Time Allowed: **180 minutes**

Tasks T1 – T10 carry 3 points each

T1. Magic Potions

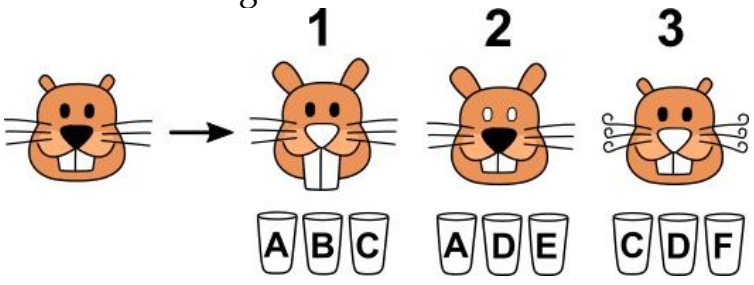
Betaro Beaver has discovered five types of new magic potions with the following effects:

- one makes ears longer;
- another makes teeth longer;
- another makes whiskers curly;
- another turns the nose white;
- the last one turns eyes white.

Betaro put each magic potion into a separate beaker. There is an additional beaker containing pure water, so there are six beakers with labels A to F. However, he forgot to record which beaker contains which magic potion!

Then, he set up the following experiments to identify the magic potion in each beaker.

- Experiment 1: If he takes the content of beakers A, B and C together, then the effects are shown in Figure 1.
- Experiment 2: If he takes the content of beakers A, D and E together, then the effects are shown in Figure 2.
- Experiment 3: If he takes the content of beakers C, D and F together, then the effects are shown in Figure 3.



Question / Challenge

Which one of the beakers contains pure water?

A) A **B)** B **C)** C **D)** D

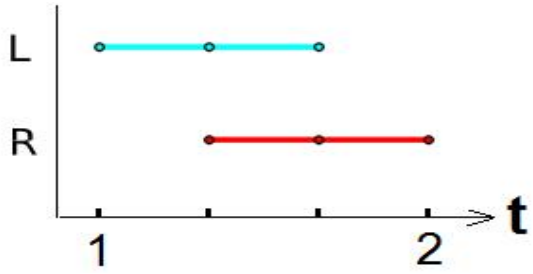
Time Allowed: **180 minutes**

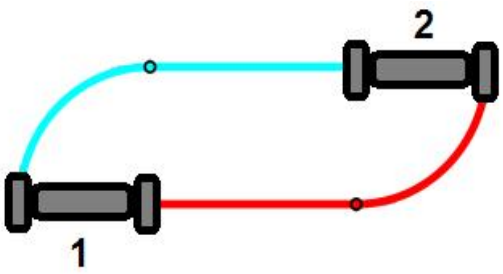
T2. Segway

Jan has a special Segway-like vehicle. He moves it by pressing two buttons: a blue (light) button on the left, and a red (dark) button on the right.

When he presses a button, the wheel on that side of the vehicle will rotate. If both buttons are pushed at the same time, both wheels will rotate and the vehicle moves forward. If he pushes a single button, only one wheel will rotate and the vehicle turns.

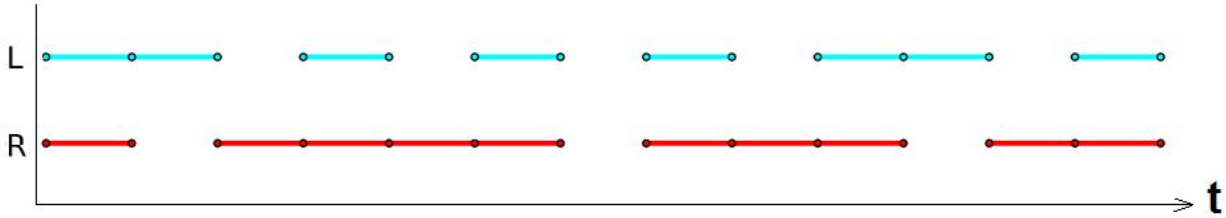
The follow tables shows which button was pushed when, and how the vehicle moved from location 1 to location 2.





First the blue button was pressed and the vehicle turned to the right. Then both buttons were pressed, causing the vehicle to move forward. Finally the red button was pressed, causing the vehicle to turn left. The orientation of the vehicle is now the same as in the beginning: facing towards the upper wall.

Question / Challenge

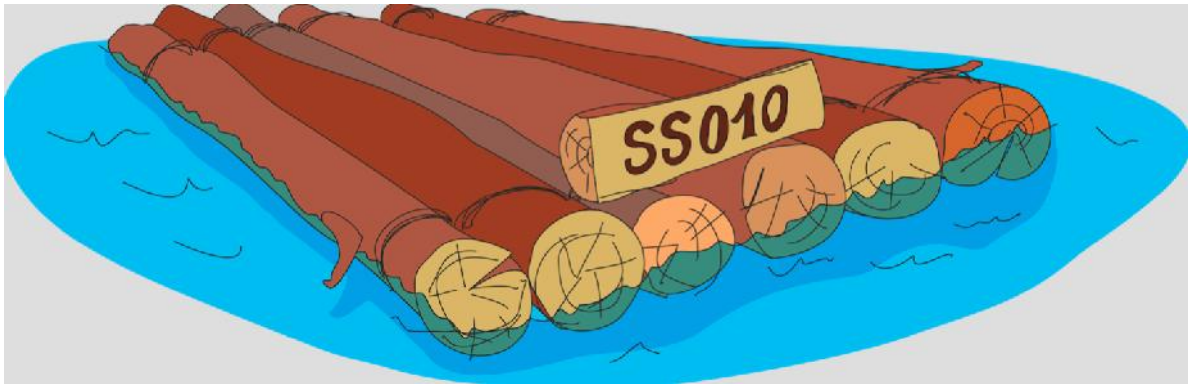


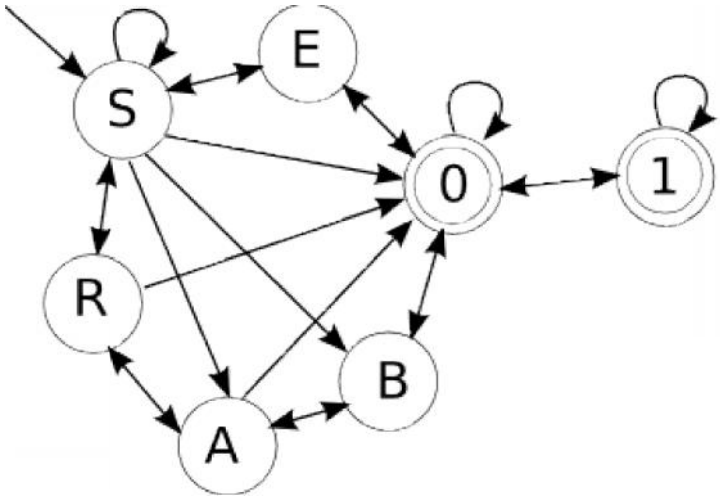
We have a record of button presses until the vehicle hit one of the walls. At the beginning the vehicle was facing towards the upper wall. Towards which wall was the vehicle facing in the end?

A) upper
B) lower
C) left
D) right

T3. Rafting

Beavers build rafts. For river traffic control, all rafts should be registered. It means that each raft should have a license plate with unique text. The text is composed of letters and digits according to below diagram: start with the letter B and end with digit 0 or 1.





Question / Challenge

Which of the following license plates cannot be registered?

