Time Allowed: **180 minutes**

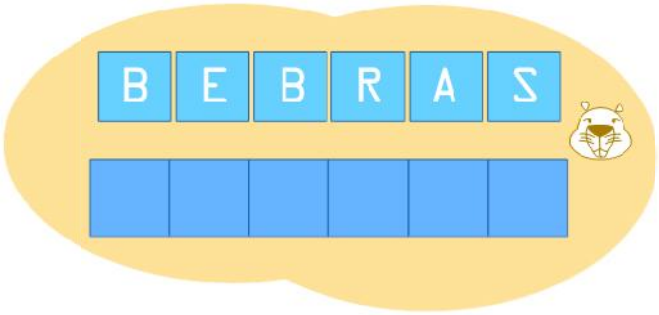
Tasks T1 – T10 carry 3 points each

T1. 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')?

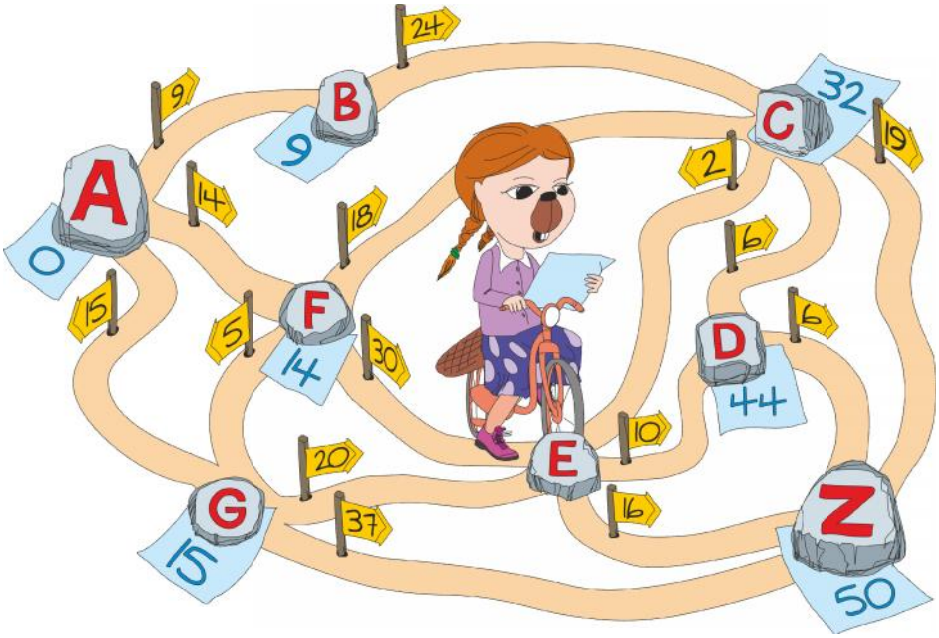


A) BRASBE
B) EBRASB
C) RASBEB
D) ASBEBR

T2. Exploring paths

Cleveria is a beaver biker. She explores one-way paths through villages labeled from A to Z. All the roads have a length and a direction. The length and direction are given in the yellow flags.

Time Allowed: **180 minutes**



Over the course of many different trips she leaves blue notes with a number under a stone in each village.

Question / Challenge

What is the meaning of the numbers she has left under the stones?

A) the length of the shortest path from A to a particular village going through the least number of villages;
B) the length of the shortest path from A to a particular village;
C) the length of the shortest path from A to a particular village by taking a left turn at crossings if possible;
D) the length of the shortest path from A to a particular village by taking a right turn at crossings if possible.

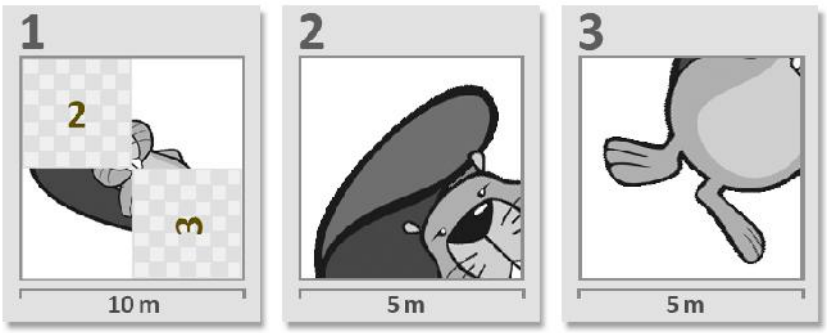
T3. Recursive Painting

Beaver and his friends have volunteered to help renovate the City Museum of Informatics. They have to paint a floor of 16 x 16 meters in one of the exhibition rooms.

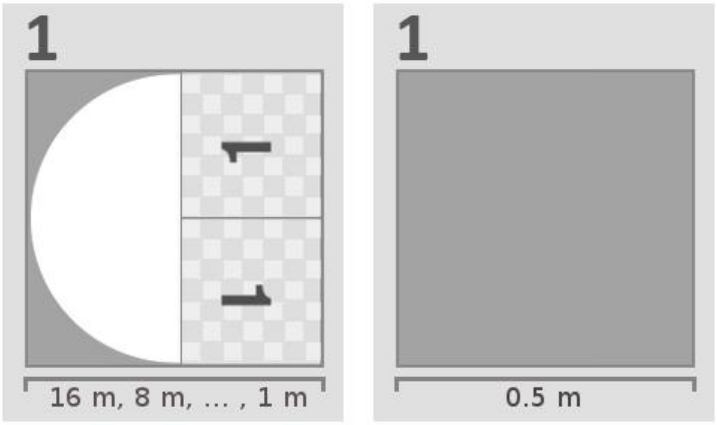
The planning department has a special set of painting instructions.

The instructions are printed on sheets that reference other sheets by number. Each sheet has a scale printed at the bottom.
Here is an example for such floor plan from a previous project. It draws a beaver.

Time Allowed: **180 minutes**



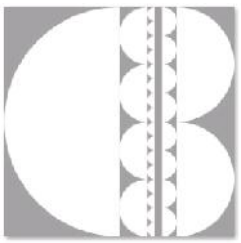
Beaver is given the plan for the new project:

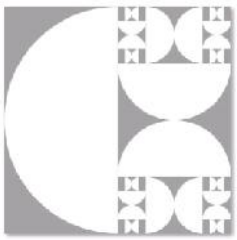


The planning sheet referenced itself and both sheets have the same number! His friend asks how this can be and beaver answers: "We can do it. The second sheet is important because it tells us when to stop."

