

	Format 類型	# Questions 題目數	Total Marks 佔分
Section A1 甲部 (一)	True or False 真假題	5	5
Section A2 甲部 (二)	Multiple Choice 多項選擇題	20	20
Section B 乙部	Fill-in-the-blanks 填充題	8 (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) Other than questions that mention compilation, assume all programs are compiled properly in Ubuntu 20.04 using the compilers and commands below.

除了有提及編譯的題目之外，假設所有程序都在 Ubuntu 20.04 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 A1 甲部 (一) (5 marks 分)

For each question, determine whether the statement is true or false, then mark the corresponding box (T: true or F: false) on the answer sheet. One mark for each correct answer. No marks will be deducted for wrong answers.  
請判斷下列每題的陳述句的真假，然後把答題紙對應的空格 (T: 真或 F: 假) 填滿。答對得一分，答錯不扣分。

1. Given that a program uses 8 bits and 32 bits to store a character and an integer respectively. It requires more bits to store the string "HKOI21" than the string "HKOIXXI".

給定一個程序分別使用 8 個位元和 32 個位元來儲存一個字符和一個整數，儲存字串 "HKOI21" 比儲存字串 "HKOIXXI" 需要更多位元。

2. The following function returns an odd number if and only if one of  $x$  and  $y$  is an odd number and another one is an even number.

以下函數當且僅當在  $x$  和  $y$  當中有一個奇數和一個偶數時返回一個奇數。

### Pascal

```
function f(x, y: longint): longint;  
var z: longint;  
begin  
  z := x xor y;  
  f := (x and y) xor (z or y)  
end;
```

### C / C++

```
int f(int x, int y) {  
  int z = x ^ y;  
  return (x & y) ^ (z | y);  
}
```

3. For any positive integer  $n$ , the sum of digits of  $n$  when written in base 2 is smaller than or equal to the sum of digits of  $n$  when written in base 8.

對於任何正整數  $n$ ， $n$  寫成二進制的數位之和小於或等於  $n$  寫成八進制的數位之和。

4. There exists a right-angled triangle such that all side lengths are positive odd integers.

存在一個直角三角形使得全部邊的長度都是正奇數。

5. It is possible to place  $1 \times 2$  dominoes without overlapping each other to completely cover a  $2020 \times 2020$  chessboard which a pair of diagonally opposite corners have been cut off.

有可能互不交疊地放置大小為  $1 \times 2$  的骨牌去完全覆蓋一個大小為  $2020 \times 2020$  且切掉一對對角的棋盤。

## Section A2 甲部 (二) (20 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。

6. Suppose  $x$  is a 32-bit signed integer variable (Pascal: `longint`, C / C++: `int`). If  $x$  is set to 8, how many bits are 1?

假設  $x$  是個 32 位元有符號的整數變量 (Pascal: `longint`, C / C++: `int`)，若  $x$  賦值為 8，有多少個位元為 1？

- A. 1
- B. 2
- C. 3
- D. 4

7. Refer to the previous question, if  $x$  is set to -1, how many bits are 1?

承上題，若  $x$  賦值為 -1，有多少個位元為 1？

- A. 1
- B. 2
- C. 31
- D. 32

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

**Pascal**

```
function f(x: longint): longint;
var a: longint;
begin
  a := x;
  while (x > 0) do
  begin
    a := a + x;
    x := x div 2
  end;
  f := a
end;
```

**C / C++**

```
int f(int x) {
  int a = x;
  while (x > 0) {
    a = a + x;
    x = x / 2;
  }
  return a;
}
```

What is the return value of  $f(16)$ ?

