Assume that all variables without declaration shown in the following program segments have already been declared properly. Integers in problem statements are 32-bit signed variables (**Pascal**: `longint`, **C**: `int`). Assume all the programs are compiled properly without using any compiler flag (except the "`-o`" option in C).

	Format	# Questions	Total Marks
Section A1	True or False	5	5
Section A2	Multiple Choice	20	20
Section B	Fill-in-the-blanks	5 (A-L)	20
Total			**45**

Section A1   (5 marks)

For each question, determine whether the statement is true or false, then put down **T** or **F** in the corresponding space on the answer sheet. One mark for each correct answer. No marks will be deducted for wrong answers

1. Data transfer faster in optic fibre than copper wire because electromagnetic waves travel faster in optic fibre than in copper.

2. The ASCII code of '`A`' is smaller than that of '`a`'.

3. A variable of data type `short` (Pascal: `smallint`) can store the value -12345.

4. A variable can be named `123abc` or `789def` but not `012abc`.

5. It takes the same time to execute each line of code in a program.

Section A2   (20 marks)

For each question, choose the most appropriate answer and write the letter (**A**, **B**, **C** or **D**) in the corresponding space on the answer sheet. One mark for each correct answer. No marks will be deducted for wrong answers.

6. In chess, "Bishop" can attack in 4 diagonal directions. On a 7x7 chessboard, at least how many bishops do you need to place so that any square on the chessboard can be attacked by at least one bishop?

A. 5

B. 7

C. 14

D. 25
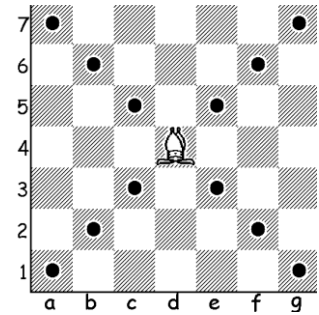
7. What is the output of the following program?

Pascal Version

```
var
    i: longint;
begin
    for i := 1 to 10 do
    begin
        if (i mod 3 = 0) then
        begin
            write(i);
            continue
        end
    end
end.
```
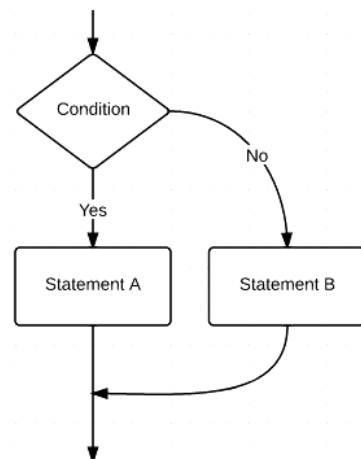
C Version

```
#include <stdio.h>
int main() {
  int i;
  for (i = 1; i <= 10; i++) {
    if (i%3 == 0) {
      printf("%d", i);
      continue;
    }
  }
  return 0;
}
```

A. 3

B. 123

C. 369

D. 12457810

8. Which control flow does the diagram on the right represent?

A. If-then

B. If-then-else

C. For loop

D. While loop

2

9. Consider the following program:

Pascal Version

```
var n: longint;
    s: string;
begin
    n := 3;
    s := 'hkoi';
1.  write(n*s);
2.  write(s*n)
end.
```

C Version

```
#include <stdio.h>
int main() {
    int n = 3;
    char s[] = "hkoi";
1.  printf("%s", n*s);
2.  printf("%s", s*n);
    return 0;
}
```

Which of the following statements is true?

A. The program compiles successfully and the output is `hkoihkoihkoihkoihkoihkoi`.

B. The program cannot compile successfully unless line 1 is removed. Subsequently, the output would be `hkoihkoihkoi`.

C. The program cannot compile successfully unless line 2 is removed, Subsequently, the output would be `hkoihkoihkoi`.

D. The program cannot compile successfully unless both lines 1 and 2 are removed.

10. The following is the truth table for operator ◊:

A	B	A ◊ B
True	True	True
True	False	True
False	True	True
False	False	False

Simplify the following boolean expression, where U and V are boolean variables

(NOT U) ◊ (U ◊ V)

A. True

B. False

C. U

D. V

11. There are many people in a party. Some pairs of people are friends. Their relationship is interesting. If A and B are friends, and B and C are friends, then A and C would be friends too. You are given the following information about the people in the party:

> Tryndamere and Taric are friends.
> Master Yi and Wukong are friends.
> Xin Zhao and Jarvan IV are friends.
> Lee Sin and Garen are friends.
> Taric and Xin Zhao are friends.

