

	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	8 (A - L)	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)	<code>fpc program.pas</code>
C:	GNU GCC (gcc-4.9 4.9.3)	<code>gcc -std=c99 program.c -o program</code>
C++:	GNU G++ (g++-4.9 4.9.3)	<code>g++ -std=c++98 program.cpp -o program</code>

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. A competitive programming club has 10 members. How many ways are there to choose, among the members, one president and two vice presidents?

一個編程學會有 10 位會員。有多少種方法從會員中選出一位主席和兩位副主席？

- A. 90
- B. 180
- C. 360
- D. 720

2. Which of the following character sets does not support Chinese characters?

以下哪個字符集不支援中文字符？

- A. ASCII
- B. Big5
- C. UTF-8
- D. UTF-16

3. Alice has an integer between -16 and 16 (inclusive) in her mind. You can ask her some questions, each of which must be in the form of “is your number strictly less than x ?” (x can be any real number). You can decide the question you are going to ask according to the answers of previous questions. In the worst case, at least how many questions should be asked to know the exact value of the integer Alice has in mind?

愛麗絲心中有一個介乎 -16 和 16 之間（含）的整數。你可以詢問她一些問題，每條問題都必須跟隨以下格式：「你所想的數字是嚴格小於 x 的嗎？」（ x 可以是任意實數）。你可以根據之前的結果決定即將要詢問的問題。在最壞情況下，最少需要詢問多少個問題以準確得知愛麗絲心中的數字？

- A. 4
- B. 5
- C. 6
- D. 7

For questions 4 to 5, consider the following procedure:

對於第 4 至 5 題，考慮以下程序：

Pascal

```
var
  cnt: longint;
  a: array[0..9] of longint =
    (4, 5, 8, 3, 0, 6, 7, 9, 1, 2);
procedure f(l, r: longint);
var m: longint;
begin
  if (l < r) then
  begin
    inc(cnt);
    m := (l + r) div 2;
    f(l, m);
    f(m + 1, r);
    if (a[l] > a[r]) then
      a[l] := a[r]
  end
end;
begin
  cnt := 0;
  f(0, 9);
  write(a[0], ' ', cnt)
end.
```

C

```
int cnt;
int a[10] = {
  4, 5, 8, 3, 0, 6, 7, 9, 1, 2
};
void f(int l, int r) {
  int m;
  if (l < r) {
    cnt++;
    m = (l + r) / 2;
    f(l, m);
    f(m + 1, r);
    if (a[l] > a[r])
      a[l] = a[r];
  }
}
int main() {
  cnt = 0;
  f(0, 9);
  printf("%d %d", a[0], cnt);
  return 0;
}
```

C++

```
int cnt;
int a[10] = {
  4, 5, 8, 3, 0, 6, 7, 9, 1, 2
};
void f(int l, int r) {
  int m;
  if (l < r) {
    cnt++;
    m = (l + r) / 2;
    f(l, m);
    f(m + 1, r);
    if (a[l] > a[r])
      a[l] = a[r];
  }
}
int main() {
  cnt = 0;
  f(0, 9);
  cout << a[0] << " " << cnt;
  return 0;
}
```

4. The program outputs two integers separated by a space. What is the first integer being output?

程序輸出兩個整數，以空格分隔。第一個輸出的整數是甚麼？

- A. 0
- B. 2
- C. 4
- D. 9

5. What is the second integer being output?

第二個輸出的整數是甚麼？

- A. 4
- B. 9
- C. 36
- D. 81

6. A simple graph is an undirected graph with no self-loops and repeated edges.

一個簡單圖是沒有自環和重邊的無向圖。

Let N be a positive integer greater than 1. What is the minimum value of M , such that all simple graphs with N nodes and M edges are connected?

