Part 1

1 How many digits "1" are there in the **binary** notation of the hexadecimal number $A1BC_{16}$?

Options:

- 1
- 2
- 8
- 16

2 The boolean function ***F*** is given by the expression:

$$(\neg x \vee y \vee z).$$

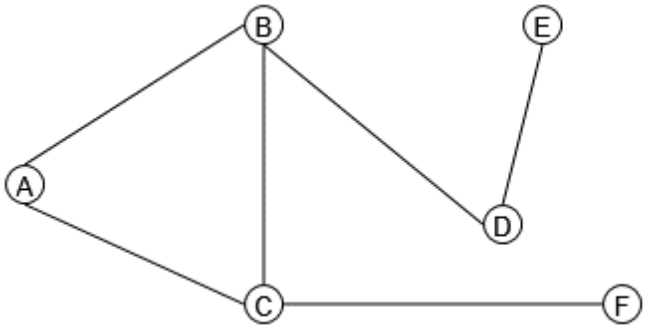
The table below is a fragment of the truth table of ***F,*** *but the columns of the table may be permuted*.
Determine which column of the truth table of the function ***F*** corresponds to variable *x*.

Variable 1	**Variable 2**	**Variable 3**	**Function**
???	**???**	**???**	***F***
0	0	1	0
1	0	0	1
1	1	1	1

Options:

- *x* corresponds to the first column
- *x* corresponds to the second column
- *x* corresponds to the third column
- None of the above

3 The figure below shows a road diagram of some country, the cities being marked with their letters.



The table below contains information about the length of these roads (in kilometers), but as the table was made by a different person than the road diagram, the cities happen to be denoted by arbitrary capital letters.

	Ausburn	Cennt	Zion	Bondon	Linberg	Fontana
Ausburn	—		45			
Cennt		—	10		21	18
Zion	45	10	—			
Bondon				—	13	
Linberg		21		13	—	5
Fontana		18			5	—

Since the table and scheme were drawn independently of each other, the numbering of settlements in the table isn't connected with the letter designations on the graph. What city is marked with letter **B** on the road diagram?

Options:

- Ausburn
- Bondon
- Cennt
- Fontana

4

The database fragment contains information about the relationships. Based on the provided database, determine who is an aunt of H.Paulig.

Table 1		
ID	Name	Gender
1	E.Kirby	F
2	J. Peters	M
3	D. Peters	M
4	S. Brennton	F
5	C. Newmon	F
6	H. Paulig	F
…	…	…

Table 2	
Parent_ID	Child_ID
1	3
2	3
1	4
2	4
3	6
5	6
…	…

Options:

- S. Brennton
- C. Newmon
- J. Peters
- D. Peters

5

The communication channel transmits messages containing only five letters:
A, B, C, D, E. For transmission, a binary code is used. The code allows unambiguous decoding. For the letters A, B, C the following code words are used: A - 111, B - 0, C - 100. What would be the word, that, being encoded, results in the following string: 0010011100

Options:

- CBABCB

- BBCABB
- BAACBA
- BABCAA

6

The machine receives a three-digit decimal number as an input. Depending on this number a new number is built according to the following rules.

1. Multiply the first and the second digits, as well as the second and the third digits.
2. The resulting two numbers are written one after another in non-decreasing order without separators.

Example. For the input number: 631 the calculated digit products would be: 6 • 3 = 18; 3 • 1 = 3, and the result thus would be: 318.

Which of the following numbers could NOT be obtained as a result of the described algorithm?

Options:

- 11
- 14
- 51
- 218

7

In the following spreadsheet a formula was copied from cell D3 to cell E4. During copying, the addresses in the formula were automatically changed. What would be the numerical value appearing in the cell **E4** in the resulting spreadsheet?

	A	**B**	**C**	**D**	**E**
1	40	4	400	70	7
2	30	3	300	60	6
3	20	2	200	= B2 + A3	5
4	10	1	100	40	

Options:

- 13
- 102
- 201
- 470

8

What number will be printed as a result of the following program. For your convenience, the same program is presented in various programming languages.

C

```
#include <stdio.h>
int main()
{
  int s = 0, n = 0;
  while (2*s < 11) {
    s = s + 8;
    n = n + 2;
  }
  printf("%d\n", n);
  return 0;
}
```

Python

```
s = 0
n = 0
while 2*s < 11:
    s = s + 8
    n = n + 2
print(n)
```

Java

```
int s = 0;
int n = 0;

while (2*s < 11) {
  s = s + 8;
  n = n + 2;
}

System.out.print(n);
```

Pascal

```
var s, n: integer;
begin
  s := 0;
  n := 0;
  while 2*s < 11 do
  begin
    s := s + 8;
    n := n + 2
  end;
  writeln(n)
end.
```

Options:

- 1
- 2
- 3
- 4

9

What is the minimum amount of memory (in KB) one needs to store a bitmap image sized 128 × 128 pixels, provided that a single pixel occupies 8 bits of memory?

