Time Allowed: **180 minutes**

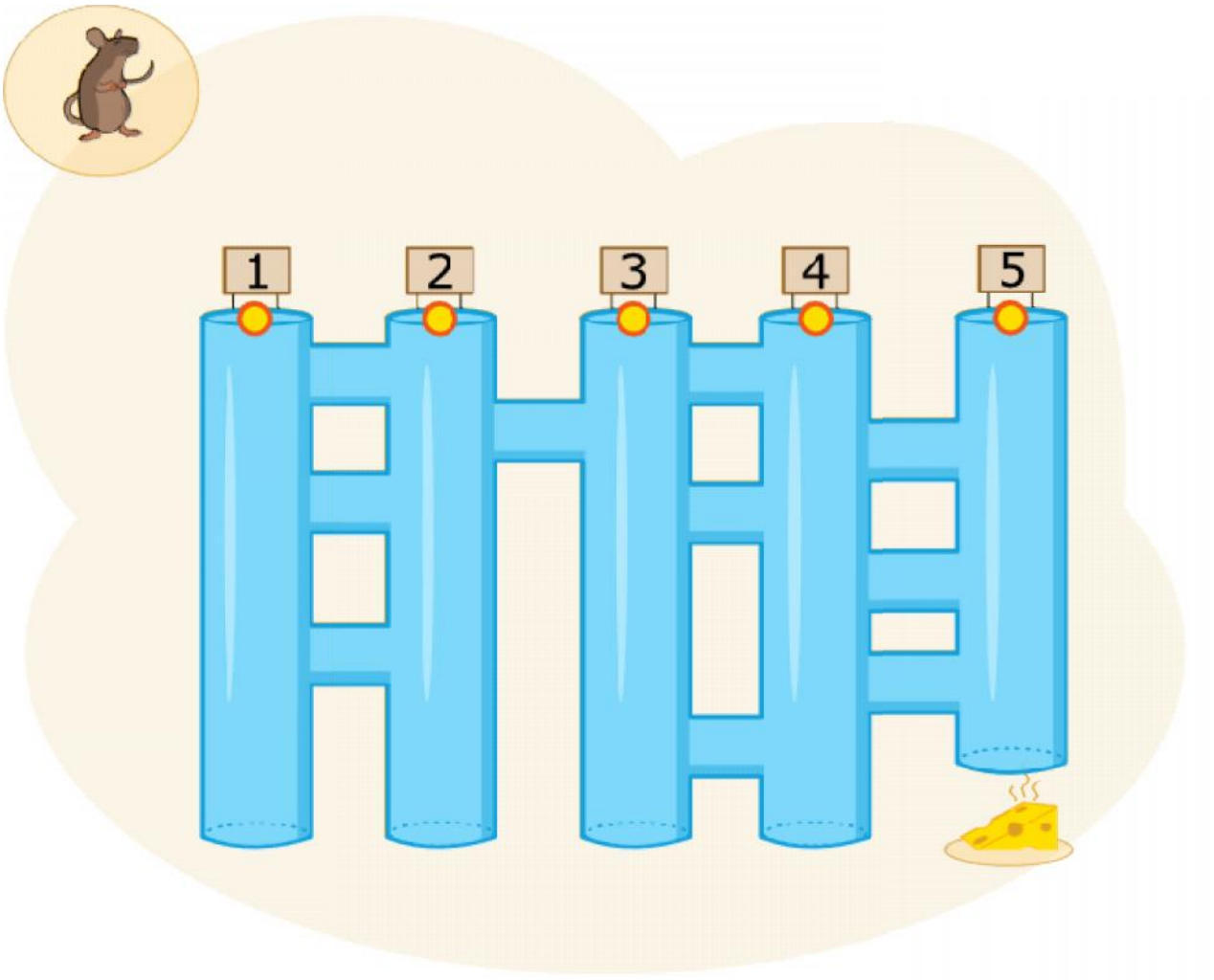
Tasks T1 – T10 carry 3 points each

T1. Tube System

A mouse is at the entrance of a tube system and wants to reach the cheese at the end of tube 5.