$f(16)$  的傳回值是甚麼？

- A. 31
- B. 32
- C. 47
- D. 48

9. 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 := 1;
  b := 3;
  for i := 1 to 2 do
  begin
    b := 2 * a + b;
    a := a + b
  end;
  write(a, ' ', b)
end.
```

**C**

```
int a, b, i;
int main() {
  a = 1;
  b = 3;
  for (i = 1; i <= 2; i++) {
    b = 2 * a + b;
    a = a + b;
  }
  printf("%d %d", a, b);
  return 0;
}
```

**C++**

```
int a, b, i;
int main() {
  a = 1;
  b = 3;
  for (i = 1; i <= 2; i++) {
    b = 2 * a + b;
    a = a + b;
  }
  cout << a << ' ' << b;
  return 0;
}
```

- A. 6 5
- B. 23 17
- C. 4 5
- D. 9 13

10. Which of the following must be true given that “If there is a typhoon, then they will cancel the school” is true?  
已知「如果有颱風，學校會停課」為真，以下哪一項必然為真？

- A. If they will cancel the school, then there is a typhoon.  
如果學校會停課，就會有颱風。
- B. If there is not a typhoon, then they will not cancel the school.  
如果沒有颱風，學校就不會停課。
- C. If they will not cancel the school, then there is not a typhoon.  
如果學校不會停課，就沒有颱風。
- D. None of the other options  
其他選項皆非

11. The juice company wants to recycle the cap on the juice bottles. It is holding an activity in which customers can trade two bottle caps for one new bottle of juice. They can also use the caps from new bottles to trade for more juice. If one has 3 bottles of juice initially, he can drink a total of 5 bottles of juice at last.

If Alice wishes to drink 83 bottles of juice at last, what is the minimum number of bottles of juice she needs to have initially?

果汁公司想要回收果汁瓶上的瓶蓋，所以舉辦了一個活動，讓顧客用兩個瓶蓋去兌換一瓶新的果汁。顧客可以再用新的果汁上的瓶蓋去兌換更多果汁。如果一個顧客本來有 3 瓶果汁，那麼他最後一共能喝 5 瓶果汁。

假設愛麗絲一共能喝 83 瓶果汁，那麼她一開始最少有多少瓶果汁？

- A. 39
- B. 40
- C. 41
- D. 42

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

**Pascal**

```
var
  a: array[0..2020] of longint;
  i: longint;
begin
  for i := 0 to 2020 do
    a[i] := 0;
  for i := 1 to 2020 do
    if (i mod 2 = 0) then
      a[i] := a[i div 2] + 1;
  write(a[2020])
end.
```

**C**

```
int a[2021];
int i;
int main() {
  for (i = 0; i <= 2020; i++)
    a[i] = 0;
  for (i = 1; i <= 2020; i++)
    if (i % 2 == 0)
      a[i] = a[i / 2] + 1;
  printf("%d", a[2020]);
  return 0;
}
```

**C++**

```
int a[2021];
int i;
int main() {
  for (i = 0; i <= 2020; i++)
    a[i] = 0;
  for (i = 1; i <= 2020; i++)
    if (i % 2 == 0)
      a[i] = a[i / 2] + 1;
  cout << a[2020];
  return 0;
}
```

- A. 2
- B. 3
- C. 10
- D. 11

13. Suppose  $x$  initially equals 2. For each step, you can either increase  $x$  by 1 or multiply  $x$  by  $x$ . How many ways are there to make  $x$  become 100?

假設  $x$  一開始等於 2。在每一步，你可以將  $x$  增加 1 或乘以  $x$ 。共有多少種方法令  $x$  變成 100？

- A. 16
- B. 18
- C. 19
- D. 21

14. Suppose  $a$  and  $b$  are 32-bit signed integer variables (Pascal: `longint`, C / C++: `int`) each storing a positive integer, which of the following expressions must evaluate to true?

假設  $a$  和  $b$  是 32 位元有符號的整數變量 (Pascal: `longint`, C / C++: `int`)，各儲存一個正整數，以下哪些表達式必為真？

	<b>Pascal</b>	<b>C / C++</b>
i.	<input type="text" value="(a or b) &gt;= a"/>	<input type="text" value="(a   b) &gt;= a"/>
ii.	<input type="text" value="(a and b) &lt;= a"/>	<input type="text" value="(a &amp; b) &lt;= a"/>
iii.	<input type="text" value="(a xor b) &lt;&gt; a"/>	<input type="text" value="(a ^ b) != a"/>

- 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

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

**Pascal**

