Chapter 1

1. a. true; b. false; c. false; d. true; e. false; f. true; g. true; h. true; i. false; j. false; k. true; l. true; m. true; n. true; o. true; p. false; q. true; r. true; s. true

3. Base 2 or binary.

5. In linking, an object program is combined with other programs in the library, used in the program, to create the executable code.

7. #

9. Programming is a process of problem solving.

11. (1) Analyze and outline the problem and its solution requirements, and design an algorithm to solve the problem. (2) Implement the algorithm in a programming language, such as C++, and verify that the algorithm works. (3) Maintain the program by using and modifying it if the problem domain changes.

13. To find the weighted average of the four test scores, first you need to know each test score and its weight. Next, you multiply each test score with its weight, and then add these numbers to get the average. Therefore,

```
1. Get testScore1, weightTestScore1
2. Get testScore2, weightTestScore2
3. Get testScore3, weightTestScore3
4. Get testScore4, weightTestScore4
5. weightedAverage = testScore1 * weightTestScore1 +
                     testScore2 * weightTestScore2 +
                     testScore3 * weightTestScore3 +
                     testScore4 * weightTestScore4;
```

15. To find the price per square inch, first we need to find the area of the pizza. Then we divide the price of the pizza by the area of the pizza. Let `radius` denote the radius and `area` denote the area of the circle, and `price` denote the price of pizza. Also, let `pricePerSquareInch` denote the price per square inch.

```
a. Get radius
b. area = π * radius * radius
c. Get price
d. pricePerSquareInch = price / area
```

17. Suppose that `radius` denotes radius of the sphere, `volume` denotes volume of the sphere, and `surfaceArea` denotes the surface area of the sphere. The following algorithm computes the volume and surface area of the sphere.

Algorithm	**C++ Instruction (Code)**
1. Get the radius.	`cin >> radius;`
2. Calculate the volume.	`volume = (4.0 / 3.0) * 3.1416 * radius * radius * radius;`

3. Calculate the surface area.	surfaceArea = 4.0 * 3.1416 * radius * radius;

19. Suppose that billingAmount denotes the total billing amount, numOfItemsOrdered denotes the number of items ordered, shippingAndHandlingFee denotes the shipping and handling fee, and price denotes the price of an item. The following algorithm computes and outputs the billing amount.

```
a. Enter the number of items bought.
b. Get numOfItemsOrdered
c. billingAmount = 0.0;
d. shippingAndHandlingFee = 0.0;
e. Repeat the following for each item bought.
     i. Enter the price of the item
     ii. Get price
     iii. billingAmount = billingAmount + price;
f. if billingAmount < 200
       shippingAndHandlingFee = 10 * numOfItemsOrdered;
g. billingAmount = billingAmount + shippingAndHandlingFee
i. Print billingAmount
```

21. Suppose x1 and x2 are the real roots of the quadratic equation.

```
a. Get a
b. Get b
c. Get c
d. if (b * b – 4 * a * c < 0)
     Print "The equation has no real roots."
   Otherwise
   {
       temp = b * b – 4 * a * c;
       x1 = (-b + temp) / (2 * a);
       x2 = (-b - temp) / (2 * a);
   }
```

23. Suppose averageTestScore denotes the average test score, highestScore denotes the highest test score, testScore denotes a test score, sum denotes the sum of all the test scores, count denotes the number of students in class, and studentName denotes the name of a student.

a. First you design an algorithm to find the average test score. To find the average test score, first you need to count the number of students in the class and add the test score of each student. You then divide the sum by count to find the average test score. The algorithm to find the average test score is as follows:

i. Set sum and count to 0.

ii. Repeat the following for each student in class.

    1. Get `testScore`

    2. Increment `count` and update the value of `sum` by adding the current test score to `sum`.

iii. Use the following formula to find the average test score.

```
if (count is 0)
    averageTestScore = 0;
otherwise
    averageTestScore = sum / count;
```

b. The following algorithm determines and prints the names of all the students whose test score is below the average test score.

Repeat the following for each student in class:

i. Get `studentName` and `testScore`

ii.

```
if (testScore is less than averageTestScore)
    print studentName
```

c. The following algorithm determines the highest test score

i. Get first student’s test score and call it `highestTestScore`.

ii. Repeat the following for each of the remaining students in the class

    1. Get `testScore`

    2.
```
if (testScore is greater than highestTestScore)
    highestTestScore = testScore;
```

d. To print the names of all the students whose test score is the same as the highest test score, compare the test score of each student with the highest test score and if they are equal print the name. The following algorithm accomplishes this.

Repeat the following for each student in the class:

i. Get `studentName` and `testScore`

ii.
```
if (testScore is equal to highestTestScore)
    print studentName
```

You can use the solutions of the subproblems obtained in parts a to d to design the main algorithm as follows:

1. Use the algorithm in part a to find the average test score.
2. Use the algorithm in part b to print the names of all the students whose score is below the average test score.
3. Use the algorithm in part c to find the highest test score.
4. Use the algorithm in part d to print the names of all the students whose test score is the same as the highest test score

Chapter 2

1. a. false; b. false; c. true; d. true; e. false; f. false; g. true; h. true; i. false; j. false; k. true; l. false

3. b, e

5. The identifiers `quizNo1` and `quizno1` are not the same. C++ is case sensitive. The fifth letter of `quizNo1` is uppercase `N` while the fifth character of `quizno1` is lowercase `n`. So these identifiers are different

7. a. `7`

   b. `5.50`

   c. `-1.00`

   d. Not possible. Both the operands of the operator `%` must be integers. `y + z` is of type `double`. Both operands, `y + z` and `x`, of `%V` must be integers.

   e. `13.50`

   f. `1`

   g. Not possible. Both the operands of the operator `%` must be integers. Because the second operand, `z`, is a floating-point value, the expression is invalid.

   h. `3.00`

9. `x = 9, y = 5, z = 3, w = -3`

11. a and c are valid

13. a. `9.0 / 5 * C + 32`

    b. `static_cast<int>('+')`

    c. `static_cast<int>(x + 0.5)`

    d. `str = "C++ Programming is exciting"`

    e. `totalInches = 12 * feet + inches`

    f. `i++`, `++i`, or `i = i + 1;`

    g. `v = 4 / 3 * (3.1416 * r * r *r);`

    h. `s = 2* (3.1416 * r * *r) + 2 * (3.1416 * r) * h;`

    i. `a + (b – c) / d * (e * f – g * h)`

    j. `(–b + (b * b – 4 * a * c)) / (2 * a)`

15. `x = 101`

    `y = 11`

    `z = 104`

    `w = 159.00`

    `t = 81.50`

17. a. `1000`

    b. `42.50`

    c. `1.25`

    d. `11.00`

    e. `9`

f. `88.25`

g. `-2.00`

19. a and c are correct

21. a.

```
int num1;
int num2;
```

b.

```
cout << "Enter two numbers separated by spaces." << endl;
```

c.

```
cin >> num1 >> num2;
```

d.

```
cout << "num1 = " << num1 << ", num2 = " << num2
       << ", 2 * num1 – num2 = " << 2 * num1 – num2 << endl;
```

23. A correct answer is:

```
#include <iostream>

using namespace std;

const char STAR = '*';
const int PRIME = 71;

int main()
{
   int count, sum;
   double x;

   int newNum;   //declare newNum

   count = 1;
   sum = count + PRIME;
   x = 25.67;   // x = 25.67;
   newNum = count * 1 + 2; //newNum = count * ONE + 2;
   sum++;  //(x + sum)++;
   sum = sum + count;   //sum + count = sum;
   x = x + sum * count; // x = x + sum * COUNT;
   sum += 3;   //sum += 3--;
   cout << " count = " << count << ", sum = " << sum
        << ", PRIME = " << PRIME << endl;
   return 0;
}
```

25. An identifier must be declared before it can be used.

27. a.

```
x += 5;
```

b.

```
x *= 2 * y
```

c.

```
totalPay += currentPay;
```

d.

```
z *= (x + 2);
```

e.

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

29.

	a	b	c
`a = (b++) + 3;`	8	3	und
`c = 2 * a + (++b);`	8	2	12
`b = 2 * (++c) – (a++);`	9	-3	11

31. (The user input is shaded.)

```
firstNum = 62
Enter three numbers: 35 10.5 27

The numbers you entered are 35, 10.5, and 27
z = 33
Enter grade: B

The letter that follows your grade is: C
```

33.

```
#include <iostream>
#include <string>

using namespace std;

const double X = 13.45;
const int Y = 18;
const char STAR = '*';

int main()
{
    string employeeID;
    string department;
    int num;
    double salary;

    cout << "Enter employee ID: ";
    cin >> employeeID;
    cout << endl;

    cout << "Enter department: ";
    cin >> department;
    cout << endl;

    cout << "Enter a positive integer less than 80: ";
    cin >> num;
    cout << endl;

    salary = num * X;

    cout << "ID: " << employeeID << endl;
    cout << "Department " << department << endl;
    cout << "Star: " << STAR << endl;
    cout << "Wages: $" << salary << endl;
    cout << "X = " << X << endl;
    cout << "X + Y = " << X + Y << endl;
    return 0;
}
```

Chapter 3

1. a. true; b. true; c. false; d. false; e. false; f. true; g. false; h. false; i. true; j. false; k. true

3. a. `int1 = 67, int2 = 48, dec1 = 56.5, dec2 = 62.72`

   b. `int1 = 48, int2 = -1, dec1 = 0.5, dec2 = 67`

   c. `int1 = 48, int2 = 62, dec1 = 56.5, dec2 = 67`

   d. `int1 = 56, int2 = 67, dec1 = 0.5, dec2 = 48`

   e. Input failure: `int1 = 56;` trying to read the `.` (period) into `int2`.

5. a. `Samantha 168.5 46`

   b. `Samantha 0.5 168`

   c. `** 2.7 45`

   Input failure: Trying to read `S` into `dec`, which is a `double` variable. The values of `dec`, `num` and `str` are unchanged.