The mouse always follows these commands:

1. go downwards **till** meet a crossing;
2. **at the crossing**, pass the vertical tube; go to command 1.



Question / Challenge

In which tube should the mouse start so that it reaches the cheese at end of tube 5?

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

Time Allowed: **180 minutes**

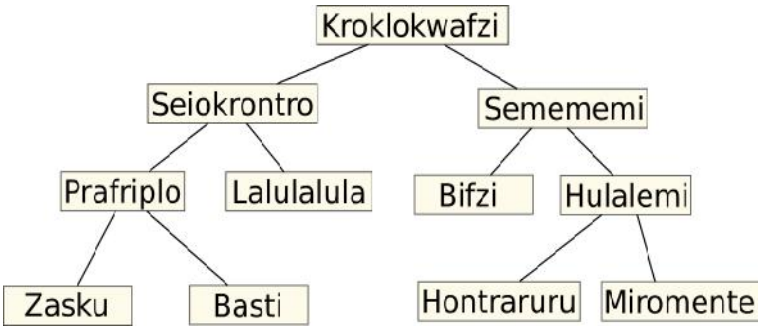
T2. Hierarchy

We have got a tree describing relationships between animals on Morgenstern planet. A link between two categories in the tree below means that all members of the lower category are also members of the upper category. Hence, some sentences can be formed looking at this tree, e. g. every "Hulalemi" is a type of "Semememi" and that some "Seiokrontro" are not a type of "Basti".

Alice and Benjamin said:

Alice: Every Basti is a type of Seiokronto

Benjamin: Some Hontraruru are not types of Semememi



Question / Challenge

What can we say about the correctness of their statements?

A) Both were correct
B) Only Benjamin was correct
C) Only Alice was correct
D) Both were incorrect

T3. Good Wood

Three beavers work to remove the rotten wood from logs. Each beaver has a different job:

- Troy measures the distance from the left of a log to the first point where the wood changes from rotten to good or from good to rotten.
- Given a distance, Justin removes this amount of wood from the left of a log.
- Given a distance, Carmen removes this amount of wood from the right of a log.

Today, they work on an N meter long log. All the wood on the left of this log is rotten up to some point and all the wood on the right is rotten up to some point. There is wood in between and it is all in good shape.

First, Troy does his job and measures X meters. Next, Troy gives X to Justin who does his job. Then Troy does his job on the remaining log and measures Y.

Time Allowed: **180 minutes**

Question / Challenge

What value should Troy give Carmen so he can complete the job of removing the rotten wood?

A) X meters
B) Y meters
C) N- X meters
D) N-X-Y meters

T4. Chain

Thomas wrote a computer program.
You can use instructions to make the program paint a chain of squares and triangles.

You can use the following instructions to make the program paint single shapes:

bS – paint a big square
sS – paint a small square
bT – paint a big triangle
sT – paint a small triangle

Moreover, you can use a repeat instruction:

N [*Inst*]

where **N** is a number and ***Inst*** is a sequence of instructions.
This command makes the program do N times all the instruction sequence *Inst* makes it do.

For example, the instruction sequence **sS 2 [bT sT] bS** makes the program paint this chain:

Question / Challenge

Which instruction sequence will make the program paint this chain?