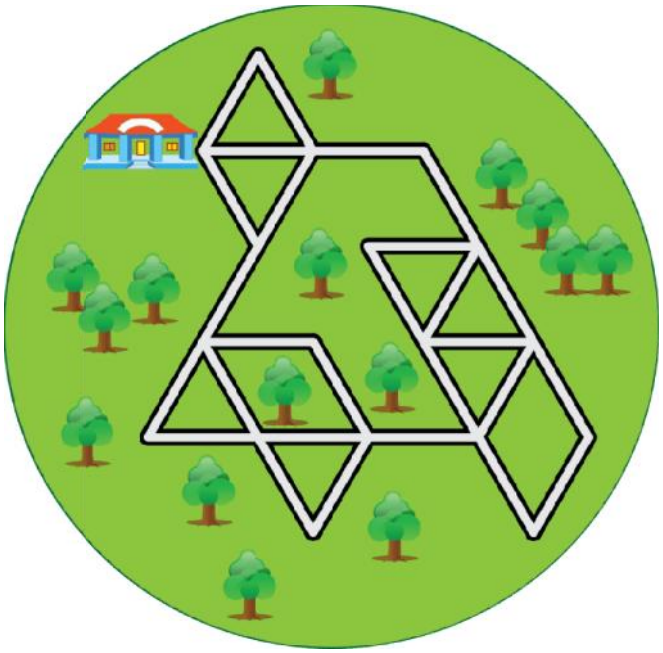
A) SS0001
B) SSS100
C) SSS001
D) SBA001

T4. Clean the Park

Jane, the school's park keeper, is responsible for keeping the paths in the park clean. There are 27 path segments (between crossroads or turns) in the park and each is exactly 10 meters long.

Naughty beavers often play with logs and leave them blocking the paths. Each morning, Jane starts and ends at the school and checks all the paths. She

wants to be efficient and so she always chooses her route so that it is as short as possible.



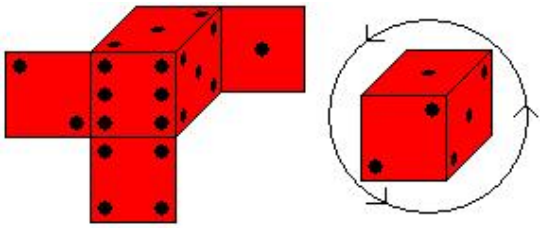
Question / Challenge

How long is her morning walk?

A) 270 m **B)** 280 m **C)** 300 m **D)** 540 m

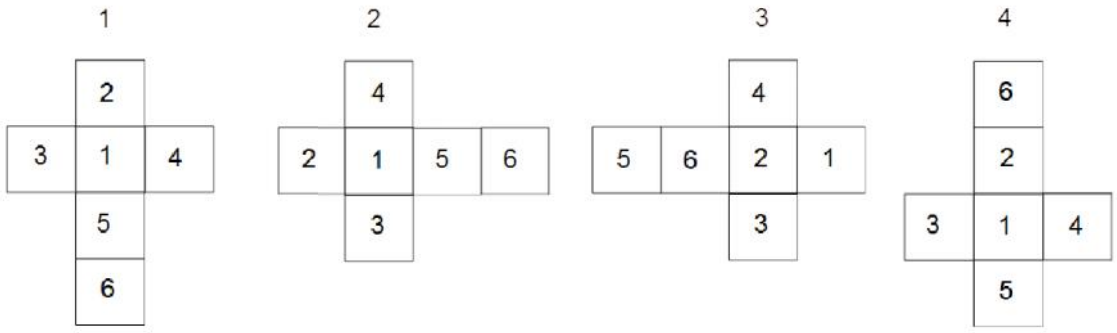
T5. Yatzy

Two beavers want to play YATZY, a game that needs five identical dice. They do not have dice so they have to make them with sheets of paper. On each sheet the net of a die is drawn. The net shows the six surfaces of the die. They cut out the net and fold it to make a die. In a regular die the numbers on opposite sides add up to 7 (1+6, 4+3 and 5+2) and if you look at the corner with the numbers 1,2 and 3, they are arranged counter clockwise.



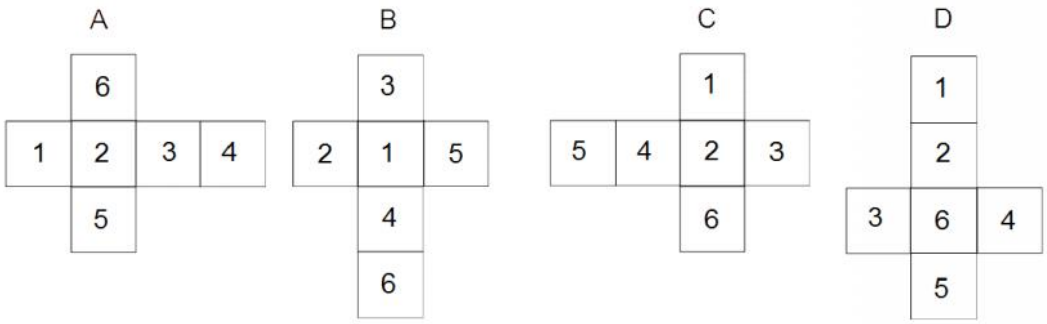
They used the nets below to build four dice and now they need to build the fifth one.

Time Allowed: **180 minutes**



Question / Challenge

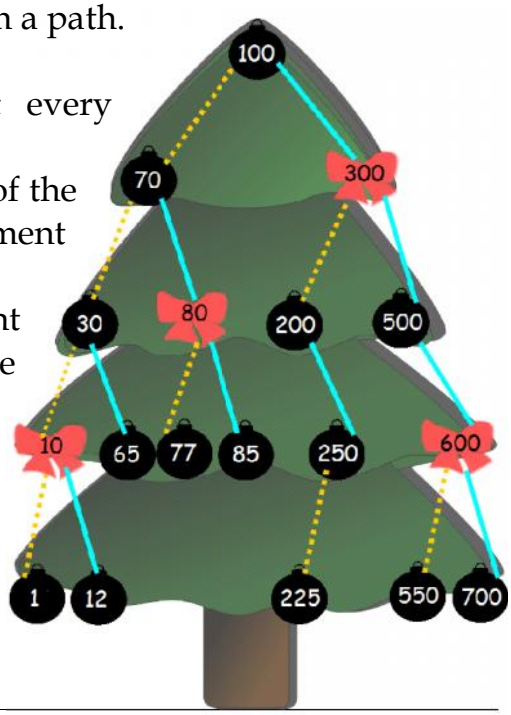
Which of the nets below can be used to build the fifth dice correctly?



T6. Holiday Tree

Buddy Beaver is decorating a tree with 4 red bows and 14 black baubles that link together. The cost of each ornament in Beaver Dollars is written on the ornament.

Starting at the top ornament and going down left or right a certain amount of times makes a path. For example, the baubles with values 100, 70, 30, the bow valued at 10 and the bauble with value 12 form a path.



A decorated tree is called pleasant if at every ornament:

* each ornament along all paths to the left of the ornament costs less than the original ornament and
* each ornament along all paths to the right of the ornament have a cost larger than the starting ornament.

Further, a tree is called a colourful tree if it is pleasant, the top ornament is a bauble, every bow has two baubles immediately below it, and every path of ornaments from top to bottom has four baubles on it.

This year, Buddy decided to decorate his tree as follows:

Question / Challenge

Which of the following is true about Buddy's Tree?

A) The tree is pleasant and colourful.
B) The tree is pleasant and not colourful.
C) The tree is not pleasant and colourful.
D) The tree is not pleasant and not colourful.