設 N 為大於 1 的正整數。要使得所有有 N 個節點和 M 條邊的簡單圖都是連通的， M 的最小值是多少？

- A. $N - 1$
B. $\frac{(N - 1)(N - 2)}{2}$
C. $\frac{(N - 1)(N - 2)}{2} + 1$
D. $\frac{N(N - 1)}{2}$

7. Which of the followings must be correct when we are considering a rooted tree with 5 nodes?

考慮一個含有五個節點的有根樹，以下哪項必為正確？

- i. It has 4 edges.
它有四條邊。
ii. Each node can reach the other 4 nodes via the edges.
每個節點都可經由一些邊到達其他 4 個節點。
iii. Each node does not contain self-loops.
每個節點都不會有自環。
iv. The height of the tree is 5.
樹的高度是 5。

- A. i and ii only 只有 i 和 ii
B. ii and iii only 只有 ii 和 iii
C. i, ii and iii only 只有 i、ii 和 iii
D. ii, iii and iv only 只有 ii、iii 和 iv

8. A machine takes 100 milliseconds to run a bubble sort on 1000 elements. Consider the same machine on running the following two programs:

一台機器對於 1000 個元素執行冒泡排序，使用了 100 毫秒。考慮同一台機器運行以下兩個程序：

- i. Bubble sort on 100000 elements.
對於 100000 個元素執行冒泡排序。
ii. Merge sort on 100000 elements.
對於 100000 個元素執行合併排序。

Which of the followings has the best run-time approximations on running the above two programs?

對於運行以上兩個程序，以下哪一項擁有最佳的運行時間預算？

- | | i. | ii. |
|----|----------------|-----------------|
| A. | 10 seconds 秒 | 1 second 秒 |
| B. | 10 seconds 秒 | 10000 seconds 秒 |
| C. | 1000 seconds 秒 | 1 second 秒 |
| D. | 1000 seconds 秒 | 10000 seconds 秒 |

9. If Charlie gets full marks in the final exam, he feels happy; if Charlie feels happy and it is raining outside, he plays computer games at home. Charlie is not playing computer games at home. Which of the followings must be true?

如果查理在考試中取得滿分，他會感到開心；如果查理感到開心且外面正在下雨，他會留在家中玩遊戲機。查理並不是留在家中玩遊戲機。以下哪項必為正確？

- A. Charlie does not get full marks in the final exam
查理未有在考試中取得滿分
- B. Charlie does not feel happy
查理不感到開心
- C. It is not raining outside
外面沒有下雨
- D. None of the above
以上皆非

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

Pascal	C	C++
<pre>var x, a, b: longint; begin read(x); a := (x - 1) div 2; b := (x + 1) div 2; if (a < b) then write('<'); if (a = b) then write('='); if (a > b) then write('>'); end.</pre>	<pre>int x, a, b; int main() { scanf("%d", &x); a = (x - 1) / 2; b = (x + 1) / 2; if (a < b) printf("<"); if (a == b) printf("="); if (a > b) printf(">"); return 0; }</pre>	<pre>int x, a, b; int main() { cin >> x; a = (x - 1) / 2; b = (x + 1) / 2; if (a < b) cout << "<"; if (a == b) cout << "="; if (a > b) cout << ">"; return 0; }</pre>

Assume that input x is an integer between -1024 and 1023 inclusive. Which of the followings is/are possible output(s)?

假設輸入 x 是個 -1024 和 1023 之間（含）的整數。以下哪些是可能的輸出？

- i. \leq
 - ii. $<$
 - iii. $=$
 - iv. $>$
- A. i only 只有 i
 - B. i and iv only 只有 i 和 iv
 - C. ii and iii only 只有 ii 和 iii
 - D. ii, iii and iv only 只有 ii、iii 和 iv

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

Pascal

```
var
  a: array[0..2018] of longint;
  i, cnt: longint;
begin
  a[1] := 1;
  cnt := 0;
  for i := 2 to 2018 do
    a[i] := a[i - 1] or i;
  for i := 2 to 2018 do
    if (a[i] <> a[i - 1]) then
      inc(cnt);
  write(cnt)
end.
```

C

```
int a[2019];
int i, cnt;
int main () {
  a[1] = 1;
  cnt = 0;
  for (i = 2; i <= 2018; i++)
    a[i] = a[i - 1] | i;
  for (i = 2; i <= 2018; i++)
    if (a[i] != a[i - 1])
      cnt++;
  printf("%d", cnt);
  return 0;
}
```

C++

```
int a[2019];
int i, cnt;
int main () {
  a[1] = 1;
  cnt = 0;
  for (i = 2; i <= 2018; i++)
    a[i] = a[i - 1] | i;
  for (i = 2; i <= 2018; i++)
    if (a[i] != a[i - 1])
      cnt++;
  cout << cnt;
  return 0;
}
```

- A. 10
- B. 11
- C. 2017
- D. 2018

12. Four players, namely W, X, Y and Z, are randomly assigned into two pairs. For each pair, the two players play a single match. The winners from these two matches play against each other in the final match.

