Section 15. Expressions and Control Flow in JavaScript

In the previous section, I introduced the basics of JavaScript and the DOM. Now it's time to look at how to construct complex expressions in JavaScript and how to control the program flow of your scripts by using conditional statements.

Expressions

JavaScript expressions are very similar to those in PHP. As you learned in Section 4, an expression is a combination of values, variables, operators, and functions that results in a value; the result can be a number, a string, or a Boolean value (which evaluates to either `true` or `false`).

Example 15-1 shows some simple expressions. For each line, it prints out a letter between `a` and `d`, followed by a colon and the result of the expressions. The `<br>` tag is there to create a line break and separate the output into four lines (remember that both `<br>` and `<br />` are acceptable in HTML5, so I chose to use the former style for brevity).

Example 15-1. Four simple Boolean expressions

```
<script>
  document.write("a: " + (42 > 3) + "<br>")
  document.write("b: " + (91 < 4) + "<br>")
  document.write("c: " + (8 == 2) + "<br>")
  document.write("d: " + (4 < 17) + "<br>")
</script>
```

The output from this code is as follows:

```
a: true
b: false
c: false
d: true
```

Notice that both expressions `a:` and `d:` evaluate to `true`, but `b:` and `c:` evaluate to `false`. Unlike PHP (which would print the number `1` and nothing, respectively), the actual strings `true` and `false` are displayed.

In JavaScript, when you are checking whether a value is `true` or `false`, all values evaluate to `true` except the following, which evaluate to `false`: the string `false` itself, `0`, `-0`, the empty string, `null`, `undefined`, and `NaN` (Not a Number, a computer engineering concept for the result of an illegal floating-point operation such as division by zero).

Note that I am referring to `true` and `false` in lowercase. This is because, unlike in PHP, these values *must* be in lowercase in JavaScript. Therefore, only the first of the two following statements will display, printing the lowercase word `true`, because the second will cause a `'TRUE' is not defined` error:

```
if (1 == true) document.write('true') // True
if (1 == TRUE) document.write('TRUE') // Will cause an error
```

Note

Remember that any code snippets you wish to type and try for yourself in an HTML file need to be enclosed within `<script>` and `</script>` tags.

Literals and Variables

The simplest form of an expression is a *literal*, which means something that evaluates to itself, such as the number `22` or the string `Press Enter`. An expression could also be a variable, which evaluates to the value that has been assigned to it. They are both types of expressions, because they return a value.

Example 15-2 shows three different literals and two variables, all of which return values, albeit of different types.

Example 15-2. Five types of literals

```
<script>
  myname = "Peter"
  myage  = 24
  document.write("a: " + 42     + "<br>") // Numeric literal
  document.write("b: " + "Hi"   + "<br>") // String literal
  document.write("c: " + true   + "<br>") // Constant literal
  document.write("d: " + myname + "<br>") // String variable
  document.write("e: " + myage  + "<br>") // Numeric variable
</script>
```

And, as you'd expect, you see a return value from all of these in the following output:

```
a: 42
b: Hi
c: true
d: Peter
e: 24
```

Operators let you create more complex expressions that evaluate to useful results. When you combine assignment or control-flow constructs with expressions, the result is a *statement*.

Example 15-3 shows one of each. The first assigns the result of the expression `366 - day_number` to the variable `days_to_new_year`, and the second outputs a friendly message only if the expression `days_to_new_year < 30` evaluates to `true`.

Example 15-3. Two simple JavaScript statements

```
<script>
  day_number       = 127  // For example
  days_to_new_year = 366 - day_number
  if (days_to_new_year < 30) document.write("It's nearly New Year")
  else                       document.write("It's a long time to go")
</script>
```

Operators

JavaScript offers a lot of powerful operators, ranging from arithmetic, string, and logical operators to assignment, comparison, and more (see Table 15-1).