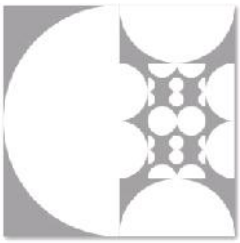
Question / Challenge

What does the painted result look like?


A)


B)


C)


D)

T4. Return back

A robotic bee has 4 arrow buttons on its back. The bee moves on a square tiled floor based on a sequence you input by pushing a combination of the following buttons:


move forward to the next tile

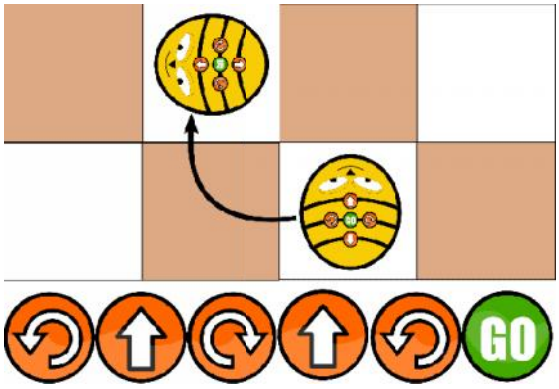

turn left 90° on the same tile

 turn right 90° on the same tile

 move in reverse to the tile behind the bee.

The button  on its back starts the execution of the inputted sequence. An example is shown of the button presses and the movement of the bee to the right.

The bee remembers the entered sequence so pressing  again causes the same movement.



Question / Challenge

If you press the  button repeatedly for the following options, which program never makes the bee return to its starting tile and starting orientation?

A) 

B) 

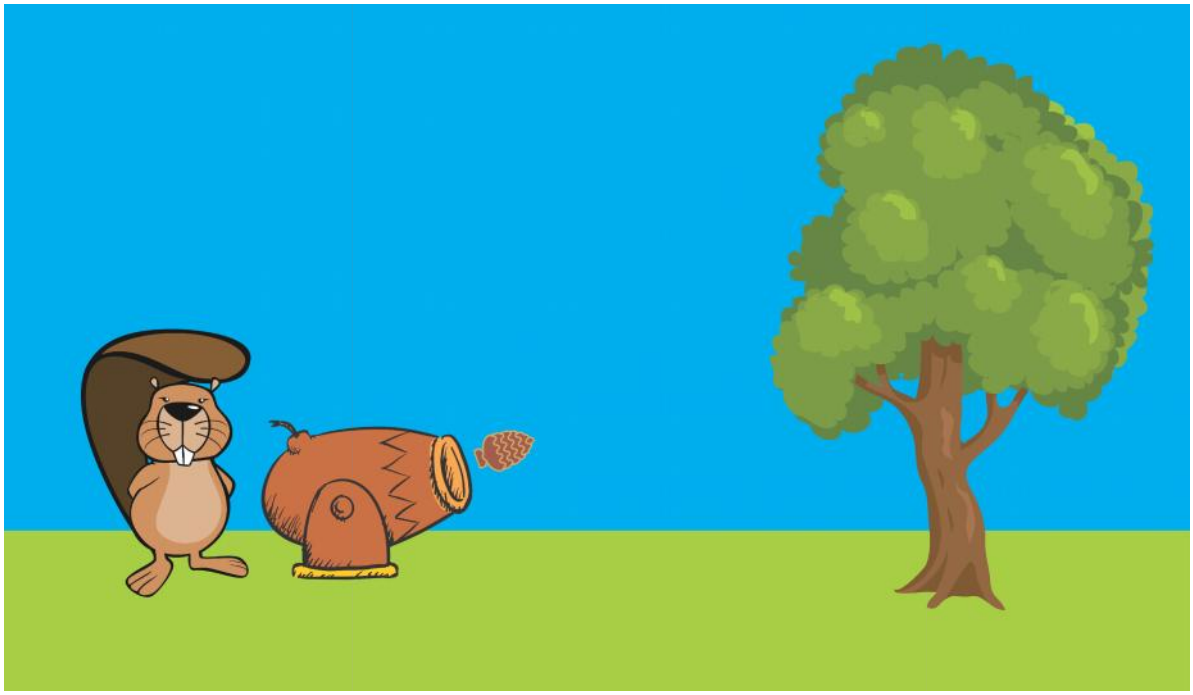
C) 

D) 

T5. Hit the tree

Bebras Jack has a passion for a computer game called "Hit the tree". The aim is to shoot a pine cone from a cannon to hit a tree. At each round the tree is placed in a different position. The player has many attempts to hit the tree. The player has to choose the shooting speed starting from 0 to the cannon max speed. The cannon position and its angle are fixed, and for any tree position there is always an integer value for the speed allowing the player to win.

Time Allowed: **180 minutes**



Bebras Jack found a way to write a program that can play "Hit the tree", combining the following instructions:

1. set the speed to a given value
2. increase the speed by a number of units
3. decrease the speed by a number of units
4. shoot

Question / Challenge

Which of the following programs is **not** guaranteed to hit the tree?

Program A

1. set the speed to zero
2. repeat the following instructions until you hit the tree:
   2.1 increase speed by 1 unit
   2.2 shoot

Program B

1. set the speed to its maximum value
2. repeat the following instructions until you hit the tree:
   2.1 shoot
   2.2 decrease speed by 1 unit

Program C

1. set the speed to an arbitrary value
2. repeat the following instructions until you hit the tree:
   2.1 increase speed by 1 unit

2.2 shoot

Program D

1. set the speed to zero
2. repeat the following instructions until you hit the tree or shoot over it:
   2.1 increase speed by 5 units
   2.2 shoot
3. if you shot over the tree, repeat the following instructions until you hit it:
   3.1 decrease speed by 1 unit
   3.2 shoot

T6. Neon text

The Beaver restaurant River has a neon text over its entrance. Individual letters repeatedly change their color. The blue color is followed by red, the red is followed by yellow, and the yellow is followed by blue.

Each color is alight a certain period of time as follows:

- Blue - 3 minutes
- Red – 2 minutes
- Yellow - 1 minute

In addition, when three blue letters appear next to each other, the middle one turns red immediately.

The restaurant owner turned on the text at 18:00 with these colors:

Question / Challenge

What was the color of the letters during the sixth minute after the text was switched on?

A) 

B) 

C) 

D) 

T7. Scanner Code

Time Allowed: **180 minutes**

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:

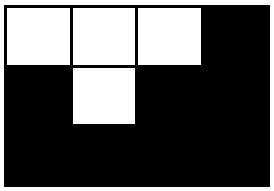
Scanner A processes the pixels row by row and restarts the encoding on the next row.