四位玩家：W、X、Y 和 Z 被隨機分配至兩對。對於每一對，兩位玩家會進行一場比賽。這兩場比賽的勝方會再進行一場決賽。

It is given the outcomes of all possible matches:

已知所有可能對陣的結果：

- | | |
|--|-------------------|
| 1. In a match between W and X, W always win. | W 和 X 之間的比賽，W 必勝。 |
| 2. In a match between W and Y, Y always win. | W 和 Y 之間的比賽，Y 必勝。 |
| 3. In a match between W and Z, Z always win. | W 和 Z 之間的比賽，Z 必勝。 |
| 4. In a match between X and Y, Y always win. | X 和 Y 之間的比賽，Y 必勝。 |
| 5. In a match between X and Z, X always win. | X 和 Z 之間的比賽，X 必勝。 |
| 6. In a match between Y and Z, Z always win. | Y 和 Z 之間的比賽，Z 必勝。 |

Which of the following pairs is/are possible result(s) in **the final match**?

以下哪些決賽結果是有可能發生的？

- | | Winner 勝方 | Loser 敗方 |
|------|-----------|----------|
| i. | W | Z |
| ii. | Y | X |
| iii. | Y | W |
- A. ii only 只有 ii
 - B. iii only 只有 iii
 - C. ii and iii only 只有 ii 和 iii
 - D. i, ii and iii i、ii 和 iii

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

Pascal

```
function same(a, b: longint): longint;
begin
  if (___X___) then
    same := 1
  else
    same := 0
end;
```

C / C++

```
int same(int a, int b) {
  if (___X___)
    return 1;
  else
    return 0;
}
```

Which of the followings can be filled in X such that the function returns 1 if and only if $a = b$?

以下哪些可以代入 X，令以上函數當且僅當 $a = b$ 時才會傳回 1？

Pascal

i.

ii.

C / C++

- 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

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

Pascal

```
var
  s: string = 'hkoi201718';
  temp: char;
  i: longint;
  arr: array[1..6] of longint =
    (1, 4, 0, 3, 5, 2);
begin
  for i := 1 to 6 do
  begin
    s[i + arr[i]] := s[i + 1];
    temp := s[i + arr[i]];
    s[i + 1] := temp
  end;
  write(s)
end.
```

C

```
char s[11] = "hkoi201718";
char temp;
int i;
int arr[6] = {1, 4, 0, 3, 5, 2};
int main() {
  for (i = 0; i <= 5; i++) {
    s[i + arr[i]] = s[i + 1];
    temp = s[i + arr[i]];
    s[i + 1] = temp;
  }
  printf("%s", s);
  return 0;
}
```

C++

```
string s = "hkoi201718";
char temp;
int i;
int arr[6] = {1, 4, 0, 3, 5, 2};
int main() {
  for (i = 0; i <= 5; i++) {
    s[i + arr[i]] = s[i + 1];
    temp = s[i + arr[i]];
    s[i + 1] = temp;
  }
  cout << s;
  return 0;
}
```

- A. hki018721o
- B. ho2011i7k8
- C. hooikii7k8
- D. hkii2o221o

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

Pascal

```
var
  a, p: array[0..7] of longint;
  i: longint;
begin
  for i := 0 to 7 do
    read(a[i]);
  p[0] := a[0];
  for i := 1 to 7 do
    p[i] := p[i - 1] + a[i];
  write((p[7] - p[6])
        * (p[4] - p[2]))
end.
```

C

```
int a[8], p[8];
int i;
int main() {
  for (i = 0; i <= 7; i++)
    scanf("%d", &a[i]);
  p[0] = a[0];
  for (i = 1; i <= 7; i++)
    p[i] = p[i - 1] + a[i];
  printf("%d", (p[7] - p[6])
        * (p[4] - p[2]));
  return 0;
}
```

C++

```
int a[8], p[8];
int i;
int main() {
  for (i = 0; i <= 7; i++)
    cin >> a[i];
  p[0] = a[0];
  for (i = 1; i <= 7; i++)
    p[i] = p[i - 1] + a[i];
  cout << (p[7] - p[6])
        * (p[4] - p[2]);
  return 0;
}
```

On which of the following inputs does the program output the largest number?

