	Format 類型	**# Questions 題目數**	**Total Marks 佔分**
Section A 甲部	Multiple Choice 多項選擇題	25	25
Section B 乙部	Fill-in-the-blanks 填充題	7 (A - M)	20
Total 總分			**45**

(1) Assume that all variables without declaration shown in the following program segments have already been declared properly as 32-bit signed integers (Pascal: `longint`, C / C++: `int`).
下列程序段中所有未有列出宣告的變量，均假設已經適當地宣告為 32 位元有符號的整數 (Pascal: `longint`, C / C++: `int`)。

(2) The following code is added to the beginning of all C and C++ programs.
在所有 C 和 C++ 程序的頂部加入以下程式碼:

C

```
#include <stdio.h>
#include <string.h>
#include <math.h>
#include <stdlib.h>
#include <stdbool.h>
```

C++

```
#include <cstdio>
#include <cmath>
#include <cstdlib>
#include <string>
#include <iostream>
using namespace std;
```

For C, `stdbool.h` defines the boolean data type `bool` and values `true` (equivalent to 1) and `false` (equivalent to 0).
對於 C，`stdbool.h` 定義了布爾數據類型 `bool` 及值 `true` (等同 1) 及 `false` (等同 0)。

(3) Assume all programs are compiled properly in Ubuntu 16.04 using the compilers and commands below.
假設所有程序都在 Ubuntu 16.04 下使用以下編譯器及指令正確地編譯。

Pascal:	Free Pascal (`fp-compiler` 3.0.0)	`fpc program.pas`
C:	GNU GCC (`gcc-4.9` 4.9.3)	`gcc -std=c99 program.c -o program`
C++:	GNU G++ (`g++-4.9` 4.9.3)	`g++ -std=c++98 program.cpp -o program`

Section A 甲部 (25 marks 分)

For each question, choose the **most appropriate** answer and mark the corresponding box (A, B, C, or D) on the answer sheet. One mark for each correct answer. No marks will be deducted for wrong answers.
請為下列每題各選一個**最適合**的答案，然後把答題紙對應的空格（A、B、C、或 D）填滿。
答對得一分，答錯不扣分。

1. In the worst case, at least how many pairwise comparisons are needed to find the maximum and minimum element in an array of 4 integers?
在最壞情況下，至少要兩兩比較多少次才能從四個整數中找出最大和最小？

A. 3
B. 4
C. 5
D. 6

2. Let $N = 10^6$. Order the following actions in ascending order according to their executing time.
設 $N = 10^6$。按照以下算法所需的運行時間，把它們由短至長排序。

i. Find the maximum number in an array of N integers.
在大小為 N 的整數陣列中找最大值

ii. Perform merge sort in an array of N integers.
把大小為 N 的整數陣列內的元素以合併排序由小至大排列

iii. Perform binary search in a sorted array of N integers.
在大小為 N 的已排序整數陣列中進行二分搜索

A. i, iii, ii
B. ii, i, iii
C. iii, i, ii
D. iii, ii, i

3. What is the output of the following program? 以下程序的輸出是?

Pascal

```pascal
var
  sum, i: longint;
begin
  sum := 0;
  for i := 1 to 2017 do
    sum := sum or i;
  write(sum)
end.
```

C

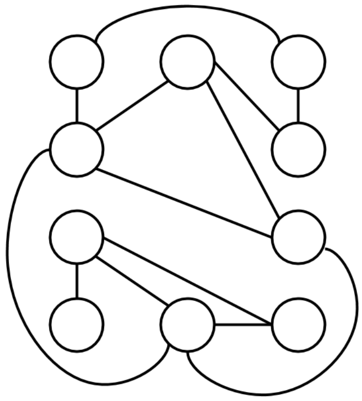
```c
int sum, i;
int main() {
  sum = 0;
  for (i = 1; i <= 2017; i++)
    sum = sum | i;
  printf("%d", sum);
  return 0;
}
```

C++

```cpp
int sum, i;
int main() {
  sum = 0;
  for (i = 1; i <= 2017; i++)
    sum = sum | i;
  cout << sum;
  return 0;
}
```

A. 0
B. 2017
C. 2047
D. 2035153

4. Consider a country consisting of 10 cities and 13 highways. The figure to the right illustrates the layout of this country, with the circles representing cities and lines representing highways that connect the cities. The country is connected; in other words, any city can travel to any other city using one or more highways. At most how many highways can be removed so that the country is still connected?
從前有一個國家，國家有十個城市和十三條公路。右圖描繪了這個國家的結構：圖圈代表城市，線條代表公路。這個國家是連通的，意思是任意一個城市可以經由一道或多道公路到達任意另一個城市。最多可以移除多少道公路使得這個國家仍然是連通的？



