	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	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) Other than questions that mention compilation, assume all programs are compiled properly in Ubuntu 16.04 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 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 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. Binary search can be used to replace linear search to find the minimum element from an array of integers as a faster alternative.
   在尋找一整數陣列的最小元素時,二分檢索法可以作為線性檢索法的替代算法,以更快的找出答案。

2. A computer can have at only one central processing unit (CPU).
   一台電腦只可以有一個中央處理器。

3. You must attribute the original author of the software if you modify and redistribute an open source program in the public domain.
   如果你修改並分發處於公有領域的開源軟件,你必須注明軟件的原作者。

4. A 32-bit signed integer can store the correct result of 2147483647+10-10.
   一個 32 位元有符號的整數能存儲 2147483647+10-10 的正確結果。

5. For any non-zero integer variables m and n, the value of the following expression must be `true`.
   對於任何非零整數變量 m 和 n,以下表達式的結果必定為 `true`。

Pascal	C / C++
`m = m div n * n + m mod n`	`m == m / n * n + m % n`

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

Pascal
```pascal
var
  i, sum, sum2: longint;
begin
  sum := 0;
  sum2 := 0;
  for i := 1 to 100 do
  begin
    if (i mod 2 = 0) then
      sum := sum + i;
      sum2 := sum2 + i * i
  end;
  write(sum, ' ', sum2)
end.
```

C
```c
int i, sum, sum2;
int main() {
  sum = 0;
  sum2 = 0;
  for (i = 1; i <= 100; i++) {
    if (i % 2 == 0)
      sum = sum + i;
      sum2 = sum2 + i * i;
  }
  printf("%d %d", sum, sum2);
  return 0;
}
```

C++
```cpp
int i, sum, sum2;
int main() {
  sum = 0;
  sum2 = 0;
  for (i = 1; i <= 100; i++) {
    if (i % 2 == 0)
      sum = sum + i;
      sum2 = sum2 + i * i;
  }
  cout << sum << " " << sum2;
  return 0;
}
```

- A. 2550 171700
- B. 2550 338350
- C. 5050 171700
- D. 5050 338350

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

Pascal
```pascal
var a: array[0..9] of longint =
  (3, 7, 2, 6, 3, 6, 1, 7, 0, 9);
    b: array[0..9] of longint;
    i: longint;
begin
  for i := 0 to 9 do
    b[a[i]] := b[a[i]] + a[i];
  write(b[3], ' ', b[5], ' ',
    b[7])
end.
```

C
```c
int a[10] =
  {3, 7, 2, 6, 3, 6, 1, 7, 0, 9};
int b[10];
int main() {
  for (int i = 0; i <= 9; i++)
    b[a[i]] = b[a[i]] + a[i];
  printf("%d %d %d", b[3], b[5],
    b[7]);
  return 0;
}
```

C++
```cpp
int a[10] =
  {3, 7, 2, 6, 3, 6, 1, 7, 0, 9};
int b[10];
int main() {
  for (int i = 0; i <= 9; i++)
    b[a[i]] = b[a[i]] + a[i];
  cout << b[3] << " " << b[5] <<
      " " << b[7];
  return 0;
}
```

- A. 0 0 0
- B. 2 0 2
- C. 3 0 14
- D. 6 0 14

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

Pascal
```pascal
var
  a: array[0..104] of longint;
  i, j: longint;
begin
  for i := 0 to 104 do
    a[i] := 1;
  for i := 2 to 100 do
    if (a[i] = 1) then
    begin
      j := i + i;
      while (j <= 100) do
      begin
        a[j] := 0;
        j := j + i
      end
    end;
  write(a[1], ' ', a[97])
end.
```

C
```c
int a[105];
int i, j;
int main() {
  for (i = 0; i <= 104; i++)
    a[i] = 1;
  for (i = 2; i <= 100; i++) {
    if (a[i] == 1) {
      j = i + i;
      while (j <= 100) {
        a[j] = 0;
        j = j + i;
      }
    }
  }
  printf("%d %d", a[1], a[97]);
  return 0;
}
```

C++
```cpp
int a[105];
int i, j;
int main() {
  for (i = 0; i <= 104; i++)
    a[i] = 1;
  for (i = 2; i <= 100; i++) {
    if (a[i] == 1) {
      j = i + i;
      while (j <= 100) {
        a[j] = 0;
        j = j + i;
      }
    }
  }
  cout << a[1] << " " << a[97];
  return 0;
}
```