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)

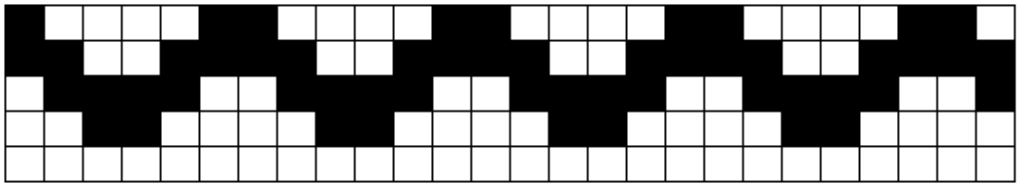
Scanner B: 3,2,1,6. (3 white, 2 black, 1 white, 6 black)



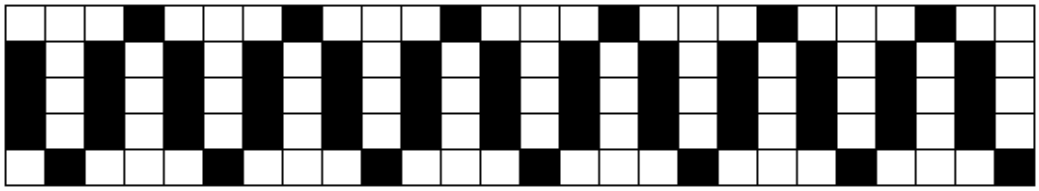
Question / Challenge

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

A)

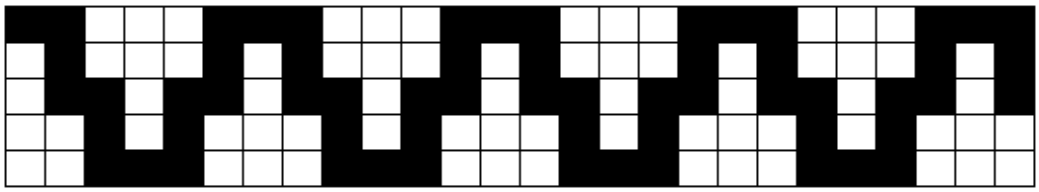


B)

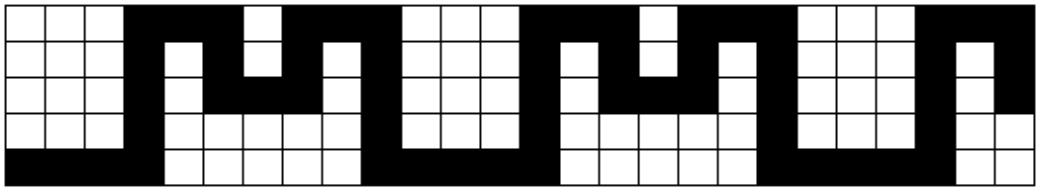


Time Allowed: **180 minutes**

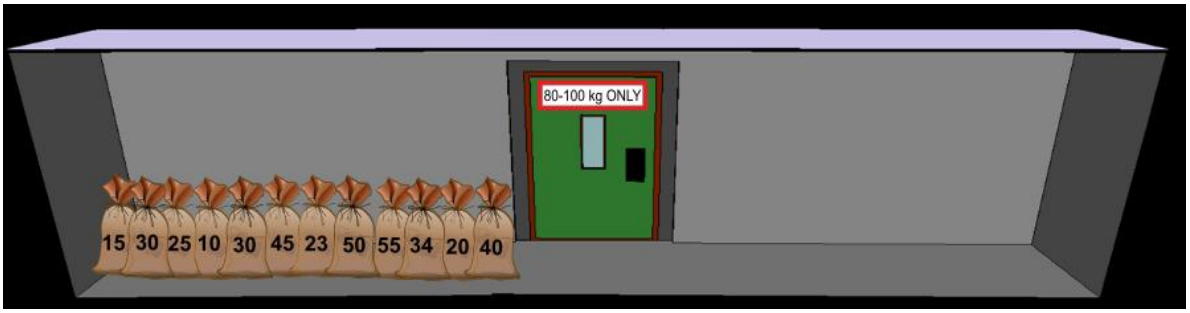
C)



D)



T8. Sacks in elevator



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

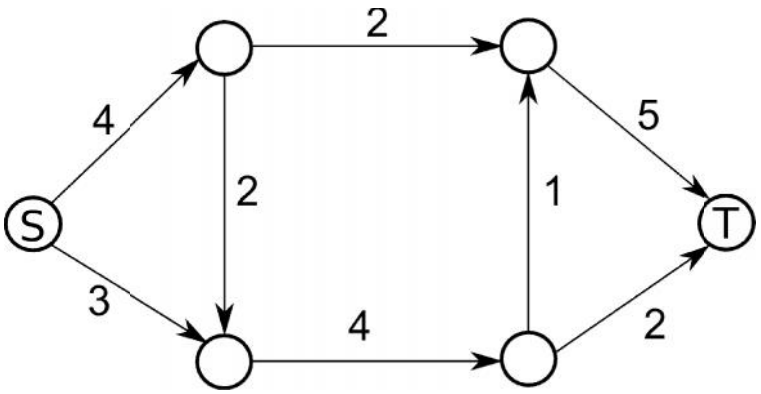
Now all sacks are sent to the store using the procedure described above.
Which of the following statements is correct?

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.

Time Allowed: **180 minutes**

T9. 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

T10. 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

Time Allowed: **180 minutes**

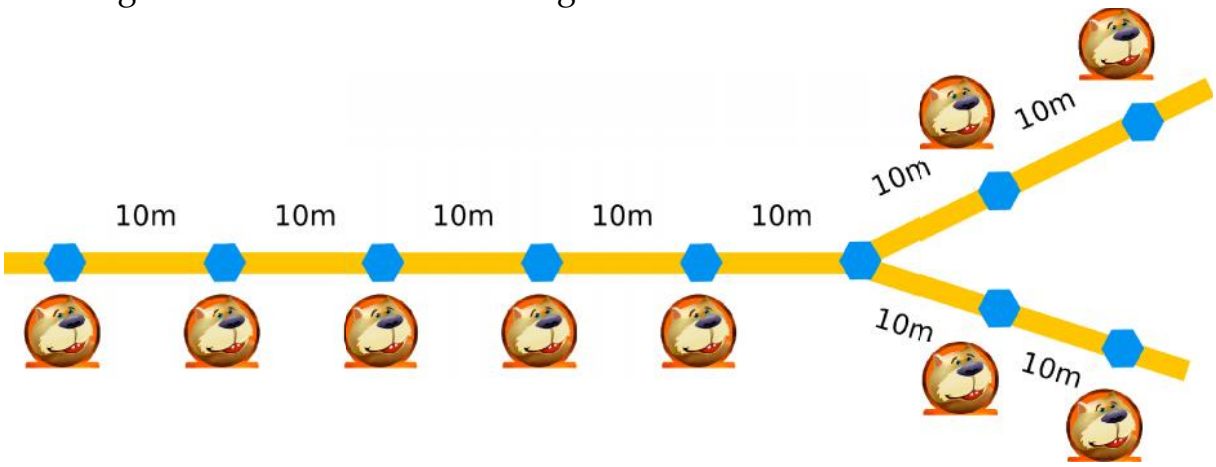
Help Alexandra order her tasks to make sure that she will avoid all of the busiest periods. In what order should she do each task in order to complete all tasks within her break ?

