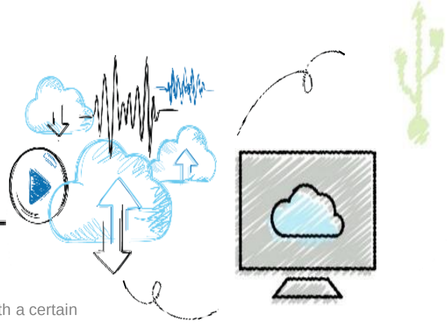
Chapter 2

Basic Elements of C++



Objectives (1 of 3)

- In this chapter, you will:
  - Become familiar with the basic components of a C++ program, including functions, special symbols, and identifiers
  - Explore simple data types
  - Discover how to use arithmetic operators
  - Examine how a program evaluates arithmetic expressions
  - Become familiar with the string data type
  - Learn what an assignment statement is and what it does

Objectives (2 of 3)

- Learn about variable declaration
- Discover how to input data into memory using input statements
- Become familiar with the use of increment and decrement operators
- Examine ways to output results using output statements
- Learn how to use preprocessor directives and why they are necessary

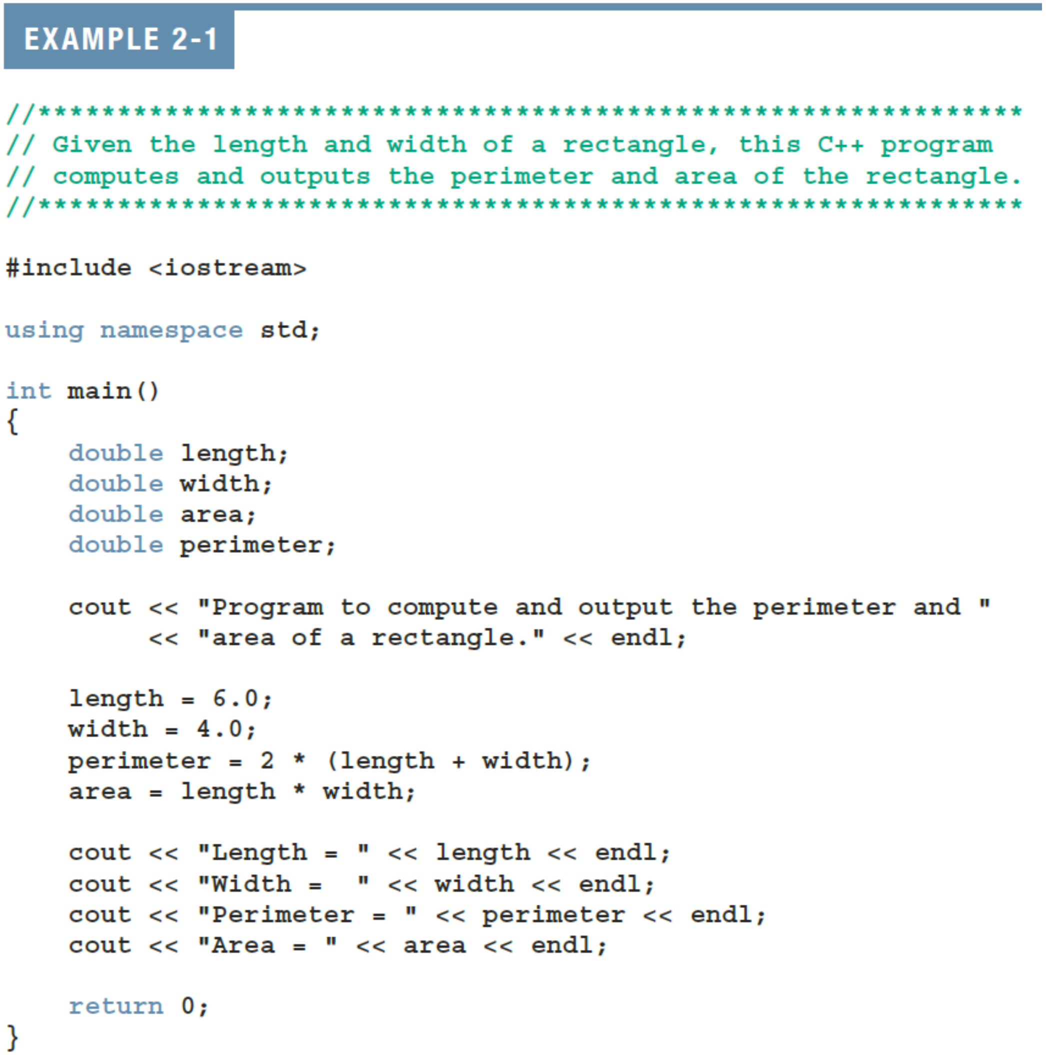
Objectives (3 of 3)

- Learn how to debug syntax errors
- Explore how to properly structure a program, including using comments to document a program
- Become familiar with compound statements
- Learn how to write a C++ program

Introduction

- Computer program
  - A sequence of statements whose objective is to accomplish a task
- Programming
  - The process of planning and creating a program
- Real-world analogy: a recipe for cooking

A Quick Look at a C++ Program (1 of 5)

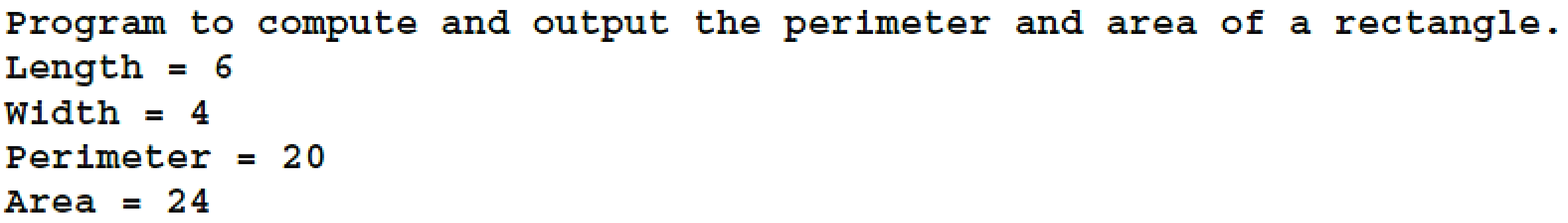


EXAMPLE 2-1

```
//**************************************************************
// Given the length and width of a rectangle, this C++ program
// computes and outputs the perimeter and area of the rectangle.
//**************************************************************

#include <iostream>

using namespace std;

int main()
{
    double length;
    double width;
    double area;
    double perimeter;

    cout << "Program to compute and output the perimeter and "
         << "area of a rectangle." << endl;

    length = 6.0;
    width = 4.0;
    perimeter = 2 * (length + width);
    area = length * width;

    cout << "Length = " << length << endl;
    cout << "Width =  " << width << endl;
    cout << "Perimeter = " << perimeter << endl;
    cout << "Area = " << area << endl;

    return 0;
}
```