A. 2
B. 3
C. 4
D. 5

5. What is the output of the following program? 以下程序的輸出是？

Pascal

```
var
  a: array [0..100] of longint;
  sum, i: longint;
begin
  a[1] := 1;
  sum := 0;
  for i := 2 to 100 do
    a[i] := (a[i - 1] * 9 + 7)
        mod 11;
  for i := 1 to 100 do
    sum := sum + a[i];
  write(sum)
end.
```

C

```
int a[101], sum, i;
int main() {
  a[1] = 1;
  sum = 0;
  for (i = 2; i <= 100; i++)
    a[i] = (a[i - 1] * 9 + 7)
        % 11;
  for (i = 1; i <= 100; i++)
    sum += a[i];
  printf("%d", sum);
  return 0;
}
```

C++

```
int a[101], sum, i;
int main() {
  a[1] = 1;
  sum = 0;
  for (i = 2; i <= 100; i++)
    a[i] = (a[i - 1] * 9 + 7)
        % 11;
  for (i = 1; i <= 100; i++)
    sum += a[i];
  cout << sum;
  return 0;
}
```

A. 380
B. 420
C. 450
D. 550

6. Ransomware is a class of computer virus that usually affects users' computers by:
勒索軟體一種電腦病毒，它通常以以下哪種方式影響電腦用家?

A. Turning off the computer suddenly 突然把電腦關機
B. Displaying advertisements repeatedly 不斷展示廣告
C. Making annoying sounds 發出煩擾聲音
D. Encrypting files 把檔案加密

7. Which of the following data structure is most suitable for simulating a recursion?
以下哪一項數據結構最適合用來模擬遞歸？

A.	Stack	堆疊 (棧)
B.	Queue	隊列
C.	Linked list	鏈表
D.	Hash table	哈希表

8. Assume function `random(n)` returns an integer from 0 to `n`-1 randomly with equal probability. Consider the following program:
假設函數 `random(n)` 會以相等的概率隨機地傳回一個由 0 至 `n`-1 之間的整數。考慮以下程序：

Pascal

```
var i, a, b: longint;
begin
  a := random(4) * 2;
  b := random(3) + random(3);
  write(b - a)
end.
```

C

```
int i, a, b;
int main() {
  a = random(4) * 2;
  b = random(3) + random(3);
  printf("%d", b - a);
  return 0;
}
```

C++

```
int i, a, b;
int main() {
  a = random(4) * 2;
  b = random(3) + random(3);
  cout << b - a;
  return 0;
}
```

What is the number of possible different outputs? 有多少種輸出的可能性？

A. 10
B. 11
C. 12
D. 13

9. Given that there is only one correct answer for this question, which one is the correct answer?
如果這條題目只有一個正確答案的話，那麼這個正確的答案是?

A.	Neither B nor C is the correct answer.	B 和 C 都不是正確答案。
B.	Neither C nor D is the correct answer.	C 和 D 都不是正確答案。
C.	Trust me, this is the correct answer.	相信我，這是正確答案。
D.	Neither A nor B is the correct answer.	A 和 B 都不是正確答案。

10. Go is a board game in which the two players, black and white, take turns to put a stone on a 19 × 19 board. The goal is to surround more territory than the opponent. Which of the following plays Go best?
圍棋 (Go) 是一種雙人棋類遊戲。對弈雙方在一個 19 × 19 的棋盤網格上交替放置黑色和白色的棋子，擴大己方棋子所圍的區域。以下哪一項最擅長下圍棋？

A. Deep Blue 深藍
B. Pokémon GO
C. AlphaGo
D. DuckDuckGo

11. Which of the following program segments is an implementation of bubble sort?
`n` is the size of the array `int a[n]` (Pascal: `a: array[0..n-1]` of longint).
以下那一段程序段是冒泡排序法的實現？
`n` 是陣列 `int a[n]` (Pascal: `a: array[0..n-1] of longint`) 的大小。

Pascal **C / C++**

A.

```pascal
for i := 0 to n - 1 do
  for j := i downto 1 do
    if (a[j] < a[j - 1]) then
    begin
      temp := a[j];
      a[j] := a[j - 1];
      a[j - 1] := temp
    end;
```

```c
for (i = 0; i <= n - 1; i++)
  for (j = i; j >= 1; j--)
    if (a[j] < a[j - 1]) {
      temp = a[j];
      a[j] = a[j - 1];
      a[j - 1] = temp;
    }
```

B.

```pascal
for i := 0 to n - 1 do
  for j := i to n - 2 do
    if (a[j] > a[j + 1]) then
    begin
      temp := a[j];
      a[j] := a[j + 1];
      a[j + 1] := temp
    end;
```

```c
for (i = 0; i <= n - 1; i++)
  for (j = i; j <= n - 2; j++)
    if (a[j] > a[j + 1]) {
      temp = a[j];
      a[j] = a[j + 1];
      a[j + 1] = temp;
    }
```