7. The function `pow` calculate x^y in a program. That is, `pow(x, y)` = x^y. To use this function the program must include the header file. `cmath`

9. The manipulator `scientific` is used to output floating-point numbers in scientific format. To use this function the program must include the header file `iomanip`.

11. The manipulator `setw` is used to output the value of an expression in a specific number of columns.

13. `iostream`

15. The function `getline` reads until it reaches the end of the current line. The newline character is also read but not stored in the `string` variable.

17. a. `name = " Christy Miller", height = 5.4`

    b. `name = " ", height = 5.4`

19.

```
#include <iostream>
#include <fstream>

using namespace std;

int main()
{
    int num1, num2;
    ifstream infile;
    ofstream outfile;

    infile.open("input.dat");
    outfile.open("output.dat");

    infile >> num1 >> num2;
    outfile << "Sum = " << num1 + num2 << endl;

    infile.close();
    outfile.close();
    return 0;
}
```

21. `fstream`

23. a. Same as before.

    b. The file contains the output produced by the program.

    c. The file contains the output produced by the program. The old contents are erased.

    d. The program would prepare the file and store the output in the file.

25. a. `outfile.open("sales.dat ");`

    b. `outfile >> fixed >> showpoint >> setprecision(2);`

    c. `revenue = numOfJuiceBottlesSold * costOfaJuiceBottle;`

    d.
    ```
    outfile >> numOfJuiceBottlesSold >> " "
            >> costOfaJuiceBottle >> " " >> revenue >> endl;
    ```

    e. `outfile.close();`

Chapter 4

1. a. false; b. false; c. false; d. false; e. true; f. false; g. false; h. false; i. false; j. false; k. false

3. a. false; b. true; c. true; d. true;

5. a. `x == z: 0`

   b. `y != z - 9: 0`

   c. `x - y == z + 10: 1`

   d. `!(z < w): 1`

   e. `w - y < x - 2 * z: 0`

7. a.
```
+--+
```
   b.
```
12 / 2 != 4 + 1
```
   c.
```
*
```
   d.
```
C++
C++
```
   e.
```
low
high
```

9. a.
```
?%!!
```
   b.
```
a b c d
##
```
   c.
```
Flying Coding
```

11. `The value of done is: 0`

13. Omit the semicolon after `else`. The correct statement is:

```
if (score >= 60)
    cout << "Pass" << endl;
else
    cout << "Fail" << endl;
```

15. The correct code is:

```
if (numOfItemsBought > 10)
    shippingCharges  = 0.0;
else if (5 <= numOfItemsBought && numOfItemsBought <= 10)
    shippingCharges = 3.00 * numOfItemsBought;
else if (0 < numOfItemsBought && numOfItemsBought < 5)
   shippingCharges = 7.00 * numOfItemsBought;
```

17. `20 10`

19.
```
if (sale > 20000)
    bonus = 0.10
else if (sale > 10000 && sale <= 20000)
    bonus = 0.05;
else
    bonus = 0.0;
```

21. a. The output is: `Discount = 10%`. The semicolon at the end of the `if` statement terminates the `if` statement. So the `cout` statement is not part of the `if` statement. The `cout` statement will execute regardless of whether the expression in the `if` statement evaluates to `true` or `false`.

b. The output is: `Discount = 10%`. The semicolon at the end of the `if` statement terminates the `if` statement. So the `cout` statement is not part of the `if` statement. The `cout` statement will execute regardless of whether the expression in the `if` statement evaluates to `true` or `false`.

23. a. `(x == y) ? z = x + y : (x + y) / 2;`

b.
```
(hours >= 40.0) ? wages = 40 * 7.50 + 1.5 * 7.5 * (hours - 40)
                : wages = hours * 7.50;
```

c. `(loanAmount >= 200000) ? closingCosts = 10000 : closingCosts = 8000;`

25. a. `40.00`
b. `40.00`
c. `55.00`

27. a. 8 b. `64` c. `1` d. `12`

29. a. `7` b. `12167` c. `8000` d. `3`

31.
```
#include <iostream>

using namespace std;
const int SECRET = 5;

int main()
{
    int x, y, w, z;

    z = 9;

    if (z > 10)
    {
        x = 12;
        y = 5;
        w = x + y + SECRET;
    }
    else
    {
        x = 12;
        y = 4;
        w = x + y + SECRET;
    }

    cout << "w = " << w << endl;

    return 0;
}
```

33.
```
switch (classStanding)
{
case 'f':
    dues = 150.00;
    break;
case 's':
    if (gpa >= 3.75)
```

```
        dues = 75.00;
    else
        dues = 120.00;
        break;
case 'j':
    if (gpa >= 3.75)
        dues = 50.00;
    else
        dues = 100.00;
    break;
case 'n':
    if (gpa >= 3.75)
        dues = 25.00;
    else
        dues = 75.00;
    break;
default:
    cout << "Invalid class standing code." << endl;
}
```

Chapter 5

1. a. true; b. false; c. true; d. false; e. true; f. true; g. true; h. false ; i. false; j. true

3. `40`

5. if `ch > 'Z'` or `ch < 'A'`

7. `Sum = 22`

9. `temp = 0`

11. a. `20  *`
    b. `  *`
    c. `41 70 111  *`
    d. `27 44 71  *`

13. Replace the `while` loop statement with the following:

```
while (response == 'Y' || response == 'y')
```

Replace the `cout` statement:

```
cout << num1 << " + " << num2 << " = " << (num1 - num2)
     << endl;
```

with the following:

```
cout << num1 << " + " << num2 << " = " << (num1 + num2)
     << endl;
```

15. `2 3 4 5 6`

17. `0 3 8 15 24`

19. Loop control variable: `j`

    The initialization statement: `j = 1;`

    Loop condition: `j <= 10;`

    Update statement: `j++`

    The statement that updates the value of `s`: `s = s + j * (j - 1);`

21. `num = 485, y = 15`

23. a. `*`

    b. infinite loop

    c. infinite loop

    d. `****`

    e. `******`

    f. `***`

25. The relationship between `x` and `y` is: $3^y = x$.

    Output: `x = 19683, y = 10`

27.

```
 0 - 24
```

```
25 - 49
50 - 74
75 - 99
100 - 124
125 - 149
150 - 174
175 - 200
```

29. a. both

    b. `do...while`

    c. `while`

    d. `while`

31. In a pretest loop, the loop condition is evaluated before executing the body of the loop. In a posttest loop, the loop condition is evaluated after executing the body of the loop. A posttest loop executes at least once, while a pretest loop may not execute at all.

33.
```
int num;

do

 {
    cout << "Enter a number less than 20 or greater than 75: ";
    cin >> num;
 }
 while (20 <= num && num <= 75);
```

35.
```
int i = 0, value = 0;

do
{
    if (i % 2 == 0 && i <= 10)
        value = value + i * i;
    else if (i % 2 == 0 && i > 10)
        value = value + i;
    else
        value = value - i;
    i = i + 1;
}
while (i <= 20);

cout << "value = " << value << endl;
```

The output is: `value = 200`

37.
```
cin >> number;
while (number != -1)
{
    total = total + number;
    cin >> number;
}
cout << endl;
cout << total << endl;
```

39. a.
```
number = 1;
while (number <= 10)
{
```

```
         cout << setw(3) << number;
         number++;
    }
```

b.

```
number = 1;
do
{
     cout << setw(3) << number;
     number++;
}
while (number <= 10);
```

41. a. `36 94 260`

    b. `4 20`

    c. `30`

    d. `98 250`

43 `-1 0 3 8 15 24`

45. `12 11 9 7 6 4 2 1`

Chapter 6

1. a. false; b. true; c. true; d. true; e. false; f. false; g. true; h. false; i. true; j. true; k. false; l. false; m. false; n. true

3. a. `18` b. `20.50` c. `87.20` d. `16.00` e. `1717.82` f. `2.80` g. `14.00` h. `11.16` i. `27.00` j. `20.00` k. `19.00` l. `-5.00` m. `2.25` n. `4096.00` o. `0.01` p. `3.03`

5. a and b

7. a, b, c, d, e are valid. In f, the second argument in the function call is missing. In g and h, the function call requires one more argument.

9. a. 2; `double`

   b. 3; `int`

   c. 3; `string`

   d. 2; `char`

   e. The function `third` requires 4 actual parameters. The type and the order of these parameters is: `string`, `string`, `int`, `double`

   f. `cout << first(2.5, 7.8) << endl;`

   g. `cout << grade(82.50, 92.50) << endl;`

   h. `cout << third("John", "Blair", 26, 132.5) << endl;`

11.

```
bool isWhitespace (char ch)
{
    if (isspace(ch))
        return true;
    else
        return false;
}
```

13. a. `(i) 72 (ii) -200`

    b. The function computes *mn*, where *m* and *n* are the arguments of the function.

15. a. `385`

    b. This function computes 1+4+9+16+25+36+49+64+81+100

17.

```
double funcEx17(double x, double y)
{
    return pow(x, y) + pow(y, x);
}
```

19. a. In a void function, a return statement is used without any value such as `return;`

    b. In a void function, a return statement is used to exit the function early.

21. a. A variable declared in the heading of a function definition is called a formal parameter. A variable or expression used in a function call is called an actual parameter.

    b. A value parameter receives a copy of the actual parameter’s data. A reference parameter receives the address of the actual parameter.

    c. A variable declared within a function or block is called a local variable. A variable declared outside of every function definition is called a global variable.