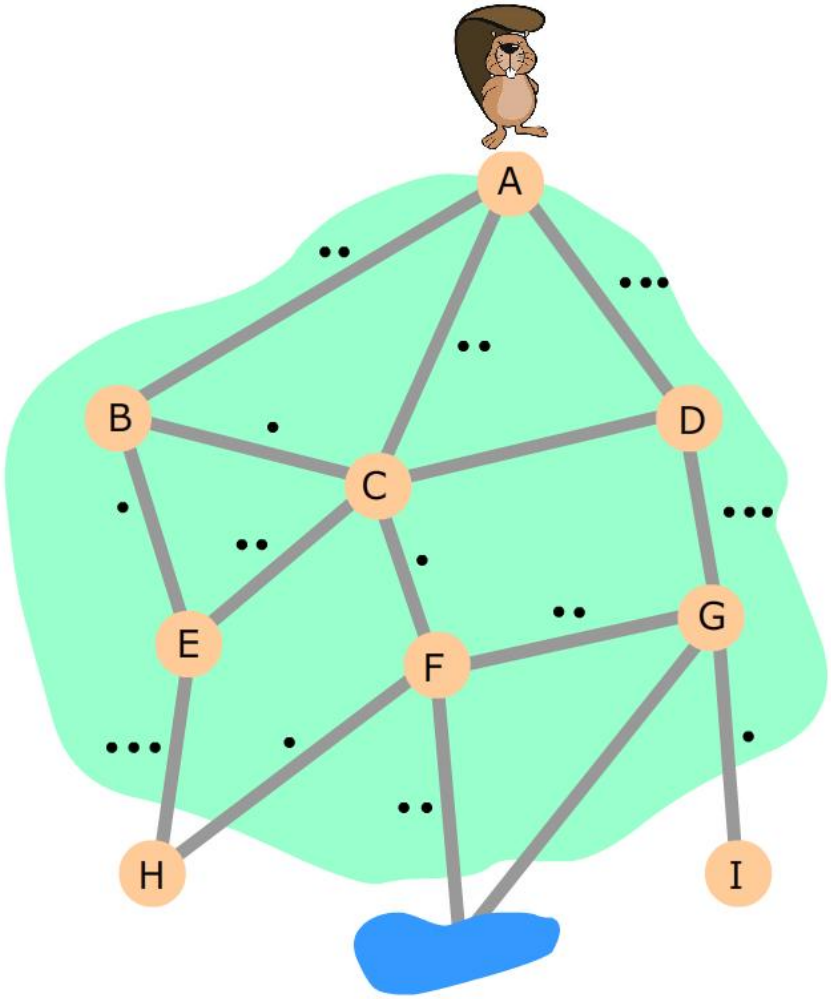
Time Allowed: **180 minutes**

A) sS 3 [sT sS bT] sT sS
B) bS 3 [sT sS bT] bS
C) bS 3 [sT sS bT] sT bS
D) bS 2 [sT sS bT] sT bS

T5. Path Through the Forest

Sometimes the beavers go downhill through the forest to the pond in the valley to get fresh water and back again. They always remain on the routes that lead through the forest. On the way downhill at each route junction a beaver randomly chooses a route section that goes downhill. If a beaver leaves the forest at the pond, he remembers the whole path he took and walks along exactly the same sections back home. If he leaves the forest at a different place (H or I in the image), he avoids the forest and walks home around it.

The number of dots at a section indicates how many times a beaver walked along this section today.



Today only one beaver went from the forest to the pond and back again.

Question / Challenge

Which path did he take?

A) A C F
B) A D G F
C) A D G
D) No path is valid

Time Allowed: **180 minutes**

T6. Keys

Beaver Bob needs to open this lock:

Question

Which of these keys can open the lock?

A)

B)

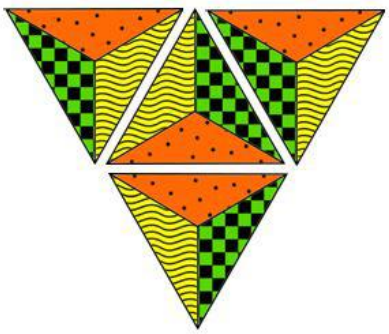
C)

D)

T7. Triangles

A beaver wants to create a mosaic with triangle-shaped tiles. He starts with one tile and, step by step, completes the pattern, by first rotating the tile 90 degrees clockwise and then adding tiles on each side of the triangle-shaped tiles, as shown in the picture below.