C.

```pascal
for i := 0 to n - 1 do
  for j := 0 to i - 1 do
    if (a[j] > a[j + 1]) then
    begin
      temp := a[j];
      a[j] := a[j + 1];
      a[j + 1] := temp
    end;
```

```c
for (i = 0; i <= n - 1; i++)
  for (j = 0; j <= i - 1; j++)
    if (a[j] > a[j + 1]) {
      temp = a[j];
      a[j] = a[j + 1];
      a[j + 1] = temp;
    }
```

D.

```pascal
for i := 0 to n - 1 do
  for j := n - 1 downto i + 1 do
    if (a[j] < a[j - 1]) then
    begin
      temp := a[j];
      a[j] := a[j - 1];
      a[j - 1] := temp
    end;
```

```c
for (i = 0; i <= n - 1; i++)
  for (j = n - 1; j >= i + 1; j--)
    if (a[j] < a[j - 1]) {
      temp = a[j];
      a[j] = a[j - 1];
      a[j - 1] = temp;
    }
```

12. How many ways are there to pick, at the same time, two different integers between 1 and 100, such that their product is **not** a multiple of four?
有多少種不同的方法在 1 和 100 之間同時選兩個不同的整數，使得它們的乘積**不是** 4 的倍數？

A. 2475
B. 2525
C. 3700
D. 3800

13. Alice and Bob are playing a game on a $N \times M$ chessboard. Initially, the chessboard is empty. The players take turn to place a rook on the chessboard, with the restriction that the rook cannot attack any other rooks on the chessboard. The player who first runs out of moves loses.
One rook can attack another piece if and only if:

    1. they are on the same row or on the same column, and
    2. there are no other pieces between them.

    愛麗絲和鮑伯在一個 $N \times M$ 的棋盤上下棋。初始時，棋盤上沒有任何棋子。他們輪流在棋盤上放一隻城堡，而該隻城堡不能攻擊其他城堡。不能放棋子的玩家為輸。
一隻城堡能攻擊另一隻棋子當且僅當:

    1. 它們位於相同的行或列，以及
    2. 它們之間沒有其他棋子。

    Alice goes first. For what board sizes (N, M) does Alice have a winning strategy?
如果愛麗絲是先手，她在以下哪一組 (N, M) 的棋盤有必勝的策略？

    i. $(N, M) = (3, 5)$
    ii. $(N, M) = (8, 8)$
    iii. $(N, M) = (7, 6)$

A.	i only	只有 i
B.	ii only	只有 ii
C.	i and iii only	只有 i 和 iii
D.	ii and iii only	只有 ii 和 iii

14. Consider the following function: 考慮以下函數:

Pascal

```
function f(x: longint): longint;
begin
  if x = 2 then
    f := x - 2
  else
    f := x * 2
end;
```

C / C++

```
int f(int x) {
  if (x == 2)
    return x - 2;
  else
    return x * 2;
}
```

Here, x is an integer in the range $[0, 2^{31} - 1]$. Which of the following is/are true?
以上函數中的 x 是一個範圍是 $[0, 2^{31} - 1]$ 的整數。以下哪些為真？

i.	f(x) must be an even number.	f(x) 必定是雙數。
ii.	f(x) must be a non-negative number.	f(x) 必定是非負數。

A.	None of the above	以上皆否
B.	i only	只有 i
C.	ii only	只有 ii
D.	i and ii	i 和 ii

15. You are given an undirected graph G. The degree of a node is the number of edges is incident to the node. Every edge of G connects two different nodes. An Eulerian path is a path which visits every edge of the graph exactly once. Which of the following is/are true?
給定一個無向圖 G，一個節點的度為連接該節點的邊數目，每一條邊連接兩個不同的節點。歐拉路徑是一條走遍圖上每一條邊恰好一次的路徑。以下哪些為真？

    i. If every node of G has an even degree, then G must have an Eulerian path.
    如果 G 的每個節點的度都是雙數，那麼 G 上必定有歐拉路徑。

    ii. If G has an Eulerian path, then every node of G must have an even degree.
    如果 G 上有歐拉路徑，那麼 G 的每個節點的度必定是雙數。

A.	None of the above	以上皆否
B.	i only	只有 i
C.	ii only	只有 ii
D.	i and ii	i 和 ii

16. Alice, Bob and Charlie are invited to a party. However, they still haven't decided whether they will go to the party or not. If Alice goes then Bob will also go; if Alice and Bob both go, then Charlie will not go. Which of the following is/are possible situations?
有人邀請愛麗絲、鮑伯和查理參加一個派對，但他們還未決定去不去。如果愛麗絲去，鮑伯也會一起去；如果愛麗絲和鮑伯都去，查理就不會去。以下哪些情況是有可能發生的？

    i. Only Alice and Bob go
    只有愛麗絲和鮑伯去

    ii. Only Alice and Charlie go
    只有愛麗絲和查理去

    iii. Only Bob and Charlie go
    只有鮑伯和查理去

A.	i only	只有 i
B.	ii only	只有 ii
C.	i and iii only	只有 i 和 iii
D.	ii and iii only	只有 ii 和 iii

17. What is the output of the following program? 以下程序的輸出是？

Pascal

```
var
 a: array[0..4, 0..4] of longint;
 i, j: longint;
begin
  for i := 0 to 4 do
    for j := 0 to 4 do
      a[i, j] := 0;
  for i := 1 to 4 do
    for j := 1 to 4 do
      a[i, j] := i * 4 + j;
  for i := 1 to 4 do
    for j := 1 to 4 do
      a[i, j] := a[i, j]
               + a[i, j - 1]
               + a[i - 1, j]
               - a[i - 1, j - 1];
  write(a[3, 4] - a[1, 4]
        - a[3, 2] + a[1, 2])
end.
```