23.

```
void funcEx23(int num)
{
    if (num % 2 == 0)
        cout << 2 * num << endl;
    else
        cout << 5 * num << endl;
}
```

25.

```
void initialize(int& x, double& y, string& str)
{
    x = 0;
    y = 0;
    str = "";
}
```

27.

```
7, 0, 0
1, 0, 8
8, 1, 8
2, 1, 1
```

29.

```
   #include <iostream>

   using namespace std;

   int secret(int, int);

   void func(int x, int& y);

   int main()
   {
        int num1, num2;

__1__   num1 = 6;

__2__   cout << "Enter a positive integer: ";
__3__   cin >> num2;
__4__   cout << endl;
__8__   cout << secret(num1, num2) << endl;
__9__   num2 = num2 - num1;
_10__   cout << num1 << " " << num2 << endl;
_15__   func(num2, num1);
_16__   cout << num1 << " " << num2 << endl;

_17__   return 0;
   }

   int secret(int a, int b)
   {
        int d;

__5__   d = a + b;
__6__   b = a * d;

__7__   return b;
   }

   void func (int x, int& y)
   {
        int val1, val2;
_11__    val1 = x + y;
_12__    val2 = x * y;
_13__    y = val1 + val2;
_14__    cout << val1 << " " << val2 << endl;
   }
```

If the input is 10, the output is:

```
96
6 4
10 24
34 4
```

31.

```
void trackVar(double& x, double y, double& z)
{
    z = floor(x) + ceil(y);
    x = x + z;
    y = y - z;
}
```

33.

```
3 5
108 0
108 5
```

35.

```
stVar = 3, u = 3, x = 2
stVar = 9, u = 3, x = 3
stVar = 18, u = 3, x = 4
stVar = 36, u = 3, x = 5
```

37. a, b, and d are correct.

Chapter 7

1. a. true; b. false; c. true; d. false; e. false; f. true; g. true; h. true; i. false; j. false; \

3. Only a and c are valid.

5.

```
flowerType readIn()
{
   string str;
   flowerType flower = 0;

   cin >> str;

   if (str == "Rose")
       flower = ROSE;
   else if (str == "Daisy")
       flower = DAISY;
   else if (str == "Carnation")
       flower == CARNATION;
   else if (str == "Freesia")
       flower = FREESIA;
   else if (str == "Gardenia")
       flower = GARDENIA;
   else if (str == "Allium")
       flower = ALLIUM;
   else if (str == "Tulip")
       flower = TULIP;
   else if (str == "Iris")
       flower = IRIS;
   else if (str == "sunflower")
       flower = SUNFLOWER;
   else if (str == "Lilac")
       bir flower d == LILAC;
   else if (str == "Orchid")
       flower = ORCHID;
   else
        cout << "Invalid flower name." << endl;

    return flower;
}
```

7. Because there is no name for an anonymous type, you cannot pass an anonymous type as a parameter to a function and a function cannot return an anonymous type value. Also, values used in one anonymous type can be used in another anonymous type, but variables of those types are treated differently.

9. The statement in Line1 1 and 2 should be:

```
#include <iostream>               //Line 1

using namespace std;              //Line 2
```

11. The statement in Line 2 should be:

```
using namespace std;                        //Line 2
```

13. Either include the statement:

```
using namespace aaa;
```

before the function `main` or refer to the identifiers `x` and `y` in `main` as `aaa::x` and `aaa::y`, respectively.

15. a. `Sammer Vucation`

    b. `Temperary Projoct`

    c. `Nocial Setwork`

17.
```
Regular exercise
Regular exercise and low fat diet
33
8
8
health insurance
insurance
Regular exercise can reduce health insurance $$$$.
$ocial Nedia!!
14
Social Media!!
```

Chapter 8

1. a. true; b. true; c. true; d. false; e. false; f. false; g. false; h. false; i. true; j. false; k. false; l. false

3. a. This declaration is correct.

b. Array size must be positive. A correct answer is: `int testScores[10];`

c. This declaration is correct.

d. Array size must be a positive integer not a range. A correct answer is: `int list100[100];`

e. `gpa` is an array of size `50`. The expression `[50]` should be after `gpa`. The correct statement is: `double gpa[50];`

f. `LENGTH` must be declared as integral, such as `int` . A correct statement is: `const int LENGTH = 26;`

g. This declaration is correct.

5. 0 to 64. first = 0, middle = 32, last = 64

7.
```
0.00 1.50 9.00 28.50 66.00
57.00 1.50 30.00 28.50 66.00
```

9. `1 2 2 4 8 32 224 6944`

11.
```
int myList[10];

for (int i = 0; i < 10; i++)
    myList[i] = i;
```

13. If array index is less than 0 or greater than arraySize – 1, we say that the array index is out-of bounds. C++ does not check for array indices within bound.

15. a. `double heights[10] = {5.2, 6.3, 5.8, 4.9, 5.2, 5.7, 6.7, 7.1, 5.10, 6.0};`

or

`double heights[] = {5.2, 6.3, 5.8, 4.9, 5.2, 5.7, 6.7, 7.1, 5.10, 6.0};`

b. `int weights[7] = {120, 125, 137, 140, 150, 180, 210};`

or

`int weights[] = {120, 125, 137, 140, 150, 180, 210};`

c. `char specialSymbols[] = {'$', '#', '%', '@', '&', '! ', '^'};`

d. `string seasons[4] = {"fall", "winter", "spring", "summer"};`

or

`string seasons[] = {"fall", "winter", "spring", "summer"};`

17. `alpha[0] = 3, alpha [1] = 12, alpha [2] = -25, alpha [3] = 72,`

`alpha [4] = 0.`

19.

```
-5 0 10 60 360 600
```

21. a. Correct.

b. Correct.

c. Incorrect. None of the formal parameters `list` and `sList` are of type `double` while the actual parameter `unitPrice` is of type `double`. So there will be mismatch data type error.

d. Incorrect. The size of the array `ids` is 50, so the call should be `printList(ids, 50);`

e. Correct.

23.

```
1 35700.00 714.00
2 96800.00 1936.00
3 55000.00 1100.00
4 72500.00 1450.00
5 87700.00 1754.00
```

25.

```
list: 810 0 270 180 90
```

27.

```
1 3.50 10.70 235.31
2 7.20 6.50 294.05
3 10.50 12.00 791.68
4 9.80 10.50 646.54
5 6.50 8.00 326.73
```

29. No.

31.

```
1 0 1 1 1 0 0 1 1
```

33. No, because during compile time the formal parameter `list` has no first and last elements.

35. a. Valid

b. Valid

c. Invalid; the assignment operator is not defined for C-strings.

d. Invalid; the relational operators are not defined for C-strings.

37. a. `strcpy(myStr, "Summer Vacation");`

b. `cout << strlen(yourStr) << endl;`

c. `strcpy(myStr, yourStr);`

d. `compare = strcmp(myStr, yourStr);`

39.

```
double matrix[4][3] = {{2.5, 3.2, 6.0}, {5.5, 7.5, 12.6},
                       {11.25, 16.85, 13.45}, {8.75, 35.65, 19.45}};
```

41. a. 30

b. 5

c. 6

d. row

e. column

43. a. `beta` is initialized to `0`.

b.
```
First row of beta: 0 1 2
Second row of beta: 1 2 3
Third row of beta: 2 3 4
```

c.
```
First row of beta: 0 0 0
Second row of beta: 0 1 2
Third row of beta: 0 2 4
```

d.
```
First row of beta: 0 2 0
Second row of beta: 2 0 2
Third row of beta: 0 2 0
```

e.
```
First row of beta: 0 0 0
Second row of beta: 0 1 2
Third row of beta: 0 2 1
```

Chapter 9

1. a. false; b. true; c. false; d. false ; e. false; f. false; g. false; h. true; i. false; j. true; k. true

3.
```
computerType newComputer;

newComputer.manufacturer = "Computer Corporation";
newComputer.modelType = "Desk Top";
newComputer.processorType = "Core I 7";
newComputer.ram = 12;
newComputer.hardDriveSize = 500;
newComputer.yearBuilt = 2016;
newComputer.price = 850.00;
```

5.
```
if (firstHouse.style == secondHouse.style &&
    firstHouse.price == secondHouse.price)
     cout << "true" << endl;
else
    cout << "false" << endl;
```

7.
```
fruitType fruit;

fruit.name = "banana";
fruit.color = "yellow";
fruit.fat = 1;
fruit.sugar = 15;
fruit.carbohydrate = 22;
```

9. Assignment statement and function return value.

11. a.
```
classList[0].name.first = "Jessica";
classList[0].name.last = "Miller";
classList[0].gpa = 3.8;
classList[0].course.name = "Data Structure";
classList[0].course.callNum = 8340;
classList[0].course.credits = 3;
classList[0].course.grade = 'B';
```

b.
```
student = classList[0];
```

13. a. Invalid; the member `name` of `newEmployee` is a `struct`. Specify the member names to store the value `"John Smith"`. For example,

```
newEmployee.name.first = "John";
newEmployee.name.last = "Smith";
```

b. Invalid; the member `name` of `newEmployee` is a `struct`. There are no aggregate output operations on a `struct`. A correct statement is:

```
cout << newEmployee.name.first << " "
     << newEmployee.name.last << endl;
```

c. Valid

d. Valid

e. Invalid; `employees` is an array. There are no aggregate assignment operations on arrays.

