

Java allows conversions between integer values and floating-point values. In addition, because every character corresponds to a number in the Unicode encoding, `char` values can be converted to and from the integer and floating-point types. In fact, `boolean` is the only primitive type that cannot be converted to or from another primitive type in Java.

There are two basic types of conversions. A *widening conversion* occurs when a value of one type is converted to a wider type—one that has a larger range of legal values. For example, Java performs widening conversions automatically when you assign an `int` literal to a `double` variable or a `char` literal to an `int` variable.

Narrowing conversions are another matter, however. A *narrowing conversion* occurs when a value is converted to a type that is not wider than it is. Narrowing conversions are not always safe: it is reasonable to convert the integer value 13 to a `byte`, for example, but it is not reasonable to convert 13,000 to a `byte`, because `byte` can hold only numbers between -128 and 127. Because you can lose data in a narrowing conversion, the Java compiler complains when you attempt any narrowing conversion, even if the value being converted would in fact fit in the narrower range of the specified type:

```
int i = 13;
// byte b = i;    // Incompatible types: possible lossy conversion
//                // from int to byte
```

The one exception to this rule is that you can assign an integer literal (an `int` value) to a `byte` or `short` variable if the literal falls within the range of the variable.

If you need to perform a narrowing conversion and are confident you can do so without losing data or precision, you can force Java to perform the conversion using a language construct known as a *cast*. Perform a cast by placing the name of the desired type in parentheses before the value to be converted. For example:

```
int i = 13;
byte b = (byte) i;    // Force the int to be converted to a byte
i = (int) 13.456;    // Force this double literal to the int 13
```

Casts of primitive types are most often used to convert floating-point values to integers. When you do this, the fractional part of the floating-point value is simply truncated (i.e., the floating-point value is rounded toward zero, not toward the nearest integer). The static methods `Math.round()`, `Math.floor()`, and `Math.ceil()` perform other types of rounding.

So far in this chapter, we've learned about the primitive types that Java programs can manipulate and seen how to include primitive values as *literals* in a Java program. We've also used *variables* as symbolic names that represent, or hold, values. These literals and variables are the tokens out of which Java programs are built.

An *expression* is the next higher level of structure in a Java program. The Java interpreter *evaluates* an expression to compute its value. The very simplest expressions are called *primary expressions* and consist of literals and variables. So, for example, the following are all expressions:

```
1.7        // A floating-point literal
true       // A Boolean literal
sum        // A variable
```

When the Java interpreter evaluates a literal expression, the resulting value is the literal itself. When the interpreter evaluates a variable expression, the resulting value is the value stored in the variable.

Primary expressions are not very interesting. More complex expressions are made by using *operators* to combine primary expressions. For example, the following expression uses the assignment operator to combine two primary expressions—a variable and a floating-point literal—into an assignment expression:

```
sum = 1.7
```

But operators are used not only with primary expressions; they can also be used with expressions at any level of complexity. The following are all legal expressions:

```
sum = 1 + 2 + 3 * 1.2 + (4 + 8)/3.0
sum/Math.sqrt(3.0 * 1.234)
(int)(sum + 33)
```

The multiplication operator has higher precedence than the addition operator, so `a` is added to the product of `b` and `c`, just as we expect from elementary mathematics. Operator precedence can be thought of as a measure of how tightly operators bind to their operands. The higher the number, the more tightly they bind.

Default operator precedence can be overridden through the use of parentheses that explicitly specify the order of operations. The previous expression can be rewritten to specify that the addition should be performed before the multiplication:

```
(a + b) * c
```

The `++` operator increments its single operand, which must be a variable, an element of an array, or a field of an object, by 1. The behavior of this operator depends on its position relative to the operand. When used before the operand, where it is known as the *pre-increment* operator, it increments the operand and evaluates to the incremented value of that operand. When used after the operand, where it is known as the *post-increment* operator, it increments its operand, but evaluates to the value of that operand before it was incremented.

For example, the following code sets both `i` and `j` to 2:

```
i = 1;
j = ++i;
```

But these lines set `i` to 2 and `j` to 1:

```
i = 1;
j = i++;
```

Similarly, the `--` operator decrements its single numeric operand, which must be a variable, an element of an array, or a field of an object, by one. Like the `++` operator, the behavior of `--` depends on its position relative to the operand. When used before the operand, it decrements the operand and returns the decremented value. When used after the operand, it decrements the operand, but returns the *undecremented* value.

The expressions `x++` and `x--` are equivalent to `x=x+1` and `x=x-1`, respectively, except that when you are using the increment and decrement operators, `x` is only evaluated once. If `x` is itself an expression with side effects, this makes a big difference. For example, these two expressions are not equivalent:

```
a[i++]++;           // Increments an element of an array

// Adds 1 to an array element and stores new value in another element
a[i++] = a[i++] + 1;
```

These operators, in both prefix and postfix forms, are most commonly used to increment or decrement the counter that controls a loop.

The comparison operators consist of the equality operators that test values for equality or inequality and the relational operators used with ordered types (numbers and characters) to test for greater than and less than relationships. Both types of operators yield a boolean result, so they are typically used with `if` statements and `while` and `for` loops to make branching and looping decisions. For example:

```
if (o != null) ...;           // The not equals operator
while(i < a.length) ...;      // The less than operator
```

Java provides the following equality operators:

Equals (==)

The `==` operator evaluates to `true` if its two operands are equal and `false` otherwise. With primitive operands, it tests whether the operand values themselves are identical. For operands of reference types, however, it tests whether

the operands refer to the same object or array. In other words, it does not test the equality of two distinct objects or arrays. In particular, note that you cannot test two distinct strings for equality with this operator.

Not equals (!=)

The `!=` operator is exactly the opposite of the `==` operator. It evaluates to `true` if its two primitive operands have different values or if its two reference operands refer to different objects or arrays. Otherwise, it evaluates to `false`.

The relational operators can be used with numbers and characters, but not with boolean values, objects, or arrays because those types are not ordered.

Java provides the following relational operators:

Less than (<)

Evaluates to `true` if the first operand is less than the second.

Less than or equal (<=)

Evaluates to `true` if the first operand is less than or equal to the second.

Greater than (>)

Evaluates to `true` if the first operand is greater than the second.

Greater than or equal (>=)

Evaluates to `true` if the first operand is greater than or equal to the second.