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

Tasks T11 – T20 carry 4 points each

T11. Bus Stop

The lodges of nine beavers are arranged as follows:

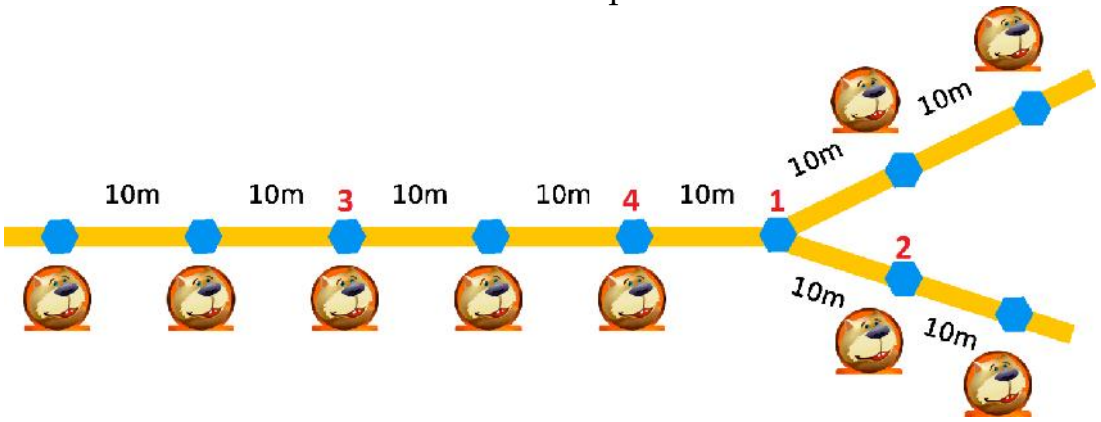


The Beavers want to establish a bus stop in one of the ten locations marked by blue hexagons. The distances between the hexagons are shown in the figure.

The nine Beavers decided that the sum of the distances from their lodges to the bus stop should be as short as possible.

Question / Challenge

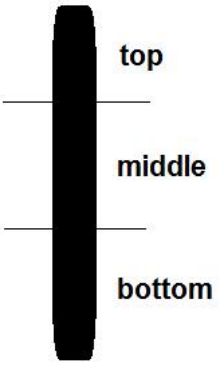
Which is the best location for the bus stop?



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

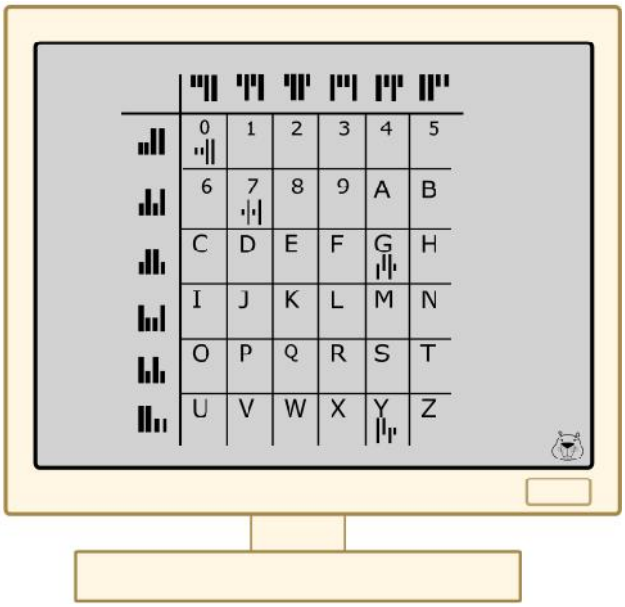
T12. Kix Code

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

T13. 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.

Time Allowed: **180 minutes**

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.

T14. Compression of flags

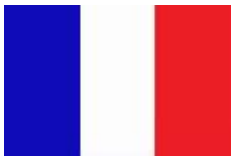
Bitmap graphic format GIW uses the following algorithm for data compression: Each row is compressed separately. Each colour is expressed using a three-letter-code. The sequence of pixels of the same colour is coded with a pair in a bracket, the first term is the three-letter-code with a "," followed 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