Table 15-1. JavaScript operator types

Operator	Description	Example
Arithmetic	Basic mathematics	`a + b`
Array	Array manipulation	`a + b`
Assignment	Assign values	`a = b + 23`
Bitwise	Manipulate bits within bytes	`12 ^ 9`
Comparison	Compare two values	`a < b`
Increment/decrement	Add or subtract one	`a++`
Logical	Boolean	`a && b`

Operator	Description	Example
String	Concatenation	`a + 'string'`

Each operator takes a different number of operands:

- *Unary* operators, such as incrementing (`a++`) or negation (`-a`), take a single operand.
- *Binary* operators, which represent the bulk of JavaScript operators—including addition, subtraction, multiplication, and division—take two operands.
- The one *ternary* operator, which takes the form `? x : y`, requires three operands. It's a terse single-line `if` statement that chooses between two expressions depending on a third one.

Operator Precedence

Like PHP, JavaScript utilizes operator precedence, in which some operators in an expression are processed before others and are therefore evaluated first. Table 15-2 lists JavaScript's operators and their precedences.

Table 15-2. Precedence of JavaScript operators (high to low)

Operator(s)	Type(s)
`() [] .`	Parentheses, call, and member
`++ --`	Increment/decrement
`+ - ~ !`	Unary, bitwise, and logical
`* / %`	Arithmetic
`+ -`	Arithmetic and string
`<< >> >>>`	Bitwise
`< > <= >=`	Comparison
`== != === !==`	Comparison
`& ^ |`	Bitwise
`&&`	Logical
`||`	Logical
`? :`	Ternary
`= += -= *= /= %=`	Assignment
`<<= >>= >>>= &= ^= |=`	Assignment
`,`	Separator

Associativity

Most JavaScript operators are processed in order from left to right in an equation. But some operators require processing from right to left instead. The direction of processing is called the operator's *associativity*.

This associativity becomes important where you do not explicitly force precedence (which you should always do, by the way, because it makes code more readable and less error prone). For example, look at the following assignment operators, by which three variables are all set to the value `0`:

```
level = score = time = 0
```

This multiple assignment is possible only because the rightmost part of the expression is evaluated first and then processing continues in a right-to-left direction. Table 15-3 lists the JavaScript operators and their associativity.

Table 15-3. Operators and associativity

Operator	Description	Associativity
`++ --`	Increment and decrement	None
`new`	Create a new object	Right
`+ - ~ !`	Unary and bitwise	Right
`?:`	Ternary	Right
`= *= /= %= += -=`	Assignment	Right
`<<= >>= >>>= &= ^= |=`	Assignment	Right
`,`	Separator	Left
`+ - * / %`	Arithmetic	Left
`<< >> >>>`	Bitwise	Left
`< <= > >= == != === !==`	Arithmetic	Left

Relational Operators

Relational operators test two operands and return a Boolean result of either `true` or `false`. There are three types of relational operators: *equality*, *comparison*, and *logical*.

Equality operators

The equality operator is == (which should not be confused with the = assignment operator). In Example 15-4, the first statement assigns a value, and the second tests it for equality. As it stands, nothing will be printed out, because `month` is assigned the string value `July`, and therefore the check for it having a value of `October` will fail.

Example 15-4. Assigning a value and testing for equality

```
<script>
  month = "July"
  if (month == "October") document.write("It's the Fall")
</script>
```

If the two operands of an equality expression are of different types, JavaScript will convert them to whatever type makes best sense to it. For example, any strings composed entirely of numbers will be converted to numbers whenever compared with a number. In Example 15-5, `a` and `b` are two different values (one is a number, and the other is a string), and we would therefore normally expect neither of the `if` statements to output a result.

Example 15-5. The equality and identity operators

```
<script>
  a = 3.1415927
  b = "3.1415927"
  if (a == b)  document.write("1")
  if (a === b) document.write("2")
</script>
```

However, if you run the example, you will see that it outputs the number `1`, which means that the first `if` statement evaluated to `true`. This is because the string value of `b` was temporarily converted to a number, and therefore both halves of the equation had a numerical value of `3.1415927`.