    A.   0 0

    B.   0 1

    C.   1 0

    D.   1 1

9. A fair six-faced dice is thrown 3 times. What is the probability that the 3 numbers thrown are strictly increasing?
    一顆公正的六面骰被擲了三次。三次擲出的結果為嚴格遞增的機率是多少？

    A. $\dfrac{5}{27}$

    B. $\dfrac{5}{54}$

    C. $\dfrac{5}{108}$

    D. $\dfrac{5}{216}$

10. How many different arrangements can be made if Tom (a boy), 5 other boys and 6 other girls are to take a photo together in a horizontal line, where Tom must either stand at the leftmost or rightmost end of the line, and boys and girls must stand alternatively in the photo?
    湯姆是個男孩。如果湯姆、5 個其他男生、6 個其他女生要排成一橫線拍照，當中湯姆必需站在線的最左或最右端，且男女生必需梅花間竹地站立，那麼可拍成多少張不同的照片？

    A.   1,036,800

    B.   518,400

    C.   172,800

    D.   86,400

11. swap(a, b) is a procedure swapping the values of a and b. Consider the following program:
    swap(a, b) 是一個交換 a 和 b 數值的子程序。考慮以下程序：

Pascal

```
var
  q: array[0..4] of longint;
  i, n, h, t: longint;
procedure push(x: longint);
begin
  q[t] := x;
  if (q[h] > q[t]) then
    swap(q[h], q[t]);
  inc(t)
end;
procedure pop();
begin
  write(q[h]);
  inc(h);
  if (q[h] > q[t - 1]) then
    swap(q[h], q[t - 1])
end;
begin
  h := 0;
  t := 0;
  for i := 0 to 3 do
  begin
    q[i] := 0;
    read(n);
    push(n)
  end;
  for i := 0 to 3 do
    pop()
end.
```

C

```
int q[5];
int i, n, h, t;
void push(int x) {
  q[t] = x;
  if (q[h] > q[t])
    swap(q[h], q[t]);
  t++;
}
void pop() {
  printf("%d", q[h]);
  h++;
  if (q[h] > q[t - 1])
    swap(q[h], q[t - 1]);
}
int main() {
  h = 0;
  t = 0;
  for (i = 0; i <= 3; i++) {
    q[i] = 0;
    scanf("%d", &n);
    push(n);
  }
  for (i = 0; i <= 3; i++)
    pop();
  return 0;
}
```

C++

```
int q[5];
int i, n, h, t;
void push(int x) {
  q[t] = x;
  if (q[h] > q[t])
    swap(q[h], q[t]);
  t++;
}
void pop() {
  cout << q[h];
  h++;
  if (q[h] > q[t - 1])
    swap(q[h], q[t - 1]);
}
int main() {
  h = 0;
  t = 0;
  for (i = 0; i <= 3; i++) {
    q[i] = 0;
    cin >> n;
    push(n);
  }
  for (i = 0; i <= 3; i++)
    pop();
  return 0;
}
```

Which of the following inputs have the same output?
以下哪些輸入擁有相同輸出？

    i.   1 4 3 2

   ii.   4 3 2 1

  iii.   4 2 3 1

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

12. Define the truth table of a logical operator $\otimes$ as follows:
    定義一邏輯運算子 $\otimes$ 的真值表如下：

A	B	A $\otimes$ B
T	T	T
T	F	T
F	T	T
F	F	T

Which of the following is logically equivalent to A $\otimes$ B ?
下列與一項在邏輯上等價於 A $\otimes$ B ?

    A.   (A OR B) OR (A XOR B)
    B.   (A OR B) XOR (A XOR B)
    C.   (A OR B) OR (A AND B)
    D.   (A OR B) XOR (A NOR B)

13. Which of the following boolean expressions are logically equivalent?
    以下哪些布爾表達式是邏輯上等價的？

    i.   ((NOT a) AND b) OR (a AND (NOT b))
    ii.   NOT (a = b)
    iii. NOT ((NOT a) = (NOT b))