Step = 1



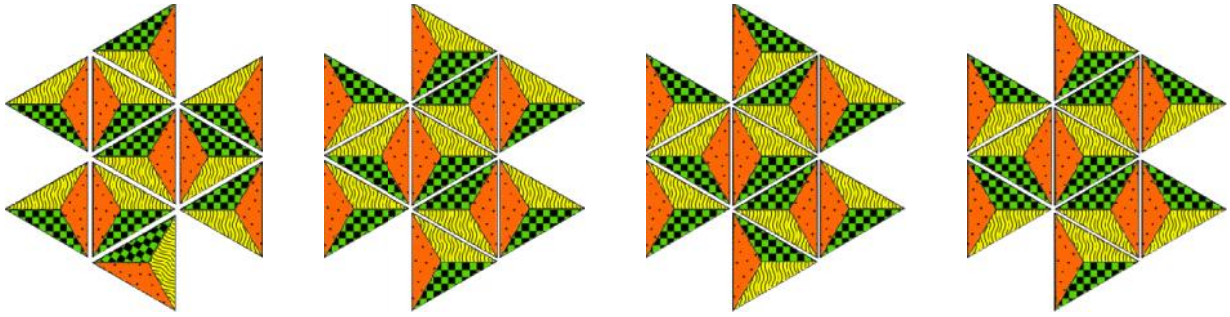
Step = 2

Step = 3

Question / Challenge

What will be the final shape of the triangles after step 3?