Options:

- 2
- 4
- 8
- 16

10

How many different words of length 5 can be formed from the letters A,B,C?
Options:

- 5
- 8
- 15
- 3^5

11 The following recursive functions F and G are written in five programming languages.

C	**Pascal**

`int F(int n)`
`{`
`  if (n > 2)`
`  return F(n-1) + G(n-2);`
`  else return 1;`
`}`
 	
`int G(int n)`
`{`
`  if (n > 2)`
`  return G(n-1) + F(n-2);`
`  else return 1;`
`}`
	`function F(n: integer): integer;`
	`begin`
	`  if n > 2 then`
	`  F := F(n - 1) + G(n - 2)`
	`  else`
	`  F := 1;`
	`end;`
	
	`function G(n: integer): integer;`
	`begin`
	`  if n > 2 then`
	`  G := G(n - 1) + F(n - 2)`
	`  else`
	`  G := 1;`
	`end;`

Python	Java

`def F(n):`
`  if n > 2:`
`  return F(n-1)+ G(n-2)`
`  else: return 1`
 	
`def G(n):`
`  if n > 2:`
`  return G(n-1) + F(n-2)`
`  else: return 1`
	`int F(int n)`
	`{`
	`  if (n > 2)`
	`  return F(n-1) + G(n-2);`
	`  else return 1;`
	`}`
	
	`int G(int n)`
	`{`
	`  if (n > 2)`
	`  return G(n-1) + F(n-2);`
	`  else return 1;`
	`}`

What will be the value calculated using a call to F(3)?

Options:

- 1
- 2
- 3
- 4

12 Choose the string which does NOT represent a valid IP address.

Options:

- 1.1.1.1
- 255.255.0.0
- 1024.1.24.3
- 0.0.1.200

13 A website requires its users to have a password of length 10. Each character of the password requires 5 **bits** to store. Each password is stored in an integer number of **bytes** of memory. How much memory will be occupied by 100 passwords?

Options:

- 500 KB
- 700 bits
- 700 Bytes
- 700 KB

14 A computer named *TheEditor* performs operations on a string of digits. *TheEditor* can execute two commands, in both commands **v** and **w** denote strings of digits.

A) **replace (v, w)**

This command replaces the first (looking from left to right) occurence of the substring **v** with the substring **w**. For example, the execution of the command

replace (111, 27)

converts the string 05111150 into the string 0527150.

(If the string does not contain any occurrences of **v**, then executing the command **replace (v, w)** does nothing).

B) **found (v)**

This command checks whether the substring **v** can be found within the processed string. If it is encountered, the command returns the logical value "true", otherwise it returns the value "false".

BEGIN
    WHILE *condition*
        commands
    END WHILE
executed until the *condition* is true.

In the snippet
    IF *condition*
      THEN *command1*
      ELSE *command2*
    END IF
the *command1* is executed if the *condition* is true or or *command2* (if the *condition* is false).

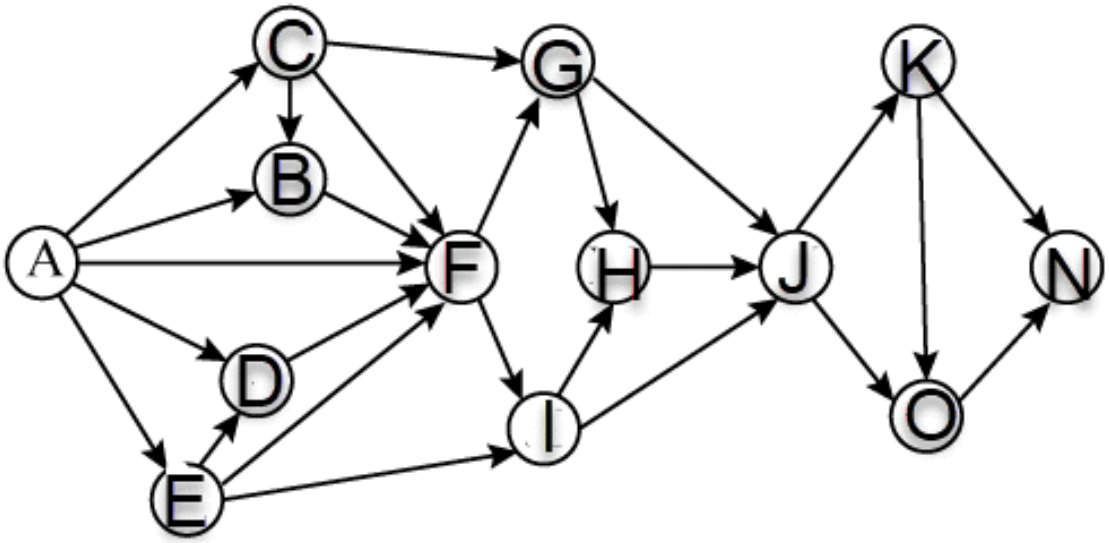
What line will be the result of applying the program below to the string "333333333"?

```
BEGIN
WHILE found (333) OR found (888)
    IF found (333)
      THEN replace (333, 8)
      ELSE replace (888, 3)
    END IF
END WHILE
END
```