In contrast, the second `if` statement uses the *identity* operator, three equals signs in a row, which prevents JavaScript from automatically converting types. `a` and `b` are therefore found to be different, so nothing is output.

As with forcing operator precedence, whenever you're in doubt about how JavaScript will convert operand types, you can use the identity operator to turn this behavior off.

Comparison operators

Using comparison operators, you can test for more than just equality and inequality. JavaScript also gives you `>` (is greater than), `<` (is less than), `>=` (is greater than or equal to), and `<=` (is less than or equal to) to play with. Example 15-6 shows these operators in use.

Example 15-6. The four comparison operators

```
<script>
  a = 7; b = 11
  if (a > b)  document.write("a is greater than b<br>")
  if (a < b)  document.write("a is less than b<br>")
  if (a >= b) document.write("a is greater than or equal to b<br>")
  if (a <= b) document.write("a is less than or equal to b<br>")
</script>
```

In this example, where `a` is `7` and `b` is `11`, the following is output (because 7 is less than 11 and also less than or equal to 11):

```
a is less than b
a is less than or equal to b
```

Logical operators

Logical operators produce true or false results and are also known as *Boolean* operators. There are three of them in JavaScript (see Table 15-4).

Table 15-4. JavaScript's logical operators

Logical operator	Description
&& *(and)*	`true` if both operands are `true`
`||` *(or)*	`true` if either operand is `true`
`!` *(not)*	`true` if the operand is `false`, or `false` if the operand is `true`

You can see how these can be used in Example 15-7, which outputs `0`, `1`, and `true`.

Example 15-7. The logical operators in use

```
<script>
  a = 1; b = 0
  document.write((a && b) + "<br>")
  document.write((a || b) + "<br>")
  document.write((  !b  ) + "<br>")
</script>
```

The && statement requires both operands to be `true` to return a value of `true`, the `||` statement will be `true` if either value is `true`, and the third statement performs a `NOT` on the value of `b`, turning it from `0` into a value of `true`.

The `||` operator can cause unintentional problems, because the second operand will not be evaluated if the first is evaluated as `true`. In Example 15-8, the `getnext` function will never be called if `finished` has a value of `1` (these are purely examples, and the action of getnext is irrelevant to this explanation—just think of it as a function that does *something* when called).

Example 15-8. A statement using the || operator

```
<script>
  if (finished == 1 || getnext() == 1) done = 1
</script>
```

If you *need* getnext to be called at each if statement, you should rewrite the code as shown in Example 15-9.

Example 15-9. The if...or statement modified to ensure calling of getnext

```
<script>
  gn = getnext()
  if (finished == 1 OR gn == 1) done = 1;
</script>
```

In this case, the code in the function getnext will be executed and its return value stored in gn before the if statement.

Table 15-5 shows all the possible variations of using the logical operators. You should also note that !true equals false and !false equals true.

Table 15-5. All possible logical expressions

Inputs		Operators and results	
a	b	&&	||
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

The with Statement

The `with` statement is not one that you've seen in the earlier sections on PHP, because it's exclusive to JavaScript, and also one that while you need to know it, you should not use (see ???). With it (if you see what I mean), you can simplify some types of JavaScript statements by reducing many references to an object to just one reference. References to properties and methods within the `with` block are assumed to apply to that object.

For example, take the code in Example 15-10, in which the `document.write` function never references the variable `string` by name.

Example 15-10. Using the `with` statement

```
<script>
  string = "The quick brown fox jumps over the lazy dog"

  with (string)
  {
    document.write("The string is " + length + " characters<br>")
    document.write("In upper case it's: " + toUpperCase())
  }
</script>
```

Even though `string` is never directly referenced by `document.write`, this code still manages to output the following:

```
The string is 43 characters
In upper case it's: THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
```

This is how the code works: the JavaScript interpreter recognizes that the `length` property and `toUpperCase` method have to be applied to some object. Because they stand alone, the interpreter assumes they apply to the `string` object that you specified in the `with` statement.