C

```
int a[5][5], i, j;
int main() {
  for (i = 0; i <= 4; i++)
    for (j = 0; j <= 4; j++)
      a[i][j] = 0;
  for (i = 1; i <= 4; i++)
    for (j = 1; j <= 4; j++)
      a[i][j] = i * 4 + j;
  for (i = 1; i <= 4; i++)
    for (j = 1; j <= 4; j++)
      a[i][j] = a[i][j]
              + a[i][j - 1]
              + a[i - 1][j]
              - a[i - 1][j - 1];
  printf("%d", a[3][4] - a[1][4]
           - a[3][2] + a[1][2]);
  return 0;
}
```

C++

```
int a[5][5], i, j;
int main() {
  for (i = 0; i <= 4; i++)
    for (j = 0; j <= 4; j++)
      a[i][j] = 0;
  for (i = 1; i <= 4; i++)
    for (j = 1; j <= 4; j++)
      a[i][j] = i * 4 + j;
  for (i = 1; i <= 4; i++)
    for (j = 1; j <= 4; j++)
      a[i][j] = a[i][j]
              + a[i][j - 1]
              + a[i - 1][j]
              - a[i - 1][j - 1];
  cout << a[3][4] - a[1][4]
      - a[3][2] + a[1][2];
  return 0;
}
```

A. 22
B. 38
C. 54
D. 70

18. x and y are 32-bit signed integers. Which of the expressions is/are always true?
x 和 y 是 32 位元 有符號整數；以下哪些表達式必定為真？

	Pascal	C / C++
i.	`(x or y) >= (x and y)`	`(x | y) >= (x & y)`
ii.	`(x or y) >= x`	`(x | y) >= x`
iii.	`(x and y) <= x`	`(x & y) <= x`

A. None of the above 以上皆否
B. i only 只有 i
C. i and ii only 只有 i 和 ii
D. i, ii and iii i, ii 和 iii

19. Consider the following program: 考慮以下程序：

Pascal

```
var
  a, b, c: longint;
begin
  read(a, b);
  if (a <= 10) then
  begin
    if (b >= 30) then      c := 15
    else if (a >= 5) then  c := 40
    else                   c := 35
  end;
  if (b >= 20) then
  begin
    if (a >= 20) then      c := 30
    else if (b <= 30) then c := 20
    else                   c := 25
  end;
  write(c)
end.
```

C

```
int a, b, c;
int main() {
  scanf("%d %d", &a, &b);
  if (a <= 10) {
    if (b >= 30)      c = 15;
    else if (a >= 5)  c = 40;
    else              c = 35;
  }
  if (b >= 20) {
    if (a >= 20)      c = 30;
    else if (b <= 30) c = 20;
    else              c = 25;
  }
  printf("%d", c);
  return 0;
}
```

C++

```
int a, b, c;
int main() {
  cin >> a >> b;
  if (a <= 10) {
    if (b >= 30)      c = 15;
    else if (a >= 5)  c = 40;
    else              c = 35;
  }
  if (b >= 20) {
    if (a >= 20)      c = 30;
    else if (b <= 30) c = 20;
    else              c = 25;
  }
  cout << c;
  return 0;
}
```

Which of the following inputs generates the greatest output?
以下哪一個輸入會生成最大的輸出？

A. `5 20`
B. `10 15`
C. `20 30`
D. `25 35`

20. Consider the following program: 考慮以下程序：

Pascal

```
var
  a, b, i, j: longint;
begin
  read(a, b);
  for i := 1 to a do
    for j := 7 downto b do
      write('*')
end.
```

C

```
int a, b, i, j;
int main() {
  scanf("%d %d", &a, &b);
  for (i = 1; i <= a; i++)
    for (j = 7; j >= b; j--)
      printf("*");
  return 0;
}
```

C++

```
int a, b, i, j;
int main() {
  cin >> a >> b;
  for (i = 1; i <= a; i++)
    for (j = 7; j >= b; j--)
      cout << "*";
  return 0;
}
```

On which of the following input does the program output the largest number of `*`s?
以下哪一項輸入會令以上程序輸出最多 `*`？