15. `sportsType soccer[20];`

```
struct sportsType
{
    string sportName;
    string teamName;
    int numberOfPlayers;
    double teamPayroll;
    double coachSalary;
};
```

17. a.
```
void getData(sportsType & sp)
{
    cin >> sp[i].sportName >> sp[i].teamName
        >> sp[i].numberOfPlayers
        >> sp[i].teamPayroll
        >> sp[i].coachSalary;
}

for (int j = 0; j < 100; j++)
    getData(soccer[i]);
```

b.
```
void printData(sportsType sp)
{
    cout << "Sport Name: " << sp[i].sportName << endl;
    cout << "Team Name: " << sp[i].teamName << endl;
    cout << "Number of Players: " << sp[i].numberOfPlayers << endl;
    cout << "Team Payroll: $" << sp[i].teamPayroll << endl;
    cout << "Coach Salary: $" << sp[i].coachSalary << endl;
    cout << "------------------------------------" << endl << endl;
}

for (int j = 0; j < 20; j++)
  printData(soccer[i]);
```

Chapter 10

1. a. false; b. false; c. true; d. false; e. false

3. A constructor has no type. The statements in Line 6 should be:

```
syntaxErrors2(int = 0,
              double = 0);      //Line 6
```

Also, replace `;` after `private` with `:`. Line 7 should be:

```
private:                        //Line 7
```

5. The function `set` must have a return type. A constructor cannot be constant. Replace `:` after `}` with `;`. The statements in Lines 4, 6, and 12 should be:

```
void set(string, int, double);   //Line 4
syntaxErrors4() const;           //Line 6
};                               //Line 12
```

7. a.

```
void foodType::set(string s, int c, double f, int su,
                     double cr, double p)
{
    name = s;

    if (c >= 0)
        calories = c;
    else
        calories = 0;

    if (f >= 0)
        fat = f;
    else
        fat = 0;

    if (su >= 0)
        sugar = su;
    else
        sugar = 0;

    if (cr >= 0)
        carbohydrate = cr;
    else
        carbohydrate = 0;

    if (p >= 0)
        potassium = p;
    else
        potassium = 0;
}
```

b.

```
void foodType::print() const
{
    cout << "Name: " << name << endl;
    cout << "Calories: " << calories << endl;
    cout << "Fat: " << fat << endl;
    cout << "Sugar: " << sugar << endl;
    cout << "Carbohydrate: " << carbohydrate << endl;
    cout << "potassium: " << potassium << endl;
}
```

c.

```
string foodType::getName() const
{
    return name;
}

int foodType::getCalories() const
{
    return calories;
}

double  foodType::getFat() const
{
    return fat;
}

int foodType::getSugar() const
{
    return sugar;
}

double foodType::getCarbohydrate() const
{
    return carbohydrate;
}

double foodType::getPotassium() const
{
    return potassium;
}
```

d.

```
foodType::foodType()
{
    set("", 0, 0.0, 0, 0.0, 0.0);
}
```

e.

```
foodType::foodType(string s, int c, double f, int su,
                  double cr, double p)
{
    set(s, c, f, su, cr, p);
}
```

f.

```
fruit2.print();
```

g.

```
foodType myFruit("Apple ",52,0.2, 10,13.8,148.0);
```

9. The functions `print`, `getQuantitiesInStock`, `getPrice`, and `getDiscount` are accessors; functions `set`, `setQuantitiesInStock`, `updateQuantitiesInStock`, `setPrice`, and `setDiscount` are mutators.

11. a. 28; b. 8 c. 1; d. 9

13. a. 14

    b. 3

    c. The `class temporary` has only one constructor. Because this is a constructor with default parameters, it can be used to initialize an object without specifying any parameters. For example, the following statement creates the object `newObject` and its instance variables are initialized to `""`, `0`, and `0`, respectively.

    ```
    temporary newObject;
    ```

15. The statement in Line 1 creates `object1` and initializes the instance variables of this object to `""`, `0`, `0`, that is, `object1.description = "";`, `object1.first = 0.0;`, and `object1.second = 0.0;`. The statement in Line 2 creates `object2` and initializes the instance variables of this object as follows: `object2.description = "rectangle";`, `object2.first = 3.0;`, and `object2.second = 5.0;`. The statement in Line 3 creates `object3` and initializes the instance variables of this object as follows: `object3.description = "circle";`, `object3.first = 6.5;`, and `object3.second = 0.0;`. The statement in Line 4 creates `object4` and initializes the instance variables of this object as follows: `object4.description = "cylinder";`, `object4.first = 6.0;`, and `object4.second = 3.5;`.

17. There two built-in operations for class objects: Member access (`.`) and assignment (=).

19.

```
10:17:00
23:59:29
00:00:29
```

21. a. `personType student("Buddy", "Arora");`

    b. `student.print();`

    c. `student.setName("Susan", "Gilbert");`

23. A constructor is a member of a class and it executes automatically when a class object is instantiated and a call to the constructor is specified in the object declaration. A constructor is included in a class so that the objects are properly initialized when they are declared.

25. A destructor is a member of a class and if it is included in a class, it executes automatically when a class object goes out of scope. Its main purpose is to deallocate the dynamic memory created by an object.

27. It typically inserts the code of an inline function at every location the function is called.

29.

a. `myClass::count = 0;`

b. `myClass.incrementCount();`

c. `myClass.printCount();`

d.

```
int myClass::count = 0;

void myClass::setX(int a)
{
    x = a;
}

void myClass::printX() const
{
    cout << x;
}

void myClass::printCount()
{
    cout << count;
}

void myClass::incrementCount()
{
    count++;
}

myClass::myClass(int a)
{
    x = a;
}
```

e. `myClass myObject1(5);`

f. `myClass myObject2(7);`

g.

The statements in Lines 1 and 2 are valid.

The statement in Line 3 should be: `myClass::printCount();`.

The statement in Line 4 is invalid because the member function `printX` is not a `static` member of the class, and so it cannot be called by using the name of class.

The statement in Line 5 is invalid because `count` is a `private static` member variable of the class.

h.

```
5
2
2
3
14
3
3
```

Chapter 11

1. a. false; b. false; c. true; d. true; e. true; f. true; g. true; h. true; i. false; j. false; k. true

3. Some of the member variables that can be added to the class employeeType are: department, salary, employeeCategory (such as supervisor and president), and employeeID. Some of the member functions are: setInfo, setSalary, getSalary, setDepartment, getDepartment, setCategory, getCategory, setID, and getID.

```
class employeeType: public personType
{
public:
    void setInfo(string, string, string, double, string, string);
    void setSalary(double);
    void setDepartment(string);
    void setCategory(string);
    void setID(string);
    double getSalary() const;
    string getDepartment(string) const;
    string getCategory()const;
    string getID()const;

private:
    string department;
    double salary;
    string employeeCategory;
    string employeeID;
};
```

5. a. The base class is shoe and the derived class is runningShoe.

   b. This is private inheritance.

7. Private members of the object newCylinder are xCoordinate, yCoordinate, radius, and height.

9. Omit the word class before employee. The first statement should be:

```
class hourlyEmployee: public employee
```

In the third line replace :: with :. This statement should be

```
public:
```

Omit the word const from the prototypes of the functions setHoursWorked and setPay because these functions modify the instance variables. These prototypes should be:

```
void setHoursWorked(double hrsWk);
void setPay();
```

Replace ; after the label private with :. This statement should be

```
private:
```

11. a.

```
void print() const;
```

b.

```
void set(int, int, int);
void get(int&, int&, int&);
```

13. First a constructor of class one will execute, then a constructor of class two will execute, and finally a constructor of class three will execute.

15. a. Invalid. z is an instance variable of the derived class, it cannot be accessed by the members of the class smart.

b. Invalid. secret is a private member of the class smart. It cannot be accessed directly outside of the class. Also z is a private member of the class superSmart. It cannot be accessed directly outside of the class.

c. Valid

d. Invalid. smart is the name of a class, not an object of this class. It cannot be used to call its member function print.

e. Invalid. superSmart is the name of a class. It cannot be used to access its members.

17. Between the preprocessor directive #ifndef and #endif. The definitions of the classes one and two can be placed between these directives as follows:

```
#ifndef H_one                      #ifndef H_two
#define H_one                      #define H_two

//place the definition of the      //place the definition of the
//class one here                   //class two here

#endif                             #endif
```

19. In a private inheritance, the public members of the base class are private members of the derived class. They can be directly accessed in the derived class. The protected members of

the base class are private members of the derived class. They can be directly accessed by the member functions (and friend functions) of the derived class. The private members of the base class are hidden in the derived class. They cannot be directly accessed in the derived class. They can be accessed by the member functions (and friend functions) of the derived class through the public or protected members of the base class.

21. In a public inheritance, the public members of the base class are public members of the derived class. They can be accessed by the member functions (and friend functions) of the derived class. The protected members of the base class are protected members of the derived class. They can be accessed by the member functions (and friend functions) of the derived class. The private members of the base class are hidden in the derived class. They cannot be directly accessed in the derived class. They can be accessed by the member functions (and friend functions) of the derived class through the public or protected members of the derived class.

23. The protected members of a base class can be directly accessed by the member functions of the derived class, but they cannot be directly accessed in a program that uses that class. The public members of a class can be directly accessed by the member functions of any derived class as well as in a program that uses that class.

25. a.
```
class yourClass: protected base
{
}
```

b. The members setXYZ, setX, getX, setY, getY, mystryNum, and print, z, setZ, and secret are protected members of the class yourClass. The private members x and y of the class base are hidden in class yourClass and they can be accessed in class yourClass only through the protected and public members of class base.

27. a. Because the memberAccessSpecifier is not specified, it is a private inheritance.

b. All members of the class base becomes private members in class derived.

29. a.

```
void base::print() const
   {
       cout << "num = " << num << ", x = " << x;
   }

   double base::compute(int n)
   {
       return n + manipulate(n, n);
   }

   double base::manipulate(int a, int b)
   {
       return num * a + x * b;
   }
```

b.

```
double derived::print() const
```

c.

```
num = 2, x = 5.50
59.50
num = 3, x = 1.50, z = 2.00
17.50
```

Chapter 12

1. a. false; b. false ; c. false; d. true; e. false; f. true; g. false; h. false; i. true; j. false; k. true; l. true; m. false; n. true; o. true; p. false;

3. a. To create a pointer, in the variable declaration, operator `*` is placed between the data type and the variable name. For example the statement `int *p;` declares p to be a pointer of type `int`.

b. To dereference a pointer, in an expression, the operator `*` is placed to the left of the pointer.

For example, if `p` is a pointer of type `int`, the expression `cout << *p << endl;` outputs the data stored in the memory space to which `p` points.

5. `*numPtr` given the address of the memory location to which `numPtr` points, while `&numPtr` gives the address of `numPtr`.