Note

Using `with` is no longer recommended and is now forbidden in ECMAScript 5 strict mode. The recommended alternative is to assign the object whose properties you want to access to a temporary variable. Be sure to note this so you can update it (if necessary) when you see it in other people's code, but do not use it yourself.

Using onerror

Using either the `onerror` event or a combination of the `try` and `catch` keywords, you can catch JavaScript errors and deal with them yourself.

Events are actions that can be detected by JavaScript. Every element on a web page has certain events that can trigger JavaScript functions. For example, the `onclick` event of a button element can be set to call a function and make it run whenever a user clicks the button.

Example 15-11 illustrates how to use the `onerror` event.

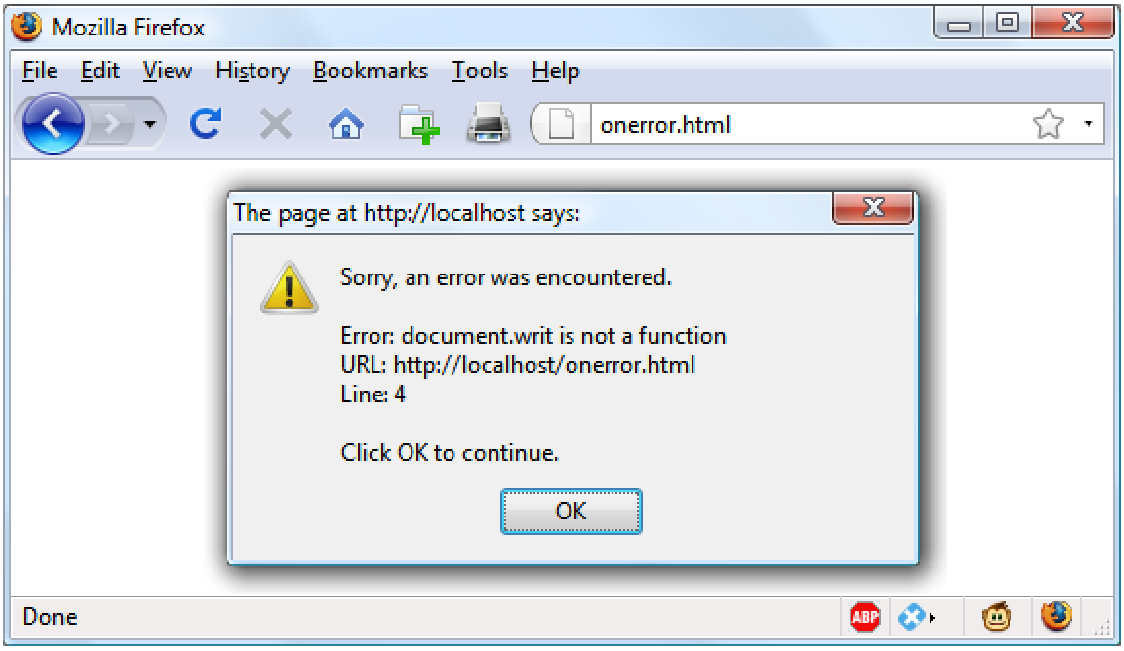
Example 15-11. A script employing the onerror event

```
<script>
  onerror = errorHandler
  document.writ("Welcome to this website") // Deliberate error

  function errorHandler(message, url, line)
  {
    out  = "Sorry, an error was encountered.\n\n";
    out += "Error: " + message + "\n";
    out += "URL: "   + url     + "\n";
    out += "Line: "  + line    + "\n\n";
    out += "Click OK to continue.\n\n";
    alert(out);
    return true;
  }
</script>
```

The first line of this script tells the error event to use the new `errorHandler` function from now on. This function takes three parameters—a `message`, a `url`, and a `line` number—so it’s a simple matter to display all these in an alert pop-up.