A. `3 4`
B. `5 6`
C. `10 10`
D. `11 7`

21. What is the output of the following program? 以下程序的輸出是？

Pascal

```
var
  i, j, t: longint;
  a: array[0..7] of longint =
      (1, 7, 5, 6, 4, 3, 8, 2);
begin
  for i := 0 to 6 do
    for j := 0 to 6 - i do
      if (a[i] < a[i + 1]) then
      begin
        t := a[i];
        a[i] := a[i + 1];
        a[i + 1] := t
      end;
  for i := 0 to 7 do
    write(a[i], ' ')
end.
```

C

```
int i, j, t;
int a[8] =
  {1, 7, 5, 6, 4, 3, 8, 2};
int main() {
  for (i = 0; i <= 6; i++)
    for (j = 0; j <= 6 - i; j++)
      if (a[i] < a[i + 1]) {
        t = a[i];
        a[i] = a[i + 1];
        a[i + 1] = t;
      }
  for (i = 0; i <= 7; i++)
    printf("%d ", a[i]);
  return 0;
}
```

C++

```
int i, j, t;
int a[8] =
  {1, 7, 5, 6, 4, 3, 8, 2};
int main() {
  for (i = 0; i <= 6; i++)
    for (j = 0; j <= 6 - i; j++)
      if (a[i] < a[i + 1]) {
        t = a[i];
        a[i] = a[i + 1];
        a[i + 1] = t;
      }
  for (i = 0; i <= 7; i++)
    cout << a[i] << " ";
  return 0;
}
```

A. `8 7 6 5 4 3 2 1`

B. `1 2 3 4 5 6 7 8`

C. `1 7 5 6 4 3 2 8`

D. `7 5 6 4 3 8 2 1`

22. What is the output of the following program? 以下程序的輸出是？

Pascal

```
begin
  write('A');
  if (0.1 * 0.2 = 0.02) then
    write('B');
  if (0.1 * 2.0 = 0.2) then
    write('C')
end.
```

C

```
int main () {
  printf("A");
  if (0.1 * 0.2 == 0.02)
    printf("B");
  if (0.1 * 2.0 == 0.2)
    printf("C");
  return 0;
}
```

C++

```
int main () {
  cout << "A";
  if (0.1 * 0.2 == 0.02)
    cout << "B";
  if (0.1 * 2.0 == 0.2)
    cout << "C";
  return 0;
}
```

A. `A`

B. `AB`

C. `ABC`

D. `AC`

23. Suppose there are n non-negative integers, a_1, a_2, ... and a_n such that $a_1! + a_2! + \cdots + a_n! = 2017$. When n is the minimum possible value, what is the minimum possible value of $a_1 + a_2 + \cdots + a_n$? ($x!$ is the factorial of x)
假設有 n 個非負整數分別為 a_1、a_2、$\ldots$ 和 a_n 使得 $a_1! + a_2! + \cdots + a_n! = 2017$。當 n 的取值為其最小可能值時，$a_1 + a_2 + \cdots + a_n$ 的最小可能值為多少? ($x!$ 是 x 的階乘)

    A. 48
    B. 49
    C. 50
    D. 51

24. The following program is written in TypeScript, a programming language developed by Microsoft. Anders Hejlsberg, who created Turbo Pascal and is the lead architect of C#, is a core developer of this language.
以下程序是以 TypeScript 編寫，它是一個由微軟開發的編程語言。Turbo Pascal 發明家、C# 主設計師 Anders Hejlsberg 是此語言的主要開發者。

TypeScript

```
interface Student {
  name: string;
  data: [number];
}
function sortByName(a: Student[]): Student[] {
  var result = a.slice(0);
  result.sort((x, y) => {
    return x.name.localeCompare(y.name);
  });
  return result;
}
```

Which of the following statement about `data` in the 3rd line of the program is true?
以下哪項關於程序中第三行 `data` 的陳述是正確的?

    A. The numerical values will be rounded to the nearest integer when stored
       儲存時數值會取至最接近整數
    B. It can only store a square number such as 0, 1, 4, 9, ...
       只能儲存一個正方形數如 0, 1, 4, 9, ...
    C. It can store an array of 10 numbers
       可儲存一大小為 10 的數字陣列
    D. `number` can be ignored to store a string
       `number` 可被忽略從而儲存一字串

25. The purpose of `a.slice(0)` in the 6th line of the program is: (Hint: the first element of array a is `a[0]`)
程序中第六行 `a.slice(0)` 的目的為: (提示: 陣列 a 的首個元素為 `a[0]`)

A.	Obtain the first element of array a	讀取陣列 a 的第一個元素
B.	Remove the first element from array a, then return a	從陣列 a 刪去第一個元素，然後傳回 a
C.	Make sure that array a is not empty	確保陣列 a 並非空白
D.	Make a copy of array a	複製一份陣列 a

END OF SECTION A 甲部完

Section B 乙部 (20 marks 分)

The blanks are labeled from A to M. Please fill in the blanks on the answer sheet.
下列各空格分別命名為 A 至 M，請在答題紙上對應的地方填上答案。

