Watch panes in JScript debugger.**

   JScript debugger includes three panes that you can use to trace variables and expressions during the course of program execution: Console, Locals, and Watch. The **Console pane** monitors variables and expressions in break mode. You can also change variables and expressions in break mode from within the Console pane. To display the value of a variable or expression in the Console pane, you enter the variable or expression and press Enter. The value prints directly beneath the variable or expression in the Console pane. To change the value of a variable, type the variable name in the Console pane followed by an equal sign and the new value, and then press Enter. The new value prints beneath the statement you entered. The **Locals pane** displays all local variables within the currently executing function, regardless of whether they have been initialized. The Locals pane helps you see how different values in the currently executing function affect program execution. You use the Locals pane when you need to be able to see all of a function's variables, regardless of whether they have been assigned a value. You can change the value of a variable in the Locals pane by right-clicking the variable and selecting Edit Value from the shortcut menu. The **Watch pane** monitors both variables and expressions in break mode. To display the value of a variable or expression, click in the next available row where it says "Click to add…" Enter the variable or expression you want to watch, and press Enter. The variable or expression you enter displays in the Watch pane, along with its value.

Short Quiz 4

1. **What does the term "bulletproofing" mean when it comes to writing code?**

   Although standard error messages that are generated by programming languages such as JavaScript are very helpful to programmers, they tend to scare users, who tend to think they somehow caused the error. Errors can and will occur, but you should never let your users think that they did something wrong. Your goal should be to write code that anticipates any problems that may occur and includes graceful methods of dealing with those problems. Writing code that anticipates and handles potential problems is often called bulletproofing. One bulletproofing technique you have already used has to do with validating submitted form data.

2. **What is an exception?**

   Another method of bulletproofing your code is to use exception handling, which allows programs to handle errors, or exceptions as they are often called, as they occur in the execution of a program. Many advanced programming languages, including ECMAScript Edition 3, include exception-handling capabilities. You use exception handling to test any type of input or functionality that is external to a program. For most programming languages, exception handling is most useful when connecting to a database or when trying to access some other type of external program. Because JavaScript cannot connect to databases and is mostly limited to working within the confines of a user's Web browser, the main reason for using exception handling is to evaluate user input. Although you could technically use exception handling for all of your JavaScript programs, your code should be tested thoroughly enough that it anticipates any potential problems that may occur. However, one area that you cannot control is whether users enter the correct type of data.

3. **Explain how to create a `try...catch` block.**

   You execute code that may contain an exception in a `try` statement. You use a `throw` statement to indicate that an error occurred within a `try` block. Using a throw statement to indicate that an error occurred is called "throwing an error." The error that you "throw" with a `throw` statement can be any type of expression. After you throw an error, you use a `catch` statement to handle, or "catch" the error. The `catch` statement accepts a single argument that you can use to refer to the thrown exception.

4. **What is the purpose of a `finally` statement?**

   JavaScript's exception-handling functionality also includes a `finally` statement that executes regardless of whether its associated `try` block throws an exception. You normally use a `finally` statement to perform some type of cleanup or any necessary tasks after code is evaluated with a `try` statement.

5. **Explain how to implement custom error handling.**

   JavaScript includes an `onerror` event that executes whenever an error occurs on a Web page. Unlike other types of events, you do not call the `onerror` event handler with an XHTML tag. Instead, you must call the `onerror` event handler as a property of the Window object. You assign to the `onerror` event handler the name of a function that you want to handle JavaScript errors. When you specify a custom error-handling function by assigning it to the `onerror` event handler, the JavaScript interpreter automatically passes three arguments in the following order to the function for any JavaScript errors that occur: error message, URL, and line number. You can use the values in your custom error-handling function by adding parameters to the function definition. You can then use the parameters in your function to point out to a user the location of any JavaScript errors that may occur.