以下哪一組輸入會生成最大的輸出？

- A. 3 1 4 1 5 9 2 6
- B. 5 3 5 8 9 7 9 3
- C. 2 3 8 4 6 2 6 4
- D. 3 3 8 3 2 7 9 5

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

Pascal

```
var
  a: array[0..199] of longint;
  i, j: longint;
  sum: longint = 0;
begin
  for i := 20 downto 1 do
    a[i] := i;
  for i := 20 downto 1 do
    begin
      for j := 1 to a[i] do
        a[i - 1] := a[i - 1] div 2;
      sum := sum + a[i]
    end;
  write(sum)
end.
```

C

```
int a[200];
int i, j;
int sum = 0;
int main() {
  for (i = 20; i >= 1; i--)
    a[i] = i;
  for (i = 20; i >= 1; i--) {
    for (j = 1; j <= a[i]; j++)
      a[i - 1] = a[i - 1] / 2;
    sum = sum + a[i];
  }
  printf("%d", sum);
  return 0;
}
```

C++

```
int a[200];
int i, j;
int sum = 0;
int main() {
  for (i = 20; i >= 1; i--)
    a[i] = i;
  for (i = 20; i >= 1; i--) {
    for (j = 1; j <= a[i]; j++)
      a[i - 1] = a[i - 1] / 2;
    sum = sum + a[i];
  }
  cout << sum;
  return 0;
}
```

- A. 19
- B. 55
- C. 110
- D. 210

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

Pascal

```
var
  a: array[0..9] of longint =
    (1, 2, 3, 4, 5, 6, 7, 8,
     9, 10);
  lo, mi, hi, t: longint;
begin
  lo := 0;
  hi := 9;
  t := 7;
  while lo <= hi do
  begin
    mi := (lo + hi) div 2;
    if (a[mi] < t) then
      lo := mi + 1
    else
      hi := mi - 1
    end;
  write(lo)
end.
```

C

```
int a[10] = {1, 2, 3, 4, 5, 6,
             7, 8, 9, 10};
int lo, mi, hi, t;
int main() {
  lo = 0;
  hi = 9;
  t = 7;
  while (lo <= hi) {
    mi = (lo + hi) / 2;
    if (a[mi] < t)
      lo = mi + 1;
    else
      hi = mi - 1;
  }
  printf("%d", lo);
}
```

C++

```
int a[10] = {1, 2, 3, 4, 5, 6,
             7, 8, 9, 10};
int lo, mi, hi, t;
int main() {
  lo = 0;
  hi = 9;
  t = 7;
  while (lo <= hi) {
    mi = (lo + hi) / 2;
    if (a[mi] < t)
      lo = mi + 1;
    else
      hi = mi - 1;
  }
  cout << lo;
}
```

- A. 5
- B. 6
- C. 7
- D. The program will not terminate 該程序不會終止

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

Pascal

```
var
  a, b, i: longint;
begin
  a := 17;
  b := 2018;
  for i := b downto 0 do
  begin
    if (a mod 2 = 0) then
      a := a div 2
    else if (a mod 3 = 0) then
      a := a div 3
    else
      a := a * 5 + 1
    end;
  write(a)
end.
```

C

```
int a, b, i;
int main() {
  a = 17;
  b = 2018;
  for (i = b; i >= 0; i--) {
    if (a % 2 == 0)
      a = a / 2;
    else if (a % 3 == 0)
      a = a / 3;
    else
      a = a * 5 + 1;
  }
  printf("%d", a);
  return 0;
}
```

C++

```
int a, b, i;
int main() {
  a = 17;
  b = 2018;
  for (i = b; i >= 0; i--) {
    if (a % 2 == 0)
      a = a / 2;
    else if (a % 3 == 0)
      a = a / 3;
    else
      a = a * 5 + 1;
  }
  cout << a;
  return 0;
}
```

- A. 1
- B. 2
- C. 3
- D. 6

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

Pascal

```
var
  a: array[0..99] of longint;
  p: longint;
procedure f(x: longint);
begin
  a[p] := x;
  inc(p)
end;
function g(): longint;
begin
  dec(p);
  g := a[p]
end;
```

C / C++

```
int a[100];
int p;
void f(int x) {
  a[p] = x;
  p++;
}
int g() {
  p--;
  return a[p];
}
```

Which of the following data structures does the above program segment implement?