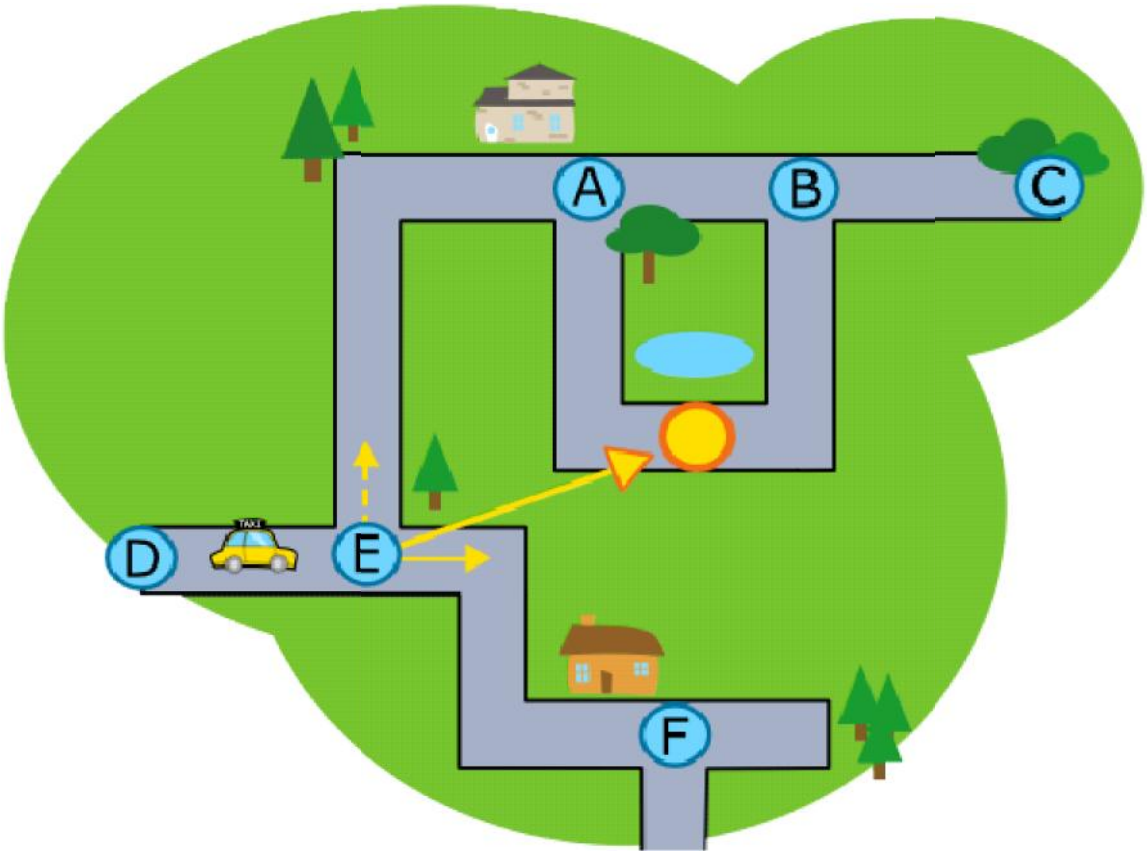
T7. Autonomous Taxi

The autonomous taxi automatically moves along the roads towards its destination according to these rules:

1. Follow the road.
2. At a junction (labeled with letters on the picture) choose the road with the smallest angle to a straight arrow to the destination, unless it is a U-turn.
3. At a dead end, make a U-turn.

The destination is marked with a yellow circle. At junction E, the car moves straight forward, because the angle between this road (short arrow) and the direction towards the destination (long arrow) is minimal compared to the other road (turning left, short dashed arrow).

Time Allowed: **180 minutes**



Question / Challenge

Which route towards the destination does the taxi take?

A) EFFED
B) EFEABC
C) EFEA
D) EFFEA

T8. Party Banner

You have a long roll of coloured paper for a party you are hosting.

The paper has three different colours (yellow, red, blue) in a regularly repeating pattern.

Your sister has cut out a section of the paper, as shown in the diagram below.

Y R R B Y R R B Y R R . . . R B Y R R B

Your sister will give you back the missing piece of paper (shown as ...) if you can correctly guess the size of the piece she cut out.

Question / Challenge

Your sister tells you the piece of paper she cut out is one of the following lengths. Which one is it?

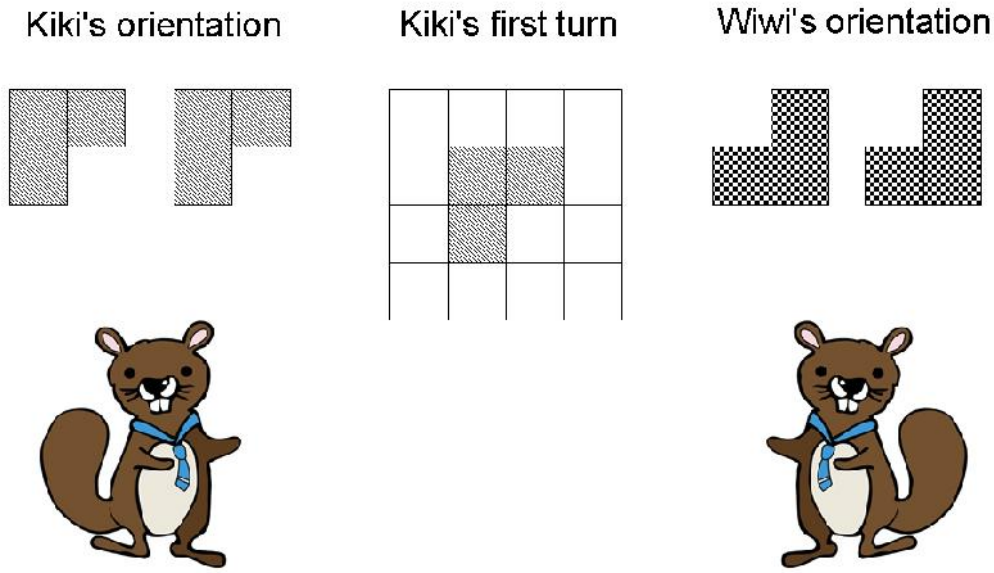
A) 31 **B)** 32 **C)** 33 **D)** 34

T9. L-Game (I)

Kiki and Wiwi are playing L-Game on a 4x4 board. They take turns placing L-shaped pieces so that

- every piece placed by Kiki is oriented as shown below,
- every piece placed by Wiwi is oriented as shown below,
- every piece is placed entirely on the board, and
- no two pieces overlap.

Pieces cannot be moved after they are placed. A player loses the game when it is their turn but it is not possible to place a piece according to the rules above. Kiki goes first as shown below.



Question / Challenge

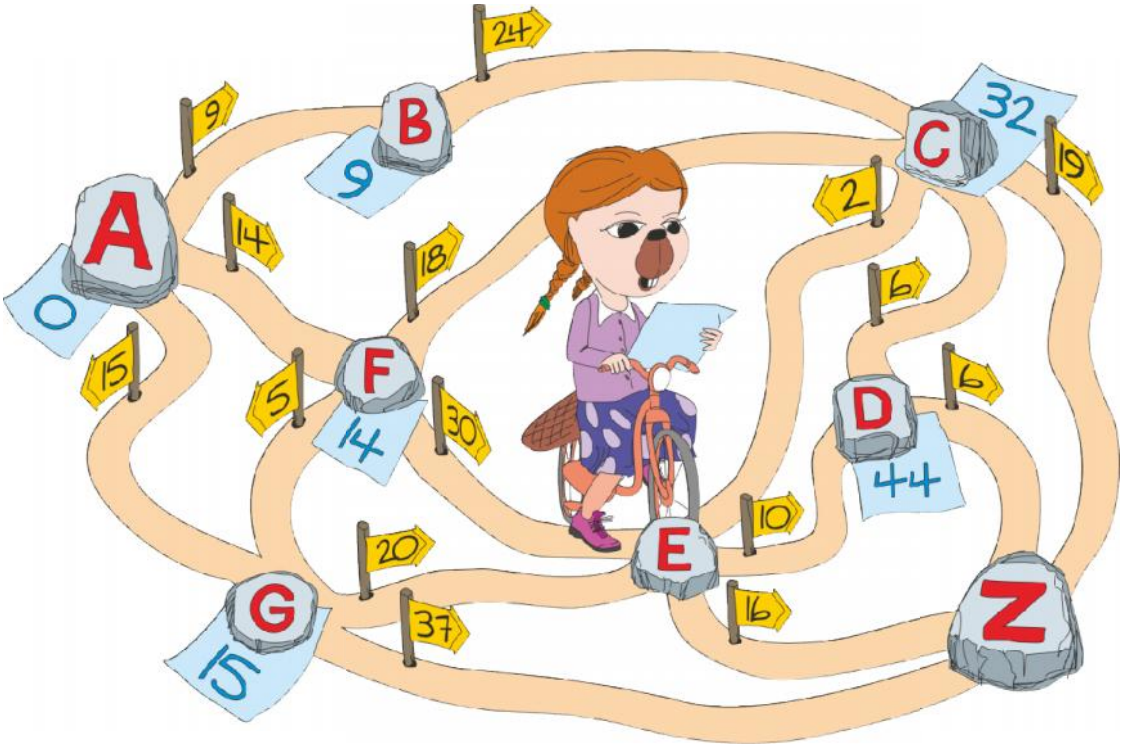
No matter how pieces are placed on future turns, which of the following statements is true?