7.

```
numPtr = &num;
(*numPtr)++;
```

9.

```
33.8 3.8
33.8 3.8
```

11. The correct code is:

```
double *length;
double *width;

cout << fixed << showpoint << setprecision(2);

length = new double;
*length = 6.5;

width = new double;
*width = 3.0;

cout << "Area: " << (*length) * (*width) << ", ";
cout << "Perimeter: " << 2 * (*length + *width) << endl;
```

Output:

```
Area: 19.50, Perimeter: 19.00
```

13.

```
Trip total cost: $550.00
Highest trip cost: $275.00
```

15. In Line 6, the operator `delete` deallocates the memory space to which `nextPtr` points. So the expression `*nextPtr`, in Line 9, does not have a valid value.

17.

```
12 37 78 62 62 13
```

19. `numPtr = 1058` and `gpaPtr = 2024`

21. The operator `delete` deallocates the memory space to which a pointer points.

23. a. `sales  = new double[50];`

b.
```
for (int i = 0; i < 50; i++)
    cin >> sales[i];
```

c.
```
int maxIndex = 0;
for (int i = 1; i < 50; i++)
    if (sales[maxIndex] < sales[i])
        maxIndex = i;
```

d. `delete []sales;`

25. Because at compile time dynamic arrays have no first and last elements, so the functions `begin` and `end` cannot be called on dynamic arrays.

27. In a shallow copy of data, two or more pointers point to the same memory space. In a deep copy of data, each pointer has its own copy of the data.

29.
```
int *myList;
int *yourList;

myList = new int[5];
myList[0] = 8;
for (int i = 1; i < 5; i++)
    myList[i] = i * myList[i - 1];

yourList = new int[5];
for (int i = 0; i < 5; i++)
    yourList[i] = 2 * myList[i];
```

31. The copy constructor makes a copy of the actual variable.

33. Classes with pointer data members should include the destructor, overload the assignment operator, and explicitly provide the copy constructor by including it in the class definition and providing its definition.

35.
```
5
small: --
x: 2, y = 3
*_*_*_*_*_*_*_*_*_*_*_*

17
small: --
x: 3, y = 5
noSmall--- z: 9
```

37. Yes.

39. a. Because `employeeType` is an abstract class, you cannot instantiate an object of this class. Therefore, this statement is illegal.

b. This statement is legal.

c. This statement is legal.

Chapter 13

1. a. true; b. false; c. true; d. false; e. false; f. false; g. false; h. false; i. true; j. false;

   k. false; l. true; m. true

3. b

5. A friend function of a class is a nonmember function of the class, but has access to all the members (`public` or non-`public`) of the class.

7. d; Because the left operand of << is a stream object, which is not of the user-defined class type.

9. a. One b. Two

11. `object1.operator+(object2)`

13. a. `bool` b. `bool`

15. a. `friend strange operator+(const strange&, const strange&);`

    b. `friend bool operator==(const strange&, const strange&);`

    c. `friend strange operator++(strange&, int);`

17. In Line 4, the formal parameter of the function `operator+` should be of type `myClass`. The correct statement is:

```
myClass operator+(const myClass& obj);    //Line 4
```

19. In Line 3, the return type of the function `operator<` should be `bool`. The correct statement is:

```
  friend bool operator<(const mystery& a,
                        const mystery& b);   //Line 3
```

21. In Line 3 and 10, the return type of the function `operator*` should be `findErrors`. In Line3, the type of the objects `a` and `b` must be `findErrors`. Also since `operator*` is a friend function of the class, the name of the class and the scope resolution operator in the heading of the function, in Line 10, is not needed. In Lines 13 and 14, to access the instance variables of the object `a`, we need to use the object `a` and the dot operator. The correct statements are:

```
  friend findErrors operator*(const findErrors& a,
                              const findErrors& b);   //Line 3
double operator*(const findErrors& a,
                 const findErrors& b)    //Line 10

temp.first = a.first * b.first;          //Line 13
temp.second = b.second * b.second;       //Line 14
```

23. A reference to an object of the class istream.

25. The function that overloads the pre increment operator has no parameter, while the function that overloads the post increment operator has one (dummy) parameter.

27. a. None b. One

29.

```
class complexType
{
      //overload the stream insertion and extraction operators
    friend ostream& operator<<(ostream&, const complexType&);
    friend istream& operator>>(istream&, complexType&);

public:
    void setComplex(const double& real, const double& imag);
      //set the complex number according to the parameters
      //Postcondition: realPart = real; imaginaryPart = imag

    complexType(double real = 0, double imag = 0);
      //constructor
      //initialize the complex number according to the parameters
      //Postcondition: realPart = real; imaginaryPart = imag

    complexType operator+(const complexType& otherComplex) const;
      //overload +
    complexType operator*(const complexType& otherComplex) const;
      //overload *

    complexType operator~() const;

    double operator!() const;

    bool operator==(const complexType& otherComplex) const;
      //overload ==

private:
    double realPart;      //variable to store the real part
    double imaginaryPart; //variable to store the imaginary part
};

     // Definitions of operator~ and operator!
complexType complexType::operator~() const
{
    complexType temp = *this;

    temp.imaginaryPart = -temp.imaginaryPart;

    return temp;
}

double complexType::operator!() const
{
    return (pow((realPart * realPart +
                 imaginaryPart * imaginaryPart), 0.5));
}
```

31. When the class has pointer data members.

33. Error in Line 4. A template instantiation can be for only a built-in type or a user-defined type. The word "`type`" between the angular brackets must be replaced either with a built-in type or a user-defined type.

35. a. `12` b. `Sunny Day`

37.

```
template <class Type>
void swap(Type &x, Type &y)
{
    Type temp;
    temp = x;
    x = y;
    y = temp;
}
```

39. These statements generate and output a random integer between 10 and 25.

Chapter 14

1. a. false; b. true; c. true; d. false; e. true; f. false; g. false; h. true; i. false; j. true; k. false; l. true; m. false;

3. The program will terminate with an error message.

5. At most one.

7. The thrown value then may not be accessible in the `catch` block exception handling code.

9. The object being thrown can be either a specific object or an anonymous object.

11. The `cout` statement in Line 12 separates the catch block from the try block. Therefore, the `catch` block has no associated `try` block and the `try` block has no associated `catch` block. The catch block in Line 13 has no parameters. The correct code is:

```
double salary = 78000;                          //Line 1
double raise;                                   //Line 2

try                                             //Line 3
{                                               //Line 4
    cout << "Enter the raise: ";                //Line 5
    cin >> raise;                               //Line 6
    cout << endl;                               //Line 7

    if (raise < 0.0)                            //Line 8
        throw raise;                            //Line 9

    cout << "Salary increase: $"
         << salary * raise / 100 << endl;       //Line 10
    cout << "Exiting the try block." << endl;   //Line 11
}                                               //Line 12
catch (double x)                                //Line 13
{                                               //Line 14
    cout << "Negative raise: " << x << endl;    //Line 15
}                                               //Line 16
```

(In a and b, the user input is shaded.)

a.
```
Enter the raise: 5

Salary increase: $3900
Exiting the try block.
```

b.
```
Enter the raise: -4

Negative raise: -4
```

13. (In the following, the user input is shaded.)

a.
```
Enter the number of items: 25

Enter the cost of one item: 5.50

Total cost: $137.50
```
b.
```
Enter the number of items: -55

Negative number of items: -55
Numer of items must be nonnegative.
```
c.
```
Enter the number of items: 37

Enter the cost of one item: -4.5

Negative unit cost: -4.50
Unit cost must be nonnegative.
```
d.
```
Enter the number of items: -10

Negative number of items: -10
Numer of items must be nonnegative.
```

15. a.
```
55
Exiting the try block.
```
b.
```
Exception: Division by 0
```
c.
```
Exception: Total score is out of range.
```
d.
```
Exception: Division by 0
```

17. a. `class out_of_range`

b. `class length_error`

c. `class runtime_error`

19. A `throw` statement.

21. (Assume that the definition of the `class tornadoException` is in the header file `tornadoException.h`.)
```
#include <iostream>
#include "tornadoException.h"

using namespace std;

int main()
{
    int miles;

    try
    {
        cout << "Enter the miles: ";
        cin >> miles;
        cout << endl;

        if (miles < 5)
            throw tornadoException();
        else
            throw tornadoException(miles);
    }
    catch (tornadoException tE)
    {
        cout << tE.what() << endl;
    }

    return 0;
}
```

23. A function specifies the exceptions it throws in its heading using the `throw` clause.

25. (1) Do nothing; (2) Partially process the exception and throw the same exception or a new exception; (3) Throw a new exception.

Chapter 15

1. a. true; b. true; c. false; d. false; e. false; f. false; g. true; h. true;

3. A definition in which something is defined in terms of a smaller version of itself.

5. Because a base case stops the recursion.

7. a. The statements from Line 3 to Line 6.

   b. The statements in Lines 7 and 8.

   c. It is a valid call. The value of `recFunc(58)` is `32`.

   d. It is a valid call. The value of `recFunc(-24)` is `24`.

   e. It is a valid call. The value of `recFunc(0)` is `0`.

9. a. `8 5 2` b. `7` c. `6 3` d. `-85`

11. a. `4 12 28`

    b. `5 15 34 72 148`

    c. `2 8 21 47 98`

    d. It does not produce any output.

13. a. `0`

    b. `4`

    c. `8`

    d. `162`

15. a. `10` b. `21` c. `-23` d. `2` e. `-56`

17.

$$multiply(m,n) = \begin{cases} 0 & if\ n = 0 \\ m & if\ n = 1 \\ m + multiply(m, n-1) & otherwise \end{cases}$$

The base cases are when *n* = 0 or *n* = 1. The general case is specified by the option otherwise.