以上程序段實現了以下哪一項數據結構？

- A. Queue 隊列
- B. Cyclic queue (circular buffer) 循環隊列 (圓形緩衝區)
- C. Stack 棧
- D. Linked list 鏈表

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

Pascal

```
var
  x, y: longint;
begin
  read(x, y);
  if (x div 2 <= y div 2) then
    write('a');
  if (x div 3 = y div 3) then
    write('b');
  if (x div 5 >= y div 5) then
    write('c')
end.
```

C

```
int x, y;
int main() {
  scanf("%d %d", &x, &y);
  if (x / 2 <= y / 2)
    printf("a");
  if (x / 3 == y / 3)
    printf("b");
  if (x / 5 >= y / 5)
    printf("c");
  return 0;
}
```

C++

```
int x, y;
int main() {
  cin >> x >> y;
  if (x / 2 <= y / 2)
    cout << "a";
  if (x / 3 == y / 3)
    cout << "b";
  if (x / 5 >= y / 5)
    cout << "c";
  return 0;
}
```

Assume inputs x and y are integers between 1 and 100 inclusive. Which of the followings are possible outputs of the program above?

假設輸入 x 和 y 分別是 1 和 100 之間 (含) 的整數。以下哪些是有可能的輸出？

- i. ab
 - ii. ac
 - iii. bc
- A. i and ii only 只有 i 和 ii
 - B. i and iii only 只有 i 和 iii
 - C. ii and iii only 只有 ii 和 iii
 - D. i, ii and iii i、ii 和 iii

21. Palindromes are strings that read the same forward or reversed. For example, “ABBA” is a palindrome while “ABCD” isn’t.

迴文是正讀反讀都一樣的字串。舉例說，“ABBA”是迴文，而“ABCD”則不是。

Which of the following strings can be re-ordered to form a palindrome?

以下哪些字串可以重組成迴文？

- i. BCBCCAACA
- ii. ZZYXZYX
- iii. RQSPSPQRPS

- 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

22. A string $s[1\dots L]$ of length L is said to be periodic, if there exists a positive divisor P of L , such that $P < L$ and $s[i + P] = s[i]$ for $1 \leq i \leq L - P$.

對於一個長度為 L 的字串 $s[1\dots L]$ ，當存在一個 L 的正因數 P 使得 $P < L$ 且對於 $1 \leq i \leq L - P$ ， $s[i + P] = s[i]$ ，我們稱這個字串為週期性的。

Which of the following strings can be re-ordered to form a periodic string?

以下哪些字串可以重組成週期性的字串？

- i. ABACCABAB
- ii. HKOIOHIK
- iii. IOIPPPPPPIOI

- 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

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

Pascal

```
function f(n: longint): longint;  
begin  
  while (n mod 2 = 0) do  
    n := n div 2;  
  f := n  
end;
```

C / C++

```
int f(int n) {  
  while (n % 2 == 0)  
    n = n / 2;  
  return n;  
}
```

Which of the followings returns the largest value?

以下哪項傳回最大值？

- A. f(65)
- B. f(122)
- C. f(4032)
- D. f(65536)

24. Let $a[0..999]$ be an integer array sorted in ascending order.

設 $a[0..999]$ 為一個由小至大排序好的整數陣列。

In array a , given that there exists a value x that appears more than 500 times, at least how many element(s) need(s) to be accessed to obtain its value?

在陣列 a 中，已知有一數值 x 出現多於 500 次，最少需要讀取多少個元素才能得取得該數值？

- A. 1
- B. 2
- C. 500
- D. 1000

25. Below is the truth table for the nor operator:

以下是 nor（或非）的真值表：

A	B	A nor B
FALSE 假	FALSE 假	TRUE 真
FALSE 假	TRUE 真	FALSE 假
TRUE 真	FALSE 假	FALSE 假
TRUE 真	TRUE 真	FALSE 假

Which of the following expressions is equivalent to $((\text{not } A) \text{ and } B)$?