Short Quiz 5

1. **Why should you check your XHTML elements if you have a bug in your program?**

   There will be occasions when you cannot locate the source of a bug, no matter how long you search. In such cases, the flaw may not lie in your JavaScript code at all, but in your XHTML elements. If you cannot locate a bug using any of the methods described in Chapter 8, then perform a line-by-line analysis of your XHTML code, making sure that all tags have opening and closing brackets. Also, be sure that all necessary opening and closing tags, such as the `<script>...</script>` tag pair are included. Better yet, use the W3C Markup Validation Service to validate your Web page; this is usually much easier than performing a line-by-line analysis.

2. **Explain how to use a JavaScript URL to test statements for bugs.**

   If you find that the error in your code is the result of a single statement, you can test the statement using a JavaScript

URL without rerunning the entire program. A JavaScript URL is used for testing and executing JavaScript statements without an XHTML document or JavaScript source file. The syntax for a JavaScript URL is `javascript:`*`statement(s)`*. You enter a JavaScript URL into your Web browser's address box, just like a normal URL. When your browser sees the URL's `javascript:` protocol, it executes the JavaScript statements that follow. For example, to display an alert dialog box without executing a script, enter `javascript:window.alert("Hello World")` into your browser Address or Location box. You can include multiple statements in a JavaScript URL if a semicolon separates them.

3. **How do you use a `for...in` statement to check object properties?**

   Sometimes program errors are caused by using the wrong object properties or by assigning the wrong value to an object property. The `for...in` statement is a looping statement that executes the same statement or command block for all of the properties within an object. You can use a `for...in` loop to determine if values are being assigned to the correct properties in an object. This technique is useful when you have an object with many properties, and you cannot trace the cause of incorrect values being assigned to properties.

Chapter 9

Short Quiz 1

1. **Explain how to use hidden form fields to maintain state information.**

   You create hidden form fields with the `<input>` element. Hidden form fields temporarily store data that needs to be sent to a server along with the rest of a form but that a user does not need to see. Examples of data stored in hidden fields include the result of a calculation or some other type of information that a program on the Web server might need. You create hidden form fields using the same syntax used for other fields created with the `<input>` element: `<input type="hidden">`. You use JavaScript to assign to a hidden form field the values that you either want to temporarily store or that you want to submit to the server.

2. **Explain how to pass state information with query strings.**

   To pass data from one Web page to another using a query string, add a question mark (`?`) immediately after a URL, followed by the query string (in name=value pairs) for the information you want to preserve. In this manner, you are passing information to another Web page, similarly to the way you can pass arguments to a function or method. You separate individual name=value pairs within the query string using ampersands (`&`).

3. **Explain how to parse query strings.**

   For a Web page to use the information in a query string, your JavaScript program must first parse the string, using a combination of several methods and the `length` property of the `String` object. (This is also true when you want to use data contained in a cookie.) The first parsing task is to remove the question mark at the start of the query string, using the `substring()` method combined with the `length` property. As you recall from Chapter 7, the `substring()` method takes two arguments: a starting index number and an ending index number. The first character in a string has an index number of 0, similarly to the first element in an array. Because you want to exclude the first character of the string (the question mark), which has an index of 0, you use a starting index of 1. For the ending index number, you use the `length` property, which tells the `substring()` method to include the rest, or length, of the string.

Short Quiz 2

1. **Explain the difference between temporary and persistent cookies. How do you configure a cookie to be persistent?**

   Cookies can be temporary or persistent. Temporary cookies remain available only for the current browser session. Persistent cookies remain available beyond the current browser session and are stored in a text file on a client computer. In this section, you will create both persistent and temporary cookies. For a cookie to persist beyond the current browser session, you must use the expires attribute of the cookie property. The `expires` attribute of the `cookie` property determines how long a `cookie` can remain on a client system before it is deleted. Cookies created without an `expires` attribute are available for only the current browser session.