Note 注意：

(1) Select exactly one programming language on the Answer Sheet. Answers must be in that language.
您必須在答題紙上選擇剛好一種編程語言，並只使用該語言作答。

(2) For C and C++, you must not use the `?:` operator.
對於 C 及 C++，答案不可以包括 `?:` 運算元。

(3) You must not use any library function unless the appropriate library has been included. (See Page 1)
除非適當的函數庫已被引用 (見頁一)，否則答案不可以包括任何函數庫內的函數。

(4) You can write only one character in each box on the answer sheet.
答題紙上每個小格只可填上一個字符。

(5) Answers must not exceed the designated number of boxes.
答案長度不得多於該題提供的小格數目。

(6) Write legibly. Unrecognizable answers will be regarded as incorrect.
字體須端正清楚，無法辨別之答案當錯誤論。

1. Suppose array `int a[10]` (Pascal: `a: array[0..9] of longint`) contains 10 distinct integers. The program segment below tries to implement insertion sort to sort the array in ascending order. However, the program contains an error that can be fixed by changing exactly one line. Find the line and correct it. You may assume variables `i`, `j`, and `t` are declared as `int` (Pascal: `longint`).
現在一陣列 `int a[10]` (Pascal: `a: array[0..9] of longint`)，儲存著 10 個不相同的整數。以下程序段嘗試實現插入排序法來把陣列由小至大排序，但是程序中有一錯誤，並只需更改一行便能修正，請找出並將其改正。假設變量 `i`, `j` 和 `t` 已被宣告為 `int` (Pascal: `longint`)。

Pascal

```
11  for i := 1 to 9 do
12  begin
13    j := i - 1;
14    t := a[i];
15    while (j >= 0) do
16    begin
17      if (t > a[j]) then
18        break;
19      a[j + 1] := a[j];
20      j := j - 1
21    end;
22    a[j] := t
23  end;
```

C / C++

```
51  for (i = 1; i <= 9; i++)
52  {
53    j = i - 1;
54    t = a[i];
55    while (j >= 0)
56    {
57      if (t > a[j])
58        break;
59      a[j + 1] = a[j];
60      j = j - 1;
61    }
62    a[j] = t;
63  }
```

Line number 行數: A1
Correction 改正: A2 (2 marks 分)

Marks will only be given when both answers are correct.
兩個答案均為正確才會得分。

2. Reverse Polish notation is a kind of postfix notation, i.e. the operator is put on the right of the numbers. For instance, “1 + 2” will be written as “1 2 +” in reverse Polish notation. The algorithm of reverse Polish notation is fairly straightforward. Whenever there are n consecutive numbers before an operator (where n is the number of operands needed for the operator; for example, $n = 2$ for the operators “+”, “-”, “×” and “÷”), we will replace the operator and the n operands with the calculated result.

For example: “5 1 2 + 4 × + 3 –” ⇒ “5 3 4 × + 3 -” ⇒ “5 12 + 3 -” ⇒ “17 3 -” ⇒ “14”

The above example is equivalent to “5 + (1 + 2) × 4 - 3” in infix notation (i.e. the common notation we use). Furthermore, parentheses are not needed for reverse Polish notation as long as each operator has a fixed number of operands.

逆波蘭表示法是一種後綴表示法，即運算符會被放在數字的後面, 例如 “1 + 2” 在逆波蘭表示法中會被寫成 “1 2 +”。逆波蘭表示法的運算方法是挺直接的，當運算符的前面有連續 n 個操作數時（n 是運算符所需的操作數數量；例如對於 “+”、“-”、“×” 和 “÷” 這些運算符，$n = 2$），該運算符將會被運算，而該運算符和前面連續 n 個操作數將會被運算結果所取代。

例如: “5 1 2 + 4 × + 3 –” ⇒ “5 3 4 × + 3 -” ⇒ “5 12 + 3 -” ⇒ “17 3 -” ⇒ “14”

上述例子是等價於中綴表示法（即我們常用的表示法）中的 “5 + (1 + 2) × 4 - 3”。此外，如果每個運算符所需的操作數數量是不變的話，使用逆波蘭表示法是不需要加上任何括號的。

Evaluate the reverse Polish expression “7 5 + 3 × 8 - 4 ÷”.