```
var
  a: array[0..9] of longint =
    (7, 1, 4, 6, 8, 9, 5, 2,
     3, 10);
  i, j, t: longint;
begin
  for i := 1 to 4 do
    for j := i + 1 to 9 do
      if (a[i] < a[j]) then
        begin
          t := a[i];
          a[i] := a[j];
          a[j] := t
        end;
  write(a[1], ' ', a[4])
end.
```

**C**

```
int a[10] = {7, 1, 4, 6, 8, 9,
             5, 2, 3, 10};
int i, j, t;
int main() {
  for (i = 1; i <= 4; i++)
    for (j = i + 1; j <= 9; j++)
      if (a[i] < a[j]) {
        t = a[i];
        a[i] = a[j];
        a[j] = t;
      }
  printf("%d %d", a[1], a[4]);
  return 0;
}
```

**C++**

```
int a[10] = {7, 1, 4, 6, 8, 9,
             5, 2, 3, 10};
int i, j, t;
int main() {
  for (i = 1; i <= 4; i++)
    for (j = i + 1; j <= 9; j++)
      if (a[i] < a[j]) {
        t = a[i];
        a[i] = a[j];
        a[j] = t;
      }
  cout << a[1] << ' ' << a[4];
  return 0;
}
```

- A. 1 4
- B. 9 6
- C. 10 6
- D. 10 7

16. Which of the following statements about stack are correct?

以下哪些對於堆疊 (棧) 的描述是正確的？

- i. Stack can be implemented by using an array.  
堆疊 (棧) 能用陣列來實現。
- ii. Stack can be implemented by using a singly linked list.  
堆疊 (棧) 能用單向鏈表來實現。
- iii. Stack is a first-in-last-out (FILO) data structure.  
堆疊 (棧) 是一個先進後出的數據結構。

- 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

17. There are 9 seats in a row. No more than two consecutive seats are occupied. If 6 seats are occupied, how many possible arrangements are there?

一行中有 9 張座椅，不能有連續超過 2 張座椅被佔用。當有 6 張椅子被佔用時，有多少種可行的安排方法？

- A. 3
- B. 4
- C. 6
- D. 10

18. Palindromes are strings which read the same backward as forward. For example, "ABA" is a palindrome while "ABC" is not.

迴文是從前往後讀和從後往前讀都一樣的字串。例如，"ABA" 是迴文，而"ABC" 不是。

If each comparison compares any two letters in the string, at least how many comparisons are needed to check whether a string of length  $n$  is a palindrome in the worst case? ( $\lfloor x \rfloor$  is the greatest integer which is not larger than  $x$ , and  $\lceil x \rceil$  is the smallest integer which is not smaller than  $x$ )

如果在一次比較中可以比較字串中的任意兩個字符，那麼在最壞情況下，至少需要多少次比較才能確定一個長度為  $n$  的字串是否為迴文？( $\lfloor x \rfloor$  表示不大於  $x$  的最大整數，而  $\lceil x \rceil$  則表示不小於  $x$  的最小整數)

- A. 1  
B.  $\lfloor \frac{n}{2} \rfloor$   
C.  $\lceil \frac{n}{2} \rceil$   
D.  $n$
19. Which of the following boolean expression is not logically equivalent to other boolean expressions?  
以下哪個布爾表達式與其他布爾表達式在邏輯上不等價？

- A. (A OR B) AND (NOT A OR NOT B)  
B. (A AND B) XOR (A OR B)  
C. (A XOR B) OR (A AND B)  
D. (A OR B) AND (A XOR B)

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

Pascal