2. **How do you configure cookies to be available to other Web pages on the server?**

   The path attribute determines the availability of a cookie to other Web pages on a server. The `path` attribute is assigned to the `cookie` property, along with an associated name=value pair, using the syntax `path=`*`path name`*. By default, a cookie is available to all Web pages in the same directory. However, if you specify a path, then a cookie is available to all Web pages in the specified path as well as to all Web pages in all subdirectories in the specified path.

3. **How do you secure cookie transmissions?**

   Internet connections are not always considered safe for transmitting sensitive information. It is possible for unscrupulous people to steal personal information, such as credit card numbers, passwords, Social Security numbers, and other types of private information online. To protect private data transferred across the Internet, Netscape developed Secure Sockets Layer, or SSL, to encrypt data and transfer it across a secure connection. The URLs for Web sites that support SSL usually start with the HTTPS protocol instead of HTTP. The secure attribute indicates that a cookie can only be transmitted across a secure Internet connection using HTTPS or another security protocol. Generally, when working with client-side JavaScript, the `secure` attribute should be omitted. However, if you wish to use this attribute, you assign it to the `cookie` property with a Boolean value of true or false, along with an associated name=value pair, using the syntax `secure=`*`boolean value`*.

4. **How do you determine if a cookie exists?**

   Use an `if` statement that checks if the `document.cookie` exists.

5. **How do you delete cookies?**

   You can delete cookies, although the way in which you delete them is not intuitive. To delete a cookie, you must set its expiration to a date in the past.

Short Quiz 3

1. **What is secure coding and why is it so important?**

   To provide even stronger software security, many technology companies, including Microsoft and Oracle, now require their developers and other technical staff to adhere to secure coding practices and principles. Secure coding, or defensive coding, refers to the writing of code in such a way that minimizes any intentional or accidental security issues. Secure coding has become a major goal for many information technology companies, primarily because of the exorbitant cost of fixing security flaws in commercial software. According to one study, it is 100 times more expensive to fix security flaws in released software than it is to apply secure coding techniques during the development phase. The National Institute of Standards & Technology estimates that $60 billion a year is spent identifying and correcting software errors. In addition, politicians have recently shown a great deal of interest in regulating software security. Tom Ridge, former secretary of the U.S. Department of Homeland Security, recently said, "A few lines of code can wreak more havoc than a bomb." Intense government scrutiny gives information technology companies a strong incentive to voluntarily improve the security of software products before state and federal governments pass legislation that requires security certification of commercial software.

2. **What are some of the security areas of most concern to JavaScript?**

   The Web was originally designed to be read-only, which is to say its primary purpose was to locate and display documents that existed on other areas of the Web. With the development of programming languages such as JavaScript, Web pages can now contain programs in addition to static content. This ability to execute programs within a Web page raises several security concerns. The security areas of most concern to JavaScript programmers are:

   - Protection of a Web page and JavaScript program against malicious tampering
   - Privacy of individual client information
   - Protection of the local file system of the client or Web site from theft or tampering

   Another security concern is the privacy of individual client information in the Web browser window. Your e-mail address, bookmarks, and history list are valuable pieces of information that many direct marketers would love to get their hands on in order to bombard you with advertising geared toward your likes and dislikes. Without security restrictions, a JavaScript program could read this information from your Web browser.

3. What is the same origin policy?

The same origin policy restricts how JavaScript code in one window or frame accesses a Web page in another window or frame on a client computer. For windows and frames to view and modify the elements and properties of documents displayed in other windows and frames, they must have the same protocol (such as HTTP) and exist on the same Web server. The same origin policy applies not only to the domain name but also to the server on which a document is located. The same origin policy prevents malicious scripts from modifying the content of other windows and frames and prevents the theft of private browser information and information displayed on secure Web pages. How crucial is the same origin policy? Consider the `src` attribute of the `Document` object, which determines the URL displayed in a window or frame. If a client has multiple windows or frames open on its system and the same origin policy did not exist, then a Web page in one window or frame could change the Web pages displayed in other windows or frames. There are plenty of unscrupulous or simply malicious advertisers who would try to force you to view only their Web pages. The security of private networks and intranets would also be at risk without the same origin policy. Consider a user who has one Web browser open to a page on the Internet and another Web browser open to a secure page from his or her private network or intranet. Without the same origin policy, the Internet Web page would have access to the information displayed on the private Web page.