    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

14. Make 1000 is an interesting game that Apple and Bun are playing. The counter initially begins with 0. Each turn, the player is allowed to add an arbitrary number from 1 to 7 to the counter. They are not allowed to skip their turns. Players will take their turns alternatively. The player that makes the counter greater than or equal to 1000 will win the game. If Apple goes first, who will win the game? (Except that Apple decides to call out a random number for her first turn, assume that both of them will play optimally in the remaining part of the game)
    「合 1000」是一個蘋果和賓治在玩的有趣遊戲。一計數器的數值被預設為 0。每一回合，玩家可任意把 1 至 7 其中一個數字加到計數器的數值上，且不可跳過他們的回合。玩家輪流進行各自的回合，且先把計數器的數值加至大於或等於 1000 的玩家勝出。如果由蘋果開始遊戲，進行首回合，那麼誰會勝出遊戲？(蘋果決定首回合隨機選擇數字，除此以外，請假設兩位玩家均會採用最佳策略進行遊戲。)

    A.   Apple 蘋果
    B.   Bun   賓治
    C.   Both of them may win, depending on the initial random number called by Apple.
          取決於蘋果於首回合選擇的隨機數字，兩個人均有可能勝出。
    D.   Both of them may win, because there does not exist an optimal strategy.
          這遊戲不存在一個最佳策略，所以兩個人均有可能勝出。

15. Following the previous question, which of the following modification(s) to the game will change your answer in the previous question? Note: The modification should be considered independently. Only one modification shall be applied at the one time.

承上題，以下哪個／些對遊戲的修改會改變你於上一題選擇的答案？注意: 請獨立考慮每個修改，每次只應用一個修改。

     i.   Set the counter to a random number X before starting the game.
        在遊戲開始前，先把計數器預設至一個隨機數 X。
        $(0 \le X < 1000)$

     ii.   Each player is allowed to use 0 for a maximum of Y times (to be determined before the game starts) in the whole game as the number to add to the counter in a turn.
        在整場遊戲當中，每位玩家將會被允許使用數字 0 不多於 Y 次 (將會在遊戲開始前預先決定)，作為一回合需要加到計數器上的數字。
        $(1 < Y < 100)$

     iii.   Additional rule: All numbers must be used for at least Z times before a number can be used the $(Z+1)$-th times (Z is the current maximum number of times that a particular number is being used)
        追加規矩：所有數字需先被最少使用 Z 次，才可使用某個數字第 $(Z + 1)$ 次。(Z 為目前某個數字被使用次數的最大值）

A.   i only   只有 i
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

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

Pascal	C	C++

```pascal
var
  x, i, c, t: longint;
begin
  x := 79622;
  c := 0;
  for i := 0 to 30 do
  begin
    t := 1 shl i;
    if ((x and t) <> 0) then
      inc(c)
  end;
  write(c)
end.
```

```c
int x, i, c, t;
int main() {
  x = 79622;
  c = 0;
  for (i = 0; i <= 30; i++) {
    t = 1 << i;
    if ((x & t) != 0)
      c++;
  }
  printf("%d", c);
  return 0;
}
```

```cpp
int x, i, c, t;
int main() {
  x = 79622;
  c = 0;
  for(i = 0; i <= 30; i++) {
    t = 1 << i;
    if ((x & t) != 0)
      c++;
  }
  cout << c;
  return 0;
}
```

A.   31
B.   30
C.   9
D.   8

17. Given that `a` is an array of length 10, which of the following expressions must be true after the function `mysort` has been executed?
已知 a 為長度 10 的數組，在 mysort 執行後以下哪些表達式必為真？

Pascal

```pascal
var a: array[0..9] of longint;
procedure mysort;
var
  i, j, tmp: longint;
begin
  for i := 0 to 9 do
    for j := 0 to 7 do
      if (a[j] > a[j + 2]) then
      begin
        tmp := a[j];
        a[j] := a[j + 2];
        a[j + 2] := tmp
      end
end;
```

C / C++

```c
int a[10];
void mysort() {
  int i, j, tmp;
  for (i = 0; i <= 9; i++)
    for (j = 0; j <= 7; j++)
      if (a[j] > a[j + 2]) {
        tmp = a[j];
        a[j] = a[j + 2];
        a[j + 2] = tmp;
      }
}
```

    i.   `a[0] <= a[1]`
    ii.   `a[0] <= a[2]`
   iii. `a[7] <= a[9]`

A.   i only   只有 i
B.   ii and iii only   只有 ii 和 iii
C.   i, ii and iii   i、ii 和 iii
D.   None of them   無

18. Assume that function `r()` returns an integer between 0 and 65535 inclusive randomly with equal probability. Which of the following expressions generate an integer between 0 and 2 inclusive randomly with equal probability?
假設函數 r() 會以相等的概率隨機地傳回一個 0 至 65535 之間 (含) 的整數。以下哪項表達式可以相等的概率隨機地生成一個介乎與 0 至 2 之間 (含) 的整數呢？