Time Allowed: **180 minutes**



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

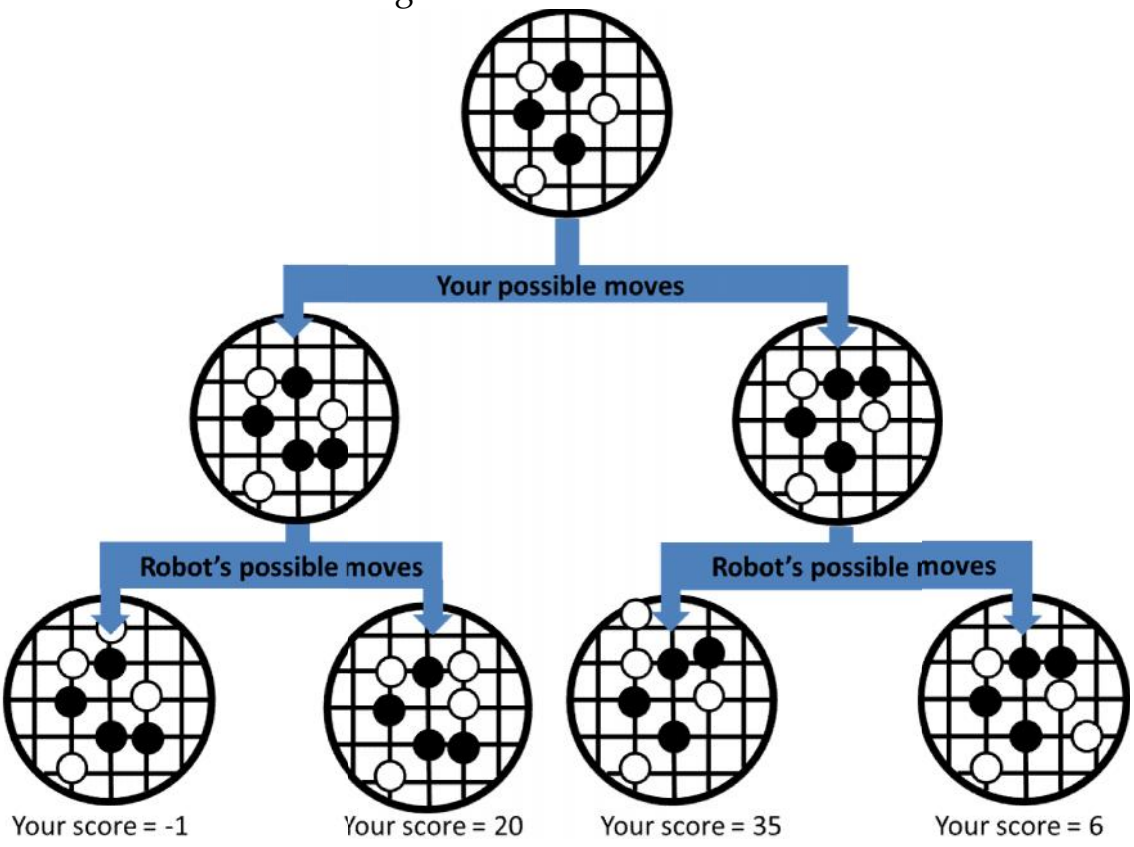
T8. BeaverGo

BeaverGo is a board game where two players alternate placing a stone on a board.

You can play BeaverGo against a robot. You play black, robot white.
The robot plays smart: when choosing between two moves, it makes the move that minimizes the score you will be able reach.

Near the end of the game you have one last move to make. After your move, the robot will move and then the game is finished.

The diagram shows which choice you have for your move, and what choices the robot player will have afterwards. It also shows what your score will be in each of the different endings.



Time Allowed: **180 minutes**

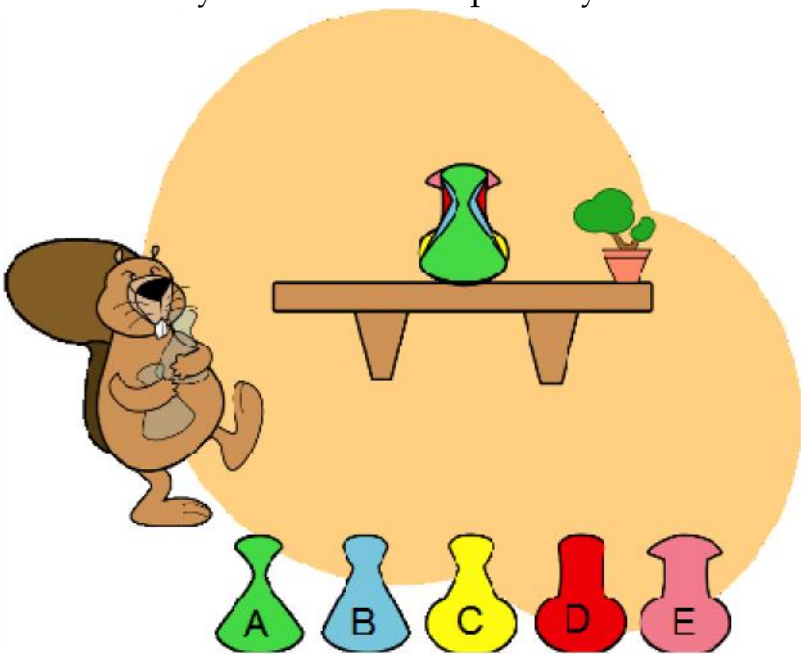
Question / Challenge

If you play to get the highest score possible, and the computer plays to give you the lowest score possible, which score will you have at the end of the game?

A) -1 **B)** 20 **C)**35 **D)** 6

T9. Bottles

Beaver is putting five bottles on a shelf. He wants to place the bottles behind each other so that every bottle is at least partially visible.



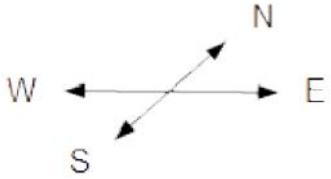
Question / Challenge

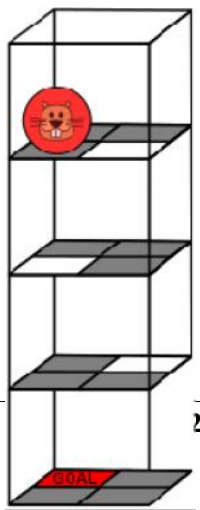
What is the correct order of the bottles so that they appear as shown on the shelf?