The same origin policy also protects the integrity of the design of your Web page. For example, without the same origin policy, a frame in one window or frame could modify the elements and properties of JavaScript objects and XHTML code in other windows and frames.

Chapter 10

Short Quiz 1

1. How can you make Web pages dynamic?

You use Dynamic HTML (DHTML), which refers to a combination of technologies that make Web pages dynamic. The term *DHTML* actually refers to a combination of JavaScript, XHTML, CSS, and the Document Object Model.

2. **What is the most important part of DHTML and why?**

   When it comes to Web page authoring, the most important part of the HTML DOM is the `Document` object. Through the `Document` object, you can access other objects that represent elements on a Web page.

3. **Explain why you would use the `open()` and `close()` methods of the DOM.**

   You use the `open()` method to create a new document in a window or frame, and then use the `write()` and `writeln()` methods to add content to the new document. The `close()` method notifies the Web browser that you are finished writing to the window or frame and that the document should be displayed. Although later versions of Internet Explorer and Netscape do not require you to use the `open()` and `close()` methods with the `write()` and `writeln()` methods, some older browsers do not display any content in the window until you execute the `close()` method. In addition, some browsers, including Firefox, do not stop the spinning icon in the upper-right browser corner that indicates a document is loading until the `close()` method executes. Because Firefox is the most widely used browser, you should always use the `open()` and `close()` methods when dynamically creating document content. You should always use the `open()` and `close()` methods when you want to use the `write()` and `writeln()` methods to update the text displayed in an existing window or frame. Specifically, if you do not use the `close()` method to notify the Web browser that you are finished writing to the window or frame, then any new calls to the `write()` and `writeln()` methods are appended to the existing text that is currently displayed in the window or frame.

Short Quiz 2

1. **Why do you need to use the `Image` object?**

   An Image object represents an image created using the `<img>` element. You need to use an `Image` object if you want to dynamically change an image that is displayed on a Web page.

2. **How do you create basic animation with the `Image` object?**

   You can create simple animation on a Web page by combining the `src` attribute of the `Image` object with the `setTimeout()` or `setInterval()` methods.

3. **Why and how do you need to ensure that all images are downloaded into a cache before commencing an animation sequence?**

   Even when you use image caching, the images must all be loaded into an `Image` object before the animation functions correctly. Often, you will want animation to start as soon as a page finishes loading, as is the case with the airplane animation. However, even though a page has finished loading, all the images may not have finished downloading and may not be stored in image caches. If you run the airplane animation across an Internet connection, the `onload` event handler of the `<body>` element may execute the animation sequence before all the frames are transferred and assigned to `Image` objects (depending on Internet connection speed). The animation will still function but will be erratic until all the images have been successfully stored in `Image` objects. To be certain that all images are downloaded into a cache before commencing an animation sequence, you use the `onload` event handler of the `Image` object.

Short Quiz 3

1. **Explain how to access elements by name.**

   The `getElementsByName()` method returns an array of elements with a name attribute that matches a specified value. You append the `getElementsByName()` method to the `Document` object and pass to it a single argument representing the name attribute of the elements you want to retrieve.

2. **Explain how to access elements by tag name.**

   The `getElementsByTagName()` method is similar to the `getElementsByName()` method, except that, instead of returning an array of elements with a name attribute that matches a specified value, it returns an array of elements that match a specified tag name. You append the `getElementsByTagName()` method to the `Document` object and pass to it a single argument representing the name of the elements you want to retrieve.