19. A selection control structure.

Chapter 16

1. a. true; b. false; c. false; d. false; e. false; f. true; g. true; h. false; i. false; j. true; k. true; l. false; m. false; n. true;

3. `nullptr`

5. Before deletion the link field of the third node stores the address of the fourth node. After deletion the link field of the third node will store the address of the next node (old) fifth node. If there was no fifth node, after deletion the link field will store the value `nullptr`. Therefore, after deleting the fourth node, the link field of the third node is changed. So a pointer to the third node is needed.

7. a. true

   b. true

   c. false

   d. true

   e. true

   f. false

9. a. `p->link->info = 24;`

   b. `q = current->link;`

   c. `first = first->link;`

   d. `trail = p->link;`

   e. `p = nullptr;`

   f. `temp->link->info = 54;`

   g.
```
while (first->info != 5)
    first = first ->link;
```

11. a.
```
while (first != nullptr)

    first = first->link;
```

   b.
```
q = new nodeType;
q->info = 17;
q->link = current->link;
current->link = q;
```

   c.
```
q = temp->link;
q->link = nullptr;
delete last;
last = q;
```

   d.
```
q = p->link;
p->link = current;
delete q;
```

   e.
```
q = current->link;
q->link = temp->link;
temp->link = q;
current->link = temp;
```

13.
```
65 5 78
```

15. `39 26 78`

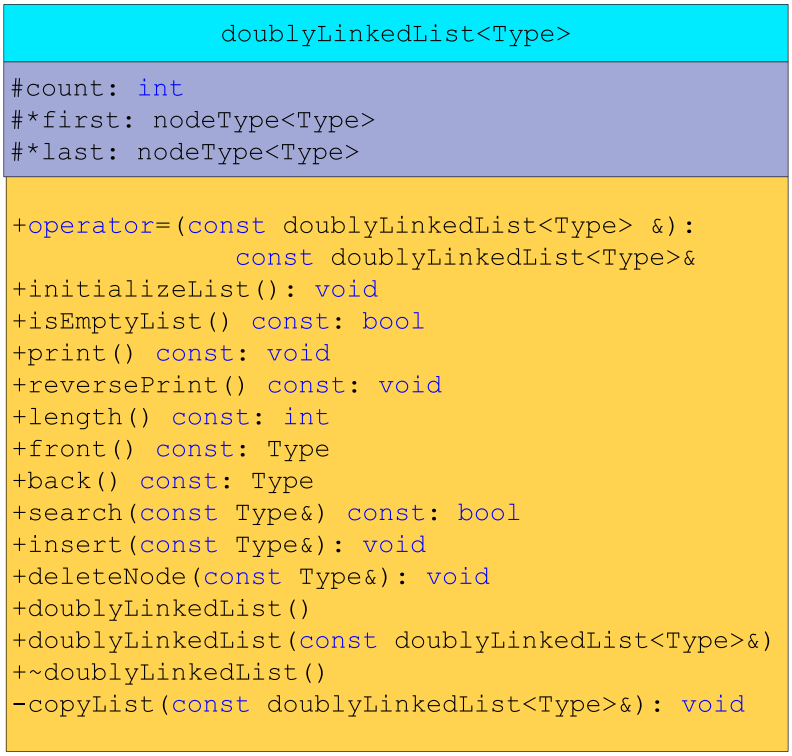
17.
```
nodeType head, p, q;

head = new nodeType;
head->info = 72;
head->link = nullptr;
p = new nodeType;
p->info = 43;
p->link = head;
head = p;
p = head->link;
q = new nodeType;
q->info = 8;
q->link = nullptr;
p->link = q;
q = new nodeType;
q->info = 12;
q->link = p;
head->link = q;

p = head;
while (p != nullptr)
{
    cout << p->info << " ";
    p = p->link;
}
cout << endl;
```

The output of this code is: `43 12 72 8`

19. a. The function `begin` returns an iterator to the first node of a linked list.
    b. The function `end` returns an iterator one past the last node of a linked list.

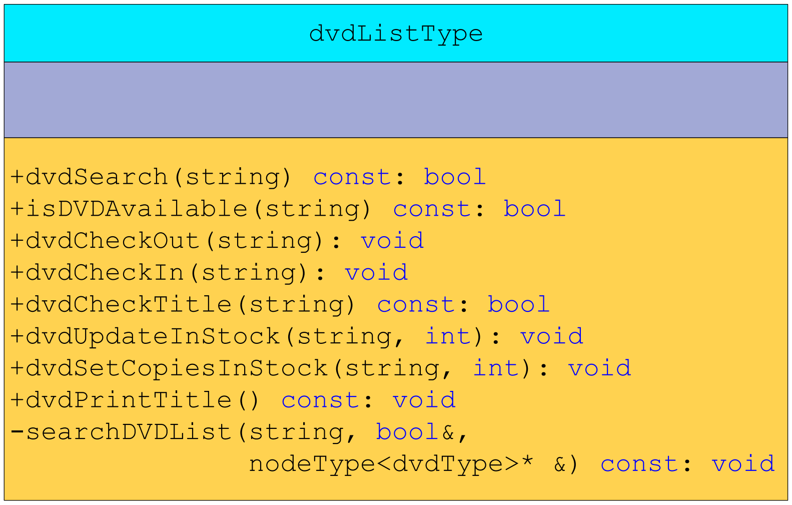
21.
```
The item to be deleted is not in the list.
90 15 65 36 30 27
```

23.



```
doublyLinkedList<Type>

#count: int
#*first: nodeType<Type>
#*last: nodeType<Type>

+operator=(const doublyLinkedList<Type> &):
              const doublyLinkedList<Type>&
+initializeList(): void
+isEmptyList() const: bool
+print() const: void
+reversePrint() const: void
+length() const: int
+front() const: Type
+back() const: Type
+search(const Type&) const: bool
+insert(const Type&): void
+deleteNode(const Type&): void
+doublyLinkedList()
+doublyLinkedList(const doublyLinkedList<Type>&)
+~doublyLinkedList()
-copyList(const doublyLinkedList<Type>&): void
```

25.



```
dvdListType


+dvdSearch(string) const: bool
+isDVDAvailable(string) const: bool
+dvdCheckOut(string): void
+dvdCheckIn(string): void
+dvdCheckTitle(string) const: bool
+dvdUpdateInStock(string, int): void
+dvdSetCopiesInStock(string, int): void
+dvdPrintTitle() const: void
-searchDVDList(string, bool&,
               nodeType<dvdType>* &) const: void
```

Chapter 17

1. a.true; b. false; c. false; d. true; e. false; f. true; g. false; h. false; i. true; j. true;

   k. true; l. false; m. false; n. false;

3. a. 8 b. 7 c. `dec = stack.top();` d. `stack.pop();`

5.
```
13
32 32 13 16 28
temp = 16
```

7. `secretNum = 226`

9. a. `16`
   b. `-4`
   c. `39`
   d. `12`
   e. `15`

11. a. `x * y + z - t`
    b. `x * (y + z) - w / u`
    c. `(x - y) * (z / u) - (t + s)`
    d. `x * (y - (z + w))`

13. `1 16 27 16 5`

15. If the stack is nonempty, the statement `stack.top();` returns the top element of the stack and the statement `stack.pop();` removes the top element of the stack.

17.
```
template <class elemType>
elemType second(stackType<elemType> stack)
{
    elemType temp1, temp2;

    if (stack.isEmptyStack())
    {
        cout << "Stack is empty." << endl;
        exit(0); //terminate the program
    }

    temp1 = stack.top();
    stack.pop();

    if (stack.isEmptyStack())
    {
        cout << "Stack has only one element." << endl;
        exit(0); //terminate the program
    }
    temp2 = stack.top();
    stack.push(temp1);

    return temp2;
}
```

19. a. 4

b. 21

c.`!queue.isEmptyQueue()`

d. `queue.addQueue("programming")`

After the insertion operation the index of the last element is `5`

21. `cin >> num;`

```
while (cin)
{
    switch (num % 2)
    {
    case 0:
        stack.push(num);
        break;
    case 1: case -1:
        if (num % 3 == 0)
            queue.addQueue(num);
        else
        {
            if (!stack.isEmptyStack())
                stack.pop();
            stack.push(num * num);
        }
    } //end switch

    cin >> num;
} //end while
```

After processing these numbers, `stack` and `queue` are:

```
stack: 14 289 10 121 28
queue: 15 -9 21 -3 33
```

23. a. 26
b. `queueFront = 35`; `queueRear = 61`.
c. `queueFront = 36`; `queueRear = 60`.

25. a. 31
b. `queueFront = 25`; `queueRear = 56`.
c. `queueFront = 26`; `queueRear = 55`.

