Enumeration Type

- Enumeration allows you to define an ordered set of values
  - Each value is an identifier
  - Useful for dealing with a fixed set
  - More efficient than using strings, more informative than using numbers
- Examples:

```
enum phoneType { HOME, WORK, MOBILE, ADDITIONAL };
enum standing { FRESHMAN, SOPHOMORE, JUNIOR, SENIOR };
enum grade { A, B, C, D, F };
enum color { RED, ORANGE, YELLOW, GREEN, BLUE, INDIGO,
  VIOLET };
```

Enumeration type

- Once you have defined a enumeration type, you can use it just like any other data type
- To declare a variable:

```
phoneType phone1Type, phone2Type;
int number1, number2;
```

- To assign it a value:

```
phone1Type = HOME;
number1 = 10;

phone2Type = phone1type;
number2 = number1;
```

Enumeration Type

- Enumeration values are identifiers
  - **Not strings or characters**
  - Must be valid identifiers
  - By convention typed **in all caps**
- The values in an enumeration must be unique
  - They can't appear in another enumeration in the same function

EXAMPLE 8-3

Consider the following statements:

```
enum grades {'A', 'B', 'C', 'D', 'F'}; //illegal enumeration type
enum places {1ST, 2ND, 3RD, 4TH};  //illegal enumeration type
```

These are illegal enumeration types because none of the values is an identifier. The following, however, are legal enumeration types:

```
enum grades {A, B, C, D, F};
enum places {FIRST, SECOND, THIRD, FOURTH};
```

EXAMPLE 8-4

Consider the following statements:

```
enum mathStudent {JOHN, BILL, CINDY, LISA, RON};
enum compStudent {SUSAN, CATHY, JOHN, WILLIAM}; //illegal
```

Suppose that these statements are in the same program in the same block. The second enumeration type, `compStudent`, is not allowed because the value `JOHN` was used in the previous enumeration type `mathStudent`.

Operations on Enumeration Types

- Arithmetic operators are not allowed:

```
phone1Type = phone2Type - 1;  // illegal
phone1Type++;                  // illegal
```

- Comparison operators are valid (since the values are ordered):

```
phone1Type == WORK
phone2Type < MOBILE
```

Functions and Enumeration Types

- Enumeration type variables are treated like any other basic data type
  - Enumeration types can be passed as parameters to functions either by value or by reference
  - A function can return a value of the enumeration type

Enumeration Type

- Enumeration allows you to define an ordered set of values
  - Each value is an identifier
  - Useful for dealing with a fixed set
  - More efficient than using strings, more informative than using numbers
- Examples:

```
enum phoneType { HOME, WORK, MOBILE, ADDITIONAL };
enum standing { FRESHMAN, SOPHOMORE, JUNIOR, SENIOR };
enum grade { A, B, C, D, F };
enum color { RED, ORANGE, YELLOW, GREEN, BLUE, INDIGO,
  VIOLET };
```

Enumeration type

- Once you have defined a enumeration type, you can use it just like any other data type
- To declare a variable:

```
phoneType phone1Type, phone2Type;
int number1, number2;
```

- To assign it a value:

```
phone1Type = HOME;
number1 = 10;

phone2Type = phone1type;
number2 = number1;
```

Enumeration Type

- Enumeration values are identifiers
  - **Not strings or characters**
  - Must be valid identifiers
  - By convention typed **in all caps**
- The values in an enumeration must be unique
  - They can’t appear in another enumeration in the same function

EXAMPLE 8-3

Consider the following statements:

```
enum grades {'A', 'B', 'C', 'D', 'F'}; //illegal enumeration type
enum places {1ST, 2ND, 3RD, 4TH};  //illegal enumeration type
```

These are illegal enumeration types because none of the values is an identifier. The following, however, are legal enumeration types:

```
enum grades {A, B, C, D, F};
enum places {FIRST, SECOND, THIRD, FOURTH};
```

EXAMPLE 8-4

Consider the following statements:

```
enum mathStudent {JOHN, BILL, CINDY, LISA, RON};
enum compStudent {SUSAN, CATHY, JOHN, WILLIAM}; //illegal
```

Suppose that these statements are in the same program in the same block. The second enumeration type, `compStudent`, is not allowed because the value `JOHN` was used in the previous enumeration type `mathStudent`.