```
var
  a: array[0..9] of longint =
    (3, 1, 4, 1, 5, 9, 2, 6,
     5, 3);
  res, i, j, x: longint;
begin
  res := 0;
  for i := 0 to 9 do
  begin
    res := res + a[i];
    x := i + a[i];
    if (x >= 9) then
      x := 9;
    for j := i + 1 to x do
      a[j] := a[j] - 1
    end;
  end;
  write(res)
end.
```

C

```
int a[10] = {3, 1, 4, 1, 5, 9,
             2, 6, 5, 3};
int res, i, j, x;
int main() {
  res = 0;
  for (i = 0; i <= 9; i++) {
    res = res + a[i];
    x = i + a[i];
    if (x >= 9)
      x = 9;
    for (j = i + 1; j <= x; j++)
      a[j] = a[j] - 1;
  }
  printf("%d", res);
  return 0;
}
```

C++

```
int a[10] = {3, 1, 4, 1, 5, 9,
             2, 6, 5, 3};
int res, i, j, x;
int main() {
  res = 0;
  for (i = 0; i <= 9; i++) {
    res = res + a[i];
    x = i + a[i];
    if (x >= 9)
      x = 9;
    for (j = i + 1; j <= x; j++)
      a[j] = a[j] - 1;
  }
  cout << res;
  return 0;
}
```

- A. 16  
B. 22  
C. 23  
D. 39

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

**Pascal**

```
function f(x: longint): longint;
var count, i: longint;
begin
  count := 0;
  for i := 1 to x do
    if (x mod i = 0) then
      inc(count);
  f := count
end;
begin
  write(f(2520))
end.
```

**C**

```
int f(int x) {
  int count, i;
  count = 0;
  for (i = 1; i <= x; i++)
    if (x % i == 0)
      count++;
  return count;
}
int main() {
  printf("%d", f(2520));
  return 0;
}
```

**C++**

```
int f(int x) {
  int count, i;
  count = 0;
  for (i = 1; i <= x; i++)
    if (x % i == 0)
      count++;
  return count;
}
int main() {
  cout << f(2520);
  return 0;
}
```

- A. 24
- B. 36
- C. 48
- D. 72

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

**Pascal**

```
var
  a: array[0..9] of longint =
    (4, 5, 8, 6, 7, 2, 1, 9,
     3, 3);
  x, y: longint;
begin
  x := a[0];
  y := a[a[0]];
  while (x <> y) do
  begin
    x := a[x];
    y := a[a[y]]
  end;
  y := 0;
  while (x <> y) do
  begin
    x := a[x];
    y := a[y]
  end;
  write(a[x])
end.
```

**C**

```
int a[10] = {4, 5, 8, 6, 7, 2,
             1, 9, 3, 3};
int x, y;
int main() {
  x = a[0];
  y = a[a[0]];
  while (x != y) {
    x = a[x];
    y = a[a[y]];
  }
  y = 0;
  while (x != y) {
    x = a[x];
    y = a[y];
  }
  printf("%d", a[x]);
  return 0;
}
```

**C++**