	Pascal	**C / C++**
i.	`r() mod 3`	`r() % 3`
ii.	`(r() + r() + r()) mod 3`	`(r() + r() + r()) % 3`

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

19. Assume that function myrand(n) returns an integer from 0 to $n - 1$ inclusive randomly with equal probability. Consider the following program:

假設函數 myrand(n) 會以相等的概率隨機地傳回一個由 0 至 n − 1(含) 之間的整數。考慮以下程序：

Pascal	C	C++
| ```pascal
var x: longint;
begin
  x := (myrand(50) - 30) mod 5;
  write(x)
end.
``` | ```c
int main() {
  int x = (myrand(50) - 30) % 5;
  printf("%d", x);
  return 0;
}
``` | ```cpp
int main() {
  int x = (myrand(50) - 30) % 5;
  cout << x;
  return 0;
}
``` |

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

    A.   4

    B.   5

    C.   8

    D.   9

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

Pascal	C	C++
| ```pascal
var
  a: array[0..4, 0..4] of
    longint = (
      (4, 2, 4, 0, 1),
      (3, 5, 1, 1, 0),
      (3, 0, 4, 5, 2),
      (3, 2, 0, 1, 0),
      (1, 2, 4, 3, 1));
  x, y, i, next: longint;
begin
  x := 0;
  y := 0;
  i := 0;
  while ((x <> 5) and (y <> 5)) do
  begin
    next := a[x][y];
    if (i mod 2 = 0) then
      x := next
    else
      y := next;
    inc(i)
  end;
  write(i)
end.
``` | ```c
int a[5][5] = {
  {4, 2, 4, 0, 1},
  {3, 5, 1, 1, 0},
  {3, 0, 4, 5, 2},
  {3, 2, 0, 1, 0},
  {1, 2, 4, 3, 1}
};
int x, y, i, next;
int main() {
  x = 0;
  y = 0;
  i = 0;
  while ((x != 5) &&
         (y != 5)) {
    next = a[x][y];
    if (i % 2 == 0)
      x = next;
    else
      y = next;
    i++;
  }
  printf("%d", i);
  return 0;
}
``` | ```cpp
int a[5][5] = {
  {4, 2, 4, 0, 1},
  {3, 5, 1, 1, 0},
  {3, 0, 4, 5, 2},
  {3, 2, 0, 1, 0},
  {1, 2, 4, 3, 1}
};
int x, y, i, next;
int main() {
  x = 0;
  y = 0;
  i = 0;
  while ((x != 5) &&
         (y != 5)) {
    next = a[x][y];
    if (i % 2 == 0)
      x = next;
    else
      y = next;
    i++;
  }
  cout << i;
  return 0;
}
``` |

    A.   10

    B.   9

    C.   1

    D.   0

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

Pascal
```
var
  queue: array[0..2] of longint;
  head, tail: longint;
procedure push(x: longint);
begin
  queue[tail] := x;
  tail := (tail + 1) mod 3
end;
procedure pop();
begin
  if (head = tail) then
    write('Empty ')
  else
  begin
    write(queue[head], ' ');
    head := (head + 1) mod 3
  end
end;
begin
  head := 0;
  tail := 0;
  push(5);
  push(7);
  push(3);
  pop();
  push(4);
  push(8);
  pop();
  pop();
  pop()
end.
```

C
```
int queue[3];
int head, tail;
void push(int x) {
  queue[tail] = x;
  tail = (tail + 1) % 3;
}
void pop() {
  if (head == tail) {
    printf("Empty ");
  } else {
    printf("%d ", queue[head]);
    head = (head + 1) % 3;
  }
}
int main() {
  head = 0;
  tail = 0;
  push(5);
  push(7);
  push(3);
  pop();
  push(4);
  push(8);
  pop();
  pop();
  pop();
  return 0;
}
```
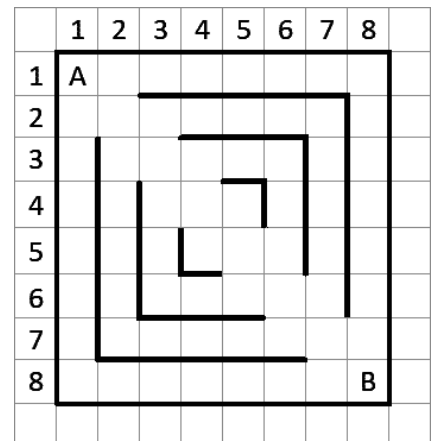
C++
```
int queue[3];
int head, tail;
void push(int x) {
  queue[tail] = x;
  tail = (tail + 1) % 3;
}
void pop() {
  if (head == tail) {
    cout << "Empty ";
  } else {
    cout << queue[head] << " ";
    head = (head + 1) % 3;
  }
}
int main() {
  head = 0;
  tail = 0;
  push(5);
  push(7);
  push(3);
  pop();
  push(4);
  push(8);
  pop();
  pop();
  pop();
  return 0;
}
```