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

T10. Spherical robot

The BeaverBall is a toy that can be operated by remote control, and understands each of four direction commands.





If the BeaverBall moves to a white square, it drops down one level. The BeaverBall ignores commands that cause it to move outside the borders.

Question / Challenge

Look at the position of the BeaverBall in the picture above. Which of the following lists of directions will cause the BeaverBall to reach the GOAL?

A) E, W, N, W, W
B) E, W, N, E, S, W
C) E, W, E, N, S, W
D) E, N, W, S, N, E, W

Tasks T11 – T20 carry 4 points each

T11. 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!

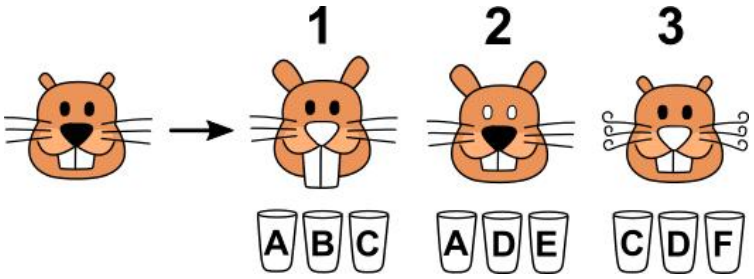
Then, he set up the following experiments to identify the magic potion in each beaker.

- 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.

Time Allowed: **180 minutes**



Question / Challenge

Which one of the beakers contains pure water?

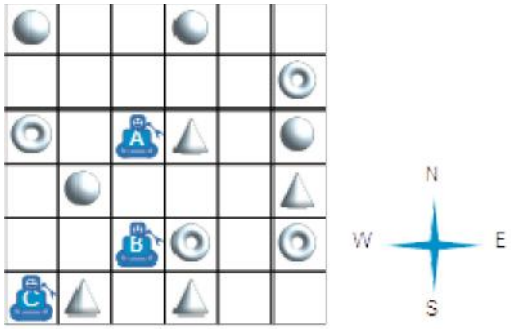
A) A **B)** B **C)** C **D)** D

T12. Concurrent directions

In a warehouse, three robots always work as a team.

When the team gets a direction symbol (N, S, E, W), all robots move one grid square in that direction at the same time. After following a list of direction symbols, each robot picks up whatever object there is in the robot's grid square.

For example, if we give the list N, N, S, S, E to the team, then robot A will pick up a cone, robot B will pick up a ring, and robot C will pick up a cone.



Question / Challenge

What list can be sent to the team so that the team picks up exactly a sphere, a cone, and a ring?

A) N, E, E, E
B) N, E, E, S, E
C) N, N, S, E, N
D) N, E, E, S, W

T13. Party Banner

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

Time Allowed: **180 minutes**

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.

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?