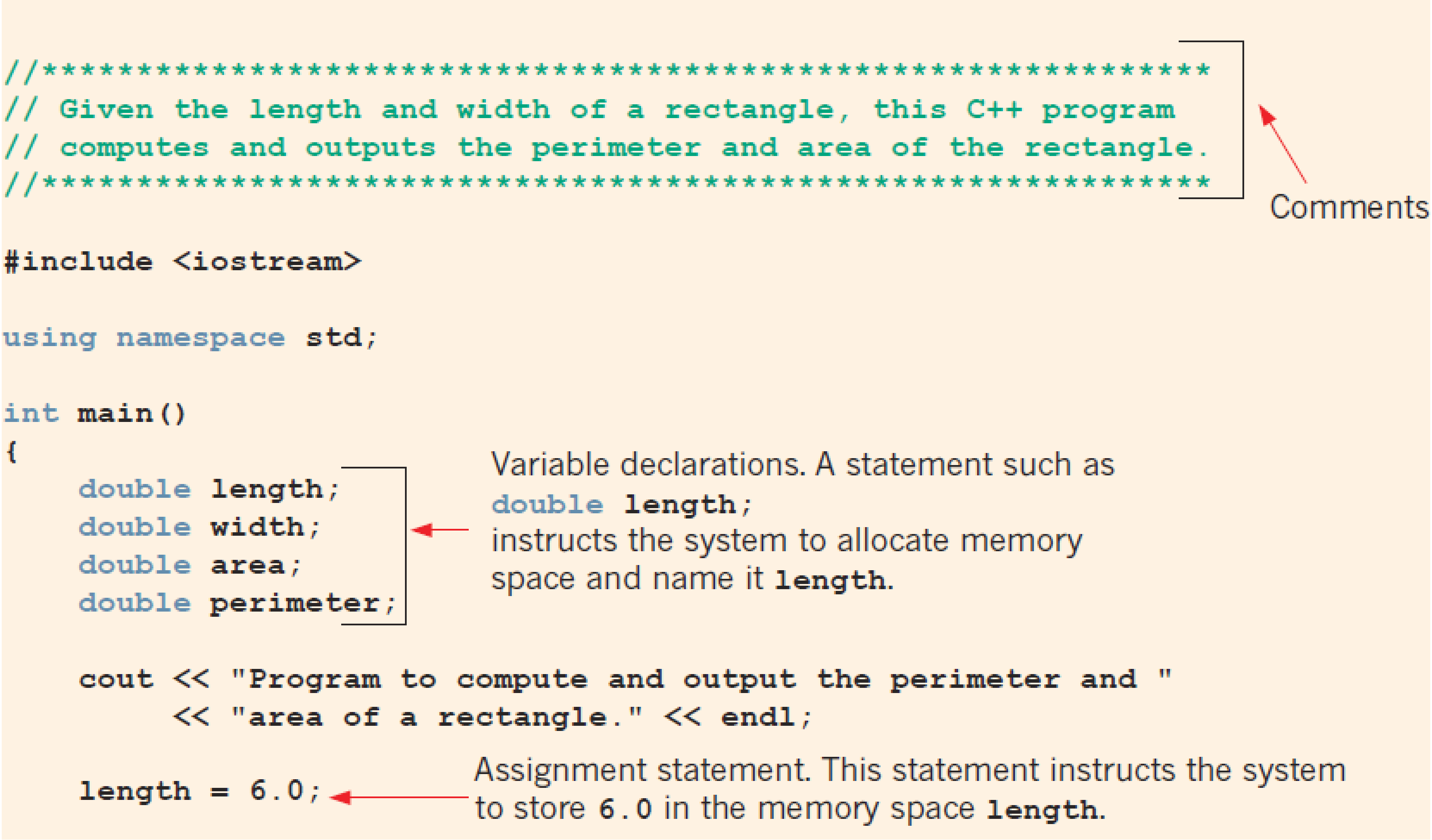
A Quick Look at a C++ Program (2 of 5)

- Sample Run:



```
Program to compute and output the perimeter and area of a rectangle.
Length = 6
Width = 4
Perimeter = 20
Area = 24
```

A Quick Look at a C++ Program (3 of 5)



```
//***************************************************************
// Given the length and width of a rectangle, this C++ program
// computes and outputs the perimeter and area of the rectangle.
//***************************************************************

#include <iostream>

using namespace std;

int main()
{
    double length;
    double width;
    double area;
    double perimeter;

    cout << "Program to compute and output the perimeter and "
         << "area of a rectangle." << endl;

    length = 6.0;
```

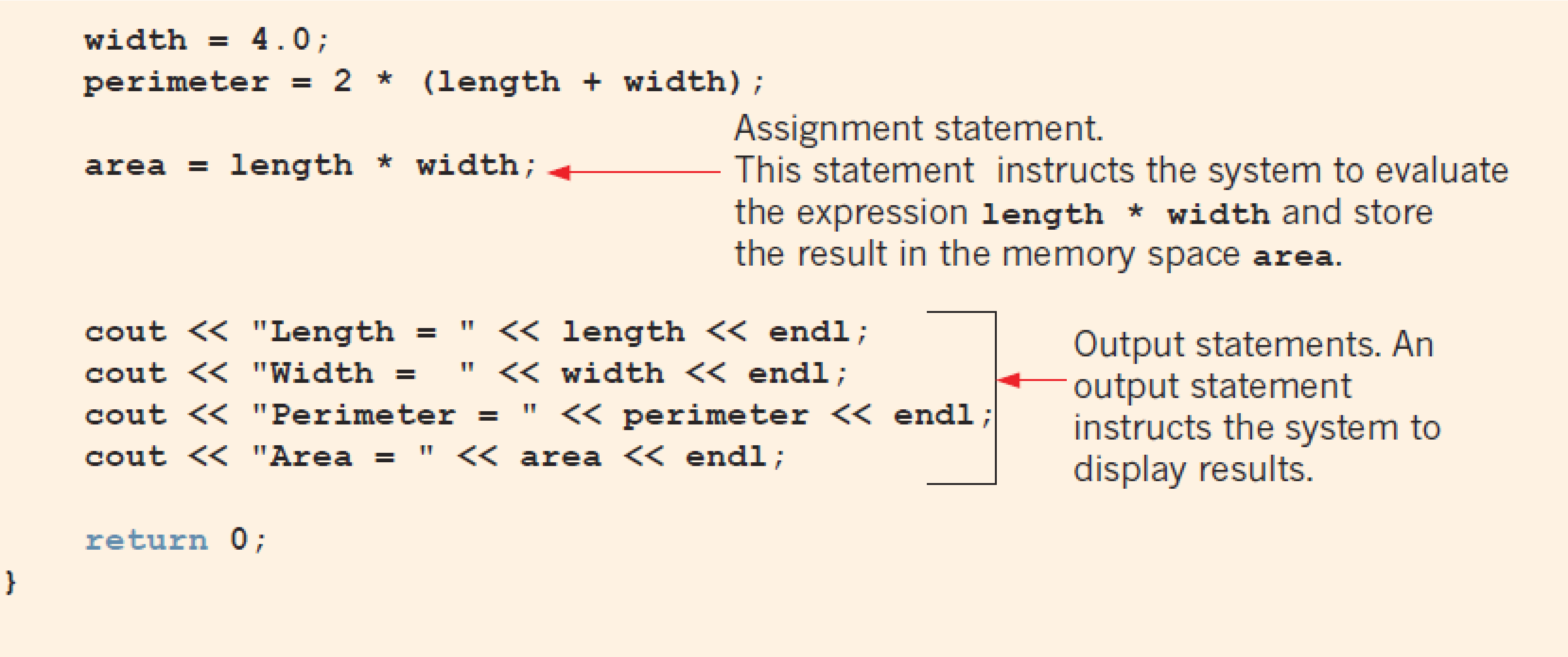
Comments

Variable declarations. A statement such as `double length;` instructs the system to allocate memory space and name it `length`.

Assignment statement. This statement instructs the system to store `6.0` in the memory space `length`.

FIGURE 2-1 Various parts of a C++ program

A Quick Look at a C++ Program (4 of 5)



```
    width = 4.0;
    perimeter = 2 * (length + width);

    area = length * width;

    cout << "Length = " << length << endl;
    cout << "Width =  " << width << endl;
    cout << "Perimeter = " << perimeter << endl;
    cout << "Area = " << area << endl;

    return 0;
}
```

Assignment statement. This statement instructs the system to evaluate the expression **`length * width`** and store the result in the memory space **`area`**.

Output statements. An output statement instructs the system to display results.

FIGURE 2-1 Various parts of a C++ program (cont'd.)