At least how many pairs of friends are there?

A. 5

B. 6

C. 7

D. 8

12. What is the name of the sorting algorithm used in the program below?

Pascal Version

```
var
   a:array[0..4] of longint;
   i, j, k:longint;
begin
   read(a[0], a[1], a[2], a[3], a[4]);
   for i := 0 to 4 do
   begin
      j := a[i];
      k := i-1;
      while (k >= 0) do
      begin
         if (a[k] < j) then break;
         a[k+1] := a[k];
         k := k-1;
      end;
      a[k+1] := j;
   end
end.
```

C Version

```
#include <stdio.h>
int a[5];
int i, j, k;
int main() {
   scanf("%d%d%d%d%d", &a[0], &a[1], &a[2],
&a[3], &a[4]);
   for (i = 0; i < 5; i++) {
      j = a[i];
      k = i-1;
      while (k >= 0) {
         if (a[k] < j) break;
         a[k+1] = a[k];
         k = k-1;
      }
      a[k+1] = j;
   }
   return 0;
}
```

A. Regular sort

B. Bubble sort

C. Insertion sort

D. Selection sort

13. Evaluate the expression.

Pascal Version	C Version
`72 div 12 div 6 mod 4`	`72 / 12 / 6 % 4`

A. 1

B. 3

C. 6

D. 12

14. Tom knows that:

> He will get full marks in the exam if and only if he studied hard the night before the exam.
> He will have a nice meal if and only if he get full marks in the exam.
> He will feel happy if and only if he get full marks in the exam.
> He will not play computer games if and only if he is not happy.

Now Tom feels happy. Which of the following may not be true?

A. He studied hard the night before the exam

B. He got full marks in the exam

C. He had a nice meal

D. He will not play computer games

15. What is the output of the following program segment?

Pascal Version	C Version
`write(12 and 4, ' ', 10 or 21);`	`printf("%d %d", 12 & 4, 10 | 21);`

A. `4 0`

B. `4 31`

C. `12 1`

D. `12 10`

16. Which of the following data types can be used as the control variable in a switch (case-of) statement?

    i.   `char`
    ii. `double` (**Pascal**: `real`)

A. None of the two types

B. i only

C. ii only

D. i and ii

17. A queue is a data structure that supports two kinds of operation, namely:

    Dequeue(): Remove the earliest element that has not been removed from the queue and return the element.

    Enqueue(x): Insert an element x into end of the queue

What is the output of the following pseudocode?

```
Enqueue(3)
Enqueue(4)
Enqueue(5)
Enqueue(6)
Dequeue()
Dequeue()
Enqueue(Dequeue())
Enqueue(7)
Dequeue()
Output Dequeue()
```

A. 4

B. 5

C. 6

D. 7

18. There are infinitely many $1 and $2 coins. You can pick up the coins one by one until you have collected exactly $6. How many different ways of picking are there? (The order matters)

A. 4

B. 5

C. 8

D. 13

19. Consider the following program segment:

Pascal Version

```
read(x);
if (x <= 0) then
begin
   write(x);
end
else
begin
   while (x < 8) do
   begin
      x := x - 1;
      while ((x mod 2) = 0) do
         x := x + 3;
   end;
   write(x);
end;
```

C Version

```
scanf("%d", &x);
if (x <= 0){
   printf("%d", x);
} else {
   while (x < 8){
      x--;
      while (x%2 == 0){
         x = x+3;
      }
   }
   printf("%d", x);
}
```

If input x = 3, what is the output?