Operations on Enumeration Types

- Arithmetic operators are not allowed:

```
phone1Type = phone2Type - 1;  // illegal
phone1Type++;                 // illegal
```

- Comparison operators are valid (since the values are ordered):

```
phone1Type == WORK
phone2Type < MOBILE
```

Functions and Enumeration Types

- Enumeration type variables are treated like any other basic data type
  - Enumeration types can be passed as parameters to functions either by value or by reference
  - A function can return a value of the enumeration type

Example: Days of the Week

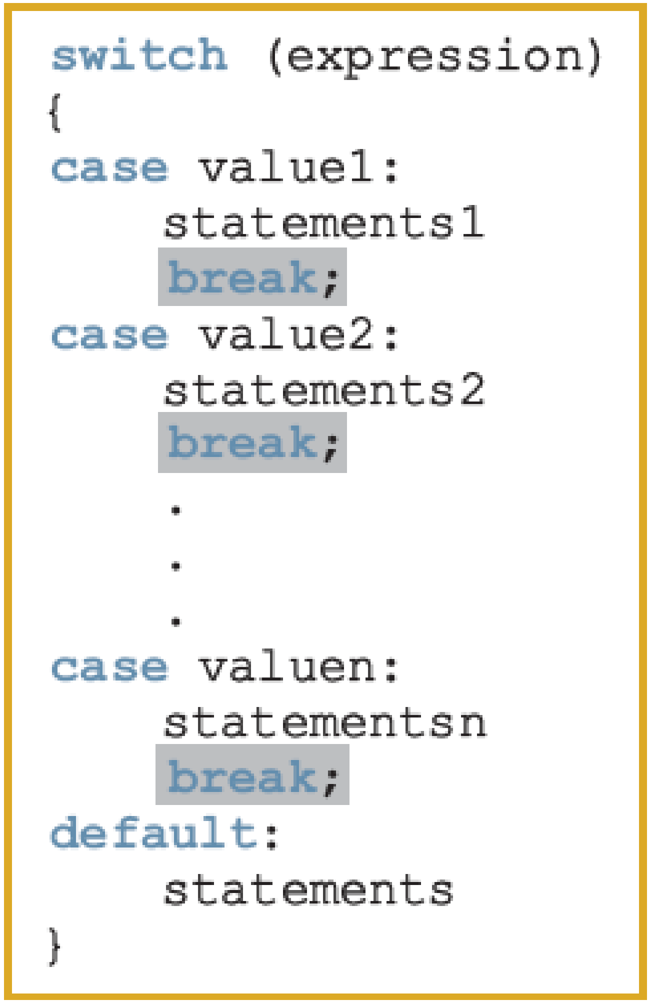
- Problem: convert from a number (1-7) to the name of the corresponding day of the week
  - Sunday is 1, Monday is 2, etc.

- Just like the months in the data conversion problem
  - Could use an if tree…

switch Structure

- Alternative to if…else
- Used with a finite set of values
  - Letter grades
  - Months of the year
  - Type codes

- expression is evaluated first (must be integer)
- Execution jumps to the corresponding case
- A default case may be included