A Quick Look at a C++ Program (5 of 5)

- Variable: a memory location whose contents can be changed

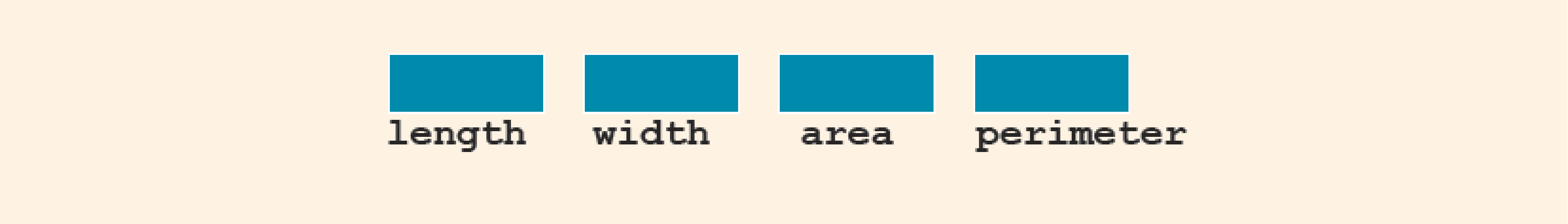


FIGURE 2-3 Memory allocation

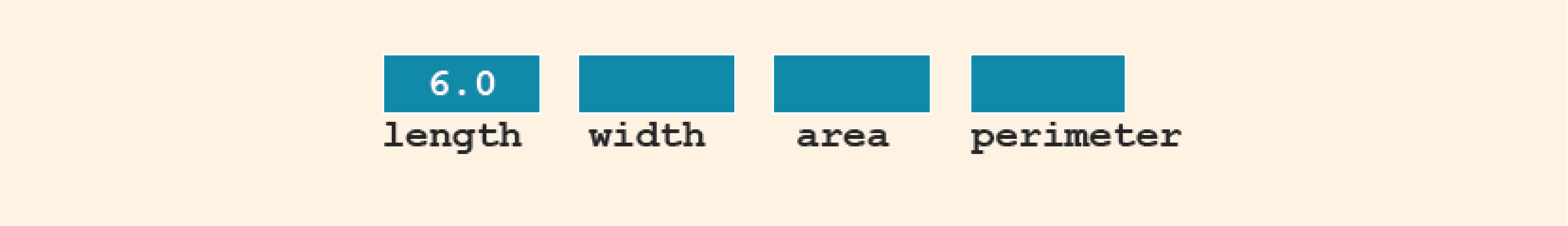


FIGURE 2-4 Memory spaces after the statement `length = 6.0;` executes

The Basics of a C++ Program

- Subprogram (or function): collection of statements
  - When executed, accomplishes something
  - May be predefined or standard
- Syntax rules: rules that specify which statements (instructions) are legal or valid
- Semantic rules: determine the meaning of the instructions
- Programming language: a set of rules, symbols, and special words

Comments

- Comments are for the reader, not the compiler
- Two types
  - Single line: begins with //

```
//*************************************************************
// Given the length and width of a rectangle, this C++ program
// computes and outputs the perimeter and area of the rectangle.
//*************************************************************
```

  - Multiple line: enclosed between /* and */

```
/*
You can include comments that can
occupy several lines.
*/
```

Special Symbols

- A token is the smallest individual unit of a program written in any language
- C++ tokens include special symbols, word symbols, and identifiers
- Special symbols in C++ include:

```
+      -      *      /
.      ;      ?      ,
<=     !=     ==     >=
```

Reserved Words (Keywords)

- Reserved word symbols (or keywords):
  - Cannot be redefined within a program
  - Cannot be used for anything other than their intended use
- Examples include:
  - `int`
  - `float`
  - `double`
  - `char`
  - `const`
  - `void`
  - `return`

Identifiers (1 of 2)

- An identifier is the name of something that appears in a program
  - Consists of letters, digits, and the underscore character (_)
  - Must begin with a letter or underscore
- C++ is case sensitive
  - `NUMBER` is not the same as `number`
- Two predefined identifiers are `cout` and `cin`
- Unlike reserved words, predefined identifiers may be redefined, but it is not a good idea

Identifiers (2 of 2)

- Legal identifiers in C++
  - first
  - conversion
  - payRate

TABLE 2-1 Examples of Illegal Identifiers

Illegal Identifier	Reason	A Correct Identifier
`employee Salary`	There can be no space between employee and Salary.	`employeeSalary`
`Hello!`	The exclamation mark cannot be used in an identifier.	`Hello`
`one+two`	The symbol + cannot be used in an identifier.	`onePlusTwo`
`2nd`	An identifier cannot begin with a digit.	`second`

Whitespaces

- Every C++ program contains whitespaces
  - Include blanks, tabs, and newline characters
- Whitespaces separate special symbols, reserved words, and identifiers
- Proper utilization of whitespaces is important
  - Can be used to make the program more readable

Data Types

- A data type is set of values together with a set of allowed operations
- C++ data types fall into three categories:
  - Simple data type
  - Structured data type
  - Pointers

Simple Data Types (1 of 2)

- Three categories of simple data
  - Integral: integers (numbers without a decimal)
    - Can be further categorized: `char`, `short`, `int`, `long`, `bool`, `unsigned char`, `unsigned short`, `unsigned int`, `unsigned long`
  - Floating-point: decimal numbers
  - Enumeration: a user-defined data type

Simple Data Types (2 of 2)

TABLE 2-2 Values and Memory Allocation for Simple Data Types

Data Type	Values	Storage (in bytes)
`int`	–147483648 (= -2^{31}) to 2147483647 (= $2^{31} - 1$)	4
`bool`	`true` and `false`	1
`char`	–128 (= -2^{7}) to 127 (= $2^{7} - 1$)	1
`long long`	–9223372036854775808 (-2^{63}) to 9223372036854775807($2^{63} - 1$)	64

- Different compilers may allow different ranges of values

`int` Data Type

- Examples
  - `-6728`
  - `0`
  - `78`
  - `+763`
- Positive integers do not require a **+** sign
- A comma cannot be used within an integer
  - Commas are only used for separating items in a list

`bool` Data Type

- `bool` type
  - Two values: `true` and `false`
  - Purpose: to manipulate logical (Boolean) expressions
- `true` and `false`
  - Logical values
- `bool`, `true`, and `false`
  - Reserved words

`char` Data Type (1 of 2)

- Data type **`char`** is the smallest integral data type
- It is used for single characters: letters, digits, and special symbols
- Each character is enclosed in single quotes
  - **`'A', 'a', '0', '*', '+', '$', '&'`**
- A blank space is a character
  - Written `' '`, with a space left between the single quotes

`char` Data Type (2 of 2)

- Different character data sets exist
- ASCII: American Standard Code for Information Interchange
  - Each of 128 values in ASCII code set represents a different character
  - Characters have a predefined ordering based on the ASCII numeric value
- Collating sequence: ordering of characters based on the character set code

Floating-Point Data Types (1 of 3)

- C++ uses scientific notation to represent real numbers (floating-point notation)

TABLE 2-3 Examples of Decimal Numbers in Scientific and C11 Floating-Point Notations

Decimal Number	Scientific Notation	C++ Floating-Point Notation
75.924	$7.5924 * 10^{1}$	7.592400E1
0.18	$1.8 * 10^{-1}$	1.800000E-1
0.0000453	$4.53 * 10^{-5}$	4.530000E-5
-1.482	$-1.482 * 10^{0}$	-1.482000E0
7800.0	$7.8 * 10^{3}$	7.800000E3

Floating-Point Data Types (2 of 3)

- `float`: represents any real number
  - Range: $-3.4 * 10^{38}$ to $3.4 * 10^{38}$ (four bytes)
- `double`: represents any real number
  - Range: $-1.7 * 10^{308}$ to $1.7 * 10^{308}$ (eight bytes)
- Minimum and maximum values of data types are system dependent

Floating-Point Data Types (3 of 3)

- Maximum number of significant digits (decimal places) for `float` values: 6 or 7
- Maximum number of significant digits for `double`: 15
- Precision: maximum number of significant digits
  - `float` values are called single precision
  - `double` values are called double precision

Data Types, Variables, and Assignment Statements

- To declare a variable, must specify its data type
- Syntax rule to declare a variable is:
  - **`dataType identifier;`**
- Examples include:

```
int counter;
double interestRate;
char grade;
```

- Assignment statement has the form: **`variable = expression`**
  - Example: **`interestRate = 0.05;`**

Arithmetic Operators, Operator Precedence, and Expressions (1 of 2)

- C++ arithmetic operators include:

  + addition

  – subtraction (or negation)

  * multiplication

  / division

  % mod (modulus or remainder)

- +, –, *, and / can be used with integral and floating-point data types
- Modulus (%) can only be used with integral data types

Arithmetic Operators, Operator Precedence, and Expressions (2 of 2)