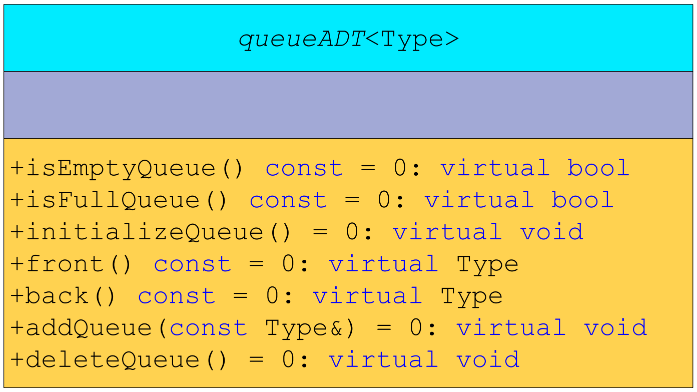
27. 51

29. `5 -4 5 -7 1 2 1 4 1 -2 2 -7 7 -6`

31.
```
template <class Type>
void reverseStack(stackType<Type> &s)
{
    linkedQueueType<Type> q;
    Type elem;

    while (!s.isEmptyStack())
    {
        elem = s.top();
        s.pop();
        q.addQueue(elem);
    }

    while (!q.isEmptyQueue())
    {
        elem = q.front();
        q.deleteQueue();
        s.push(elem);
    }
}
```

33.
```
template <class Type>
int queueType<Type>::queueCount()
{
    return count;
}
```

35.



queueADT<Type>

```
+isEmptyQueue() const = 0: virtual bool
+isFullQueue() const = 0: virtual bool
+initializeQueue() = 0: virtual void
+front() const = 0: virtual Type
+back() const = 0: virtual Type
+addQueue(const Type&) = 0: virtual void
+deleteQueue() = 0: virtual void
```

Chapter 18

1. a. true; b. false; c. true; d. false; e. false; f. true; g. false; h. true; i. true; j. true; k. false; l. true; m. true; n. false

3. a.

```
template<class elemType>
int seqOrdSearch(const elemType list[], int length,
                 const elemType& item)
{
    int loc;
    bool found = false;

    for (loc = 0; loc < length; loc++)
        if (list[loc] >= item)
        {
            found = true;
            break;
        }

    if (found)
        if (list[loc] == item)
            return loc;
        else
            return -1;
    else
        return -1;
} //end seqOrdSearch
```

b. i. 2 ii. 8 iii. 10 iv. 9 v. 13

5. a. 6 b. 7 c. 8 d. 7 e. 1 f. 3 g. 8

7. 26

9. 9

11. a. Suppose that the list is of length *n*. Then `length` = *n*. Consider the first iteration of the outer `for` loop, that is, when the value of `iteration = 1`. Now the inner loop executes *n* – 1. Before the execution of the inner `for` loop, the variable `isSorted` is set to `true`, assuming that the list is sorted. If the list is already sorted, then the expression `list[index] > list[index + 1]` in the `if` statement always evaluates to `false`, so the body of the `if` statement never executes. Because the inner loop executes *n* – 1 times, there are *n* – 1 comparisons. In the second iteration of the outer loop, because the variable `isSorted` is `true`, the loop condition, `(iteration < length) && !isSorted`, evaluates to `false`, so the outer `for` loop terminates. It follows that, if the list is already sorted, the outer `for` loop executes only once. Hence, the total number of comparisons is *n* – 1 = *O*(*n*).

b. 30.

13. 4

15. a. `8, 12, 18, 25, 38, 45, 74, 60, 30`

b. 10

17. Bubble sort: 21,121,750; selection sort: 21,121,750; insertion sort: 10,567,374

19. In quick sort, the list is partitioned according to an element, called pivot, of the list. After partition, elements in the first sublist are smaller than the pivot and in the second sublist are larger than the pivot. The merge sort partitions the list by dividing into two sublists of nearly equal size by breaking the list in the middle.

21. a. 48
    b. 10, 30, 35, 8, 15, 48, 55, 58, 60, 70, 78, 75, 80, 62, 90
    c. 18
    d. 5 and 2

23. a. 48
    b. 38, 18, 13, 25, 40, 44, 32, 41, 48, 75, 80, 90, 70, 65, 60, 52
    c. 27
    d. 8 and 7

25. a. 8 b. 38 c. 84

27. Quick sort: 10000×$\log_2(10000)$ = 132878; merge sort: 132878.

HeapSort-Algorithm

1. 95, 92, 87, 65, 80, 82, 81, 59, 52, 78, 50, 53, 63, 47, 58, 42, 34, 37, 7, 20

Chapter 19

1. a. false; b. true; c. false; d. true; e. false; f. true; g. false; h. true; i. true; j. true; k. true

3. $L_A = \{B, D, E, H, I, L, M, O, P, Q, T, U\}$.

5. $L_C = \{F, J\}$.

7. $L_E = \{ L, O, T, U \}$.

9. 4

11. 6

13. *D*, *E*, *F*, *G*, *K*, *L*.

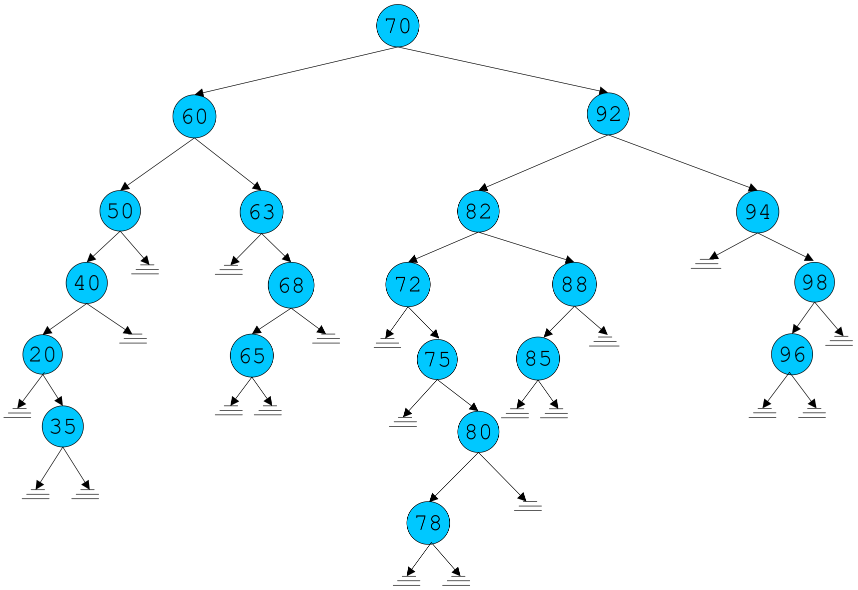
15. 4

17. *A*, *B*, *D*, *H*, *M*, and *P*

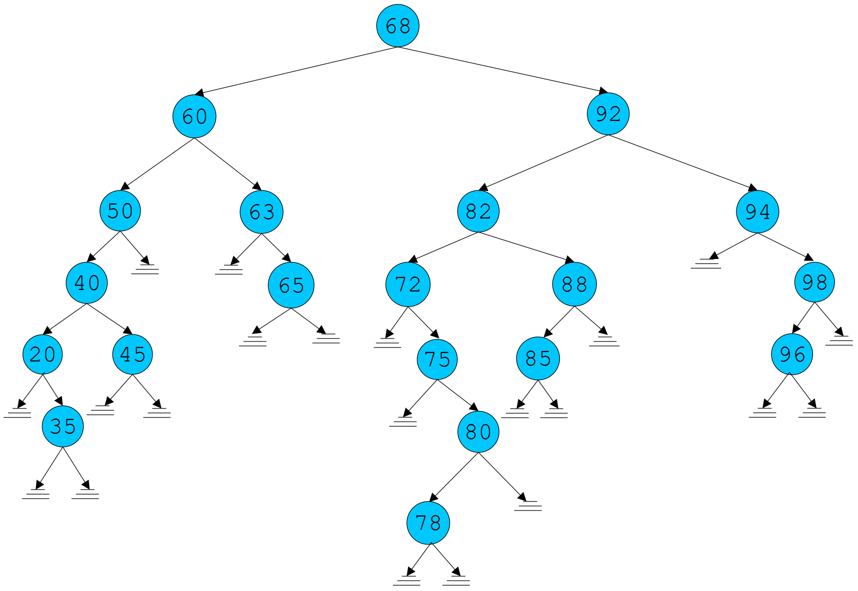
19. *A, B, D, H, L, O, T, U, M, P, Q, E, I, C, F, J, G, K, N, R, S*

21. a. 7 b. 4 c. 92-82-72-75-80-78

23. Binary search tree after deleting 45. After deleting 45, the height of the tree is 7.

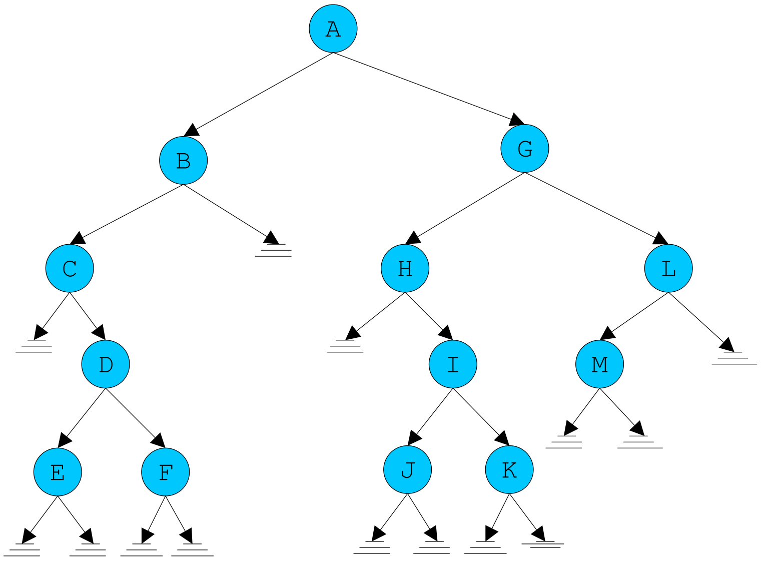


25. The height of the tree after deleting `70` is 7. Binary search tree after deleting `70`.

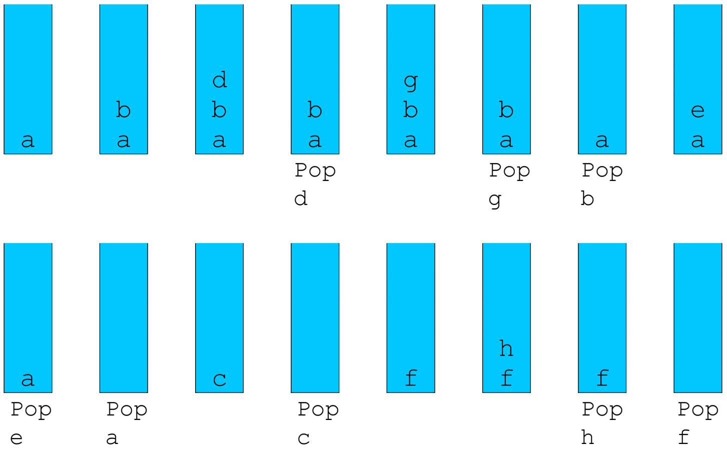


27. Each node has two pointers. Thus, there are 2*n* pointers in all the nodes of the binary tree. The pointer pointing to the root node is an external pointer. Each of the remaining *n* – 1 nodes has one pointer pointing to it, which is a pointer from the parent node. The remaining pointers in all the nodes, which is 2*n* – (*n* – 1) = *n* + 1, are `nullptr`. This implies that the binary tree has *n* + 1 empty subtrees.