```
int a[10] = {4, 5, 8, 6, 7, 2,
             1, 9, 3, 3};
int x, y;
int main() {
  x = a[0];
  y = a[a[0]];
  while (x != y) {
    x = a[x];
    y = a[a[y]];
  }
  y = 0;
  while (x != y) {
    x = a[x];
    y = a[y];
  }
  cout << a[x];
  return 0;
}
```

- A. 2
- B. 3
- C. 6
- D. 8



23. Which of the followings is/are possible?

以下那些是可能的？

- i. Generating a random integer between 1 and 3 (inclusive) with uniform probability by using a finite number of flips of a fair coin  
利用拋一個公平的硬幣有限次，從而按均一機率生成一個 1 和 3 之間（含）的整數。
- ii. Generating a random integer between 1 and 9 (inclusive) with uniform probability by using a finite number of rolls of a fair 6-faced die  
利用擲一個公平的 6 面骰子有限次，從而按均一機率生成一個 1 和 9 之間（含）的整數。

- A. i only                      只有 i
- B. ii only                     只有 ii
- C. i and ii                    i 和 ii
- D. None of them            無

24. There are seven people standing at a line to take a photo, including Silloh(a girl), three other girls and three boys. Silloh is the tallest among all girls but she is shorter than all boys. It is given that Silloh can't see the camera if someone taller than her stands in front of her in terms of position (eg : Silloh can't see the camera if a boy stands at position 1 and Silloh stands at position 4).

If we uniformly randomize their order, what is the probability that Silloh is able to see the camera?

有七個人站在一條直線上拍照，其中包括思洛（一個女孩），其他三個女孩和三個男孩。思洛是所有女孩中最高的，但是她比所有男孩都要矮。已知若有比思洛高的人站在比她前的位置，思洛將無法看到攝影機（例如：如果有一個男孩站在位置 1 而思洛站在位置 4，思洛將無法看到攝影機）。

如果我們按均一機率去排列他們的位置，請問思洛能夠看到攝影機的機率為多少？

- A.  $\frac{1}{3}$
- B.  $\frac{1}{4}$
- C.  $\frac{3}{8}$
- D.  $\frac{3}{16}$

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

**Pascal**

```
var
  a: array[0..4] of longint;
  c, i, j, k: longint;
begin
  c := 0;
  for i := 0 to 4 do
    read(a[i]);
  for i := 0 to 4 do
    begin
      k := a[i] - 1;
      for j := 0 to k do
        c := c + a[i]
          * a[(i + 2) mod 5]
    end;
  write(c)
end.
```

**C**

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

**C++**

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

Which of the following inputs gives the largest output?

以下哪組輸入會造成最大的輸出？

- A. 7 2 -3 5 6
- B. -1 6 0 3 2
- C. -1 3 7 8 2
- D. 2 -1 5 -5 6

**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。
- (7) If blank X is divided into N parts X1, X2, ..., XN, it means that marks will only be given when X1, X2, ..., XN are all correct.  
如果空格 X 分為 N 部份 X1、X2、...、XN，那麼 X1、X2、...、XN 皆為正確才會給分。

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

#### Pascal

```
function g(x: longint): boolean;
var c: longint;
begin
  c := 0;
  while (x > 0) do
  begin
    c := c + x mod 10;
    x := x div 10
  end;
  g := (c mod 3 = 0)
end;
```

#### C

```
bool g(int x) {
  int c = 0;
  while (x > 0) {
    c = c + x % 10;
    x = x / 10;
  }
  return (c % 3 == 0);
}
```

Write down the return values of  $g(426)$ ,  $g(825)$  and  $g(1000)$  (true/false).

寫下  $g(426)$ 、 $g(825)$  及  $g(1000)$  的傳回值 (true/false)。

$g(426)$ : \_\_\_\_\_ A1 \_\_\_\_\_

$g(825)$ : \_\_\_\_\_ A2 \_\_\_\_\_

$g(1000)$ : \_\_\_\_\_ A3 \_\_\_\_\_ (1.5 marks 分)

Write down the number of possible integer  $x$  such that  $1 \leq x \leq 1000$  and  $g(x)$  returns false.

寫下有多少可能的整數  $x$  符合  $1 \leq x \leq 1000$  及  $g(x)$  的傳回值是 false。

Answer 答案: \_\_\_\_\_ B \_\_\_\_\_ (1.5 marks 分)

2. Fill in each of the numbers 0, 1, 2 three times in the table below such that each row and column meets the target sum.

(The number at the leftmost is the target sum for each row; The number at the top is the target sum for each column)

在表格中填入每一個數字 0, 1, 2 各三次使每一行與列都符合其目標總和。

(在最左的數字是該行的目標總和；在最上的數字是該列的目標總和)

Target sum 目標總和	1	5	3
5			
3			
1			

Answer 答案: \_\_\_\_\_ C \_\_\_\_\_ (1 mark 分)

Fill in each of the numbers 121, 112, 102 three times in the table below such that each row and column meets the target sum.

在表格中填入每一個數字 121, 112, 102 各三次使每一行與列都符合其目標總和。

Target sum 目標總和	316	335	354
316			
354			
335			

Answer 答案: \_\_\_\_\_ D \_\_\_\_\_ (2 marks 分)

3. Complete the following program such that its output is n.

完成以下程序使得其輸出是 n。

**Pascal**