- When you use / with integral data types, the integral result is truncated (no rounding)
- Arithmetic expressions contain values and arithmetic operators
- Operands are the numbers appearing in the expressions
- Operators can be unary (one operand) or binary (two operands)

Order of Precedence

- All operations inside `()` are evaluated first
- `*`, `/`, and `%` are at the same level of precedence and are evaluated next
- `+` and `–` have the same level of precedence and are evaluated last
- When operators are on the same level
  - Operations are performed from left to right (associativity)
- `3 * 7 - 6 + 2 * 5 / 4 + 6` means `(((3 * 7) – 6) + ((2 * 5) / 4 )) + 6`

Expressions

- Integral expression: all operands are integers
  - Yields an integral result
  - Example: `2 + 3 * 5`
- Floating-point (decimal) expression: all operands are floating-point
  - Yields a floating-point result
  - Example: `12.8 * 17.5 - 34.50`

Mixed Expressions (1 of 2)

- Mixed expression
  - Has operands of different data types
  - Contains integers and floating-point
- Examples of mixed expressions

```
2 + 3.5
6  /  4 + 3.9
5.4  *  2 – 13.6 + 18  /  2
```

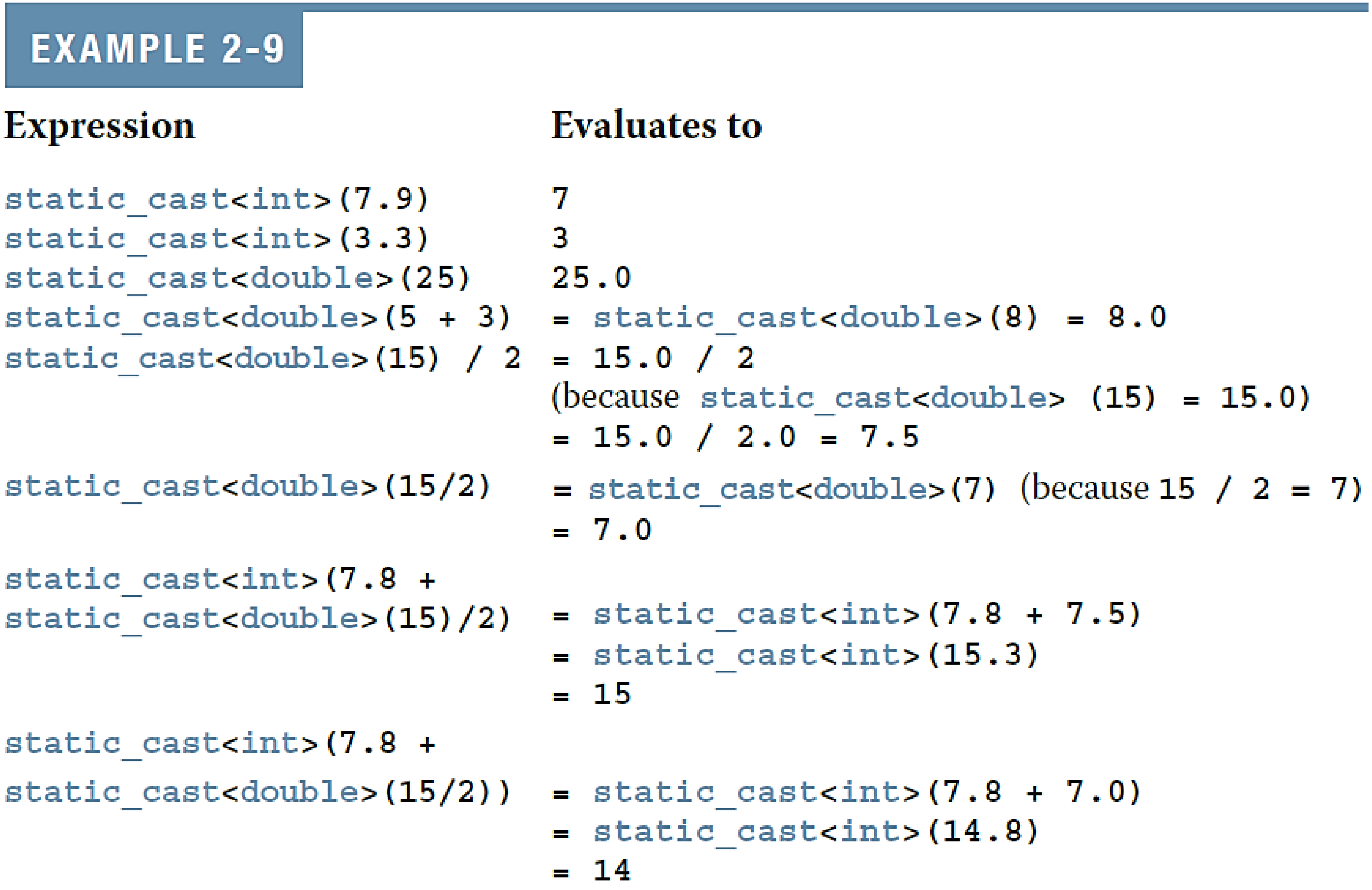
Mixed Expressions (2 of 2)

- Evaluation rules
  - If operator has same types of operands
    - The operator is evaluated according to the type of the operands
  - If operator has both types of operands
    - Integer is changed to floating-point
    - Operator is evaluated
    - Result is floating-point
  - Entire expression is evaluated according to precedence rules

Type Conversion (Casting) (1 of 2)

- Implicit type coercion: when the value of one type is automatically changed to another type
- Cast operator (also called type conversion or type casting): provides explicit type conversion
  - `static_cast<dataTypeName>(expression)`

Type Conversion (Casting) (2 of 2)



EXAMPLE 2-9

Expression	Evaluates to
`static_cast<int>(7.9)`	`7`
`static_cast<int>(3.3)`	`3`
`static_cast<double>(25)`	`25.0`
`static_cast<double>(5 + 3)`	`= static_cast<double>(8) = 8.0`

`static_cast<double>(15) / 2`	`= 15.0 / 2`
	(because `static_cast<double> (15) = 15.0`)
	`= 15.0 / 2.0 = 7.5`

`static_cast<double>(15/2)`	`= static_cast<double>(7)` (because `15 / 2 = 7`) `= 7.0`

`static_cast<int>(7.8 +`
`static_cast<double>(15)/2)`
	`= static_cast<int>(7.8 + 7.5)`
	`= static_cast<int>(15.3)`
	`= 15`

`static_cast<int>(7.8 +`
`static_cast<double>(15/2))`
	`= static_cast<int>(7.8 + 7.0)`
	`= static_cast<int>(14.8)`
	`= 14`

`string` Type

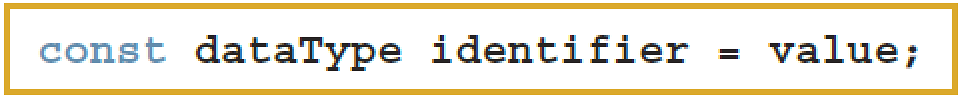
- Data type `string` is a programmer-defined type supplied in ANSI/ISO Standard C++ library
- A string is a sequence of zero or more characters enclosed in double quotation marks
- A null (or empty) string is a string with no characters
- Each character has a relative position in the string
  - Position of first character is **0**
- The length of a string is the number of characters in it
  - Example: length of **`"William Jacob"`** is 13

Variables, Assignment Statements, and Input Statements

- Data must be loaded into main memory before it can be manipulated
- Storing data in memory is a two-step process:
  1. Instruct the computer to allocate memory
  2. Include statements in the program to put data into the allocated memory

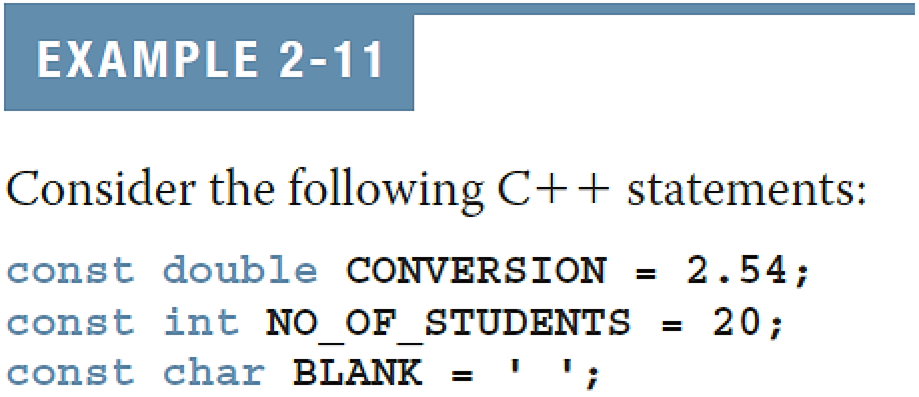
Allocating Memory with Constants and Variables (1 of2)