A) Kiki will definitely win the game.
B) Wiwi will definitely win the game.
C) Kiki will probably win the game but Wiwi might win the game.
D) Wiwi will probably win the game but Kiki might win the game.

T10. The shortest route

Beaver Alice is choosing the shortest route from A to Z. There are only one-way cycle paths. She knows a clever approach (an algorithm) how to find the route and put hints on sheets of paper at crossings.

Time Allowed: **180 minutes**



Question / Challenge

What number is she writing down for E?

A) 14 **B)** 15 **C)** 30 **D)** 34

Tasks T11 – T20 carry 4 points each

T11. Find the Thief

OH NO! The famous Blue Diamond was stolen from the museum today: a thief has swapped it for a cheap imitation with a green color.

Time Allowed: **180 minutes**

There were 2000 people who visited the diamond exhibition today. They entered the diamond room one by one. Inspector Bebro must find the thief by interrogating some of these visitors. He has a list of all 2000 visitors in the order they entered the room. He will ask each person the same question: *Did the diamond have the color green or blue when you saw it?* Each person will answer truthfully, except for the thief, who will say that the diamond was already green.

Question / Challenge

Inspector Bebro is very clever and will use a strategy where the number of people interviewed is as small as possible. **Which of the following statements can he make without lying?**

A) I can guarantee that I will find the thief by interrogating fewer than 20 people.
B) Interrogating 20 people will not be enough (unless I am lucky) but I can certainly do the job by interrogating fewer than 200.
C) This is going to be a difficult job: I will need to interrogate at least 200 people, but possibly as many as 1999.
D) I cannot promise anything. If I am very unlucky I might need to interrogate every single visitor.

T12. Scanner Code

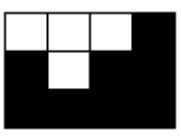
Two scanners encode an image by translating its pixels into a special code. The code lists the number of all consecutive pixels of the same color (black/white), followed by the number of all consecutive pixels of the other color, and so on, starting from the top left corner, and going from left to right, and row by row.

The two scanners use different methods to handle the end of a row:

Scanner A processes the pixels row by row and restarts the encoding on the next row.

Scanner B processes the pixels row by row but does not restart the encoding on the next row.

For example, the image on the right would be represented by the following codes:



Scanner A: 3,1,1,1,2,4 (3 white, 1 black, 1 black; 1 white, 2 black, 4 black)

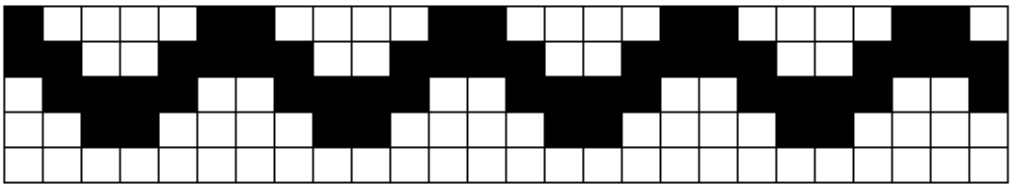
Scanner B: 3,2,1,6. (3 white, 2 black, 1 white, 6 black)

Time Allowed: **180 minutes**

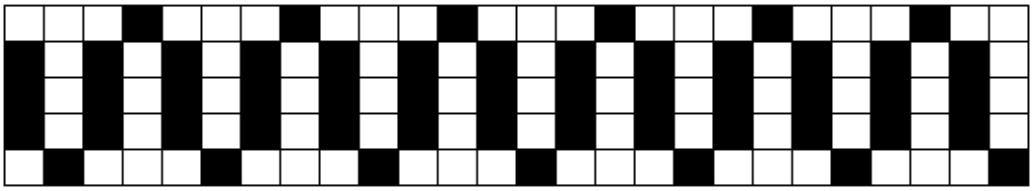
Question / Challenge

Which of the following pictures will have the same code no matter which scanner is used?

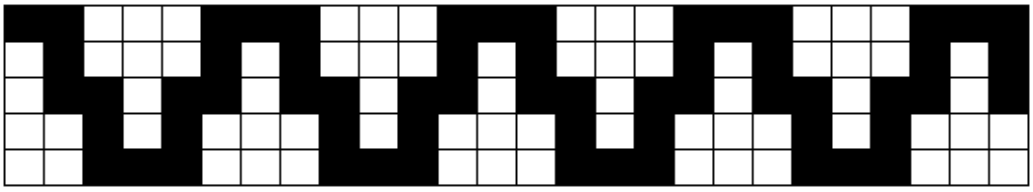
A)



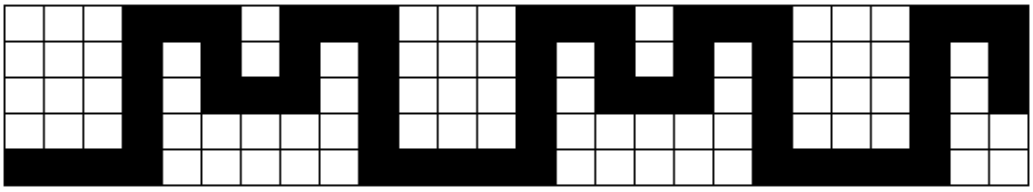
B)



C)



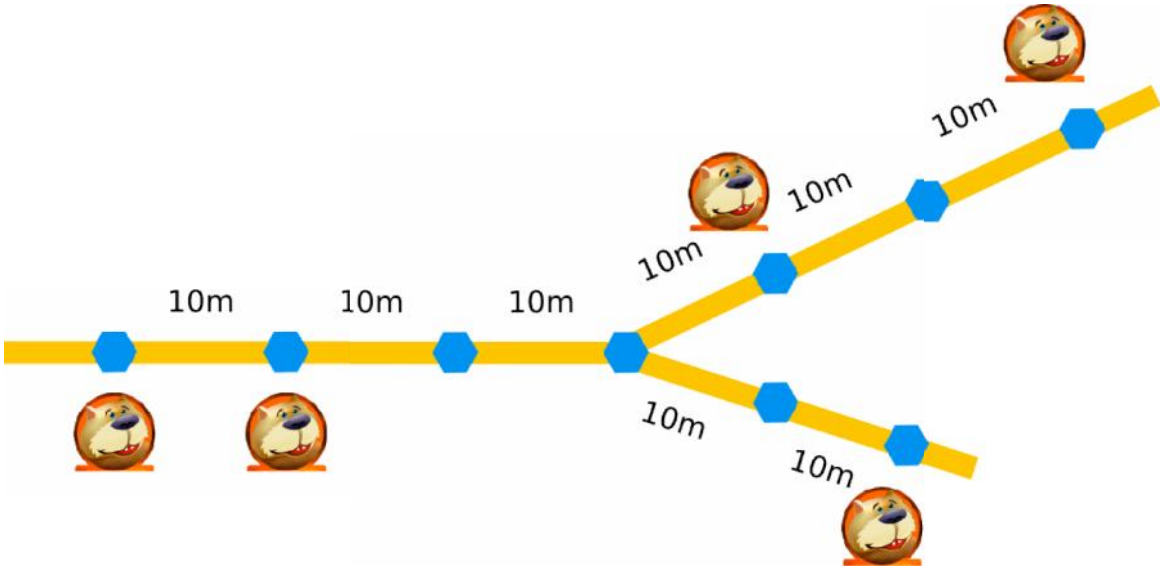
D)



T13. Bus Stop

The lodges of five beavers are arranged as follows:

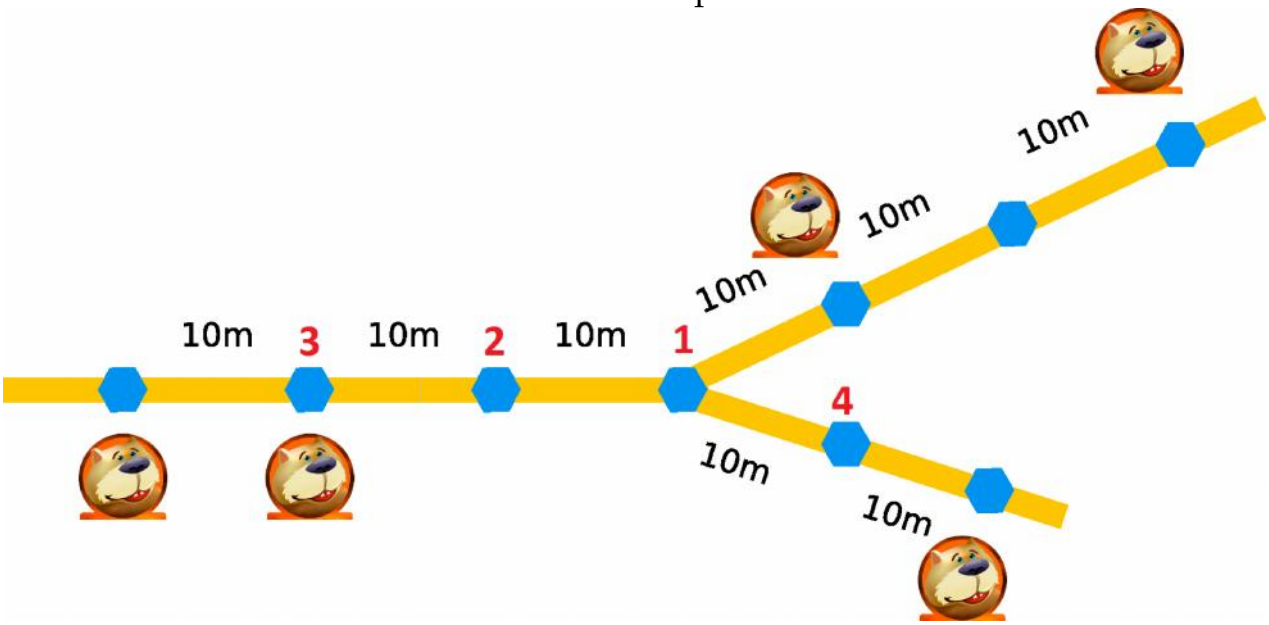
Time Allowed: **180 minutes**



The Beavers want to establish a bus stop in one of the nine locations marked by blue hexagons. The distances between the hexagons are shown in the figure.
The five Beavers decided that the sum of the distances from their lodges to the bus stop must be as short as possible.

Question / Challenge

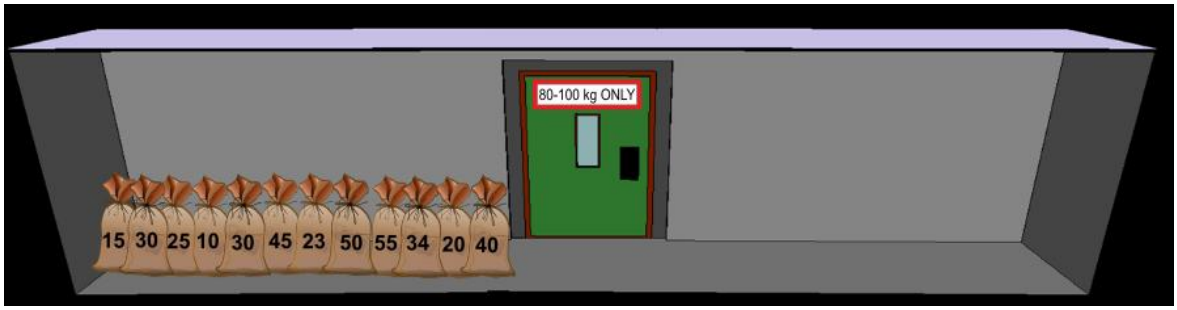
Which is the best location for the bus stop ?



A) 1 **B)** 2 **C)** 3 **D)** 4

T14. Sacks in elevator

Time Allowed: **180 minutes**



A bunch of sacks were put in a corridor, close to a lift. The corridor is so narrow that sacks must stand in line. The sacks are labeled with their weight in kg.

With the lift, the sacks are sent to a store. The lift will go as soon as its load weighs 80 kg at least, but no more than 100 kg. Then it will come back automatically.
When loading the lift, always the sack closest to the lift is taken next. In case this sack overloads the lift, it is carried to the opposite end of the corridor. Otherwise it is put into the lift.

If all sacks from the initial line are taken, the newly-formed line at the opposite end of the corridor is used in the same way.

Question / Challenge

Now all sacks are sent to the store using the procedure described above. Which of the following statements is correct?

A) The second load sent to the store weighs 98 kg.
B) The opposite end of he corridor is not used.
C) One load sent to the store weighs exactly 100 kg.
D) The sacks are sent to the store in five loads.

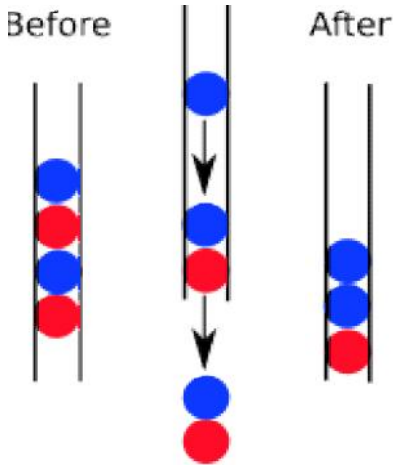
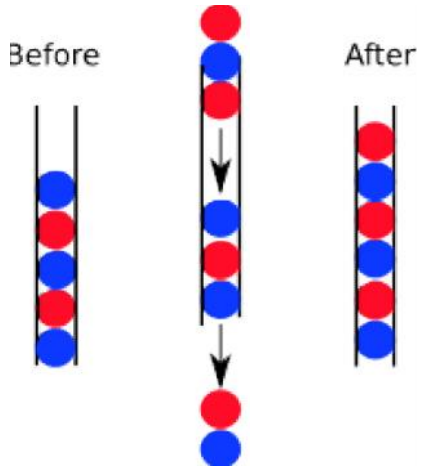
T15. Red and blue marbles

Beaver Emil is trying a new puzzle on his computer. He has to arrange a stack consisting of at least three coloured marbles in a cylinder. Each marble is either red or blue.

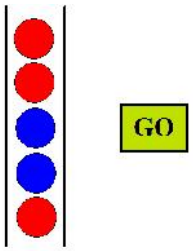
By clicking once the GO button the two lowest marbles drop out and depending on the colour of the first marble that dropped out, one of the two following things happen:

if that first marble was *red*,	if that first marble was *blue*,

Time Allowed: **180 minutes**

a new *blue* marble drops on the top of the cylinder	three new marbles drop on the top of the cylinder: one *red*, one *blue*, and one *red*.
	

If at least three marbles remain in the cylinder, Emil will click the GO button again, and so on. The game will only end if and when two or fewer marbles remain in the cylinder.



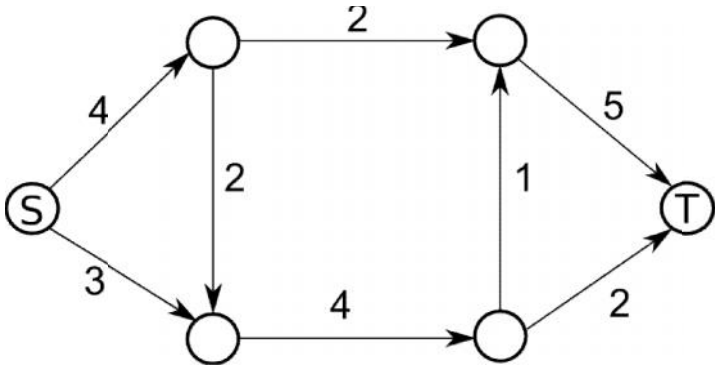
Question / Challenge

If Emil prepares the stack shown in the figure above, how many clicks on "GO" are required to end the game?