以下哪一表達式等同 $((\text{not } A) \text{ and } B)$ ？

- A. $A \text{ nor } (B \text{ nor } B)$
- B. $(A \text{ nor } A) \text{ nor } B$
- C. $(A \text{ nor } B) \text{ nor } B$
- D. $(A \text{ nor } B) \text{ nor } (B \text{ nor } B)$

END OF SECTION A 甲部完

Section B 乙部 (20 marks 分)

The blanks are labeled from A to L. Please fill in the blanks on the answer sheet.

下列各空格分別命名為 A 至 L，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。
- (7) If blank X is divided into X1 and X2, it means that marks will only be given when X1 and X2 are both correct.
如果空格 X 分為 X1 和 X2，那麼 X1 和 X2 均為正確才會給分。

1. The input to the following program segment will be 99 distinct integers between 1 and 100 (inclusive).
以下程序段的輸入是 99 個不同的、在 1 和 100 之間 (含) 的整數。

Pascal

```
var
  i, a, x: longint;
function f(): longint;
begin
  a := 0;
  for i := 1 to 99 do
  begin
    read(x);
    a := _____ A1 _____
  end;
  f := _____ A2 _____
end;
```

C

```
int i, a, x;
int f() {
  a = 0;
  for (i = 1; i <= 99; i++) {
    scanf("%d", &x);
    a = _____ A1 _____;
  }
  return _____ A2 _____;
}
```

C++

```
int i, a, x;
int f() {
  a = 0;
  for (i = 1; i <= 99; i++) {
    cin >> x;
    a = _____ A1 _____;
  }
  return _____ A2 _____;
}
```

Complete function f() so that it returns the integer between 1 and 100 (inclusive) that does not appear in the input.

完成函數 f() 使其回傳在 1 和 100 之間 (含) 而沒有在輸入出現的整數。

Answer 答案: _____ A1 _____

Answer 答案: _____ A2 _____ (2 marks 分)

2. Consider the following program segment: 考慮以下程序段：

Pascal

```
var
  a: array[0..99] of longint;
procedure swap(x, y: longint);
var t: longint;
begin
  _____ B _____
end;
procedure f(k: longint);
var i: longint = 0;
begin
  while (i < _____ C _____) do
  begin
    swap(i, k - i - 1);
    inc(i)
  end
end;
procedure g(k: longint);
begin
  _____ D _____
end;
```

C / C++

```
int a[100];
void swap(int x, int y) {
  int t;
  _____ B _____;
}
void f(int k) {
  int i = 0;
  while (i < _____ C _____) {
    swap(i, k - i - 1);
    i++;
  }
}
void g(int k) {
  _____ D _____;
}
```

Assume that a is an array of 100 integers and k is an integer between 0 and 100 inclusive.

假設 a 是一個存有 100 個整數的陣列，而 k 是一個 0 和 100 之間（含）的整數。

Complete the procedure `swap` so that it swaps the values of $a[x]$ and $a[y]$. You must NOT make use of the procedures `f` or `g`.

完成程序 `swap` 使得它會交換 $a[x]$ 和 $a[y]$ 的數值。你不可以利用程序 `f` 或 `g`。

Answer 答案: _____ B _____ (1 mark 分)

Complete the procedure `f` so that it reverses the first k elements in the array a .

完成程序 `f` 使得它會倒轉陣列 a 的前 k 個元素。

Answer 答案: _____ C _____ (1.5 marks 分)

Complete the procedure `g` so that it reverses the last k elements in the array a . You may make use of the procedures `swap` and `f`.

完成程序 `g` 使得它會倒轉陣列 a 的後 k 個元素。你可以利用程序 `swap` 和 `f`。

Answer 答案: _____ D _____ (1.5 marks 分)

Hint: you can write several program statements in one line by separating them with semi-colon (;).