Options:

- "3"
- "8"
- "333"
- "888"

15 The figure shows a diagram of the roads connecting the cities A, B, C, D, E, F, G, H, I, J, K, N, O. On each road you can only move in one direction indicated by the arrow. To which city there are more paths from the city A?



Options:

- *F*
- *G*
- *H*
- *I*

16 Arithmetic expression value: $\mathbf{9^8 + 3^5 + 9}$ has been recorded in the number system with base 3. How many digits "2" this record contains?

Options:

- 0
- 1
- 2
- 3

17 In the search engine query language, the symbol "|" is used to indicate the logical operation "OR", and the symbol "&" is used to designate the logical operation "AND". Select the query that will lead to the largest possible amount of pages found.

Options:

- *London* & *Manchester* & *Liverpool*
- *London* | *Manchester* | *Liverpool*
- "*London Manchester Liverpool*"
- *London* | *Manchester* & *Liverpool*

18 For what is the smallest non-negative integer A, such that the formula

$$(A < 30) \rightarrow (A^2 > 7)$$

is true?

Options:

- 1
- 3
- 7
- 30

19 The program processes a one-dimensional integer array A with indices from 0 to 9. The values of the array elements are 6, 7, 3, 8, 5, 1, 2, 0, 9, 4, respectively, i.e. A [0] = 6, A [1] = 7, etc. What will the array be after execution of the program?

Java	**Python**

`for (i = 0; i < 5; i++) {`
`  t = A[9-i];`
`  A[9-i] = A[i];`
`  A[i] = t;`
`}`
	`for i in range(5):`
	`  t = A[9-i]`
	`  A[9-i] = A[i]`
	`  A[i] = t`

C	**Pascal**

`for (i = 0; i < 5; i++) {`
`  t = A[9-i];`
`  A[9-i] = A[i];`
`  A[i] = t;`
`}`
	`for i := 0 to 5 do`
	`  begin`
	`  t := A[9-i];`
	`  A[9-i] := A[i];`
	`  A[i] := t;`
	`  end;`

Options:

- 4,9,0,2,1,5,8,3,7,6
- 3,2,6,1,4,8,7,9,0,5
- 0,1,2,3,4,5,6,7,8,9
- 9,8,7,6,5,4,3,2,1,0

20 Below you can see the algorithm implemented in five programming languages. Receiving the numbers *x* and *y* as inputs, this algorithm prints the number M. What should the values of x and y be so that the resulting value of M is 3?

Java	**Python**

`M = 0;`
`while (x != y){`
`  if (x > y){`
`  x = x - y;`
`  M = y;`
`  } else {`
`  y = y - x;`
`  M = x;`
	`M = 0`
	`while x != y:`
	`  if x > y:`
	`  x = x - y`
	`  M = y`
	`  else:`
	`  y = y - x`
	`  M = x`

```
    }
}
```

C	Pascal

`M = 0;`
`while (x != y){`
`  if (x > y){`
`  x = x - y;`
`  M = y;`
`  } else {`
`  y = y - x;`
`  M = x;`
`  }`
`}`
	`M := 0;`
	`while x != y do begin`
	`  if x > y then begin`
	`  x = x - y;`
	`  M = y;`
	`  end;`
	`  else begin`
	`  y = y - x;`
	`  M = x;`
	`  end;`
	`end;`

Options:

- $x = 3, y = 1$
- $x = 18, y = 15$
- $x = 7, y = 4$
- $x = 4, y = 7$

21 What is the value of the input variable *k*, such that the program gives the same answer as for the input value *k = 2*?

Java	Python

`int f(int n) {`
`  return n*n - 10*n;`
`}`
 	
`i = k;`
`while (f(i) > f(i+1))`
`  i++;`
 	
`System.out.print(i);`
	`def f(n):`
	`  return n*n - 10*n`
	
	`i = k`
	`while f(i) > f(i+1):`
	`  i += 1`
	
	`print (i)`

C	**Pascal**

`#include<stdio.h>`
`long f(long n) {`
`  return n*n - 10*n;`
`}`
 	
`int main()`
`{`
`  long k, i;`
`  scanf("%ld", &k);`
`  i = k;`
`  while (f(i) > f(i+1))`
`  i++;`
`  printf("%ld", i);`
	`var`
	`  k, i : longint;`
	
	`function f(n: longint): longint;`
	`begin`
	`  f := n*n - 10*n;`
	`end;`
	
	`begin`
	`  readln(k);`
	`  i := k;`
	`  while f(i) > f(i+1) do`
	`  i := i+1;`

`  return 0;` `}`	`  writeln(i)` `end.`

Options:

- $k = 3$
- $k = 6$
- $k = 9$
- $k = 10$

22 Some machine is processing numbers using two commands.

ADD 1

MULT 2

The first command increases the number by 1, and the second multiplies it by 2.
How many programs exist that turn number 2 into 10?