Then, to test the new function, we deliberately place a syntax error in the code with a call to `document.writ` instead of `document.write` (the final `e` is missing). Figure 15-1 shows the result of running this script in a browser. Using `onerror` this way can also be quite useful during the debugging process.



The page at http://localhost says:

Sorry, an error was encountered.

Error: document.writ is not a function
URL: http://localhost/onerror.html
Line: 4

Click OK to continue.

Figure 15-1. Using the `onerror` event with an alert method pop-up

Using try...catch

The `try` and `catch` keywords are more standard and more flexible than the `onerror` technique shown in the previous section. These keywords let you trap errors for a selected section of code, rather than all scripts in a document. However, they do not catch syntax errors, for which you need `onerror`.

The `try...catch` construct is supported by all major browsers and is handy when you want to catch a certain condition that you are aware could occur in a specific part of your code.

For example, in Section 18 we'll be exploring Ajax techniques that make use of the `XMLHttpRequest` object. Therefore, we can use `try` and `catch` to trap this case and do something else if the function is not available. Example 15-12 shows how.

Example 15-12. Trapping an error with `try` and `catch`

```
<script>
  try
  {
    request = new XMLHTTPRequest()
  }
  catch(err)
  {
    // Use a different method to create an XMLHTTPRequest object
  }
</script>
```

There's also another keyword associated with `try` and `catch` called `finally` that is always executed, regardless of whether an error occurs in the `try` clause. To use it, just add something like the following statements after a `catch` statement:

```
finally
{
  alert("The 'try' clause was encountered")
}
```

Conditionals

Conditionals alter program flow. They enable you to ask questions about certain things and respond to the answers you get in different ways. There are three types of nonlooping conditionals: the `if` statement, the `switch` statement, and the `?` operator.

The if Statement

Several examples in this section have already made use of `if` statements. The code within such a statement is executed only if the given expression evaluates to `true`. Multiline `if` statements require curly braces around them, but as in PHP, you can omit the braces for single statements, although it's often a good idea to use them anyway, especially when writing code in which the number of actions within an `if` statement might change as development proceeds. Therefore, the following statements are valid:

```
if (a > 100)
{
  b=2
  document.write("a is greater than 100")
}

if (b == 10) document.write("b is equal to 10")
```

The else Statement

When a condition has not been met, you can execute an alternative by using an `else` statement, like this:

```
if (a > 100)
{
  document.write("a is greater than 100")
}
else
{
  document.write("a is less than or equal to 100")
}
```

Unlike PHP, JavaScript has no `elseif` statement, but that’s not a problem because you can use an `else` followed by another `if` to form the equivalent of an `elseif` statement, like this:

```
if (a > 100)
{
  document.write("a is greater than 100")
}
else if(a < 100)
{
  document.write("a is less than 100")
}
else
{
  document.write("a is equal to 100")
}
```

As you can see, you can use another `else` after the new `if`, which could equally be followed by another `if` statement, and so on. Although I have shown braces on the statements, because each is a single line, the previous example could be written as follows:

```
if     (a > 100) document.write("a is greater than 100")
else if(a < 100) document.write("a is less than 100")
else             document.write("a is equal to 100")
```

The switch Statement

The `switch` statement is useful when one variable or the result of an expression can have multiple values and you want to perform a different function for each value.

For example, the following code takes the PHP menu system we put together in Section 4 and converts it to JavaScript. It works by passing a single string to the main menu code according to what the user requests. Let’s say the options are Home, About, News, Login, and Links, and we set the variable `page` to one of these according to the user’s input.

The code for this written using `if...else if...` might look like Example 15-13.

Example 15-13. A multiline `if...else if...` statement

```
<script>
  if      (page == "Home")  document.write("You selected Home")
  else if (page == "About") document.write("You selected About")
  else if (page == "News")  document.write("You selected News")
  else if (page == "Login") document.write("You selected Login")
  else if (page == "Links") document.write("You selected Links")
</script>
```

But using a `switch` construct, the code could look like Example 15-14.