3. **Explain how to access elements by ID.**

   The `getElementsByName()` and `getElementsByTagName()` methods are extremely useful if you need to work with collections of elements that have the same name attribute or are of the same type. However, if you are only interested in accessing a single element, you should use the `getElementById()` method, which returns the first element in a document with a matching id attribute. You append the `getElementById()` method to the `Document` object and pass to it a single argument representing the ID of the element you want to retrieve.

4. **Explain how to modify elements with the `innerHTML` property.**

   To use the `innerHTML` property, you append it to an object representing the element whose value you want to retrieve or modify. You can also append the `innerHTML` property to an element that is returned from the `getElementById()`, `getElementsByName()`, or `getElementsByTagName()` methods.

Chapter 11

Short Quiz 1

1. **How do you modify styles with methods of the `Document` object?**

   In order to modify CSS properties without using the `this` reference, you must first gain access to the styles by using the `getElementById()`, `getElementsByName()`, or `getElementsByTagName()` methods of the `Document` object. Then, you can use the `style` property to access the required CSS style.

2. **Why doesn't this book use code that checks whether the browser is compliant with the W3C DOM?**

   Chapter 11 primarily discusses DOM techniques that are compatible with the W3C's standardized version of DHTML. That makes sense because, at the time of this writing, well over 90% of Internet users access the Web with a W3C-compliant browser. If you anticipate that your DHTML code will run in older browsers, you need to learn the DHTML techniques for each type of browser.

3. **Explain how to use a browser sniffer.**

   Although there are several ways to write a browser sniffer, including using properties of the `Navigator` object, the easiest way to test whether a Web browser is compatible with the W3C DOM is to check whether the browser includes the `getElementById()` method. You can check whether a browser includes the `getElementById()` method using a statement similar to if `(document.getElementById)`. If the method is available in the browser, then a value of true is returned, meaning that the browser is compatible with the W3C DOM.

Short Quiz 2

1. **What is the most critical CSS positioning property and what are the values you can assign to it?**

   The most critical CSS positioning property is the `position` property, which determines the type of positioning applied to an element. You can assign to the `position` property the values "absolute", which positions an element in a specific location on a Web page; "fixed", which positions an element in relation to the browser window; "relative", which positions an element in relation to other elements on a Web page; and "static", which positions an element in relation to other elements on a Web page.

2. **What is the easiest way to dynamically position Web page elements?**

   The easiest way to dynamically position an element with CSS is to use the `left` and `top` properties. The `left` property specifies an element's horizontal distance from the upper-left corner of the window, whereas the `top` property specifies an element's vertical distance from the upper-left corner of the window. Both property values are assigned in pixels.

3. **How do you create traveling animation?**

   Use the `setInterval()` function with the `left` and `top` properties to dynamically position the image.

Short Quiz 3

1. **Explain how to create expandable menus.**

   The display property specifies whether to display an element on a Web page. You can use the `display` property to simulate expandable and collapsible menus on a Web page. You typically use the `display` property with a block-level element, which gives a Web page its structure. Most Web browsers render block-level elements so that they appear on their own line. Block-level elements can contain other block-level elements or inline elements. The `<p>` element and heading elements (`<h1>`, `<h2>`, and so on) are examples of common block-level elements with which you have worked. Inline elements, or text-level elements, describe the text that appears on a Web page. Unlike block-level elements, inline elements do not appear on their own lines; instead, they appear within the line of the block-level element that contains them. Examples of inline elements include the `<b>` (bold) and `<br />` (line break) elements. One block-level element you may be familiar with is the <div> element, which formats a group of block-level and inline elements with styles. By placing elements and text within a `<div>` element, you can use the `display` property to simulate expandable and collapsible menus.

2. **Explain how to create navigation menus.**

   Although there are several ways to create a navigation menu, the easiest way is to use a table to contain your menu items. First, you create a master table whose purpose is to contain nested tables for each individual menu. You nest the contents of a navigation menu within the same cell as the top navigation menu heading. To show and hide each menu, you use the visibility property, which determines whether an element is visible.