Time Allowed: **180 minutes**

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



A) France

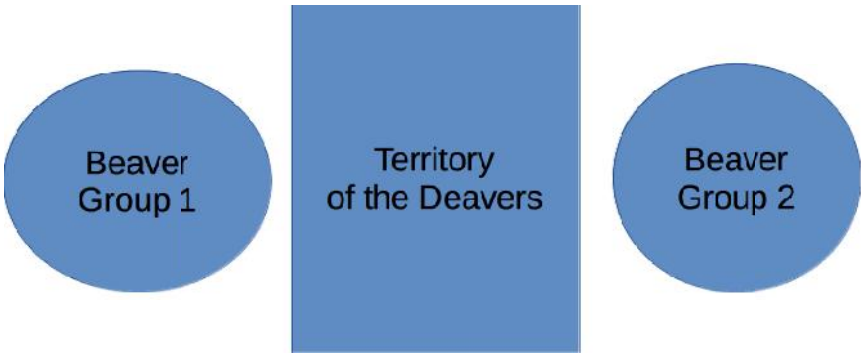
B) Germany

C) Czechia

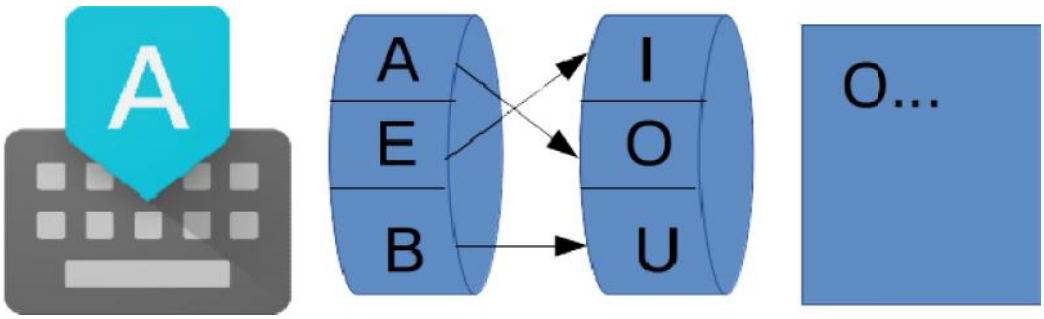
D) Sweden

T15. B-Enigma

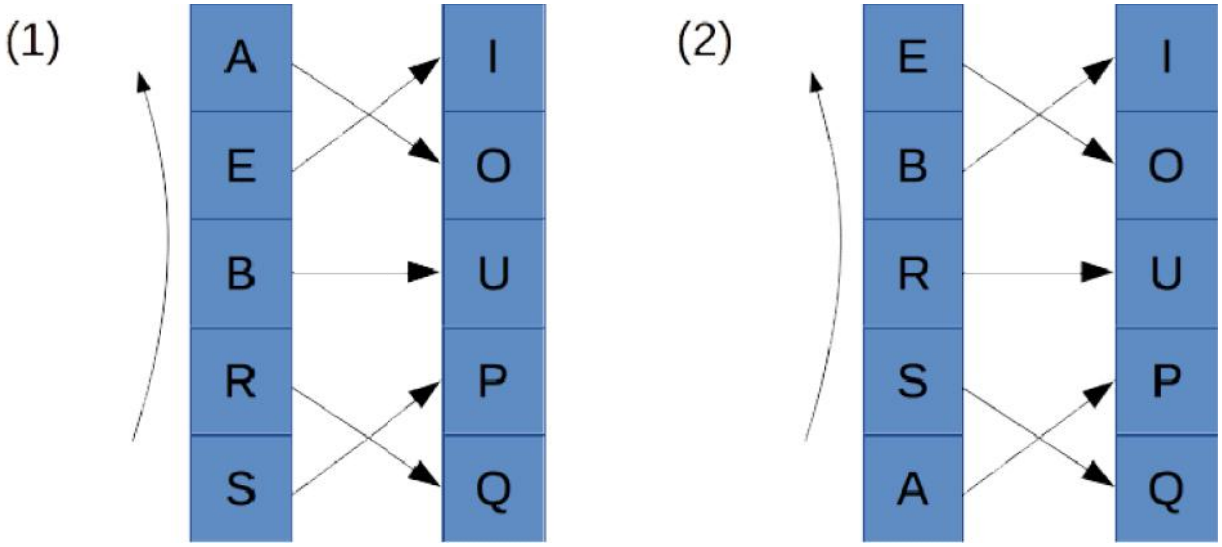
The Beavers are playing a game with the Deavers. The Beavers need to communicate secretly, but their message will pass through a zone controlled by the Deavers. The Beavers decide to use a mechanism called the B-Enigma machine to hide (encrypt) their messages while sending them from one side to the other.



The B-Enigma works as shown below: each time you type a letter for encryption (e.g. "A"), the left rotor will determine a corresponding letter on the right rotor (e.g. "O" for "A" in the first step). After typing a letter, the left rotor will move one position in the direction shown by the arrow, arriving at position (2). However, the rotor on the right never moves. The links between the two rotors (shown by the arrows) also remain the same. On the bottom you see all the five letters available.



Time Allowed: **180 minutes**



Question / Challenge

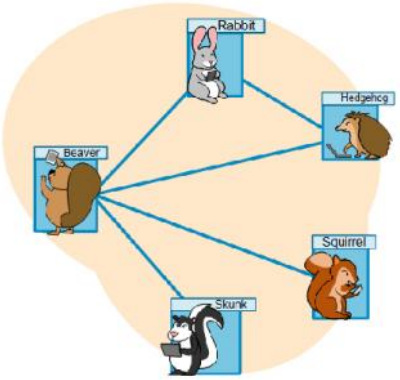
The Beaver Group 1 wishes to send the message "BEBRAS" to Group 2. What will the encrypted message be if we start from position (1)?

A) UOSAEB **B)** UOUQOP **C)** UOOOIP **D)** UOOUPQ

T16. Instachat and Snapgram

Information is given below about the friendships between a beaver, rabbit, hedgehog, squirrel and skunk on the social network Instachat.

In the picture, the lines show which animals are friends with each other. The table records how many friends each animal has.



Five different animals are on a different social network Snapgram and the same information is recorded in the same way.

Animal	Number of Friends
beaver	4
rabbit	2
hedgehog	2
squirrel	1
skunk	1

Time Allowed: **180 minutes**

Question / Challenge

Which of the following **cannot** be the table recording how many friends each animal has on Snapgram?

A)

Animal	Number of Friends
fox	2
groundhog	2
chipmunk	2
turtle	2
snake	2

B)

Animal	Number of Friends
fox	2
groundhog	3
chipmunk	4
turtle	3
snake	2

C)

Animal	Number of Friends
fox	1
groundhog	4
chipmunk	3
turtle	4
snake	1

D)

Animal	Number of Friends
fox	3
groundhog	3
chipmunk	4
turtle	3
snake	3

T17. MapReduce

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

- (R f (x_1, x_2, … x_n)) will give x_1 f x_2 f … f x_n
  (f is a binary operator and x_i are numbers)
  For example: (R + (1, 2, 3, 4)) would produce 1 + 2 + 3 + 4 which gives 10.

- (M f (x_1 x_2 ... x_n)) will give (f(x_1), f(x_2), … f(x_n))
  (f is a function and x_i are numbers)
  For example: q(x) = -x, then (M q (1, 2, 3, 4)) would produce (-1, -2, -3, -4).

He can use any function he wishes for these. For instance, if he defines t(x) = 3x + 2, then (M t (1, 2, 3)) would produce (5, 8, 11).