計算逆波蘭表達式 “7 5 + 3 × 8 - 4 ÷”。

Answer 答案: ________B________ (1.5 marks 分)

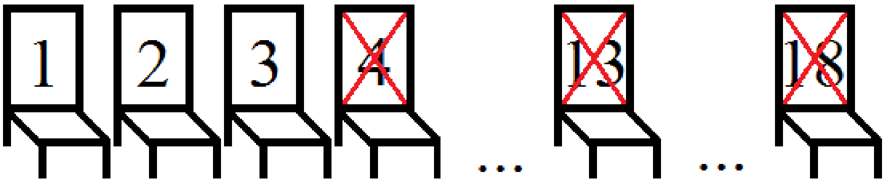
Rewrite the infix expression “7 + 5 × 3 - 8 ÷ 4” in reverse Polish notation where the ordering of numbers is the same as the original expression. Spaces between operators and operands are optional. (Hint: The above two expressions are not equivalent)

以逆波蘭表示法重寫中綴表達式 “7 + 5 × 3 - 8 ÷ 4” 而數字的次序跟原表達式相同。可忽略運算符和操作數之間的空格。 (提示：以上的兩項表達式並不等價)

Answer 答案: ________C________ (1.5 marks 分)

3. There is a row of 18 seats, numbered 1 to 18. Three people are already seated with seat numbers 4, 13, and 18 (each marked by a cross in the following diagram).

有 18 個座位排成一行，座號是 1 至 18。三個人已分別坐在 4、13 和 18 號位（在下圖以交叉標示）。



Now, three more people come. Where should they sit so that the minimum distance between any pair of people is maximal? Write down their seat numbers (in any order), as well as the maximal distance.

The distance between seat A and seat B ($A < B$) is $B - A$.

現在，又有三個人來了。他們應該坐在哪裡，使得坐得最相近的兩個人之間的距離最大？寫下他們的座號（次序不限），以及最大距離。

座位 A 與座位 B （$A < B$）之間的距離是 $B - A$。

Seat numbers 座號:___D1___, ___D2___, ___D3___ (1 mark for all correct; 全對得 1 分)

Maximal distance 最大距離: ________E________ (1 mark 分)

4. A string is a palindrome if and only if it reads the same backward or forward. For example, abcba and adda are palindromes while abcab and abc are not. A substring of a string is a continuous segment of characters appearing in the given string. For example, a, ab, bc and abc are substrings of abc while ac is not.
The function `f(st, ed)` verifies if the substring `s[st..ed]` is a palindrome. It should return `true` if `s[st..ed]` is a palindrome and returns `false` otherwise. Please complete the following function so that it can verify if a substring is a palindrome correctly. Assume that `st` and `ed` are valid positions of the string and `st <= ed`.
我們稱一個字串為迴文當且僅當把這字串按相反順序重新排列後，得到的字串和原來的字串一樣。例如 abcba 和 adda 是迴文，abcab 和 abc 則不是迴文。我們稱一個字串的任何一段連續的字為它的子字串。例如 a、ab、bc 和 abc 是 abc 的子字串，ac 則不是。
函數 `f(st, ed)` 是用來檢驗 `s` 的子字串 `s[st..ed]` 是否一個迴文，如 `s[st..ed]` 是迴文，函數應傳回 `true`，在其他情況下傳回 `false`。完成函數令其能正確檢驗一個子字串是否迴文。假設 `st` 和 `ed` 均為合法的字串位置且 `st <= ed`。

Pascal

```
var
  s: ansistring;
function f(st, ed: longint): boolean;
var
  i: longint;
begin
  for i := st to ed do
    if (s[i] <> s[ ___F___ ]) then
    begin
      f := false;
      exit
    end;
  f := true
end;
```

C

```
char s[100];
bool f(int st, int ed) {
  int i;
  for (i = st; i <= ed; i++)
    if (s[i] != s[ ___F___ ])
      return false;
  return true;
}
```

C++

```
string s;
bool f(int st, int ed) {
  int i;
  for (i = st; i <= ed; i++)
    if (s[i] != s[ ___F___ ])
      return false;
  return true;
}
```

Answer 答案: _______F_______ (1 mark 分)

Implement another approach to verify if `s[st..ed]` is a palindrome. Complete the following function.
實作另一種方式去檢驗 `s[st..ed]` 是否迴文，完成以下函數。

Pascal

```
var
  s: ansistring;
function f(st, ed: longint): boolean;
begin
  if (ed - st = 0) then
    f := ___G___
  else if (ed - st = 1) then
    f := ___H___
  else if (ed - st >= 2) then
    f := ___I___;
end;
```

C

```
char s[100];
bool f(int st, int ed) {
  if (ed - st == 0)
    return ___G___;
  else if (ed - st == 1)
    return ___H___;
  else if (ed - st >= 2)
    return ___I___;
}
```

C++

```
string s;
bool f(int st, int ed) {
  if (ed - st == 0)
    return ___G___;
  else if (ed - st == 1)
    return ___H___;
  else if (ed - st >= 2)
    return ___I___;
}
```

Answer 答案: _______G_______ (1 mark 分)
Answer 答案: _______H_______ (1 mark 分)
Answer 答案: _______I_______ (2 marks 分)

5. Complete the function so that `f(x, y)` returns `true` if `x` and `y` have the same **set** of prime factors and `false` if otherwise. You may assume that `x` and `y` are integers in the range $[1, 30]$. The table on the right shows some examples.