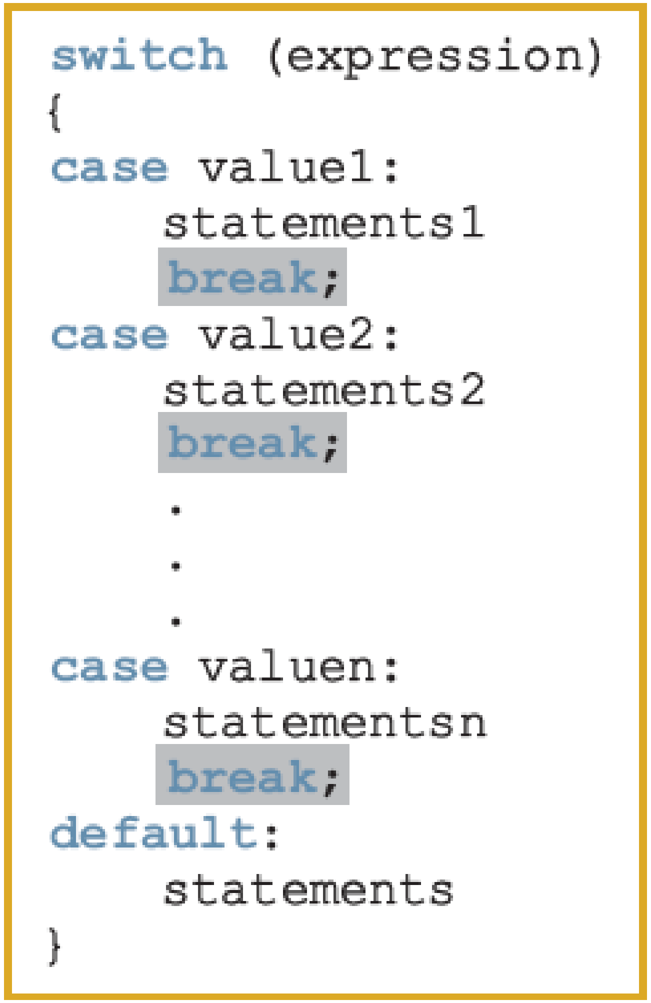


```
switch (expression)
{
case value1:
        statements1
        break;
case value2:
        statements2
        break;
        .
        .
        .
case valuen:
        statementsn
        break;
default:
        statements
}
```

C++ Programming: Program Design Including Data Structures, Fourth Edition

case, break and default

- Unlike if…else, each case in a switch is not a block of code
- case labels determine only where execution jumps to, not where it ends
- To skip the rest of the cases, you use break
  - (But you don't have to)



```
switch (expression)
{
case value1:
      statements1
      break;
case value2:
      statements2
      break;
      .
      .
      .
case valuen:
      statementsn
      break;
default:
      statements
}
```