- A.   5 7 3 4
- B.   5 3 4 8
- C.   Empty 4 8 Empty
- D.   Empty Empty Empty Empty

22. Percy is navigating through a maze which can be represented by a grid of 8×8 cells. He is currently at cell A and would like to reach cell B. In each move, he may only move to the cell to the right or the cell below. Also, he cannot pass through the maze walls (indicated by thick line). How many different paths may Percy possibly take?

小駿正嘗試穿過一個 8×8 格的迷宮，他正在空格 A 並想走到空格 B。每一步他可以向右方或下方的空格移動，但他不能穿過迷宮牆壁 (以粗線表示)。問小駿共有多少種不同的路徑走法？

- A.   154
- B.   156
- C.   170
- D.   216

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

Pascal

```pascal
var
  a: array[0..9] of longint =
      (2, 5, 6, 9, 15, 18, 21,
      35, 45, 50);
  res, x, i, j: longint;
  flag: boolean;
begin
  res := 0;
  for i := 0 to 9 do
  begin
    if (a[i] = 0) then
      continue;
    flag := false;
    x := a[i];
    for j := i to 9 do
    begin
      if (a[j] mod x = 0) then
      begin
        a[j] := 0;
        flag := true
      end
    end;
    if (flag) then
      inc(res)
  end;
  write(res)
end.
```

C

```c
int a[10] = {2, 5, 6, 9, 15,
             18, 21, 35, 45, 50};
int res, x, i, j;
bool flag;
int main() {
  res = 0;
  for (i = 0; i <= 9; i++) {
    if (a[i] == 0)
      continue;
    flag = false;
    x = a[i];
    for (j = i; j <= 9; j++) {
      if (a[j] % x == 0) {
        a[j] = 0;
        flag = true;
      }
    }
    if (flag)
      res++;
  }
  printf("%d", res);
  return 0;
}
```

C++

```cpp
int a[10] = {2, 5, 6, 9, 15,
             18, 21, 35, 45, 50};
int res, x, i, j;
bool flag;
int main() {
  res = 0;
  for (i = 0; i <= 9; i++) {
    if (a[i] == 0)
      continue;
    flag = false;
    x = a[i];
    for (j = i; j <= 9; j++) {
      if (a[j] % x == 0) {
        a[j] = 0;
        flag = true;
      }
    }
    if (flag)
      res++;
  }
  cout << res;
  return 0;
}
```

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

24. Two players are playing a game. In every independent round, both players have equal probability to win, and winner gets one point. What is the probability that, the first tie occurs at the end of the sixth round?
兩個玩家正在玩遊戲。在每一獨立回合中，雙方有均等機率獲勝，勝方取得一分。在第六回合結束時出現第一次打和的機率是多少呢？

- A. $\dfrac{1}{32}$
- B. $\dfrac{1}{16}$
- C. $\dfrac{3}{32}$
- D. $\dfrac{3}{16}$

25. There are four doors numbered from 1 to 4. A gift is placed behind one of these four doors. You have the following information:

已知有四道編號為 1 至 4 的門，一份禮物被放置於其中一道門後。現有以下資訊：

Door 門	Time to unlock this door 解鎖此門所需時間	Probability of the gift behind this door 禮物被放置於此門後的機率
1	10 seconds 秒	0.1
2	10 seconds 秒	0.2
3	15 seconds 秒	0.2
4	40 seconds 秒	0.5

You are going to unlock the doors one by one in any order you want, until you find the gift. What is the best strategy to unlock the doors so that the expected time required can be minimized? (The time walking between doors can be omitted)