A) 1 **B)** 2 **C)** 4 **D)** 5

T16. Hauling Logs

Leslie the Beaver must drag logs through a system of canals. The logs must move in the direction of the arrow between the stations, which are marked as circles. The canals have a maximum capacity of logs which they can take between the various stations within the day, described by the number on the arrows. From a station, Leslie can send logs through different canals.



Question / Challenge

What is the maximum number of logs that can be moved from S to T by Leslie in one day?

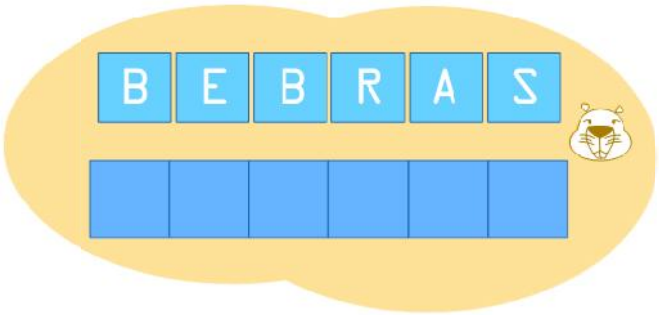
A) 4 **B)** 5 **C)** 6 **D)** 7

T17. Function TotalSwap(n,s)

The function TotalSwap takes two inputs: one number and a word. It outputs a modified word. Below you see how TotalSwap(3, 'computer') behaves.

Question / Challenge

What will be the result of the function TotalSwap(4, 'BEBRAS')?



A) BRASBE **B)** EBRASB
C) RASBEB **D)** ASBEBR

T18. Propogate

Beavers like to buy old computer hardware.

Roberta Beaver has purchased an older computer that only allows one decimal point in any calculation: anything after that digit is cut off.

For example, if we try to compute 7/5 on Roberta's machine, this will be stored as 1.4 (which is exactly correct) but if we compute 7/4, this will be stored as 1.7 (since 7/4=1.75, the "5" will be removed from the end). Notice there is an "error" of 0.05 in Roberta's stored value when compared to the correct answer.

This removal will occur after every operation. For example, when Roberta computes (7/4)/2, she will first compute 7/4 to give 1.7, then 1.7/2 would be stored as 0.8, which has an error of 0.075 from the correct answer.

Question / Challenge

If Roberta computes ((10/3)*(10/3))*9, what is the error (the difference between the stored value and the correct value)?

A) 0.0 **B)** 1.3 **C)** 2.8 **D)** 3.3

T19. Four Errands

Beaver Alexandra wants to do the following tasks during her break (12:00 – 13:00):

- buy a book at a bookstore;
- buy a bottle of milk at a grocery;
- send the newly bought book by post;
- drink a cup of coffee in a cafeteria.

Alexandra estimated the time to complete each task. But these estimates are valid only outside of the busiest periods. So she is trying to avoid the busiest periods.

Place	Duration	Busiest periods
Bookstore	15 min	12:40 – 13:00
Grocery	10 min	12:00 – 12:40
Post office	15 min	12:00 – 12:30
Cafeteria	20 min	12:30 – 12:50

Question / Challenge

Help Alexandra order her tasks to make sure that she will avoid all of the busiest periods. In what order should she do each task in order to complete all tasks within her break ?

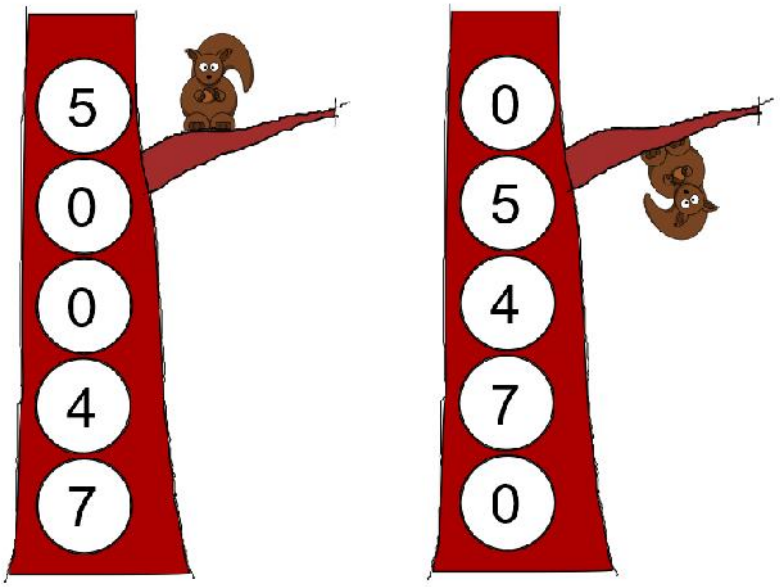
A) bookstore, post office, grocery, cafeteria
B) cafeteria, bookstore, post office, grocery
C) bookstore, grocery, cafeteria, post office
D) post office, grocery, cafeteria, bookstore

Time Allowed: **180 minutes**

T20. Selfish squirrels

Selfish squirrels live in tree holes. There is a tree with five big holes one above the other, and there are 16 squirrels, so they have to live together in holes.

Each day every squirrel checks which number is the least: the current number of its neighbors, the number of squirrels living in the hole above, or, the number of squirrels living in the hole below. The next night each squirrel secretly moves to the hole with the least value. If values are same, a squirrel prefers its current hole to the hole above, and prefers the hole above to the hole below.



Today **Tomorrow**

So, if, for example, today there are correspondingly 5, 0, 0, 4, 7 squirrels in the holes from top to bottom, then tomorrow all 5 top squirrels will move to the hole below (0 neighbors is better that 4). 7 squirrels from the bottom hole move up (4 neighbors is better than 6), and 4 squirrels from the hole next to the bottom will go up (0 neighbors is better than 3)

Question / Challenge

Here is an initial situation for the number of squirrels living in holes.

6
3
3
0
4

After how many days all squirrels will end up together in the same hole?

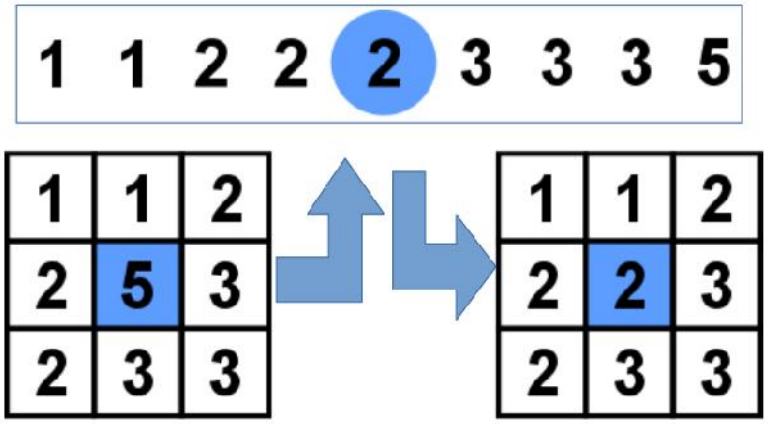
A) 2 **B)** 3 **C)** 4 **D)** never

Tasks T21 – T30 carry 5 points each

T21. Median Filter

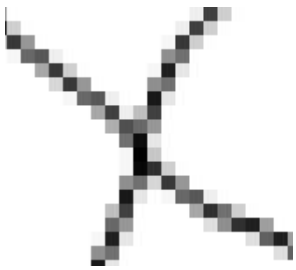
A grayscale image is stored as a table of numbers where each cell corresponds to a pixel. A cell with number 1 denotes a black pixel, a cell with number 5 denotes a white pixel, and values between 1 and 4 denote different shades of gray.