3. **Explain how to create sliding menus.**

   Although the `visibility` and `display` properties are quite effective in showing and hiding menus, they simply display their associated elements without any sort of effect. In order to simulate a sliding effect, you must use the `left` and `top` properties (depending on whether you are creating a horizontal or vertical menu) along with simple animation techniques. In order to "hide" the contents of a horizontal navigation menu, you must assign a negative value to the table's `left` property. In order to hide the contents of a vertical navigation menu, you must assign a negative value to the table's `left` property.

Chapter 12

Short Quiz 1

1. **How do you access content on a separate domain?**

   Two methods you can use for accessing content on a separate domain are RSS and Web services. RSS (for RDF Site Summary or Rich Site Summary) is an XML format that allows Web sites to publish content that can be read by other

Web sites. Typical types of data that are published with RSS feeds include news listings, blogs, and digital content such as podcasts. A Web service, or XML Web service, is a software component that resides on a Web server. Web services do not contain any sort of graphical user interface or even a command line interface. Instead, they simply provide services and data in the form of methods and properties; it is up to the client accessing a Web service to provide an implementation for a program that calls a Web service.

2. **How do you run AJAX from a Web server?**

   Because AJAX relies on the `XMLHttpRequest` object to retrieve data, you must open your AJAX files from a Web server with the HTTP protocol (http://). You can turn a computer into a Web server by installing Web server software on it. The most popular Web server software used on the Internet is Apache HTTP Server (typically referred to as Apache), which is used by more than half of today's Web sites. The second most popular Web server is Microsoft Internet Information Services (IIS) for Windows operating systems, which is used on about one-third of today's Web sites.

3. **What are the primary steps for creating an AJAX script?**

   - Instantiate an `XMLHttpRequest` object for the Web browser where the script will run.
   - Use the `XMLHttpRequest` object to send a request to the server.
   - Read and process the data returned from the server.

Short Quiz 2

1. **What are HTTP messages and headers?**

   HTTP client requests and server responses are both known as HTTP messages. When you submit a request for a Web page, the HTTP client opens a connection to the server and submits a request message. The Web server then returns a response message that is appropriate to the type of request. Each message can include zero or more lines containing headers, which define information about the request or response message and about the contents of the message body. The RFC2616 recommendation defines 46 HTTP 1.1 headers, categorized by generic headers that can be used in request or response messages and headers that are specific to a request, a response, or the message body. The format for using a header is *header*: *value*.

2. **Explain how caching is used with Web pages and why you should avoid using it with AJAX.**

   Caching refers to the temporary storage of data for faster access. If caching is enabled in a Web browser, the Web browser will attempt to locate any necessary data in its cache before making a request from a Web server. For example, assume that caching is turned on when you open the stock quotes Web page. If you enter the same stock symbol more than once and click the Get Quotes button, the browser will retrieve the stock data stored in its cache and not the most recent data from the server. While this technique improves Web browser performance, it goes against the reason for using AJAX, which is to dynamically update portions of a Web page with the most recent data from a server. For this reason, you should always include in your AJAX programs the `Cache-Control` header, assigned a value of "no-cache".

3. **List and explain the response codes returned from an HTTP server.**

   HTTP response messages take the same format as request messages, except for the contents of the start line and the headers. Instead of containing a request method, the start line (also known as the status line), returns the protocol and version of the HTTP server (such as HTTP/1.1) along with a status code and descriptive text. The status codes returned from an HTTP server consist of three digits. The codes that begin with 1 (101, 102, etc.) are purely information, indicating, for instance that the request was received. The codes that begin with 2 indicate a successful request. The following list summarizes the types of messages provided by the three digit codes that begin with 1 through 5.