你正要按你所想的次序逐一解鎖這四道門，直至你找到禮物為止。若要將所需時間的期望值降至最低，解鎖這些門的最佳策略是甚麼呢？（可以忽略在門與門之間行走的時間）

A. Door 1 → Door 2 → Door 3 → Door 4
   1 號門 → 2 號門 → 3 號門 → 4 號門
B. Door 4 → Door 3 → Door 2 → Door 1
   4 號門 → 3 號門 → 2 號門 → 1 號門
C. Door 1 → Door 4 → Door 3 → Door 2
   1 號門 → 4 號門 → 3 號門 → 2 號門
D. Door 2 → Door 3 → Door 4 → Door 1
   2 號門 → 3 號門 → 4 號門 → 1 號門

END OF SECTION A 甲部完

Section B 乙部 (20 marks 分)

The blanks are labeled from A to O. Please fill in the blanks on the answer sheet.
下列各空格分別命名為 A 至 O，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. The input to the following program is an integer between 0 and 10^{100} inclusive in decimal notation without leading zeroes, separator symbols nor decimal point. Complete the following program so that it outputs `Yes` if and only if the input number is a multiple of 100.
以下程序的輸入是一個 0 及 10^{100} 之間 (含) 的整數，且保證不含前導零、分隔符號或小數點。完成以下程序使其輸出 `Yes` 當且僅當輸入的數字是個 100 的倍數。

Pascal	C	C++
| ```pascal
var
  s: ansistring;
  n: longint;
begin
  read(s);
  n := length(s);
  if (_____A_____) then
    writeln('Yes')
end.
``` | ```c
char s[200];
int n;
int main() {
  scanf("%s", s);
  n = strlen(s);
  if (_____A_____)
    printf("Yes");
  return 0;
}
``` | ```cpp
string s;
int n;
int main() {
  cin >> s;
  n = s.length();
  if (_____A_____)
    cout << "Yes";
  return 0;
}
``` |

Answer 答案: _____A_____ (2 marks 分)

2. Complete the following program **WITHOUT** using array a so that array b is equal to array a.
    在**不使用**數組 a 的情況下，完成以下程序使數組 b 與數組 a 相等。

Pascal	C	C++
| ```
var
  a, b: array[0..8] of longint;
  i: longint;
begin
  for i := 0 to 8 do
  begin
    a[i] := 0;
    b[i] := 0
  end;
  for i := 1 to 8 do
  begin
    read(a[i]);
    b[i] := a[i] - a[i - 1]
  end;
  for i := 1 to 8 do
          B
end.
``` | ```
int a[9], b[9];
int i;
int main() {
  for (i = 0; i <= 8; i++) {
    a[i] = 0;
    b[i] = 0;
  }
  for (i = 1; i <= 8; i++) {
    scanf("%d", &a[i]);
    b[i] = a[i] - a[i - 1];
  }
  for (i = 1; i <= 8; i++)
          B       ;
  return 0;
}
``` | ```
int a[9], b[9];
int i;
int main() {
  for (i = 0; i <= 8; i++) {
    a[i] = 0;
    b[i] = 0;
  }
  for (i = 1; i <= 8; i++) {
    cin >> a[i];
    b[i] = a[i] - a[i - 1];
  }
  for (i = 1; i <= 8; i++)
          B       ;
  return 0;
}
``` |

Answer 答案: _____B_____ (1.5 marks 分)

The above program is modified to the following program. Complete the following program **WITHOUT** using array a so that array b is equal to array a.