Question / Challenge

Suppose t(x) = 3x + 2 and q(x) = -x.
What is produced when he performs the following operation:

(R + ((R + (M t (0, 2, 4))), (R + (M q (M t (3, 5))))))

A) 7 **B)** 0 **C)** -7 **D)** -4

Time Allowed: **180 minutes**

T18. Quick Exponentiating

You need to calculate the value of 2^{37}, but the power key of your calculator is broken. A friend gives you the following two hints:

- When the exponent of a power is even, calculate 2 powered to the half of the exponent and then multiply the result with itself, for example $2^5 \times 2^5 = 2^{10}$.
- When the exponent of a power is odd, calculate 2 powered to the exponent reduced by one (that is even) and then multiply the result by 2, for example $2^{10} \times 2 = 2^{11}$.

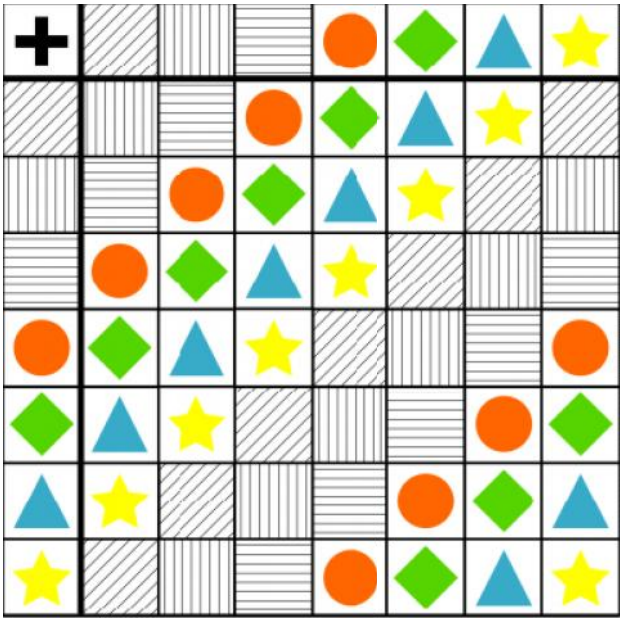
Question / Challenge

If you use these hints, how many multiplications do you require to calculate 2^{37}?

A) 1 **B)** 2 **C)** 7 **D)** 37

T19. Bebras Painting

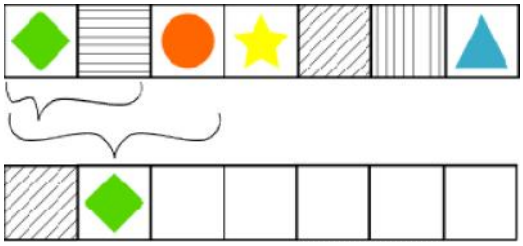
The little Beavers can change any painting using a magic brush that works as follows: it combines each shape with the ones on its left and right, obtaining a new shape according to the table shown in the figure below. This table shows the result of combining two shapes (e.g. diamond with triangle gives a circle). To combine three shapes (A, B, C), you first combine A and B and then you combine the resulting shape with C.



Question / Challenge

What will the painting below look like after applying the magic brush over it? Two shapes are shown as examples.

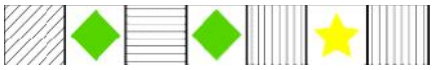
Time Allowed: **180 minutes**



A) 

B) 

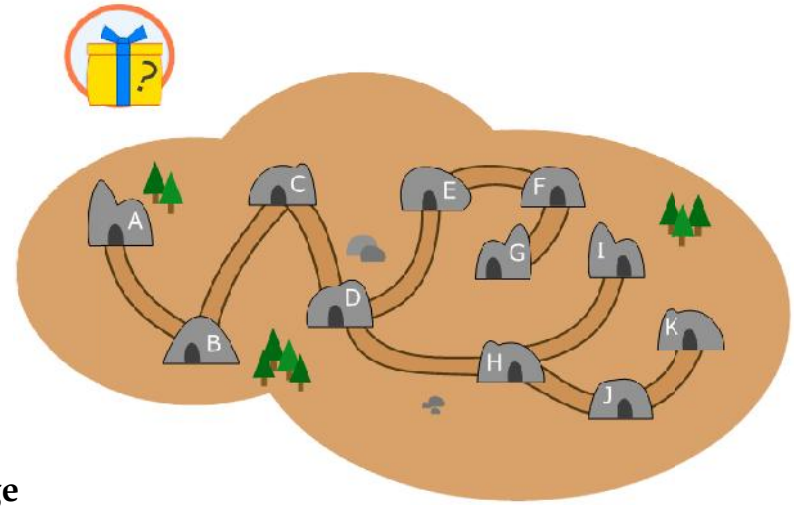
C) 

D) 

T20. 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

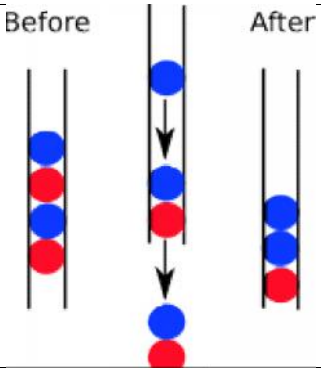
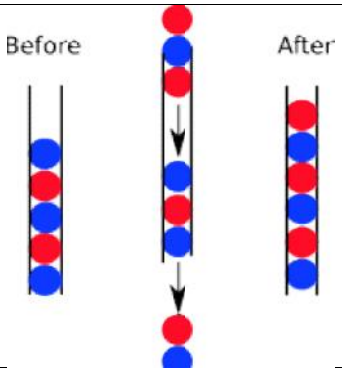
Tasks T21 – T30 carry 5 points each

T21. Red and blue marbles

Time Allowed: **180 minutes**

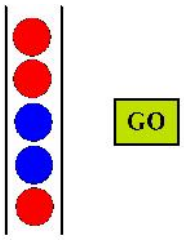
Beaver Emil is trying a new puzzle on his computer. He has to arrange a stack consisting of at least three coloured marbles in a cylinder. Each marble is either red or blue.

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*, a new *blue* marble drops on the top of the cylinder	if that first marble was *blue*, then 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.

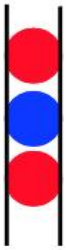
For example, if Emil prepares the stack shown in the figure on the right, only two blue marbles will remain in the cylinder (after five clicks), so the game will end.



Question / Challenge

Which of the following starting stacks result in a game that will never stop anymore?