完成以下函數，使得 `f(x, y)` 在 `x` 和 `y` 的質因數**集合**相同時傳回 `true`，否則傳回 `false`。你可假設 `x` 和 `y` 是在 $[1, 30]$ 之內的整數。右表顯示一些例子。

Function call 函數呼叫	Return value 傳回值
`f(2, 16)`	`true`
`f(3, 5)`	`false`
`f(6, 12)`	`true`
`f(12, 18)`	`true`
`f(1, 7)`	`false`
`f(1, 1)`	`true`
`f(28, 28)`	`true`

Pascal

```
function f(x, y: longint): boolean;
begin
  f := _______J_______
end;
```

C / C++

```
bool f(int x, int y) {
  return _______J_______;
}
```

Answer 答案: _______J_______ (2 marks 分)

6. Complete function `g(a, b)` so that for any -4 ≤ `a`, `b` ≤ 4, `f(a,b)` equals `g(a,b)`. In your answer you may make use of the function `min` and `max`, but not the function `f` or any of the following relational operators: <, >, <=, >=, == (Pascal: =), != (Pascal: <>).

完成函數 `g(a, b)` 使得對於所有 -4 ≤ `a`, `b` ≤ 4，`f(a,b)` 等於 `g(a,b)`。填寫答案時，你可以利用函數 `min` 和 `max`，但不可以利用函數 `f` 或以下任何比較運算符: <, >, <=, >=, == (Pascal: =), != (Pascal: <>)。

Pascal

```
function min(a, b: longint): longint;
begin
  if (a < b) then
    min := a
  else
    min := b
end;
function max(a, b: longint): longint;
begin
  if (a > b) then
    max := a
  else
    max := b
end;
function f(a, b: longint): longint;
begin
  if (max(a, -a) < max(b, -b)) then
    f := a
  else if (max(a, -a) > max(b, -b)) then
    f := b
  else
    f := min(a, b)
end;
function g(a, b: longint): longint;
begin
  g := _______K_______
end;
```

C / C++

```
int min(int a, int b) {
  if (a < b)
    return a;
  else
    return b;
}

int max(int a, int b) {
  if (a > b)
    return a;
  else
    return b;
}

int f(int a, int b) {
  if (max(a, -a) < max(b, -b))
    return a;
  else if (max(a, -a) > max(b, -b))
    return b;
  else
    return min(a, b);
}

int g(int a, int b) {
  return _______K_______;
}
```

Answer 答案: _______K_______ (2 marks 分)

7. Consider the following program: 考慮以下程序:

Pascal

```
var
  a: array[0..7] of longint =
      (5, 7, 4, 3, 2, 6, 1, 8);
function dinv(): longint;
var
  i, j, r: longint;
begin
  r := 0;
  for i := 0 to 7 do
    for j := 0 to i - 1 do
      if (a[j] > a[i]) then
        r := r + 1;
  dinv := r
end;
function tinv(): longint;
var
  i, j, k, r: longint;
begin
  r := 0;
  for i := 0 to 7 do
    for j := 0 to i - 1 do
      for k := 0 to j - 1 do
        if ((a[k] > a[j]) and
            (a[j] > a[i])) then
          r := r + 1;
  tinv := r
end;
begin
  writeln(dinv());
  writeln(tinv())
end.
```

C

```
int a[8] =
  {5, 7, 4, 3, 2, 6, 1, 8};
int dinv() {
  int i, j, r;
  r = 0;
  for (i = 0; i <= 7; i++)
    for (j = 0; j <= i - 1; j++)
      if (a[j] > a[i])
        r = r + 1;
  return r;
}
int tinv() {
  int i, j, k, r;
  r = 0;
  for (i = 0; i <= 7; i++)
    for (j = 0; j <= i - 1; j++)
      for (k = 0; k <= j - 1; k++)
        if ((a[k] > a[j] &&
             a[j] > a[i]))
          r = r + 1;
  return r;
}
int main() {
  printf("%d\n", dinv());
  printf("%d\n", tinv());
  return 0;
}
```

C++

```
int a[8] =
  {5, 7, 4, 3, 2, 6, 1, 8};
int dinv() {
  int i, j, r;
  r = 0;
  for (i = 0; i <= 7; i++)
    for (j = 0; j <= i - 1; j++)
      if (a[j] > a[i])
        r = r + 1;
  return r;
}
int tinv() {
  int i, j, k, r;
  r = 0;
  for (i = 0; i <= 7; i++)
    for (j = 0; j <= i - 1; j++)
      for (k = 0; k <= j - 1; k++)
        if ((a[k] > a[j]) &&
            (a[j] > a[i]))
          r = r + 1;
  return r;
}
int main() {
  cout << dinv() << endl;
  cout << tinv() << endl;
  return 0;
}
```

What is the first output number? 第一個輸出的數值是?

Answer 答案: _______L_______ (2 marks 分)

What is the second output number? 第二個輸出的數值是?

Answer 答案: _______M_______ (2 marks 分)

END OF PAPER 全卷完