以上程序被修改為以下程序。在**不使用**數組 a 的情況下，完成以下程序使數組 b 與數組 a 相等。

Pascal	C	C++
| ```
var
  a, b: array[0..8] of longint;
  i: longint;
begin
  for i := 0 to 8 do
  begin
    a[i] := 0;
    b[i] := 0
  end;
  for i := 1 to 8 do
  begin
    read(a[i]);
    b[i] := b[i - 1] + a[i]
  end;
  for i := 1 to 8 do
          C
end.
``` | ```
int a[9], b[9];
int i;
int main() {
  for (i = 0; i <= 8; i++) {
    a[i] = 0;
    b[i] = 0;
  }
  for (i = 1; i <= 8; i++) {
    scanf("%d", &a[i]);
    b[i] = b[i - 1] + a[i];
  }
  for (i = 1; i <= 8; i++)
          C       ;
  return 0;
}
``` | ```
int a[9], b[9];
int i;
int main() {
  for (i = 0; i <= 8; i++) {
    a[i] = 0;
    b[i] = 0;
  }
  for (i = 1; i <= 8; i++) {
    cin >> a[i];
    b[i] = b[i - 1] + a[i];
  }
  for (i = 1; i <= 8; i++)
          C       ;
  return 0;
}
``` |

Answer 答案: _____C_____ (1.5 marks 分)

J - 14

3. Words in a dictionary are sorted in lexicographical order. Let letter "a" is smaller than "b" and "b" is smaller than "c" and so on. To compare two words in lexicographical order, we compare the leftmost letter from both words first. If their leftmost letter are different then the word with smaller leftmost letter is smaller. If their leftmost letter are equal then compare the next letter until the last letter of the shorter word. If we can not determine after above process, the shorter word is smaller. So "abc" is smaller than "d", "abc" is smaller than "abd", "abc" is equal to "abc" and "abc" is smaller than "abcd".

字典內的字是以字典順序排列。設字母 "a" 是小於 "b" 及 "b" 是小於 "c" 如此類推。若要以字典順序比較兩字，我們首先比較最左的字母。如果它們最左的字母不同，則最左的字母較小的字為較小。如果它們最左的字母相同，則繼續比較下一字母直到較短的字的最後字母。如果經過以上步驟我們仍不能決定大小，則較短的字為較小。所以 "abc" 是小於 "d"，"abc" 是小於 "abd"，"abc" 等於 "abc" 及 "abc" 是小於 "abcd".

Complete the function cmp, so that the function cmp return 0 when string a is smaller than or equal to string b and return 1 when string a is larger than string b in lexicographical order.

完成函數 cmp，使得函數 cmp 以字典順序比較，字串 a 小於或等於字串 b 時傳回 0 及字串 a 大於字串 b 時傳回 1。

Pascal

```
function cmp(a, b: ansistring):
            longint;
var
  x, y, s: longint;
begin
  x := length(a);
  y := length(b);
  s := 1;
  while (_____D1_____) do
  begin
    if (_____D2_____) then
    begin
      cmp := 0;
      exit
    end;
    if (_____D3_____) then
    begin
      cmp := 1;
      exit
    end;
    s := s + 1;
  end;
  if (___E___ = x + 1) then
    cmp := 0
  else
    cmp := 1
end;
```

C

```
int cmp(char a[], char b[]) {
  int x = strlen(a);
  int y = strlen(b);
  int s = 0;
  while (_____D1_____) {
    if (_____D2_____) {
      return 0;
    }
    if (_____D3_____) {
      return 1;
    }
    s = s + 1;
  }
  if (___E___ == x) {
    return 0;
  } else {
    return 1;
  }
}
```

C++

```
int cmp(string a, string b) {
  int x = a.length();
  int y = b.length();
  int s = 0;
  while (_____D1_____) {
    if (_____D2_____) {
      return 0;
    }
    if (_____D3_____) {
      return 1;
    }
    s = s + 1;
  }
  if (___E___ == x) {
    return 0;
  } else {
    return 1;
  }
}
```

Answer 答案: _____D1_____ _____D2_____ _____D3_____ (2 marks 分)

Answer 答案: _____E_____ (1 mark 分)

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

Pascal

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

C / C++

```
int f(int x) {
  int res = 0;
  int i;
  for (i = 1; i <= x; i++)
    if (x % i == 0)
      res++;
  return res;
}
```

Write down the return values of f(10) and f(121).

寫下 f(10) 及 f(121) 的傳回值。

f(10): _____F_____

f(121): _____G_____

Answer 答案: _____F_____ (1 mark 分)

Answer 答案: _____G_____ (1 mark 分)

The following program uses the function f above. What is the output of the program?

以下程序中使用了以上的函數 f，程序的輸出是什麼?

Pascal

```
var
  c, i: longint;
begin
  c := 0;
  for i := 1 to 10000 do
    if (f(i) = 3) then
      inc(c);
  write(c)
end.
```

C

```
int c, i;
int main() {
  c = 0;
  for (i = 1; i <= 10000; i++)
    if (f(i) == 3)
      c++;
  printf("%d", c);
  return 0;
}
```

C++

```
int c, i;
int main() {
  c = 0;
  for (i = 1; i <= 10000; i++)
    if (f(i) == 3)
      c++;
  cout << c;
  return 0;
}
```

Answer 答案: _____H_____ (2 marks 分)

J - 16

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

Pascal

```
function f(n: longint): longint;
var start, acc, i: longint;
begin
  start := (n - 2) div 4 * 4 + 2;
  acc := _____J1_____;
  for i := start + 1 to n do
    acc := _____J2_____;
  f := acc
end;
function g(n: longint): longint;
var i, sum: longint;
begin
  sum := 0;
  for i := 1 to n do
    sum := sum xor i;
  g := sum
end;
```

C / C++