提示：只要用分號（;）分隔，就可以在一行之內填寫數句程序語句。

3. Consider a rectangular grid, where the cell labeled with S is the *starting-point*, cell labeled with T is the *target-point*, and cells labeled with C are the *checkpoints*. We call a path an *interesting path* if and only if it is a path that walk from the starting-point to the target-point by repeatedly walking to either the cell below or on the right, and passing through **EXACTLY ONE** checkpoint. For example, for the following 3×3 grid, there are 4 distinct interesting paths:

考慮一個長方網格，標示 S 的格子為起點、標示 T 的格子為終點、而標示 C 的格子為檢查站。我們稱一條路徑為有趣路徑當且僅當這條路徑是由起點反覆往下面或右面的格子走而到達終點，而且途中恰好經過一個檢查站。舉例說，對於下面所示的 3×3 長方網格，一共有 4 條有趣路徑。

S	C	
	C	T

Now consider the 5×5 grid below: (cell A1 labeled as S and cell E5 labeled as T)

現在考慮下面所示的 5×5 長方網格：(方格 A1 標示為 S、方格 E5 標示為 T)

	A	B	C	D	E
1	S				
2					
3					
4					
5					T

On the answer sheet, label exactly **TWO** cells as checkpoints (C) so that the number of distinct interesting paths is **EXACTLY** 16.

請在答題紙上將恰好兩個方格標示為檢查站 (C)，使得有趣路徑的數目恰好是 16。

Answer 答案: _____ E _____ (1 mark 分)

On the answer sheet, label exactly **TWO** cells as checkpoints (C) so that the number of distinct interesting paths is **EXACTLY** 55.

請在答題紙上將恰好兩個方格標示為檢查站 (C)，使得有趣路徑的數目恰好是 55。

Answer 答案: _____ F _____ (2 marks 分)

4. Consider a string that consists of 100 lowercase letters. You may remove an arbitrary number of characters in the string without changing the order of the remaining characters. In the worst case, at least how many characters should you remove so that the remaining string is a palindrome? (Hint: Palindromes are strings that read the same forward or reversed. For example, "ABBA" is a palindrome while "ABCD" isn't.)

考慮一個由 100 個小寫英文字母組成的字串。你可以在不影響剩餘字母次序的情況下，在這個字串中移除任意數目的字母。在最壞情況，你最少需要移除多少個字母使得剩餘的字串是一個迴文？(提示：迴文是正讀反讀都一樣的字串。舉例說，“ABBA”是迴文，而“ABCD”則不是。)

Answer 答案: _____ G _____ (2 marks 分)

5. Complete the function $f(x)$ so that the function $g(ch)$ can convert lowercase letters to uppercase and vice versa. For example, $g('A')$ should return a and $g('q')$ should return Q .
完成函數 $f(x)$ 使得函數 $g(ch)$ 可以將小寫英文字母轉換成大寫英文字母，反過來也一樣。舉例說， $g('A')$ 應傳回 a ，而 $g('q')$ 應傳回 Q 。

Pascal

```
function f(x: longint): longint;  
begin  
  f := _____ H _____  
end;  
function g(ch: char): char;  
var tmp: longint;  
begin  
  tmp := ord(ch);  
  tmp := f(tmp);  
  g := chr(tmp)  
end;
```

C / C++

```
int f(int x) {  
  return _____ H _____;  
}  
char g(char ch) {  
  int tmp;  
  tmp = (int)ch;  
  tmp = f(tmp);  
  return (char)tmp;  
}
```

Answer 答案: _____ H _____ (2 marks 分)

6. Complete the function $find_sum()$ so that it returns the sum of all positive numbers in $num[0..99]$. You may assume that the values stored in $num[0..99]$ are integers between -100 and 100 inclusive.

Special rule: Your answers are **NOT** allowed to include any of the following characters: $<$, $>$ and $=$.

完成函數 $find_sum()$ 使得它傳回所有在 $num[0..99]$ 之中正整數的總和。你可假設 $num[0..99]$ 中的數值都是 -100 和 100 之間（含）的整數。

特殊規則：在你的答案中**不能**包含以下字符： $<$, $>$ 和 $=$ 。

Pascal

```
var  
  num: array[0..99] of longint;  
  temp, i: longint;  
function find_sum(): longint;  
begin  
  temp := 0;  
  for i := 0 to 99 do  
    temp := temp + _____ I1 _____;  
  find_sum := _____ I2 _____  
end;
```

C / C++

```
int num[100];  
int temp, i;  
int find_sum() {  
  temp = 0;  
  for (i = 0; i <= 99; i++)  
    temp = temp + _____ I1 _____;  
  return _____ I2 _____;  
}
```