```
var
  q: array[0..10] of char =
    ('h', 'k', 'o', 'i',
     '2', '0', 'n', 'o',
     'v', '2', '1');
  a, b: longint;
begin
  a := 0;
  b := 0;
  while (b < 11) do
  begin
    a := a + 1;
    b := _____ E _____
  end;
  write(q[a])
end.
```

**C**

```
char q[11] =
    {'h', 'k', 'o', 'i',
     '2', '0', 'n', 'o',
     'v', '2', '1'};
int a, b;
int main() {
  a = 0;
  b = 0;
  while (b < 11) {
    a = a + 1;
    b = _____ E _____;
  }
  printf("%c", q[a]);
}
```

**C++**

```
char q[11] =
    {'h', 'k', 'o', 'i',
     '2', '0', 'n', 'o',
     'v', '2', '1'};
int a, b;
int main() {
  a = 0;
  b = 0;
  while (b < 11) {
    a = a + 1;
    b = _____ E _____;
  }
  cout << q[a];
}
```

Answer 答案: \_\_\_\_\_ E \_\_\_\_\_ (1.5 marks 分)

4. Find a 10-digit number where the first digit is how many zeros in the number, the second digit is how many 1s in the number etc. until the tenth digit which is how many 9s in the number. For example, 1000009000 means that there should be exactly one 0 and nine 6s in this number, which is obviously incorrect.

找出一個十位數，當中第一個數位是該數字中 0 的數量；第二個數位是該數字中 1 的數量，如此類推，直至第十個數位是該數字中 9 的數量。例如 1000009000 代表這個數字應有恰好一個 0 和九個 6，但明顯地這不正確。

Answer 答案:         F         (2 marks 分)

5. SwapInt(x, y) and SwapChar(x, y) (C: SwapInt(&x, &y) and SwapChar(&x, &y)) are procedures that swap the values of x and y. Consider the following program:

SwapInt(x, y) 及 SwapChar(x, y) (C: SwapInt(&x, &y) 及 SwapChar(&x, &y)) 是交換 x 和 y 數值的子程序。考慮以下程序：

Pascal	C	C++
<pre> var s: string;     a: array[1..50] of longint;     n, i, j: longint; procedure SwapInt(var x, y:     longint); var t: longint; begin     t := x; x := y; y := t end; procedure SwapChar(var x, y:     char); var t: char; begin     t := x; x := y; y := t end; begin     read(s);     n := length(s);     for i := 1 to n do         a[i] := i;     for i := 1 to n do         for j := i to n - 1 do             if (s[j] &gt; s[j + 1]) then                 begin                     SwapInt(a[j], a[j + 1]);                     SwapChar(s[j], s[j + 1])                 end;         for i := 1 to n do             write(a[i])         end. </pre>	<pre> char s[50]; int a[50]; int n, i, j; void SwapInt(int* x, int* y) {     int t;     t = *x; *x = *y; *y = t; } void SwapChar(char* x,                char* y) {     char t;     t = *x; *x = *y; *y = t; } int main() {     scanf("%s", s);     n = strlen(s);     for (i = 0; i &lt;= n - 1; i++)         a[i] = i + 1;     for (i = 0; i &lt;= n - 1; i++)         for (j = i; j &lt;= n - 2; j++)             if (s[j] &gt; s[j + 1]) {                 SwapInt(&amp;a[j],                        &amp;a[j + 1]);                 SwapChar(&amp;s[j],                         &amp;s[j + 1]);             }     for (i = 0; i &lt;= n - 1; i++)         printf("%d", a[i]);     return 0; } </pre>	<pre> string s; int a[50]; int n, i, j; void SwapInt(int&amp; x, int&amp; y) {     int t;     t = x; x = y; y = t; } void SwapChar(char&amp; x,                char&amp; y) {     char t;     t = x; x = y; y = t; } int main() {     cin &gt;&gt; s;     n = s.length();     for (i = 0; i &lt;= n - 1; i++)         a[i] = i + 1;     for (i = 0; i &lt;= n - 1; i++)         for (j = i; j &lt;= n - 2; j++)             if (s[j] &gt; s[j + 1]) {                 SwapInt(a[j], a[j + 1]);                 SwapChar(s[j],                         s[j + 1]);             }     for (i = 0; i &lt;= n - 1; i++)         cout &lt;&lt; a[i];     return 0; } </pre>

If the input is ABBBAB, what is the output?

若程序的輸入是 ABBBAB，那麼輸出是什麼？

Answer 答案:         G         (1.5 marks 分)

Give an input with A and B **only**, such that the program outputs 246135.

給一個**只包括** A 和 B 的輸入，使得程序輸出 246135。

Answer 答案:         H         (1.5 marks 分)

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