A. 3

B. 9

C. 10

D. 11

20. What is the output of the following program?

Pascal Version

```
var
   i, j:longint;
   a:array[0..8] of longint =
     (2, 0, 3, 7, 5, 8, 6, 4, 2);
begin
   j := 1;
   for i := 0 to 6 do
     j := a[j];
   write(a[j]);
end.
```

C Version

```
#include <stdio.h>
int i, j;
int a[9] = {2, 0, 3, 7, 5, 8, 6, 4, 2};
int main() {
   j = 1;
   for (i = 0; i <= 6; i++) {
     j = a[j];
   }
   printf("%d", a[j]);
   return 0;
}
```

A. 2

B. 0

C. 8

D. 5

21. What is the output of the following program?

Pascal Version

```
var
   i, j:longint;
   a:array[0..8] of longint =
     (2, 0, 3, 7, 5, 8, 6, 4, 2);
begin
   j := 0;
   for i := 0 to 10007 do
     j := a[j];
   write(a[j]);
end.
```

C Version

```
#include <stdio.h>
int i, j;
int a[9] = {2, 0, 3, 7, 5, 8, 6, 4, 2};
int main() {
   j = 0;
   for (i = 0; i <= 10007; i++) {
     j = a[j];
   }
   printf("%d", a[j]);
   return 0;
}
```

A. 2

B. 8

C. 0

D. 3

22. Consider the following program segment:

Pascal Version

```
var x:longint;
...
x := 32768;
if (x*x*2 > x) then
   write('true')
else
   write('false');
```

C Version

```
int x;
...
x = 32768;
if (x*x*2 > x)
   printf("true");
else
   printf("false");
```

Which of the following statements is true?

A. The output is `false`.

B. The output is `true`.

C. The program segment causes runtime error.

D. The program segment causes compilation error.

23. Consider the following program segment. The variables `a`, `b` and `c` are declared as certain data types.

Pascal Version

```
b := a;
c := b;
if (a = c) then
    write('Yes')
else
    write('No');
```

C Version

```
b = a;
c = b;
if (a == c)
    printf("Yes");
else
    printf("No");
```

Which of the following statements is true?

A. If `a` and `c` are declared as 32-bit signed integers, and `b` is declared as 16-bit signed integer, then the output is always "Yes" for any initial value of `a`.

B. If `a` and `c` are declared as 32-bit signed integers, and `b` is declared as 16-bit signed integer, then the output is always "No" for any initial value of `a`.

C. If `a` and `c` are declared as 16-bit signed integers, and `b` is declared as 32-bit signed integer, then the output is always "Yes" for any initial value of `a`.

D. If `a` and `c` are declared as 16-bit signed integers, and `b` is declared as 32-bit signed integer, then the output is always "No" for any initial value of `a`.

For questions 24 to 25, consider the following program segment:

Pascal Version

```
[I]
begin
   write('1');
   [J]
   begin
       [K]
       begin
           write('3')
       end;
       write('2')
   end
end
```

C Version

```
[I] {
   printf("1");
   [J] {
       [K] {
           printf("3");
       }
       printf("2");
   }
}
```

We would fill in each space ([I], [J] and [K]) by one of the following lines:

Pascal Version

```
L: for i := 0 to 1 do
M: for j := 0 to 2 do
N: for k := 0 to 3 do
```

C Version

```
L: for (i = 0; i <= 1; i++)
M: for (j = 0; j <= 2; j++)
N: for (k = 0; k <= 3; k++)
```

24. Which of the following assignments produces the output
    "13332333213332333213332333213332333 2"?

	[I]	[J]	[K]
A.	L	M	N
B.	M	N	L
C.	N	L	M
D.	N	M	L

25. Which assignment produces the smallest output? (Treat the output as a decimal number.)

	[I]	[J]	[K]
A.	L	M	N
B.	M	N	L
C.	N	L	M
D.	N	M	L

END OF SECTION A

Section B   (20 marks)

The blanks are labeled from A to L. Please fill in the blanks on the answer sheet.
Except otherwise specified, two marks for each correct blank. No marks will be deducted for wrong answers.

Note:

(1) You must not use the `?:` operator in C.

(2) You must not use any library function unless the appropriate library(s) is/are included.

(3) You can write only one character in each box on the answer sheet.

(4) No answer with length greater than the designated number of boxes will be accepted.