   - 1*xx* (informational)—Request was received
   - 2*xx*: (success)—Request was successful
   - 3*xx*: (redirection)—Request cannot be completed without further action
   - 4*xx*: (client error)—Request cannot be fulfilled due to a client error
   - 5*xx*: (server error)— Request cannot be fulfilled due to a server error

Short Quiz 3

1. **Why is the `XMLHttpRequest` object the key to turning your JavaScript script into an AJAX program?**

   The `XMLHttpRequest` object is the key to turning your JavaScript script into an AJAX program because it allows you to use JavaScript and HTTP to exchange data between a Web browser and a Web server. More specifically, you use the methods and properties of an instantiated `XMLHttpRequest` object with JavaScript to build and send request messages and to receive and process response messages.

2. **Explain how to instantiate an `XMLHttpRequest` object for different browsers.**

   For Mozilla-based browsers, such as Firefox, and for Internet Explorer 7, you instantiate an `XMLHttpRequest` object with the `XMLHttpRequest` constructor, as follows:

   ```
   var httpRequest = new XMLHttpRequest();
   ```

   For Internet Explorer 6, you use the following syntax to instantiate an `XMLHttpRequest` object by passing a value of "Msxml2.XMLHTTP" to the ActiveX object constructor:

   ```
   var httpReq = new ActiveXObject("Msxml2.XMLHTTP");
   ```

   Internet Explorer 5.5 requires the following slightly different syntax to instantiate an `XMLHttpRequest` object by passing a value of "Microsoft.XMLHTTP" instead of "Msxml2.XMLHTTP" to the ActiveX object constructor:

   ```
   var httpReq = new
   ActiveXObject("Microsoft.XMLHTTP");
   ```

3. **Explain how to open and send a request with an `XMLHttpRequest` object.**

   After you instantiate an `XMLHttpRequest` object, you use the `open()` method with the instantiated `XMLHttpRequest` object to specify the request method (such as "get" or "post") and URL. The `open()` method also accepts three optional arguments. The first two optional arguments— a user name and password—are only necessary if the Web server requires authentication. The third optional argument, the *async* argument, can be assigned a value of true or false to determine whether the request will be handled synchronously or asynchronously. Assigning a value of true to the *async* argument performs the request asynchronously, while a value of false performs the request synchronously. If you omit the *async* argument, it defaults to a value of true, which performs the request asynchronously. After you have defined the basic request criteria with the `open()` method, you use the `send()` method with the instantiated `XMLHttpRequest` object to submit the request to the server. The `send()` method accepts a single argument containing the message body.

Short Quiz 4

1. **Explain how to send and receive synchronous responses.**

   The value of the `open()` method's third argument determines whether the HTTP request is performed synchronously or asynchronously. A synchronous request stops the processing of the JavaScript code until a response is returned from the server. To create a synchronous request, you should check the value of the `XMLHttpRequest` object's `status` property, which contains the HTTP status code (such as 200 for "OK" or 404 for "Not Found") that was returned with the response, to ensure that the response was received successfully.

2. **Explain how to send and receive asynchronous responses.**

   In contrast to a synchronous request, an asynchronous request allows JavaScript to continue processing while it waits for a server response. To create an asynchronous request, you pass a value of true as the third argument of the `open()` method or omit the argument altogether. To receive a response for an asynchronous request, you must use the `XMLHttpRequest` object's `readyState` property and `onreadystatechange` event. The `readyState` property contains one of the following values, which represents the state of the HTTP request: 0 (uninitialized), 1 (open), 2 (sent), 3 (receiving), or 4 (loaded). The `onreadystatechange` event is triggered whenever the value assigned to the `readyState` property changes. You assign to the `onreadystatechange` event the name of a function that will execute whenever the `readyState` property changes.

3. **Explain how to refresh server data automatically.**

   To automatically refresh data that is obtained from an HTTP server, you use JavaScript's `setTimeout()` or `setInterval()` methods to send a request to the server, and read and process the data returned from the server.

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Note: Page numbers in boldface type indicate pages where key terms are defined.

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