Example 15-14. A `switch` construct

```
<script>
  switch (page)
  {
    case "Home":
      document.write("You selected Home")
      break
    case "About":
      document.write("You selected About")
      break
    case "News":
      document.write("You selected News")
      break
    case "Login":
      document.write("You selected Login")
      break
    case "Links":
      document.write("You selected Links")
      break
  }
</script>
```

The variable `page` is mentioned only once at the start of the `switch` statement. Thereafter, the `case` command checks for matches. When one occurs, the matching conditional statement is executed. Of course, a real program would have code here to display or jump to a page, rather than simply telling the user what was selected.

Note

You may also supply multiple cases for a single action. For example:

```
switch (heroName)
{
  case "Superman":
  case "Batman":
  case "Wonder Woman":
    document.write("Justice League")
    break
  case "Iron Man":
  case "Captain America":
  case "Spiderman":
    document.write("The Avengers")
    break
}
```

Breaking out

As you can see in Example 15-14, just as with PHP, the `break` command allows your code to break out of the `switch` statement once a condition has been satisfied. Remember to include the `break` unless you want to continue executing the statements under the next `case`.

Default action

When no condition is satisfied, you can specify a default action for a `switch` statement by using the `default` keyword. Example 15-15 shows a code snippet that could be inserted into Example 15-14.

Example 15-15. A default statement to add to Example 15-14

```
default:
  document.write("Unrecognized selection")
  break
```

The ? Operator

The `ternary` operator (`?`), combined with the `:` character, provides a quick way of doing `if...else` tests. With it you can write an expression to evaluate and then follow it with a `?`

symbol and the code to execute if the expression is `true`. After that, place a `:` and the code to execute if the expression evaluates to `false`.

Example 15-16 shows the ternary operator being used to print out whether the variable `a` is less than or equal to 5 and prints something either way.

Example 15-16. Using the ternary operator

```
<script>
  document.write(
    a <= 5 ?
    "a is less than or equal to 5" :
    "a is greater than 5"
  )
</script>
```

The statement has been broken up into several lines for clarity, but you would be more likely to use such a statement on a single line, in this manner:

```
size = a <= 5 ? "short" : "long"
```

Looping

Again, you will find many close similarities between JavaScript and PHP when it comes to looping. Both languages support `while`, `do...while`, and `for` loops.

while Loops

A JavaScript `while` loop first checks the value of an expression and starts executing the statements within the loop only if that expression is `true`. If it is `false`, execution skips over to the next JavaScript statement (if any).

Upon completing an iteration of the loop, the expression is again tested to see if it is `true`, and the process continues until such a time as the expression evaluates to `false` or until execution is otherwise halted. Example 15-17 shows such a loop.

Example 15-17. A `while` loop

```
<script>
  counter=0

  while (counter < 5)
  {
    document.write("Counter: " + counter + "<br>")
    ++counter
  }
</script>
```

This script outputs the following:

```
Counter: 0
Counter: 1
Counter: 2
Counter: 3
Counter: 4
```

Warning

If the variable `counter` were not incremented within the loop, it is quite possible that some browsers could become unresponsive due to a never-ending loop, and the page may not even be easy to terminate with Escape or the Stop button. So, be careful with your JavaScript loops.

---

do...while Loops

When you require a loop to iterate at least once before any tests are made, use a `do...while` loop, which is similar to a `while` loop, except that the test expression is checked only after each iteration of the loop. So, to output the first seven results in the 7 times table, you could use code such as that in Example 15-18.