1.   You want to carry some items from one city to another. There are two types of goods that you can choose:

    Rice - each bag weighs 2 kg and can be sold for $6.
    Cabbage - each pack weighs 3 kg and can be sold for $10.

What is the maximum dollar amount you can get after selling the goods, assuming that you can only carry not more than 16 kg of goods?

Answer: $_____A_____   (2 marks)

2.   Assume $n = 1, 2, 3$ or 4. Function `f(n)` computes the n-th prime number. Complete the function.

Pascal Version

```
function f(n:longint):longint;
begin
  if (   B1   ) then    B2   ;
  else f :=    C   ;
end;
```

C Version

```
int f(int n) {
  if (   B1   )    B2   ;
  else return    C   ;
}
```

B1 and B2: 2 marks if both correct

C: 2 marks

3. Consider the following program:

Pascal Version

```
var
  n, a, i, s:longint;
begin
  read(n);
  s := 0;
  for i := 1 to n do
  begin
    read(a);
    if (a > 0) then
      s := s+a;
  end;
  write(s/n:0:3);
end.
```

C Version

```
#include <stdio.h>
int n, a, i, s;
int main() {
  scanf("%d", &n);
  s = 0;
  for (i = 1; i <= n; i++) {
    scanf("%d", &a);
    if (a > 0)
      s = s+a;
  }
  printf("%.3f", (double)s/n);
  return 0;
}
```

What is the output of the program when given the following input?

```
8
6 3 -2 9 13 1 2 5
```

Answer: _____D_____ (2 marks)

What should X and Y be if the program outputs `32.500` given the following input? Write down one possible combination.

```
4
100 200 X Y
```

X: _____E1_____, Y: _____E2_____ (2 marks if both correct)

11

4. Consider the following program:

Pascal Version

```
11 | var
12 |    i, n:longint;
13 | begin
14 |    write('Input integer n: ');
15 |    read(n);
16 |    for i := 1 to 45 do
17 |    begin
18 |       if (i*(i+1) = n*2) then
19 |       begin
20 |          write('n is a triangular number');
21 |       end
22 |    end;
23 |    write('n is not a triangular number');
24 | end.
```

C Version

```
51 | #include <stdio.h>
52 | int n, i;
53 | int main() {
54 |    printf("Input integer n: ");
55 |    scanf("%d", &n);
56 |    for (i = 1; i <= 45; i++) {
57 |       if (i*(i+1) == n*2) {
58 |          printf("n is a triangular number");
59 |       }
60 |    }
61 |    printf("n is not a triangular number");
62 |    return 0;
63 | }
```

The above program determines whether input n is a triangular number. You may assume that n is an integer in [1, 1000]. However there is one error. Determine the type of error (compilation, run-time or logic), line number and then correct it.

Type of error: _____F_____ (1 mark, check ☑ the appropriate answer)

Line number: _____G_____ (1 mark)

Correct the line: _____H_____ (2 marks)

5. Assume function/procedure `swap(i, j)` swaps the values of `a[i]` and `a[j]`.
    Say if `a[3] = 5` and `a[6] = 1`, after `swap(3, 6)`, `a[3]` becomes 1 and `a[6]` becomes 5.

Complete the following program segment so that it sorts array `a[9]` (**Pascal**: `a[0..8]`) in ascending order.

Pascal Version

```
p := 0;
while (p < 8) do
begin
   if a[p] > a[p+1] then
   begin
        I    ;
      if (    J1    ) then
            J2   ;
   end
   else
   begin
        K    ;
   end
end;
```

C Version

```
p = 0;
while (p < 8) {
   if (a[p] > a[p+1]) {
        I   ;
      if (    J1    )
            J2    ;
   } else {
        K   ;
   }
}
```

I: 1 mark   J1 and J2: 2 marks if both correct   K: 1 mark

Now, complete the following implementation of function/procedure `swap(i, j)`.

Pascal Version

```
procedure swap(i:longint; j:longint);
begin
   a[i] := a[i] + a[j];
        L   ;
   a[i] := a[i] - a[j];
end;
```

C Version

```
void swap(int i, int j) {
   a[i] = a[i] + a[j];
        L   ;
   a[i] = a[i] - a[j];
}
```

L: 2 marks

END OF PAPER