```
int f(int n) {
  int start, acc, i;
  start = (n - 2) / 4 * 4 + 2;
  acc = _____J1_____;
  for (i = start + 1; i <= n; i++)
    acc = _____J2_____;
  return acc;
}
int g(int n) {
  int i, sum;
  sum = 0;
  for (i = 1; i <= n; i++)
    sum = sum ^ i;
  return sum;
}
```

Write down the return value of g(10).

寫下 g(10) 的傳回值。

Answer 答案: _____I_____ (1 mark 分)

Complete the function f, so that f(n) has the same return value as g(n) for $10 \le n \le 100$

完成函數 f，使得對於 $10 \le n \le 100$，f(n) 和 g(n) 的傳回值一樣。

Answer 答案: _____J1_____ _____J2_____ (2 marks 分)

6. Given that the function median(a, b, c) returns the median of three integers a, b, c. Consider the following program segment:

已知函數 median(a, b, c) 傳回整數 a, b, c 的中位數。考慮以下程序段：

Pascal

```
function f(a: longint): longint;
begin
  if (a < 0) then
    f := -a
  else
    f := a
end;
function range(a, b, c: longint): longint;
var m: longint;
begin
  m := median(a, b, c);
  range := _____K_____
end;
```

C / C++

```
int f(int a) {
  if (a < 0)
    return -a;
  else
    return a;
}
int range(int a, int b, int c) {
  int m = median(a, b, c);
  return _____K_____;
}
```

Complete the function range, so that range(x,y,z) returns the range of x, y, z (i.e. the greatest value minus the least value among x, y, z) for integers x, y, z $(-100 \le x, y, z \le 100)$.

完成函數 range，使得對於整數 x, y, z $(-100 \le x, y, z \le 100)$，range(x,y,z) 傳回 x, y, z 的分佈域（即 x, y, z 中之最大值減去最小值）。

Answer 答案: _____K_____ (2 marks 分)

J - 17

7. The program tries to evaluate an additive expression from the input. However, the program contains an error. For example, the program outputs 51 when the input is 100+1.

以下程序嘗試運算一條加法算式，但是程序中有一錯誤。例如，當輸入是 100+1 時，程序會輸出 51。

Pascal

```pascal
11 var
12   s: ansistring;
13   sum, temp, len, i, x: longint;
14 begin
15   read(s);
16   sum := 0;
17   temp := 0;
18   len := length(s);
19   i := 1;
20   while (i <= len) do
21   begin
22     if (s[i] = '+') then
23     begin
24       sum := sum + temp;
25       temp := 0
26     end;
27     x := ord(s[i]) - ord('0');
28     temp := temp * 10 + x;
29     inc(i)
30   end;
31   write(sum + temp)
32 end.
```

C

```c
41 char s[200];
42 int sum, temp, len, i, x;
43 int main() {
44   scanf("%s", s);
45   sum = 0;
46   temp = 0;
47   len = strlen(s);
48   i = 0;
49   while (i < len)
50   {
51     if (s[i] == '+')
52     {
53       sum = sum + temp;
54       temp = 0;
55     }
56     x = int(s[i]) - int('0');
57     temp = temp * 10 + x;
58     i++;
59   }
60   printf("%d", sum + temp);
61   return 0;
62 }
```

C++

```cpp
71 string s;
72 int sum, temp, len, i, x;
73 int main() {
74   cin >> s;
75   sum = 0;
76   temp = 0;
77   len = s.length();
78   i = 0;
79   while (i < len)
80   {
81     if (s[i] == '+')
82     {
83       sum = sum + temp;
84       temp = 0;
85     }
86     x = int(s[i]) - int('0');
87     temp = temp * 10 + x;
88     i++;
89   }
90   cout << sum + temp;
91   return 0;
92 }
```

What is the output when the input is 10+10?

當輸入是 10+10 時，程序的輸出是什麼？

Answer 答案:　　　　L　　　　 (1 mark 分)

The bug can be fixed by changing exactly one line. Find the line and correct it so that it outputs the correct answer for all of the following cases:

此錯誤只需更改一行便能修正，請找出並將其改正使得程序對於以下情況均輸出正確的答案。

Input 輸入	Output 輸出
123+4567	4690
2019+20	2039
12+13	25
89+43	132
1+2+3+4	10

Line number 行數: ___M1___

Correction 改正: _____M2_____ (2 marks 分)

END OF PAPER 全卷完