Options:

- 4
- 5
- 7
- 10

23 How many different tuples of boolean values exist x_1, x_2, x_3, x_4, x_5, that meet the conditions below?

$$x_1 \vee x_2 \vee x_3 x_4 \vee x_5 = 0$$

Options:

- 2
- 3
- 16
- 32

24 Consider the following question: given a positive integer N, what is the smallest integer K for which the inequality holds:

$$1 + 2 + \cdots + K \geq N.$$

Aiming at answering this question, the student wrote the program, but made a mistake. Point out how to correct it.

Below this program for your convenience is given in five programming languages.

Java	**Python**

`k = 1;`
`while (n>=0) {`
`  k = k + 1;`
`  n = n - k;`
`}`
	`n = int(input())`
	`k = 1`
	`while n >= 0:`
	`  k = k + 1`
	`  n = n - k`

	`print(k)`
C	**Pascal**

`#include <stdio.h>`
`int main(){`
`  int n, k;`
`  scanf("%d",&n);`
`  k = 1;`
`  while (n>=0) {`
`  k = k + 1;`
`  n = n - k;`
`  }`
`  printf("%d", k);`
`  return 0;`
`}`
	`var n, k: integer;`
	`begin`
	`  read(n);`
	`  k := 1;`
	`  while n>=0 do begin`
	`  k := k + 1;`
	`  n := n - k;`
	`  end;`
	`  writeln(k)`
	`end.`

Options:

- Change the assignment “n = n – k” to “n = n + k”
- Change the assignment “k = k – 1” to “k = k + 1”
- Change the assignment “n >= 0” to “n <= 0”
- Change the condition “n >= 0” to “n > 0”

25 An array containing 2019 non-negative integers is given. A *peak* is a position in the array which is neither the first nor the last one, with a value greater than both of its

neighbors. For instance, in the array 4, 9, 2, 17, 3, 8, there are two peaks: 9 and 17. Which of the program snippets finds the peak correctly?

snippet no.	snippet (C++/Java style)	snippet (Python style)

1	`for(i = 1; i < 2018; i++){`
	`  if(A[i] > A[i-1] && A[i] > A[i+1]){`
	`  peak = i;`
	`  }`
	`}`
		`for i in range(1, 2018):`
		`  if A[i] > A[i-1] and A[i] > A[i+1]:`
		`  peak = i;`

2	`for(i = 0; i < 2019; i++){`
	`  if(A[i] > A[i-1] && A[i] > A[i+1]){`
	`  peak = i;`
	`  }`
	`}`
		`for i in range(2019):`
		`  if A[i] > A[i-1] and A[i] > A[i+1]:`
		`  peak = i;`

3	`for(i = 1; i < 2018; i++){`
	`  if(A[i] < A[i-1] && A[i] < A[i+1]){`
	`  peak = i;`
	`  }`
	`}`
		`for i in range(1, 2018):`
		`  if A[i] < A[i-1] and A[i] < A[i+1]:`
		`  peak = i;`

4	`for(i = 1; i < 2018; i++){`
	`  if(A[i] > A[i-1] && A[i] > A[i+1]){`
	`  i = peak;`
	`  }`
	`}`
		`for i in range(1, 2018):`
		`  if A[i] > A[i-1] and A[i] > A[i+1]:`
		`  i = peak;`

Options:

- Snippet #1
- Snippet #2
- Snippet #3
- Snippet #4

26

Two players, Felix and Sally, are playing the following game. Before the players are two piles of stones. Players take turns, and Felix moves first. In one move, a player can add one stone to one of the piles (of his choice) or double the number of stones in a pile. For example, let one pile have 20 stones, and the other have 7 stones; such a state of the game can be denoted by (20, 7). Then in one move one can get any of the four states: (21, 7), (40, 7), (20, 8), (20, 14).

The game ends at the moment when the total number of stones in the piles becomes at least 20. The winner is the player who made the last move, that is, the first to obtain a state with 20+ stones in the piles.

Both players play optimally (each trying his/her best to win or at least to loose as late as possible).

In three of the following four initial game states Felix wins, and in one of them Sally wins. Which one is that?

Options:

- (8,1)
- (9,1)
- (9,4)
- (8,4)