Example 15-18. A `do...while loop`

```
<script>
  count = 1

  do
  {
    document.write(count + " times 7 is " + count * 7 + "<br>")
  } while (++count <= 7)
</script>
```

As you might expect, this loop outputs the following:

```
1 times 7 is 7
2 times 7 is 14
3 times 7 is 21
4 times 7 is 28
5 times 7 is 35
6 times 7 is 42
7 times 7 is 49
```

for Loops

A `for` loop combines the best of all worlds into a single looping construct that allows you to pass three parameters for each statement:

- An initialization expression
- A condition expression
- A modification expression

These are separated by semicolons, like this: `for (`*`expr1`*` ; `*`expr2`*` ; `*`expr3`*`)`. The initialization expression is executed at the start of the first iteration of the loop. In the case of the code for the multiplication table for 7, `count` would be initialized to the value `1`. Then, each time around the loop, the condition expression (in this case, `count <= 7`) is tested, and the loop is entered only if the condition is `true`. Finally, at the end of each iteration, the modification expression is executed. In the case of the multiplication table for 7, the variable `count` is incremented. Example 15-19 shows what the code would look like.

Example 15-19. Using a `for` loop

```
<script>
  for (count = 1 ; count <= 7 ; ++count)
  {
    document.write(count + "times 7 is " + count * 7 + "<br>");
  }
</script>
```

As in PHP, you can assign multiple variables in the first parameter of a `for` loop by separating them with a comma, like this:

```
for (i = 1, j = 1 ; i < 10 ; i++)
```

Likewise, you can perform multiple modifications in the last parameter, like this:

```
for (i = 1 ; i < 10 ; i++, --j)
```

Or you can do both at the same time:

```
for (i = 1, j = 1 ; i < 10 ; i++, --j)
```

Breaking Out of a Loop

The `break` command, which you'll recall is important inside a `switch` statement, is also available within `for` loops. You might need to use this, for example, when searching for a match of some kind. Once the match is found, you know that continuing to search will only waste time and make your visitor wait. Example 15-20 shows how to use the `break` command.

Example 15-20. Using the break command in a for loop

```
<script>
  haystack     = new Array()
  haystack[17] = "Needle"

  for (j = 0 ; j < 20 ; ++j)
  {
    if (haystack[j] == "Needle")
    {
      document.write("<br>- Found at location " + j)
      break
    }
    else document.write(j + ", ")
  }
</script>
```

This script outputs the following:

```
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16,
- Found at location 17
```

The continue Statement

Sometimes you don't want to entirely exit from a loop but instead wish to skip the remaining statements just for this iteration of the loop. In such cases, you can use the `continue` command. Example 15-21 shows this in use.

Example 15-21. Using the `continue` command in a `for` loop

```
<script>
  haystack     = new Array()
  haystack[4]  = "Needle"
  haystack[11] = "Needle"
  haystack[17] = "Needle"

  for (j = 0 ; j < 20 ; ++j)
  {
    if (haystack[j] == "Needle")
    {
      document.write("<br>- Found at location " + j + "<br>")
      continue
    }

    document.write(j + ", ")
  }
</script>
```

Notice how the second `document.write` call does not have to be enclosed in an `else` statement (as it did before), because the `continue` command will skip it if a match has been found. The output from this script is as follows:

```
0, 1, 2, 3,
- Found at location 4
5, 6, 7, 8, 9, 10,
- Found at location 11
12, 13, 14, 15, 16,
- Found at location 17
18, 19,
```

Explicit Casting

Unlike PHP, JavaScript has no explicit casting of types such as `(int)` or `(float)`. Instead, when you need a value to be of a certain type, use one of JavaScript's built-in functions, shown in Table 15-6.

Table 15-6. JavaScript’s type-changing functions

Change to type	Function to use
Int, Integer	parseInt()
Bool, Boolean	Boolean()
Float, Double, Real	parseFloat()
String	String()
Array	split()

So, for example, to change a floating-point number to an integer, you could use code such as the following (which displays the value 3):

```
n = 3.1415927
i = parseInt(n)
document.write(i)
```

Or you can use the compound form:

```
document.write(parseInt(3.1415927))
```

That’s it for control flow and expressions. The next section focuses on the use of functions, objects, and arrays in JavaScript.