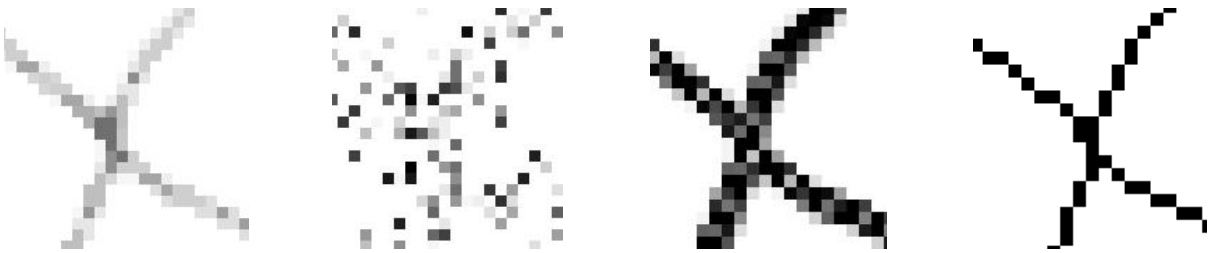
We use a "median filter" to transform an image in the following way: For each pixel in the image, the value of the pixel and the values of its neighboring pixels are sorted in ascending order, and the middle value (the fifth one) is used as a new value for the pixel. A filter transforms all pixels simultaneously. For example, in the figure below, the value of the central pixel is changed from 5 to 2.



Question / Challenge

What will this image look like after the application of the median filter?





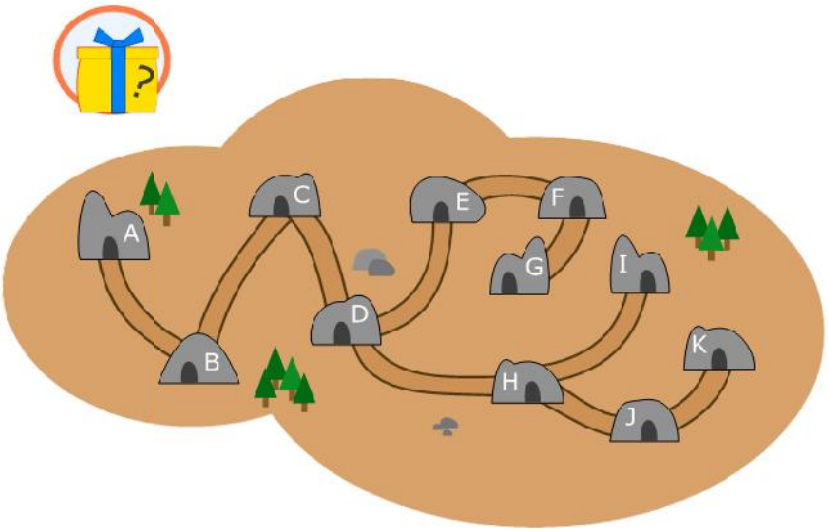
A) **B)** **C)** **D)**

Time Allowed: **180 minutes**

T22. Cave game

In the Bebras Country there is a region with several caves. The caves are connected by paths; between any two caves there is only one path between them, as shown in the map below.

Hale and Serge live in this region, and they are playing a game. Hale hid a toy in one of the caves. Serge wants to find which cave it is. To do so, he has the map below and he can only ask questions of the form "Is the toy in cave X?" If that is the case, Hale will answer "yes". Otherwise, she will tell Serge the neighboring cave of X which is on the path to the hidden toy. When Serge knows for sure where the toy is, the game is over and he will walk to this cave.



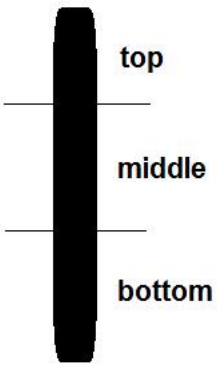
Question / Challenge

Serge wants to ask as few questions as possible to know where the toy is. In the worst case, how many questions does he need to be sure to have found the toy?

A) 2 **B)** 3 **C)** 4 **D)** 7

T23. Kix Code

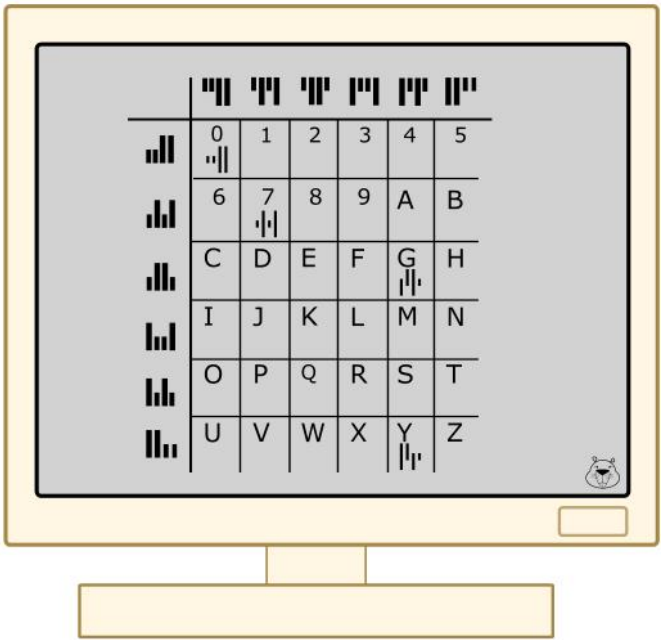
The Bebras Post Office uses postal codes from a set of 36 characters ('A'..'Z' and '0'..'9'). To make the postal codes readable by machines, they convert the postal codes into Kix codes.



In a Kix code, each character is represented by a code that has 2 sections (upper and lower).
Both the upper and lower sections contain 4 vertical bars. The upper section contains only the middle and the top bars, while the lower section contains only the middle and

the bottom bars.

This table shows the codes for several characters:



For example, the Kix code for  is "G7Y0"

Question / Challenge

Another postal code has this Kix code 

What is the postal code?

A) 6C1B **B)** BC16 **C)** HV9H **D)** 2016

T24. MapReduce

Alonzo's computer processes information in a very specific way, using only a few operations:

- (max x_1 x_2 … x_n) will pick the maximum of all values x_1 x_2 … x_n
- (min x_1 x_2 … x_n) will pick the minimum of all values x_1 x_2 … x_n
- (+ x_1 x_2 … x_n) will calculate $x_1 + x_2 + \ldots + x_n$
- (· x_1 x_2 … x_n) will calculate $x_1 \cdot x_2 \cdot \ldots \cdot x_n$

He can nest these operations together, for example (+ (· 2 3) (+ 1 2)) gives the value 9.

Question / Challenge

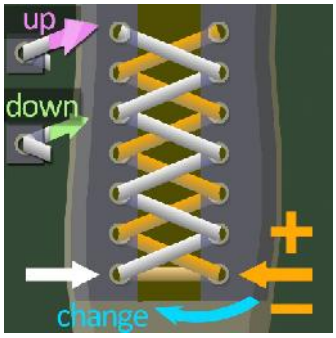
What is the value of

(+ (max (min 3 9 2) (· (max 0 4) (min 0 4))) (min (max 3 6) (max 5 7 2)))

A) 5 **B)** 8 **C)** 13 **D)** 0

T25. Shoe laces

Beaver loves fancy shoe lacing. He wants a robot that can tie his laces for him, but he said to himself: „How would I tell the robot which way I want my shoes laced? I would need some sort of programming language. What would this language look like?" Consider the traditional lacing method in the following picture.



Let's assume that the lace starting at the right side is always orange and the lace starting at the left side is always white. Beaver suggested following program for this lacing method:

```
{
orange: + change up
white: + change up
}
```

Explanation:

{…}	everything between the brackets will be repeated as many times as possible
3 {…}	same as above but repeated exactly 3 times, use accordingly for other numbers
orange:	following commands will only be applied to the orange lace
white:	following commands will only be applied to the white lace
up	runs the lace through the eyelet in an upwards direction at the position of the orange or white arrow shown above in its starting position
down	same as above but downwards direction
+	moves the orange or white arrow forward one position (to the next eyelet)
-	moves arrow back one eyelet
change	lets the orange or white arrow change from right to left or from left to right (depending on its current position)

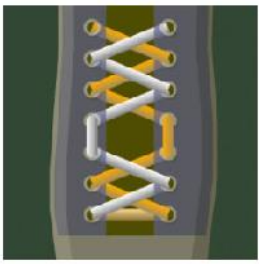
Question / Challenge

Which lacing pattern is created by the following program?