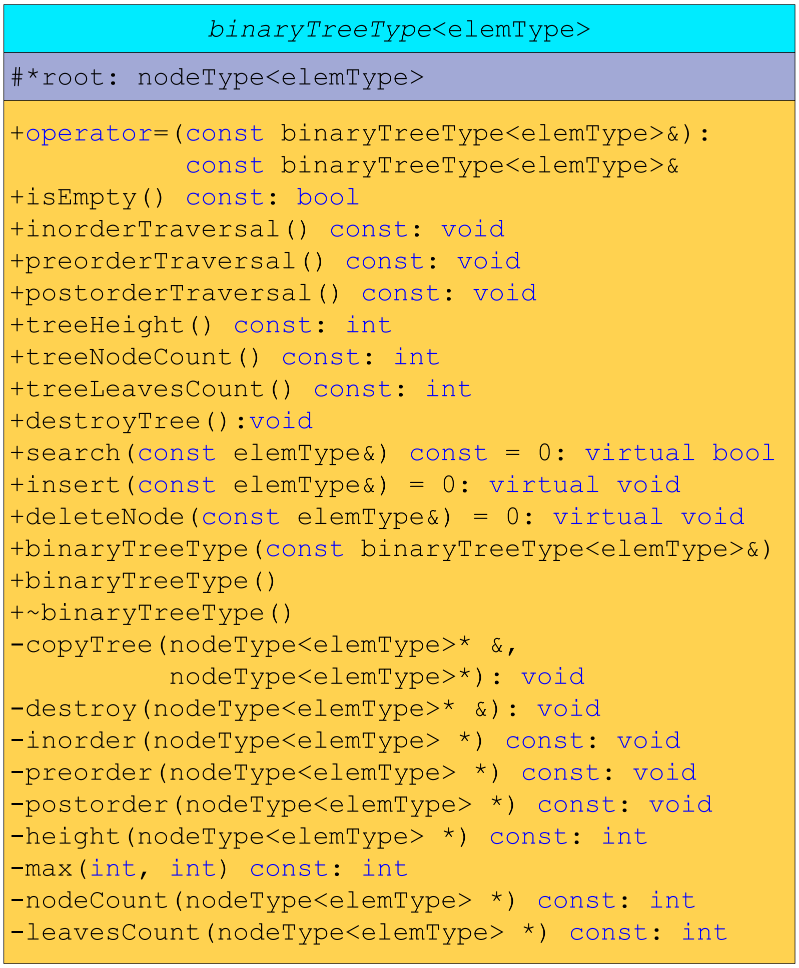
29.



31.



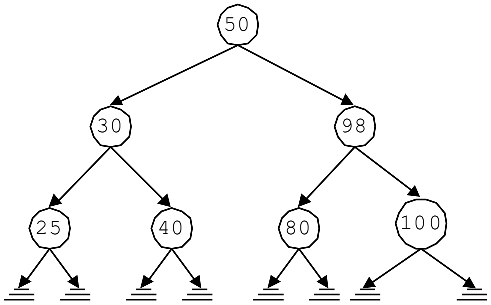
33.



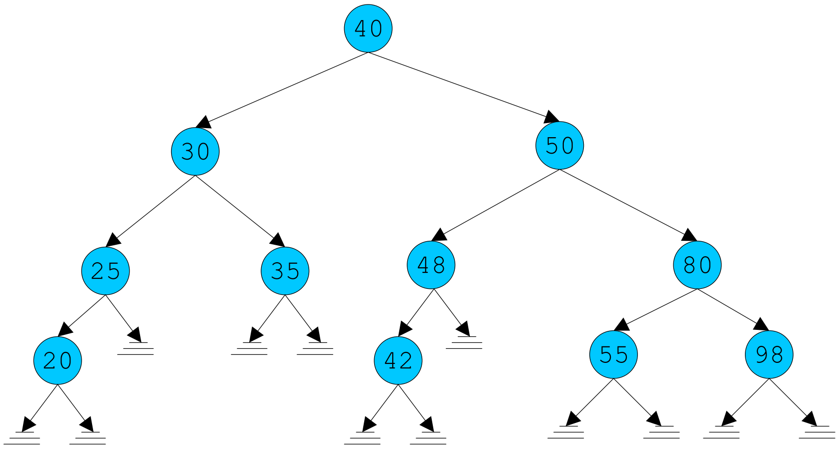
```
binaryTreeType<elemType>
#*root: nodeType<elemType>
+operator=(const binaryTreeType<elemType>&):
           const binaryTreeType<elemType>&
+isEmpty() const: bool
+inorderTraversal() const: void
+preorderTraversal() const: void
+postorderTraversal() const: void
+treeHeight() const: int
+treeNodeCount() const: int
+treeLeavesCount() const: int
+destroyTree():void
+search(const elemType&) const = 0: virtual bool
+insert(const elemType&) = 0: virtual void
+deleteNode(const elemType&) = 0: virtual void
+binaryTreeType(const binaryTreeType<elemType>&)
+binaryTreeType()
+~binaryTreeType()
-copyTree(nodeType<elemType>* &,
          nodeType<elemType>*): void
-destroy(nodeType<elemType>* &): void
-inorder(nodeType<elemType> *) const: void
-preorder(nodeType<elemType> *) const: void
-postorder(nodeType<elemType> *) const: void
-height(nodeType<elemType> *) const: int
-max(int, int) const: int
-nodeCount(nodeType<elemType> *) const: int
-leavesCount(nodeType<elemType> *) const: int
```

AVL-Trees

1. The balance factor of the root node is 0.



3 The balance factor of the root node is 0.



Chapter 20

1. a. true; b. false; c. true; d. true; e. false; f. true; g. false; h. false; i. true

3. 4-7-8-6-3-10; Length of this path is 5.

5. Vertices 2 and 9 are not connected.

7. Vertices 0 and 8 are connected. A path from 0 to 8 is 0-6-11-4-2-9-8

9. 1-2-9-8-3

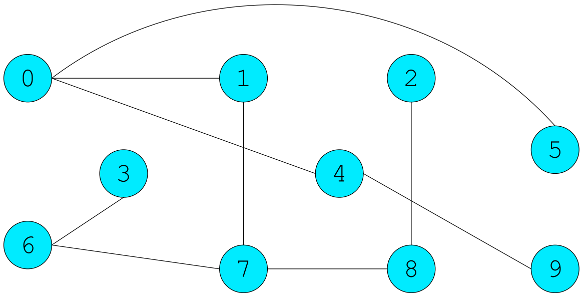
11.
$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

13. 0, 1, 4, 2, 5, 6, 3, 7, 8, 9

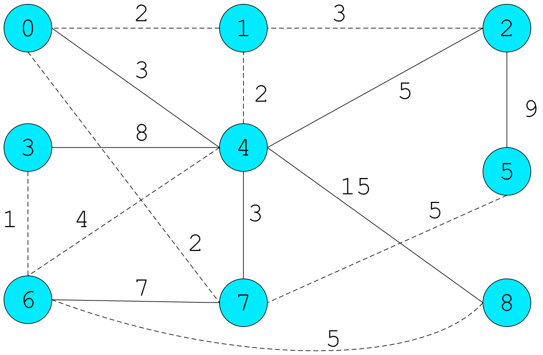
15. 0, 1, 2, 5, 7, 3, 6, 10, 11, 9, 4, 8

17.
$$\begin{bmatrix} \infty & \infty & 14 & 2 & \infty & 7 & \infty \\ \infty & \infty & \infty & \infty & 12 & \infty & 8 \\ \infty & \infty & \infty & \infty & 3 & \infty & \infty \\ \infty & \infty & 4 & \infty & \infty & \infty & \infty \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty \\ \infty & \infty & \infty & 1 & \infty & \infty & 9 \\ \infty & \infty & \infty & \infty & \infty & \infty & \infty \end{bmatrix}$$

19.



21.



```
Source Vertex: 0
Edges    Weight
(0, 1)     2
(1, 2)     3
(6, 3)     1
(1, 4)     2
(7, 5)     5
(4, 6)     4
(0, 7)     2
(6, 8)     5

Minimal Spanning Tree Weight: 24
```

Topological Ordering

1. 1, 7, 0, 2, 6, 5, 4, 8, 3, 9

Chapter 21

1. a. true; b. false; c. true; d. false; e. true; f. false; g. false; h. true; i. true; j. false; k. false; l. true; m. false; n. true; o. false; p. false; q. true

3. A container is used to store data, while an algorithm is used to manipulate the data stored in a container.

5. A STL function object contains a function that can be treated as a function using the function call operator.

7.
```
66 2 15 99 37 13 87 18 35 46 32

32 46 35 18 46 35 18 87 13 37 99
```

9.
```
0 0 8 12 24
```

11. a. `intList1 = {7, 8, 19, 90, 15, 13, 15, 16, 18,`
```
                90, 30, 11, 88, 26}
```
b. `intList1 = {12, 14, 20, 13, 15, 16, 18, 90, 30, 11, 88, 26}`

13. A `back_inserter` uses the `push_back` operation of the container while a `front_inserter` uses the `push_front` operation of the container to add elements to the container. Furthermore, a `front_inserter` cannot be used for the `vector` container.

15.
```
5
```

17.
```
+ - = @ ! 1 2 3 4 5
@ ! 1 2 - = + 3 4 5
```

19.
```
22 6 52 2 30 24 35 18
```

21. 9