Answer 答案: _____ I1 _____

Answer 答案: _____ I2 _____ (2 marks 分)

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

Pascal

```
function is_prime(n: longint): longint;
var i: longint;
begin
  if (n = 1) then
  begin
    is_prime := 0;
    exit
  end;
  _____ J1 _____
  while (i * i <= n) do
  begin
    if (_____ J2 _____) then
    begin
      is_prime := 0;
      exit
    end;
    inc(i)
  end;
  is_prime := 1
end;
function prime_count(n: longint): longint;
var answer, i: longint;
begin
  answer := 0;
  for i := 1 to n do
    answer := _____ K _____;
  prime_count := answer
end;
```

C / C++

```
int is_prime(int n) {
  int i;
  if (n == 1) {
    return 0;
  }
  _____ J1 _____
  while (i * i <= n) {
    if (_____ J2 _____) {
      return 0;
    }
    i++;
  }
  return 1;
}
int prime_count(int n) {
  int answer, i;
  answer = 0;
  for (i = 1; i <= n; i++)
    answer = _____ K _____;
  return answer;
}
```

It is guaranteed that n is an integer between 1 and 100 inclusive.

保證 n 是 1 和 100 之間（含）的整數。

Complete the function `is_prime(n)`, so that `is_prime(n)` returns 1 if n is a prime, and 0 otherwise.

完成函數 `is_prime(n)`，使得 `is_prime(n)` 在 n 是質數時傳回 1，否則傳回 0。

Answer 答案: _____ J1 _____

Answer 答案: _____ J2 _____ (1.5 marks 分)

Complete the function `prime_count(n)`, so that `prime_count(n)` returns the number of primes between 1 and n (inclusive).

完成函數 `prime_count(n)`，使得 `prime_count(n)` 傳回 1 和 n 之間（含）的質數數目。

Answer 答案: _____ K _____ (1.5 marks 分)

8. The input to the following program is 100 integers between 0 and 10000 inclusive. The program tries to output the number of distinct integers in the input. However, the program contains an error that can be fixed by changing exactly one line. Find the line and correct it.

以下程序的輸入為 100 個 0 至 10000 之間（含）的整數。此程序嘗試輸出輸入內有多少個不同的整數，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。

Pascal	C	C++
11 var	41 int a[100];	71 int a[100];
12 a: array [0..99] of longint;	42 int f[10001];	72 int f[10001];
13 f: array [0..10000] of longint;	43 int i, answer;	73 int i, answer;
14 i, answer: longint;	44 int main() {	74 int main() {
15 begin	45 answer = 0;	75 answer = 0;
16 answer := 0;	46 for (i = 0; i <= 10000; i++)	76 for (i = 0; i <= 10000; i++)
17 for i := 0 to 10000 do	47 {	77 {
18 begin	48 f[i] = 0;	78 f[i] = 0;
19 f[i] := 0	49 }	79 }
20 end ;	50 for (i = 0; i <= 99; i++)	80 for (i = 0; i <= 99; i++)
21 for i := 0 to 99 do	51 {	81 {
22 begin	52 scanf("%d", &a[i]);	82 cin >> a[i];
23 read(a[i])	53 }	83 }
24 end ;	54 for (i = 0; i <= 99; i++)	84 for (i = 0; i <= 99; i++)
25 for i := 0 to 99 do	55 {	85 {
26 begin	56 f[a[i]]++;	86 f[a[i]]++;
27 inc(f[a[i]])	57 }	87 }
28 end ;	58 for (i = 0; i <= 99; i++)	88 for (i = 0; i <= 99; i++)
29 for i := 0 to 99 do	59 {	89 {
30 begin	60 if (f[i] > 0)	90 if (f[i] > 0)
31 if (f[i] > 0) then	61 {	91 {
32 begin	62 answer++;	92 answer++;
33 inc(answer)	63 }	93 }
34 end	64 }	94 }
35 end ;	65 printf("%d", answer);	95 cout << answer;
36 write (answer)	66 return 0;	96 return 0;
37 end .	67 }	97 }

Line number 行數: L1

Correction 改正: L2 (2 marks 分)

END OF PAPER 全卷完