A) 

B) 

C) 

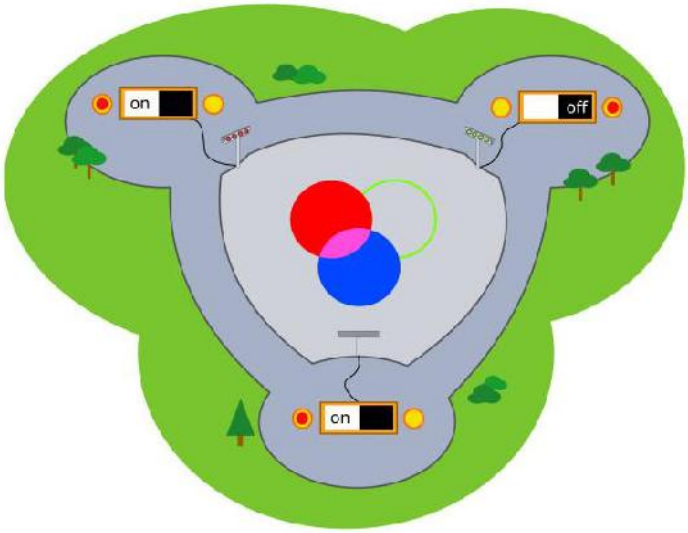
D) None of them

T22. Switches

Time Allowed: **180 minutes**

Edward Beaver has constructed a very nice display with colorful lights in the center of town. The lights can be made to flash in 8 different pretty patterns by turning 3 switches on and off.

Edward wants to know if his display works perfectly, so he needs to tryout all 8 different on/off combinations of the 3 switches.



Unfortunately, the switches are each 1 km apart and Edward has to walk to a switch to be able to change it.

Question / Challenge

How many kilometers must he walk at least to try out all 8 different switch combinations?

A) 2 km **B)** 4 km **C)** 6 km **D)** 8 km

T23. Email Software

There are two email software packages: T-Mail and B-Mail.

When forwarding an email to another person, T-Mail always adds the new email content at the top of the existing email thread, while B-Mail always adds at the bottom.

4 friends have been sending emails to each other. Anna and Bella only use T-Mail.

Chloe and Diane sometimes use T-mail, and sometimes use B-Mail.

Suppose that Anna is the first sender sending an email to Chloe.

Chloe used B-mail to forward the email to Bella.

Finally, Bella forwards the email to Diane.

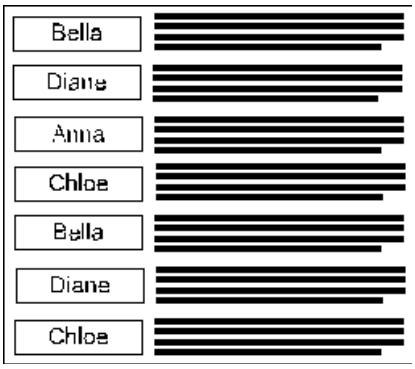
The resultant email thread then looks like the image shown on the right hand side.

Time Allowed: **180 minutes**

Question / Challenge

The following image shows another email thread. It is not clear who sent the first email.

The table on the right shows who used which email package.



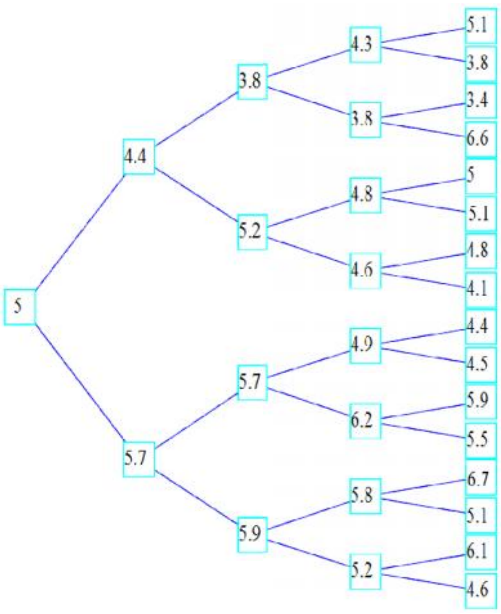
User	Use email softwares
Anna	T-mail
Bella	T-mail
Chloe	T-mail, B-mail
Diane	T-mail, B-mail

Who could not have been the sender of the first email?

A) Anna
B) Bella
C) Chloe
D) Anybody could have sent the first email

T24. The game

Beaver Big is playing a game against Beaver Small on a special game board shown. They start from the leftmost box (5). First, it is Beaver Big's turn. She can choose to move up or down: if she chooses up, they will move to the upper box (4.4); if she chooses down they will move to the lower box (5.7).



Then, it is Beaver Small's turn to choose whether to move up or down. After that, is Beaver Big's turn again, and finally Beaver Small chooses the final box in the rightmost column.

Because both beavers **can see all numbers on the game board all the time,** they are able to plan their moves accordingly.

Question / Challenge

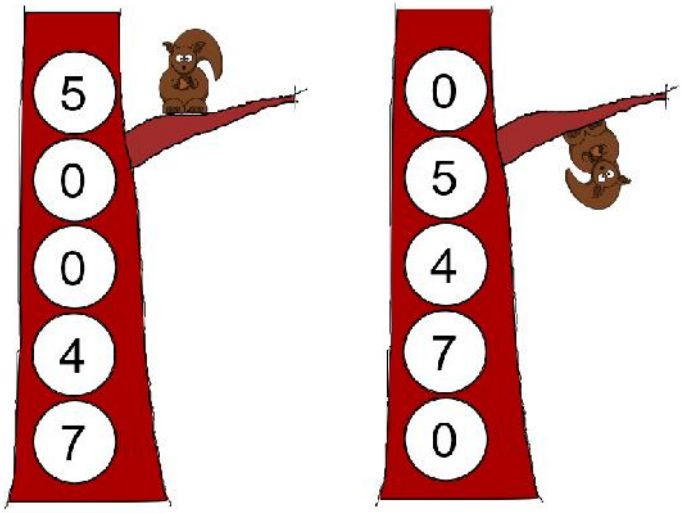
If Beaver Big plays so that their final box will have the **biggest possible value** and Beaver Small the **smallest**, and if both always play the perfect game (as well as they possible can), what will the number in the final box be?

A) 5.5 **B)** 5.1 **C)** 3.4 **D)** 6.7

T25. 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.

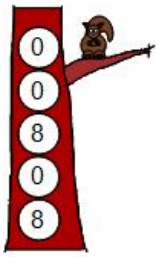


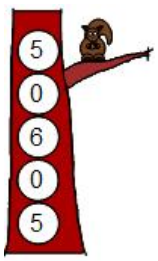
Today **Tomorrow**

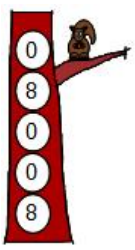
So, if, for example, today there are correspondingly 5, 0, 0, 4, 7 squirrels in the holes from top to bottom, then tomorrow all 5 top squirrels will move to the hole below (0 neighbors is better that 4). 7 squirrels from the bottom hole move up (4 neighbors is better than 6), and 4 squirrels from the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

Question / Challenge

In many situations, the squirrels will end up in the same hole. Which of the following initial situations does not result in squirrels living in the same hole?