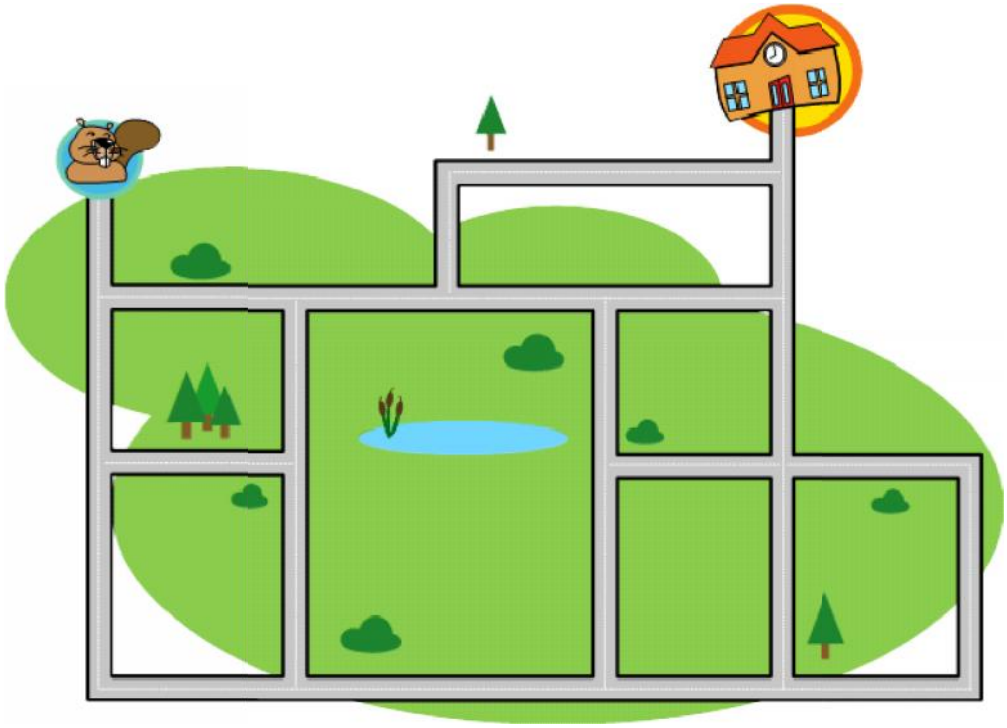
A) 31 **B)** 32 **C)** 33 **D)** 34

T14. Car Trip

A self-driving car needs to transport a student to school.
The car is programmed in such a way to only use these 3 instructions:
Forward: go forward until you cannot go forward anymore
Left: turn 90° left
Right: turn 90° right

Question / Challenge

Which sequence of instructions (a program) will get the beaver to his school?



Time Allowed: **180 minutes**

A) 

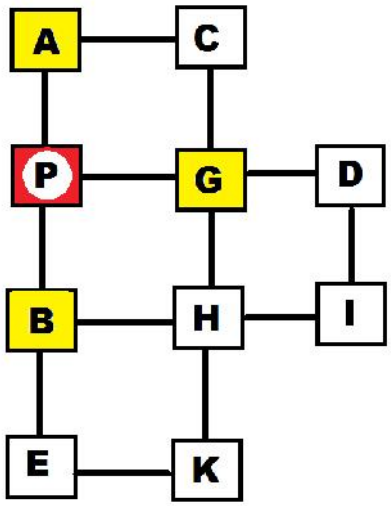
B) 

C) 

D) 

T15. A postman tour

Each segment in the picture represents a street. The intersections of the streets are named by letters. Beaver Tom is a postman. Every day he starts walking from post office P, visits houses in all streets and returns to the post office. The distance between each intersection is 1.



Question / Challenge

Tom stands at P and wants to pass each street at least once.
What is the minimum distance covered by Tom to accomplish his task?

A) 12 **B)** 14 **C)** 16 **D)** 18

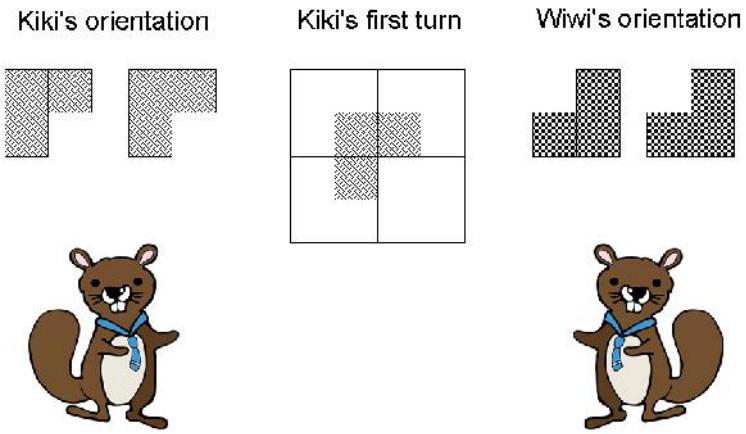
T16. L-Game (I)

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.