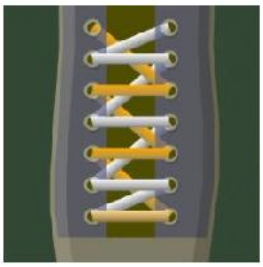
```
orange: up
white: up
2 {
```

```
orange: + change up
white: + change up
}
orange: + down
white: + down
{
orange: + change up
white: + change up
}
```

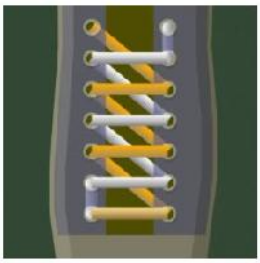
Hint: concentrate on one of the laces.



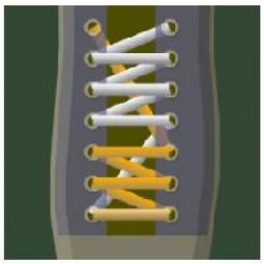
A)



B)



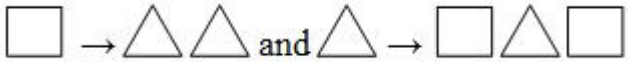
C)



D)

T26. Application

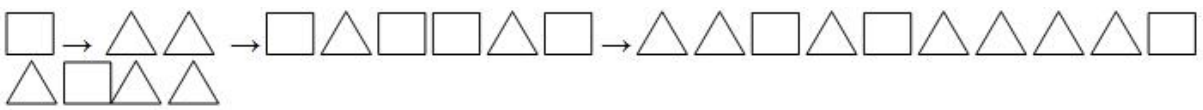
Alice wants to play a game with John. Alice owns some geometrical shaped cards and wants to exchange some of them with John. Alice uses the replacement rules to play the game:



According to the replacement game:

- a square card is replaced with two triangle cards,
- one triangle card is replaced by one square card, one triangle and another square.

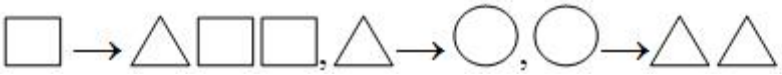
If she started from a square card using the replacement rules, she would get the cards in the order below after 3 steps:

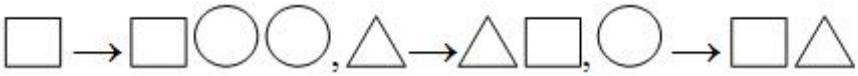


Question / Challenge

Alice now starts a new game with one of the following possible shaped cards: triangle, circle or square. Which set of replacement rules could yield?

Time Allowed: **180 minutes**

A) 

B) 

C) 

D) 

T27. Bebras Tunnel

Little Benno would like to take a hike. Since it is a nice day his whole family joins him. They hiked up a mountain and see a tunnel. The tunnel is very narrow and dark. For safety reason, only one or two beavers can travel in the tunnel at any given time, and only if they have a flashlight.

Luckily Bennos sister Anna has brought a flashlight with her, but only one. It takes different time for the Benno family members to cross the tunnel: Little Benno, who is quite sporty, can make it in 5 minutes, his sister Anna takes double that time. Because the tunnel is so narrow, the mother needs 20 minutes and the father because of his sprained ankle needs 25 minutes. The family wants to be on the other side of the tunnel within one hour.

Question / Challenge

What is the fastest time for the entire family to get to the other side of the tunnel?

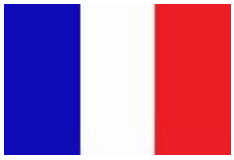
A) 35 minutes
B) 45 minutes
C) 60 minutes
D) impossible for the entire family to get to the other side of the tunnel within one hour.

T28. Compression of flags

Bitmap graphic format GIW uses the following algorithm for data compression: Each row is compressed separately. Each colour is expressed using a three-letter-code. The sequence of pixels of the same colour is coded with a pair in a bracket, the first term is the three-letter-code with a "," followed by the number of pixels.
For example two brackets ***(gre,20)(whi,13)*** code a row with 20 green pixels followed by 13 white pixels.

Question / Challenge

We have 4 files of country flags pictures of the same size. Which of these flag files compressed in GIW format is the biggest?



A) France

B) Germany

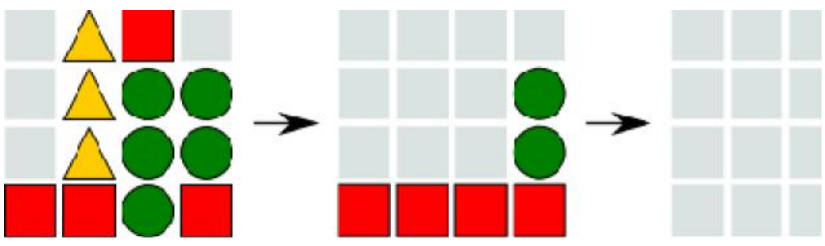
C) Czechia

D) Sweden

T29. Three-in-a-row game

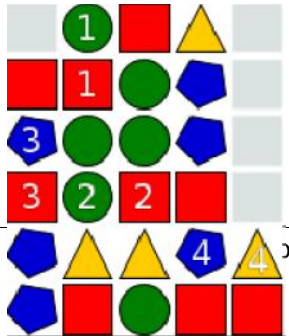
Three-in-a-row is popular computer game genre, where players swap stones. Then if three or more stones of the same shape stay in a row, either vertical or horizontal, they disappear, and all other stones fall down. After they fall, the process continues while there are three or more figures in a row.

The goal of the game is to make all stones disappear. Here is an example of the game situation:



Question / Challenge

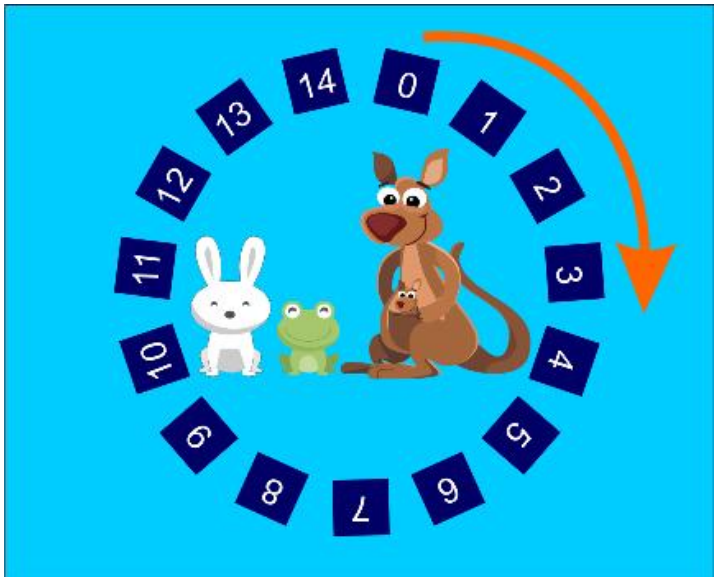
Which stones should a player swap to make all the stones disappear in the following game situation?



A) stones labeled 1
B) stones labeled 2
C) stones labeled 3
D) stones labeled 4

T30. The hopping race

One sunny day three friends, a bunny, a frog and a kangaroo, decided to participate in a hopping race. The track is circular of length 15 steps. The track is numbered from 0 to 14. When somebody reaches the step 14, the track continues from step 0.



The beaver, who is the referee, blows a whistle every second during the race. With each whistle, the bunny jumps 3 steps forward; the frog jumps 2 steps forward and the kangaroo jumps 5 steps forward.

All three friends start the race from the step 0. The race will finish when all of the animals jump onto the same step at the same time.

Question / Challenge

How many times must the referee blow the whistle before the race is over?

A) 5 **B)** 10 **C)** 15 **D)** 20