C++ Programming: Program Design Including Data Structures, Fourth Edition

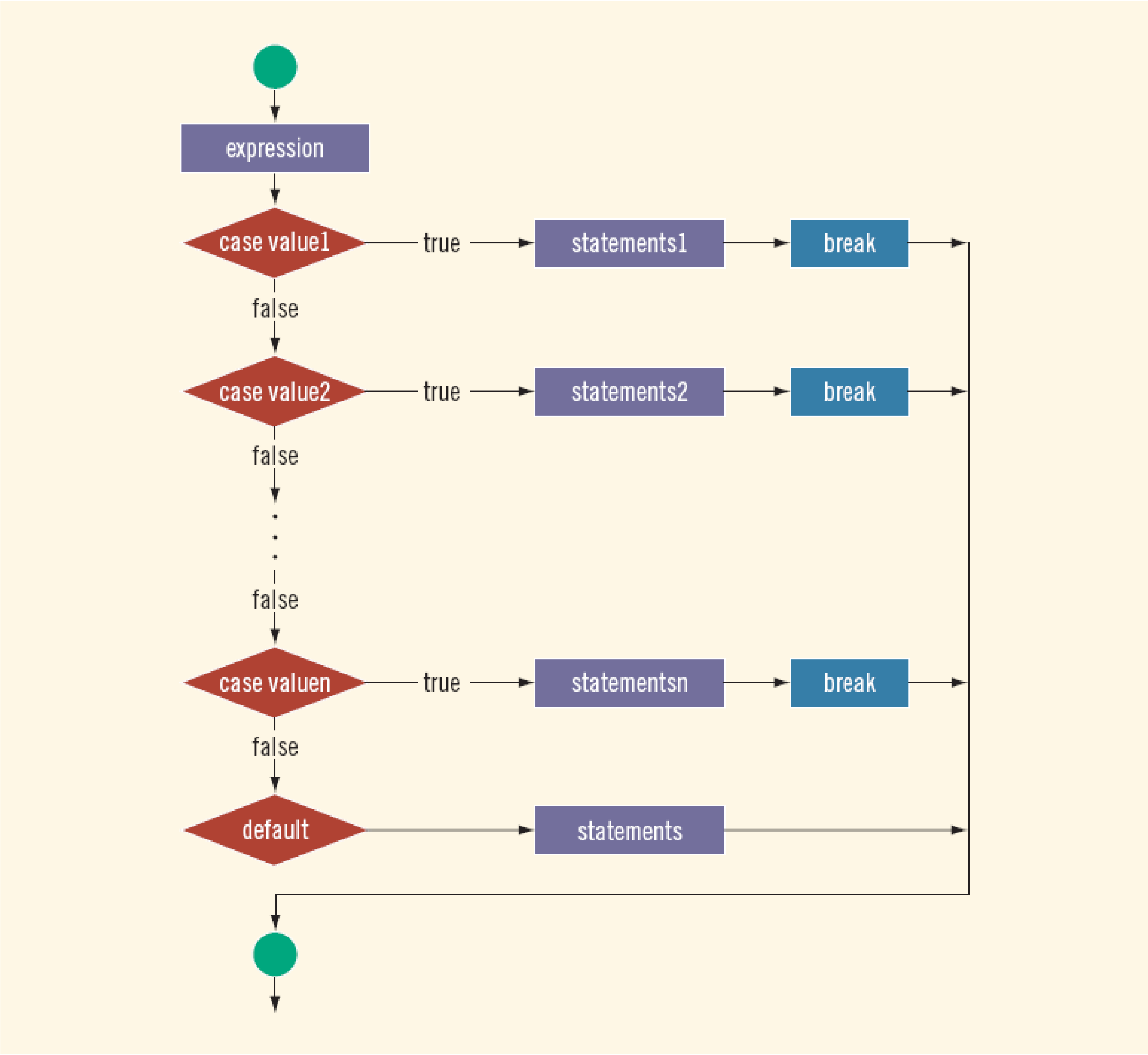


FIGURE 4-4 `switch` statement

EXAMPLE 4-24

Consider the following statements, where grade is a variable of type char:

```
switch (grade)
{
case 'A':
    cout << "The grade is 4.0.";
    break;
case 'B':
    cout << "The grade is 3.0.";
    break;
case 'C':
    cout << "The grade is 2.0.";
    break;
case 'D':
    cout << "The grade is 1.0.";
    break;
case 'F':
    cout << "The grade is 0.0.";
    break;
default:
    cout << "The grade is invalid.";
}
```

In this example, the expression in the switch statement is a variable identifier. The variable grade is of type char, which is an integral type. The possible values of grade are 'A', 'B', 'C', 'D', and 'F'. Each case label specifies a different action to take, depending on the value of grade. If the value of grade is 'A', the output is:

```
The grade is 4.0.
```

Exercise

```
int unitID;
double overheadRate;
…
switch( unitID )
{
case 0:
   overheadRate = 2.9;
   break;
case 1:
case 2:
   overheadRate = 3.4;
   break;
case 3:
   overheadRate = 4.1;
   break;
default:
   overheadRate = 5.0;
}
```

What values for this table correspond to that code?

Unit ID	Overhead Rate

More Interesting Version

```
int unitID;
double overheadRate;
…
switch( unitID / 100 )
{
case 0:
   overheadRate = 2.9;
   break;
case 1:
case 2:
   overheadRate = 3.4;
   break;
case 3:
   overheadRate = 4.1;
   break;
default:
   overheadRate = 5.0;
}
```

What values for this table correspond to that code?

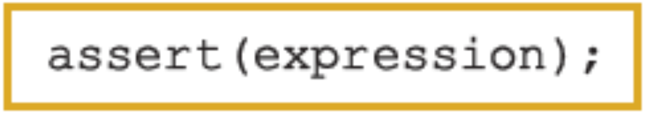
Unit ID	Overhead Rate

Terminating a Program with the `assert` Function

- Certain types of errors that are very difficult to catch can occur in a program
  - Example: division by zero can be difficult to catch using any of the programming techniques examined so far
- The predefined function, `assert`, is useful in stopping program execution when certain elusive errors occur

The `assert` Function (continued)

- Syntax:



```
assert(expression);
```

- `expression` is any logical expression
  - If `expression` evaluates to `true`, the next statement executes
  - If `expression` evaluates to `false`, the program terminates and indicates where in the program the error occurred
- To use `assert`, include `cassert` header file

The `assert` Function (continued)

- `assert` is useful for enforcing programming constraints during program development
- After developing and testing a program, remove or disable assert statements
- To disable the assert statement:

```
#define NDEBUG
#include <cassert>
```