A) 

B) 

C) 

D) It is not possible to find an initial situation

Time Allowed: **180 minutes**

T26. Swinging Monkey

A leafy tree  is surrounded by two bare trees  and two palm trees 

Five types of bananas, say P, Q, R, S, T, are placed on the trees, a different type for each tree. A monkey swings from one tree to another tree to enjoy one banana, and then swings to another tree. It takes the monkey

- three seconds to swing from the leafy tree to any other tree or vice versa, and to eat one banana,
- two seconds to swing from a bare tree to a palm tree or vice versa, and to eat one banana,
- seven seconds to swing between two bare trees or two palm trees while avoiding the leafy tree along the way, and to eat one banana.

The monkey swings and eats bananas of type P, Q, S, R, T, R, P.

Question / Challenge

What type of bananas can possibly be on the leafy tree if the total amount of time the monkey swings and eats is as small as possible?

A) P or Q or T
B) P or S or T
C) Q or S or T
D) Q or R or S

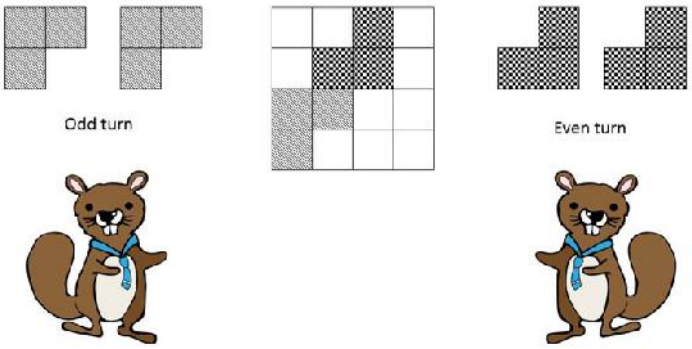
T27. L-Game (II)

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. An example where Kiki goes first is shown below. In this exampe, Kiki can win the game by placing a pice at the bottom-right corner.



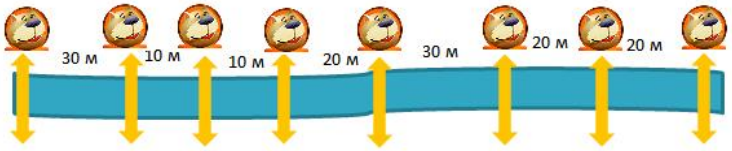
Question / Challenge

For how many of Kiki's nine possible first moves is he/she guaranteed to win no matter how pieces are placed in following turns?

A) 0 **B)** 1 **C)** 2 **D)** 3

T28. Bridges

The Lodges of the eight beavers are arranged at the specified distances along the river, as shown in the picture below.



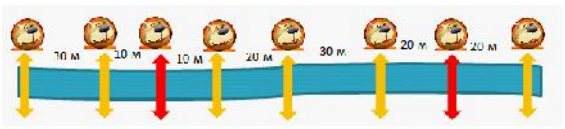
Beavers are allowed to build two bridges across the river in front of their houses.

Friends decided that the sum of the distances from their houses to the nearest bridge should be as short as possible.

Question / Challenge

Which are the locations for the two bridges constructions?

A)



B)

C)

Time Allowed: **180 minutes**

D)

T29. Algorithmic art

Recursion is when an algorithm refers to itself within the algorithm. A real world example would be when you hold a mirror up to a mirror and the image is reflected recursively.

This is an example of a recursive algorithm:

The command DrawSquare(x, y, s) instructs the computer to complete the following steps:

Draw a square with side s which has the centre point x,y.

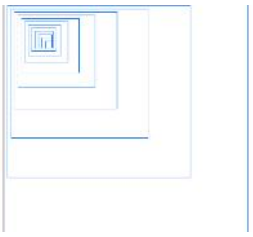
If the side of the square is more than 2 pixels,

DrawSquare(x+s/2, y, s/2) (draw a smaller square to the right)
DrawSquare(x-s/2, y, s/2) (draw a smaller square to the left)

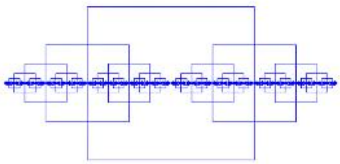
Question / Challenge

Which of the patterns below could have been created by the DrawSquare command?

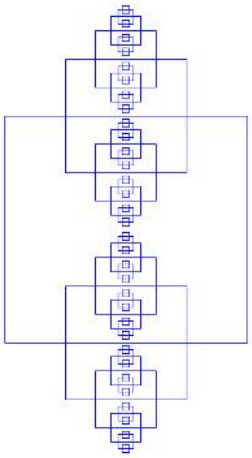
A)



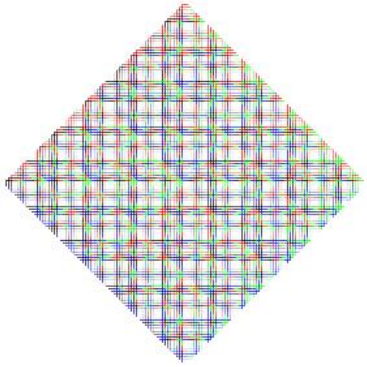
B)



C)



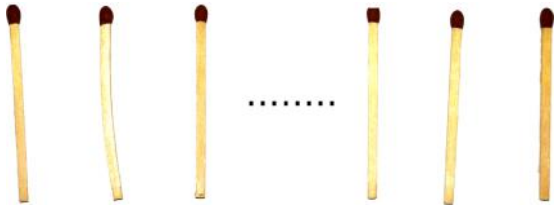
D)



Time Allowed: **180 minutes**

T30. Match Game

Bibor meets a friend to play the so-called Match Game. He explains the game to his friend: „There are 13 matches in a row. Player One starts the game by removing 1, 2, or 3 matches. Then it is the turn of Player Two, who also removes 1, 2, or 3 matches. Then it is again Player One's turn, then Player Two, and so on. The player who removes the last match wins the game."



Bibor starts the game.

Hint: If 4 matches are left Bibor cannot take the last match. He needs to avoid this situation!

Question / Challenge

How many matches does Bibor need to remove in his first turn to win the game?

A) One match
B) Two matches
C) Three matches
D) It doesn't matter how many matches