- Named constant: memory location whose content cannot change during execution
- Syntax to declare a named constant



```
const dataType identifier = value;
```

- In C++, `const` is a reserved word



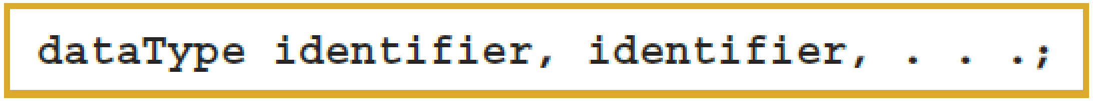
EXAMPLE 2-11

Consider the following C++ statements:

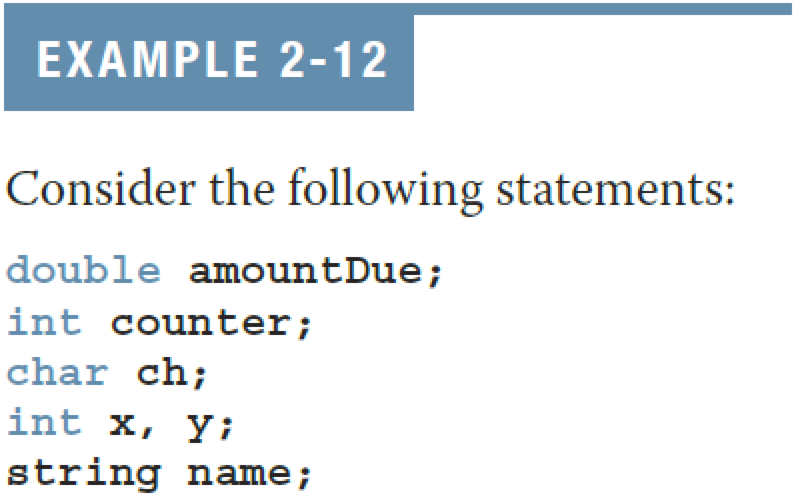
```
const double CONVERSION = 2.54;
const int NO_OF_STUDENTS = 20;
const char BLANK = ' ';
```

Allocating Memory with Constants and Variables (2 of 2)

- Variable: memory location whose content may change during execution
- Syntax to declare one or multiple variables



```
dataType identifier, identifier, . . .;
```



EXAMPLE 2-12

Consider the following statements:

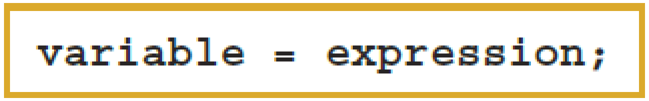
```
double amountDue;
int counter;
char ch;
int x, y;
string name;
```

Putting Data into Variables

- Ways to place data into a variable
  - Use C++’s assignment statement
  - Use input (read) statements

Assignment Statement (1 of 4)

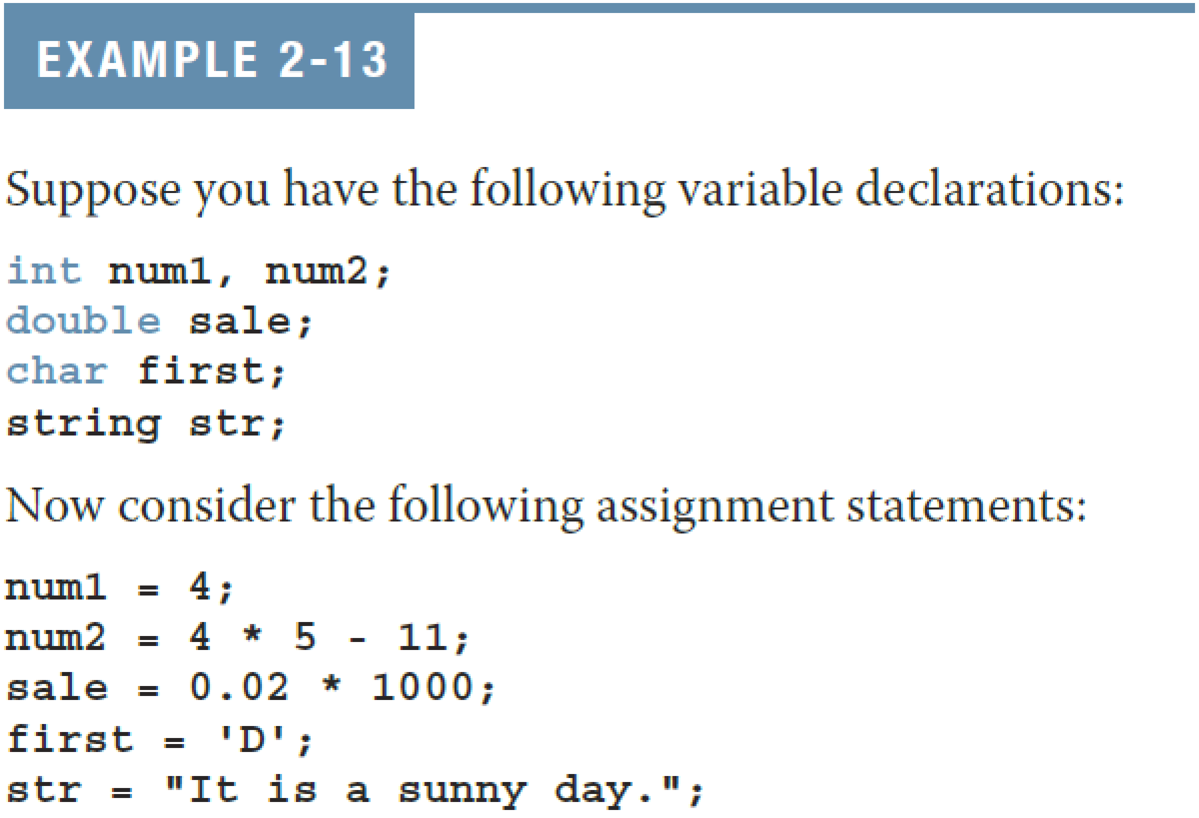
- The assignment statement takes the form:



```
variable = expression;
```

- Expression is evaluated and its value is assigned to the variable on the left side
- A variable is said to be initialized the first time a value is placed into it
- In C++, **=** is called the assignment operator

Assignment Statement (2 of 4)



EXAMPLE 2-13

Suppose you have the following variable declarations:

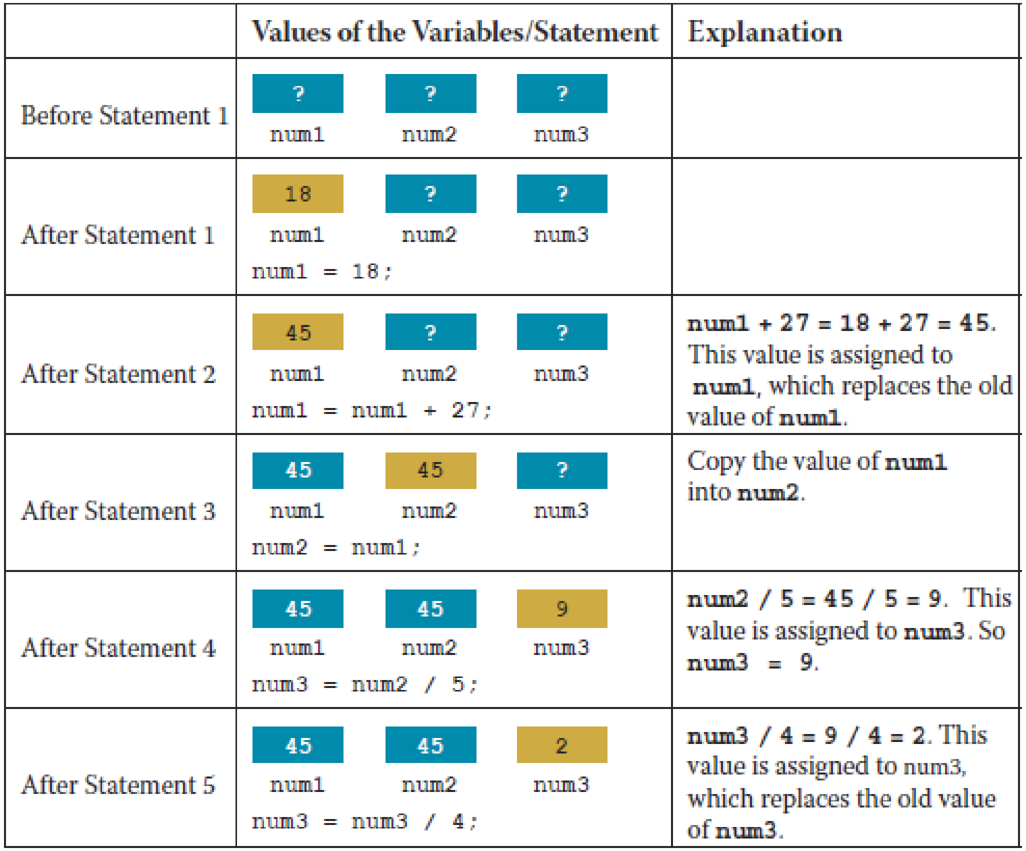
```
int num1, num2;
double sale;
char first;
string str;
```

Now consider the following assignment statements:

```
num1 = 4;
num2 = 4 * 5 - 11;
sale = 0.02 * 1000;
first = 'D';
str = "It is a sunny day.";
```

Assignment Statement (3 of 4)

- Example 2-14 illustrates a walk-through (tracing values through a sequence)



	Values of the Variables/Statement	Explanation
Before Statement 1	? ? ? num1 num2 num3	
After Statement 1	18 ? ? num1 num2 num3 `num1 = 18;`	
After Statement 2	45 ? ? num1 num2 num3 `num1 = num1 + 27;`	**num1 + 27 = 18 + 27 = 45**. This value is assigned to **num1**, which replaces the old value of **num1**.
After Statement 3	45 45 ? num1 num2 num3 `num2 = num1;`	Copy the value of **num1** into **num2**.
After Statement 4	45 45 9 num1 num2 num3 `num3 = num2 / 5;`	**num2 / 5 = 45 / 5 = 9**. This value is assigned to **num3**. So **num3 = 9**.
After Statement 5	45 45 2 num1 num2 num3 `num3 = num3 / 4;`	**num3 / 4 = 9 / 4 = 2**. This value is assigned to num3, which replaces the old value of **num3**.

Assignment Statement (4 of 4)

- Given `int` variables `x`, `y`, and `z`. How is this legal C++ statement evaluated?

```
x = y = z
```

- The assignment operator is evaluated from right to left
  - The associativity of the assignment operator is from right to left

Saving and Using the Value of an Expression

- Declare a variable of the appropriate data type
- Assign the value of the expression to the variable that was declared
  - Use the assignment statement
- Wherever the value of the expression is needed, use the variable holding the value

Declaring and Initializing Variables

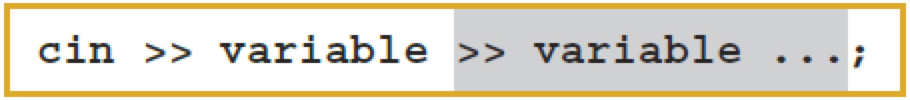
- Not all types of variables are initialized automatically
- Variables can be initialized when declared:

```
int first = 13, second = 10;
char ch = ' ';
double x = 12.6;
```

- All variables must be initialized before they are used
  - But not necessarily during declaration

Input (Read) Statement (1 of 3)

- **cin** is used with **>>** to gather one or more inputs



```
cin >> variable >> variable ...;
```

- This is called an input (read) statement
- The stream extraction operator is **>>**
- For example, if miles is a **double** variable:
  cin >> miles;
  - Causes the computer to get a value of type double and places it in the variable **miles**

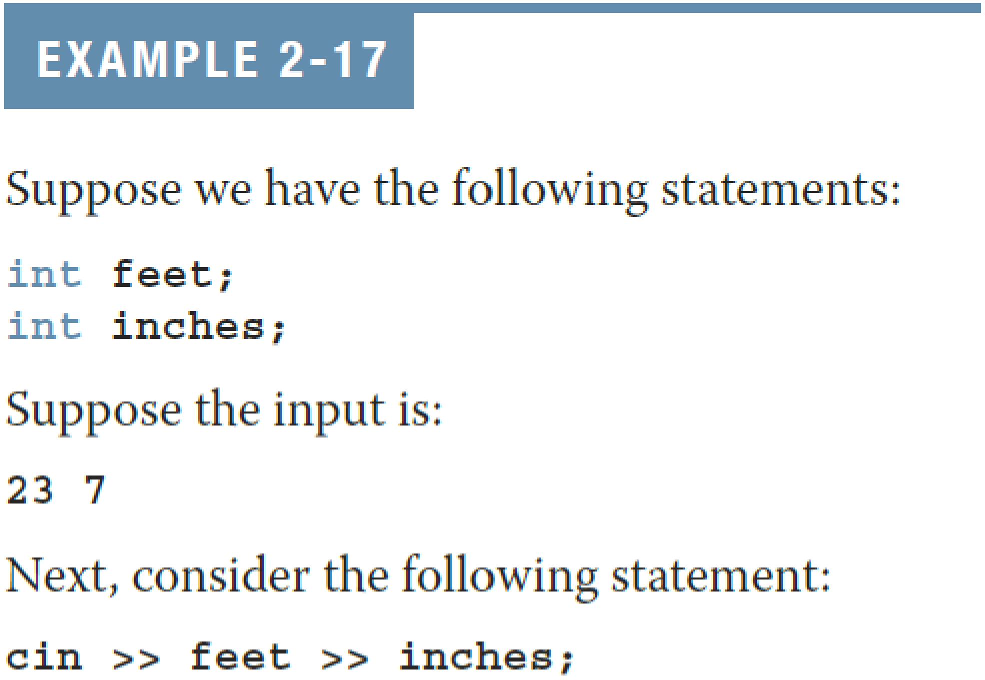
Input (Read) Statement (2 of 3)

- Using more than one variable in **`cin`** allows more than one value to be read at a time
- Example: if **`feet`** and **`inches`** are variables of type **`int`**, this statement:

```
cin >> feet >> inches;
```

  - Inputs two integers from the keyboard
  - Places them in variables **`feet`** and **`inches`** respectively

Input (Read) Statement (3 of 3)



EXAMPLE 2-17

Suppose we have the following statements:

```
int feet;
int inches;
```

Suppose the input is:

```
23 7
```

Next, consider the following statement:

```
cin >> feet >> inches;
```

Increment and Decrement Operators

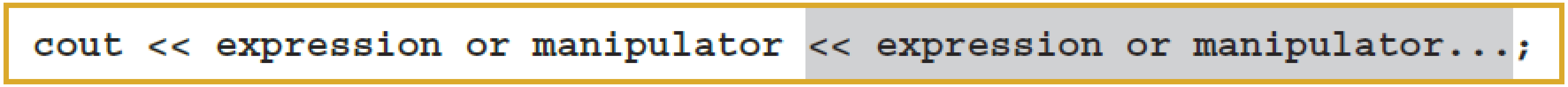
- Increment operator (**++**): increase variable by 1
  - Pre-increment: **`++variable`**
  - Post-increment: **`variable++`**
- Decrement operator: (**--**) decrease variable by 1
  - Pre-decrement: **`--variable`**
  - Post-decrement: **`variable--`**
- What is the difference between the following?

```
x = 5;
y = ++x;
```

```
x = 5;
y = x++;
```

Output (1 of 4)

- The syntax of **`cout`** and **<<** is:

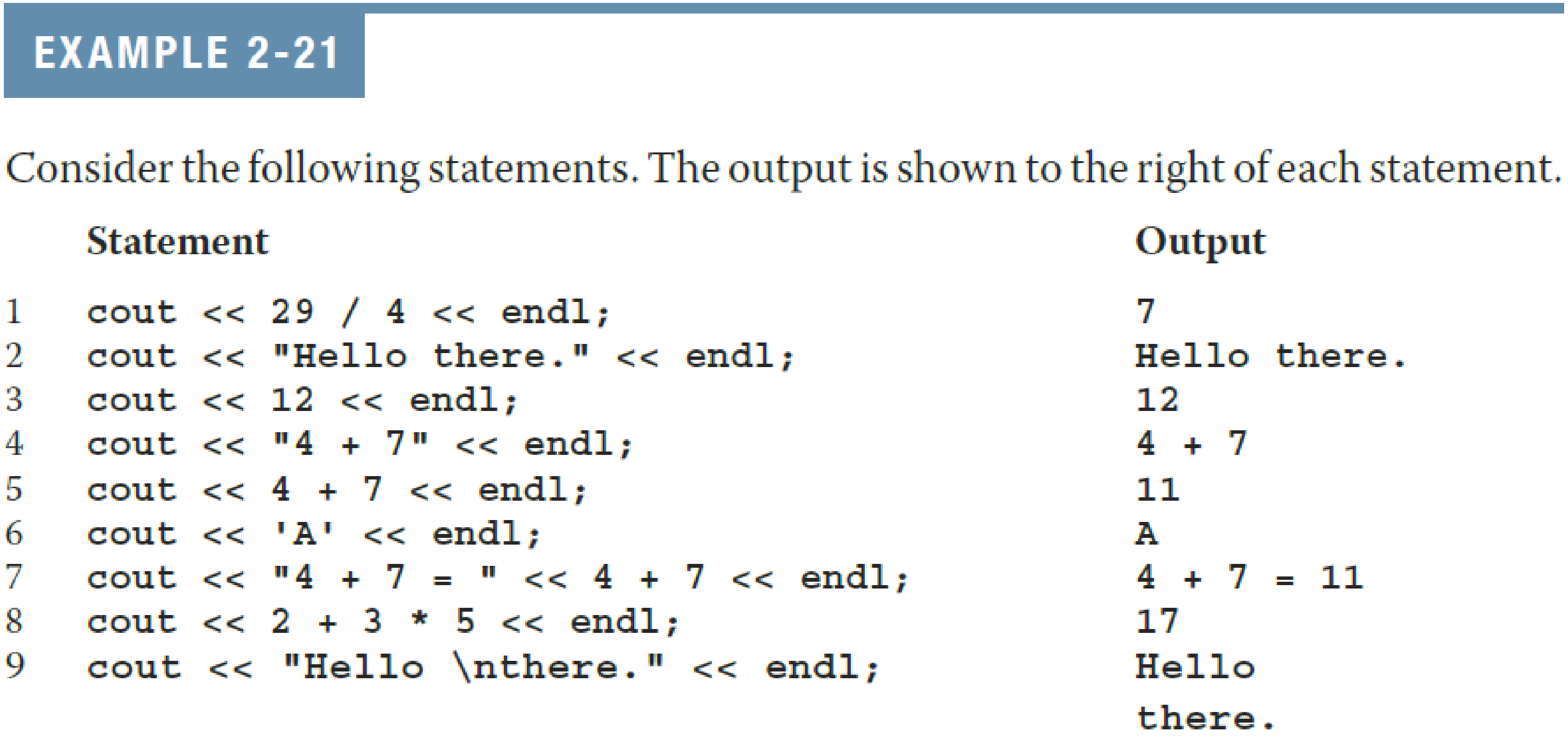


```
cout << expression or manipulator << expression or manipulator...;
```

  - Called an output statement
- The stream insertion operator is **<<**
- Expression evaluated and its value is printed at the current cursor position on the screen

Output (2 of 4)

- A manipulator is used to format the output
  - Example: **`endl`** causes the insertion point to move to beginning of next line



EXAMPLE 2-21

Consider the following statements. The output is shown to the right of each statement.

	Statement	Output
1	`cout << 29 / 4 << endl;`	`7`
2	`cout << "Hello there." << endl;`	`Hello there.`
3	`cout << 12 << endl;`	`12`
4	`cout << "4 + 7" << endl;`	`4 + 7`
5	`cout << 4 + 7 << endl;`	`11`
6	`cout << 'A' << endl;`	`A`
7	`cout << "4 + 7 = " << 4 + 7 << endl;`	`4 + 7 = 11`
8	`cout << 2 + 3 * 5 << endl;`	`17`
9	`cout << "Hello \nthere." << endl;`	`Hello` `there.`

Output (3 of 4)

- The new line character (new line escape sequence) is `'\n'`
  - May appear anywhere in the string
- Examples

```
cout << "Hello there.";
cout << "My name is James.";
```

Output:

```
Hello there.My name is James.
```

```
cout << "Hello there.\n";
cout << "My name is James.";
```

Output :

```
Hello there.
My name is James.
```

Output (4 of 4)

TABLE 2-4 Commonly Used Escape Sequences

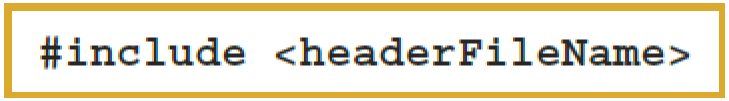
	Escape Sequence	Description
`\n`	Newline	Cursor moves to the beginning of the next line
`\t`	Tab	Cursor moves to the next tab stop
`\b`	Backspace	Cursor moves one space to the left
`\r`	Return	Cursor moves to the beginning of the current line (not the next line)
`\\`	Backslash	Backslash is printed
`\'`	Single quotation	Single quotation mark is printed
`\"`	Double quotation	Double quotation mark is printed

Preprocessor Directives (1 of 2)

- C++ has a small number of operations
- Many functions and symbols needed to run a C++ program are provided as collection of libraries
- Every library has a name and is referred to by a header file
- Preprocessor directives are processed by the preprocessor program
- All preprocessor commands begin with **#**
- No semicolon is placed at the end of these commands

Preprocessor Directives (2 of 2)

- Syntax to include a header file



```
#include <headerFileName>
```

- For example:

```
#include <iostream>
```

  - Causes the preprocessor to include the header file **`iostream`** in the program
- Preprocessor commands are processed before the program goes through the compiler

namespace and Using cin and cout in a Program

- **cin** and **cout** are declared in the header file **iostream**, but within **std namespace**
- To use **cin** and **cout** in a program, use the following two statements:

```
#include <iostream>

using namespace std;
```

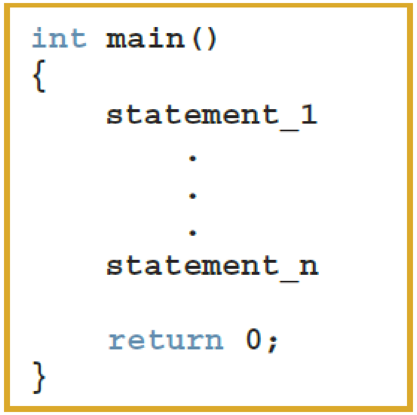
Using the string Data Type in a Program

- To use the **string** type, you need to access its definition from the header file string
- Include the following preprocessor directive:

```
#include <string>
```

Creating a C++ Program (1 of 3)

- A C++ program is a collection of functions, one of which is the function **`main`**
- The syntax of the function **`main`** used in this book has this form:



```
int main()
{
    statement_1
         .
         .
         .
    statement_n

    return 0;
}
```

Creating a C++ Program (2 of 3)

- Source code is comprised of preprocessor directives and program statements
- The source code file (source file) contains the source code
- The compiler generates the object code (file extension `.obj`)
- Executable code (file extension `.exe`) results when object code is linked with the system resources
- The first line of the function **`main`** is called the heading of the function:

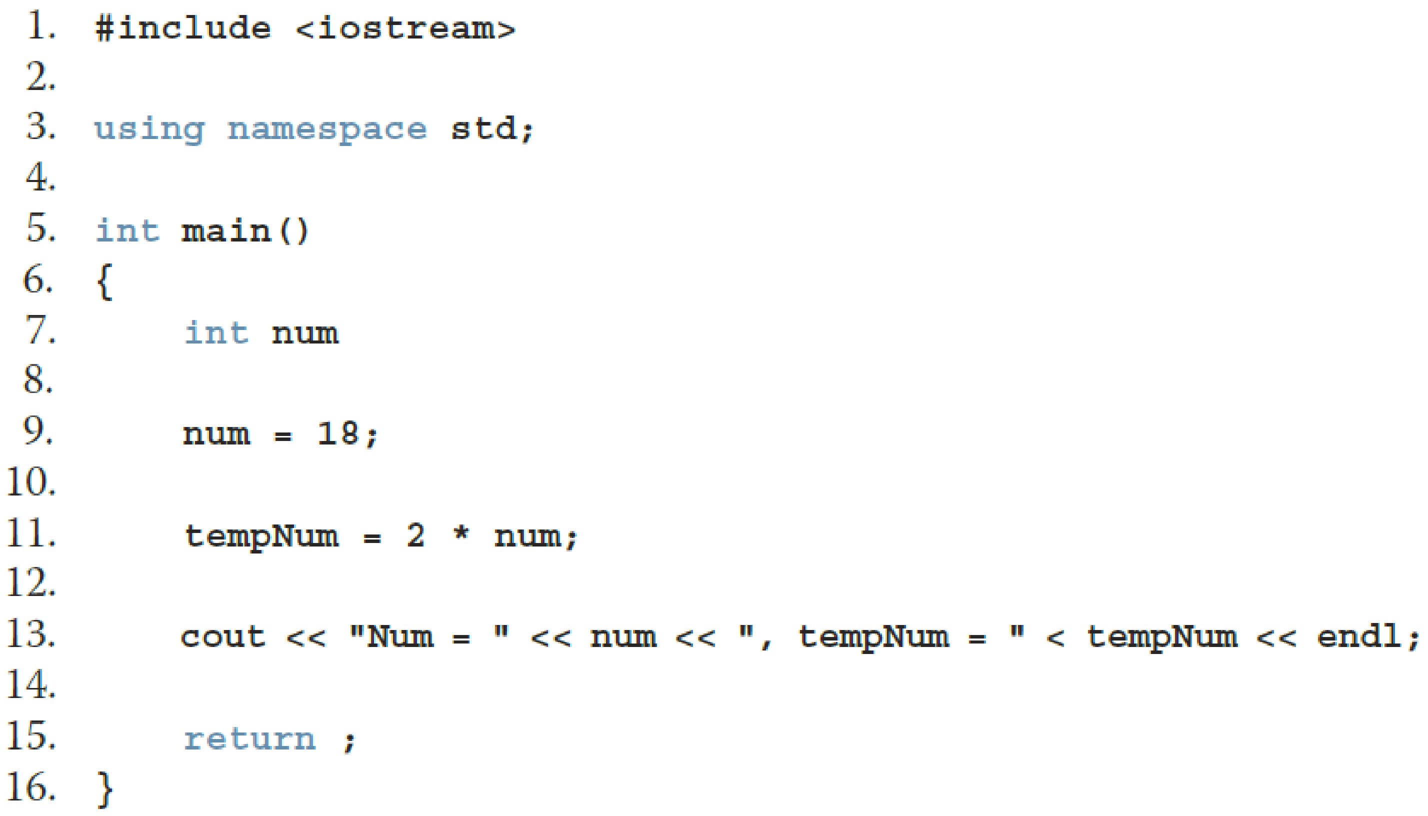
```
int main()
```

Creating a C++ Program (3 of 3)

- The statements enclosed between the curly braces (**{** and **}**) form the body of the function
- A C++ program contains two types of statements:
  - Declaration statements declare things, such as variables
  - Executable statements perform calculations, manipulate data, create output, accept input, etc.

Debugging: Understanding and Fixing Syntax Errors (1 of 2)

- Sample program with line numbers added on the left



```
1.  #include <iostream>
2.
3.  using namespace std;
4.
5.  int main()
6.  {
7.        int num
8.
9.        num = 18;
10.
11.       tempNum = 2 * num;
12.
13.       cout << "Num = " << num << ", tempNum = " < tempNum << endl;
14.
15.       return ;
16. }
```

Debugging: Understanding and Fixing Syntax Errors (2 of 2)

- Compile the program
  - Compiler will identify the syntax errors
  - The line numbers where the errors occur are specified:

```
ExampleCh2_Syntax_Errors.cpp
c:\examplech2_syntax_errors.cpp(9): error C2146: syntax error:
missing ';' before identifier 'num'
c:\examplech2_syntax_errors.cpp(11): error C2065: 'tempNum':
undeclared identifier
```

Program Style and Form: Syntax

- Syntax rules indicate what is legal and what is not legal
- Errors in syntax are found in compilation

```
int x;        //Line 1
int y         //Line 2
double z;     //Line 3

y = w + x;    //Line 4
```

- Compilation errors would occur at:
  - Line 2 (missing semicolon)
  - Line 4 (identifier **w** used but not declared)

Use of Blanks

- In C++, you use one or more blanks to separate numbers when data is input
- Blanks are also used to separate reserved words and identifiers from each other and from other symbols
- Blanks must never appear within a reserved word or identifier

Use of Semicolons, Brackets, and Commas

- All C++ statements end with a semicolon
  - Also called a statement terminator
- **{** and **}** are not C++ statements
  - Can be regarded as delimiters
- Commas separate items in a list
  - Declaring more than one variable following a data type

Semantics

- Semantics: set of rules that gives meaning to a language
  - Possible to remove all syntax errors in a program and still not have it run
  - Even if it runs, it may still not do what you meant it to do
- Example: `2 + 3 * 5` and `(2 + 3) * 5`
  - Both are syntactically correct expressions but have different meanings

Naming Identifiers

- Identifiers can be self-documenting
  - **`CENTIMETERS_PER_INCH`**
- Avoid run-together words
  - **`annualsale`**
- Solutions may include:
  - Capitalizing the beginning of each new word: **`annualSale`**
  - Inserting an underscore just before a new word: **`annual_sale`**

Prompt Lines

- Prompt lines: executable statements that inform the user what to do

```
cout << "Please enter a number between 1 and 10 and "
     << "press the return key" << endl;
cin >> num;
```

- Always include prompt lines when input is needed from users

Documentation

- A well-documented program is easier to understand and modify
- You use comments to document programs
- Comments should appear in a program to:
  - Explain the purpose of the program
  - Identify who wrote it
  - Explain the purpose of particular statements

Form and Style

- Consider two ways of declaring variables:
  - Method 1

    ```
    int feet, inches;
    double x, y;
    ```

  - Method 2

    ```
    int feet,inches; double x,y;
    ```

- Both are correct; however, the second is harder to read

More on Assignment Statements

- Two forms of assignment
  - Simple and compound
  - Compound operators provide more concise notation
- Compound operators: **+=**, **-=**, ***=**, **/=**, **%=**
- Simple assignment statement example

```
x = x * y;
```

- Compound assignment statement example

```
x *= y;
```

Quick Review (1 of 3)

- A C++ program is a collection of functions, one of which is always called **`main`**
- Identifiers consist of letters, digits, and underscores, and begin with a letter or an underscore
- The arithmetic operators in C++ are addition (**`+`**), subtraction (**`-`**), multiplication (**`*`**), division (**`/`**), and modulus (`%`)
- Arithmetic expressions are evaluated using the precedence associativity rules

Quick Review (2 of 3)

- All operands in an integral expression are integers
- All operands in a floating-point expression are decimal numbers
- A mixed expression contains both integers and decimal numbers
- Use the cast operator to explicitly convert values from one data type to another
- A named constant is initialized when declared
- All variables must be declared before used

Quick Review (3 of 3)

- Use **`cin`** and the stream extraction operator **>>** to input from the standard input device
- Use **`cout`** and the stream insertion operator **<<** to output to the standard output device
- Preprocessor commands are processed before the program goes through the compiler
- A file containing a C++ program usually ends with the extension **`.cpp`**