```
Pascal
11 function IsPrime(x: longint): boolean;
12 var
13   i: longint;
14   a: boolean;
15 begin
16   a := true;
17   if (x = 1) then
18     a := false;
19   i := 2;
20   while (i * i < x) do
21     begin
22       if (x mod i = 0) then
23         a := false;
24       inc(i)
25     end;
26   IsPrime := a
27 end;
```

```
C / C++
41 bool IsPrime(int x) {
42   int i;
43   bool a;
44   a = true;
45   if (x == 1)
46     a = false;
47   i = 2;
48   while (i * i < x)
49   {
50     if (x % i == 0)
51       a = false;
52     i++;
53   }
54   return a;
55 }
56
57
```

The above IsPrime function tries to check whether  $x$  is a prime. A prime is any integer greater than 1 that is only divisible by 1 and itself.

以上之 IsPrime 函數嘗試判斷  $x$  是否一個質數。質數是任何大於 1 且只能被 1 及自己整除的整數。

However, there is a bug in the function.

但此函數含有一錯誤。

For how many  $x$  where  $1 \leq x \leq 100$ , the function returns a wrong answer?

有多少  $1 \leq x \leq 100$  中的  $x$  會使此函數回傳錯誤的答案？

Answer 答案: \_\_\_\_\_ I \_\_\_\_\_ (1 mark 分)

The bug can be fixed by changing exactly one line. Find the line and correct it so that the function correctly determine whether  $x$  is a prime for all  $1 \leq x \leq 10^9$ .

此錯誤只需更改一行便能修正，請找出並將其改正使得函數正確判斷所有  $1 \leq x \leq 10^9$  中的  $x$  是否質數。

Line number 行數: \_\_\_\_\_ J1 \_\_\_\_\_

Correction 改正: \_\_\_\_\_ J2 \_\_\_\_\_ (1.5 marks 分)

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

**Pascal**

```
var
  n, i, j: longint;
begin
  n := 9;
  for i := 1 to n do
  begin
    for j := 1 to n do
      if (      K, L      ) then
        write('#')
      else
        write('.');
    writeln
  end
end.
```

**C**

```
int n, i, j;
int main() {
  n = 9;
  for (i = 1; i <= n; i++) {
    for (j = 1; j <= n; j++)
      if (      K, L      )
        printf("#");
      else
        printf(".");
    printf("\n");
  }
  return 0;
}
```

**C++**

```
int n, i, j;
int main() {
  n = 9;
  for (i = 1; i <= n; i++) {
    for (j = 1; j <= n; j++)
      if (      K, L      )
        cout << '#';
      else
        cout << '.';
    cout << endl;
  }
  return 0;
}
```

Complete the program so that it outputs the following:

完成程序使其得到以下輸出:

```
##.....
###.....
.###.....
..###....
...###...
....###..
.....###.
.....###
.....##
```

Answer 答案:     K     (1.5 marks 分)

Complete the program so that it outputs the following:

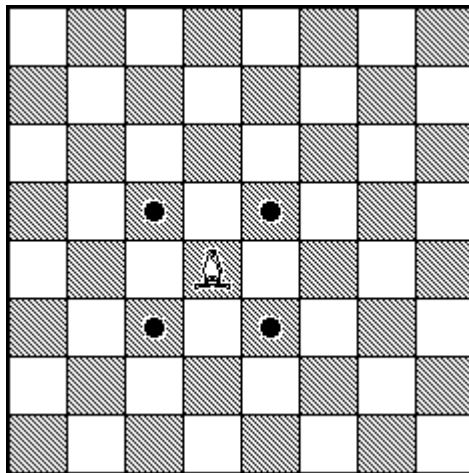
完成程序使其得到以下輸出:

```
.....##
.....###
.....###.
....###..
...###...
..###....
.###.....
###.....
##.....
```

Answer 答案:     L     (1.5 marks 分)

8. In International Chess, a bishop can move diagonally. In this question, we suppose it can only move to a grid with its edge touching the grid it is located in, as shown in the following diagram.

在國際象棋，「象」可以在一步到達四個斜線方向上任何格子。在這條問題上，我們假設它每步只能向與它現在的格子有角相鄰的格子移動，如下圖所示：



You can use commands to control the bishop: 你可以用命令控制「象」：

- $\searrow$ : go south-east 往東南方走
- $\nearrow$ : go north-east 往東北方走
- $\swarrow$ : go south-west 往西南方走
- $\nwarrow$ : go north-west 往西北方走
- $[command]n$ : repeat *command* for  $n$  times, where  $n$  is an integer from 1 to 9 (inclusive).  
[命令] $n$ ：重複命令  $n$  次， $n$  是一個 1 至 9 之間 (含) 的整數

Formally,  $\searrow \nearrow \swarrow \nwarrow$  are the fundamental **commands**. Concatenation of two or more **commands** is also a **command** and those commands are executed from left to right in order.  $[command]n$  is also a **command**.

嚴格來說， $\searrow \nearrow \swarrow \nwarrow$  為基礎命令。兩條或以上的命令連在一起也是命令，那些命令由左至右順序執行。 $[命令]n$  也是命令。

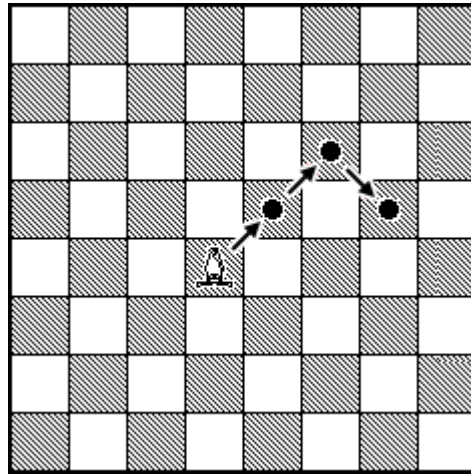
If a fundamental **command** will move the bishop out of the chessboard, the bishop will skip that fundamental **command**.

如果一基礎命令會使得「象」離開棋盤範圍，則它會無視該基礎命令。



For example, command [↗]2↘ would move the bishop two steps towards towards its upper-right cell, then one step towards its lower-right cell:

例如，命令 [↗]2↘ 會使「象」往右上走兩步，然後往右下走一步。



Suppose the bishop is initially at the **top-left** cell of the chessboard, write a command to make the bishop visit each **white** grid in the above chessboard at least once.

假設「象」起初在棋盤**左上角**的格子，寫出一命令，使「象」到訪每個**白色**格子至少一次。

Answer 答案: \_\_\_\_\_ M \_\_\_\_\_ (2 marks 分)

**END OF PAPER 全卷完**