Time Allowed: **180 minutes**



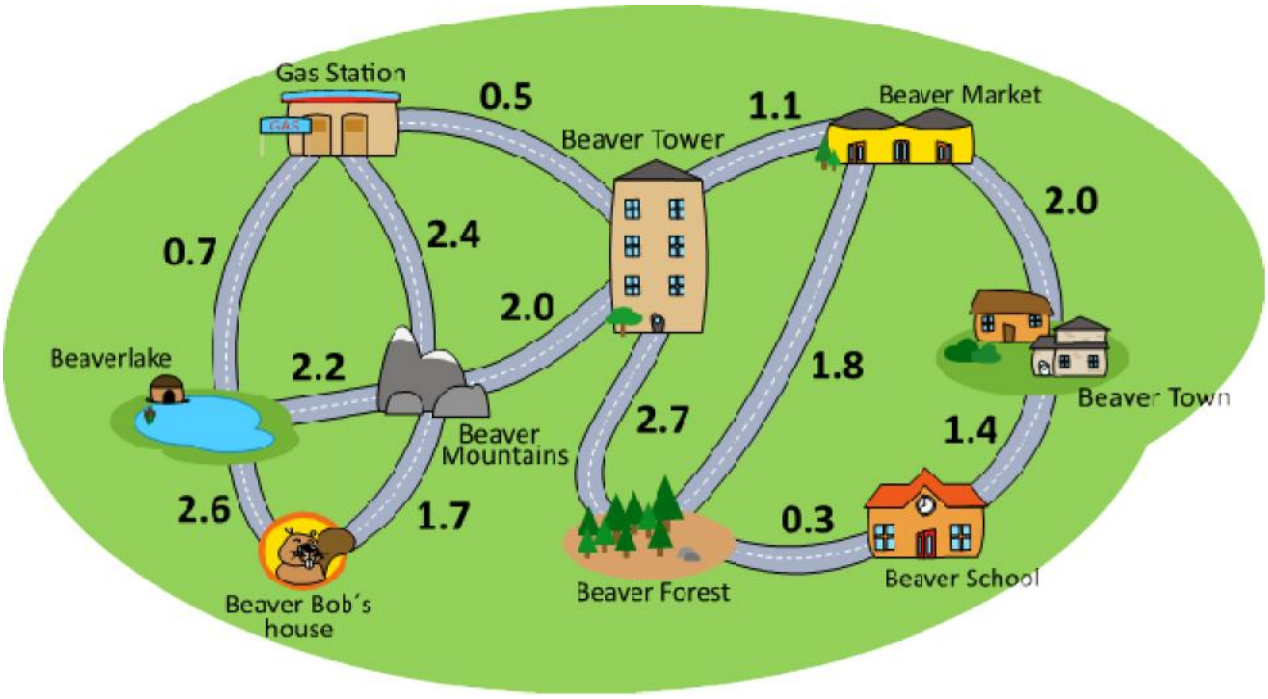
Question / Challenge

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.

T17. Late for dinner

Beaver Bob wants to visit his friends in Beavertown because he is invited for dinner at 7:00 p.m. Bob wants to buy a present for his friend at the Beavermarket. He also needs to pick up his son Rob at Beaverschool before he drives to Beavertown. Bob's car has fuel left to drive 4 hours so he additionally needs to visit the gas station to refuel his car. Once he refueled his car, he can drive for another 9 hours. The duration for a specific road is given in hours. It's 10:00 a.m. right now and Bob needs to hurry up, because he doesn't want to be late.



Time Allowed: **180 minutes**

Question / Challenge

Which roads should Bob choose?

A) Beaver Bob's House → Beaverlake → Gas Station → Beavertower → Beaverforest → Beaverschool → Beaverforest → Beavermarket → Beavertown

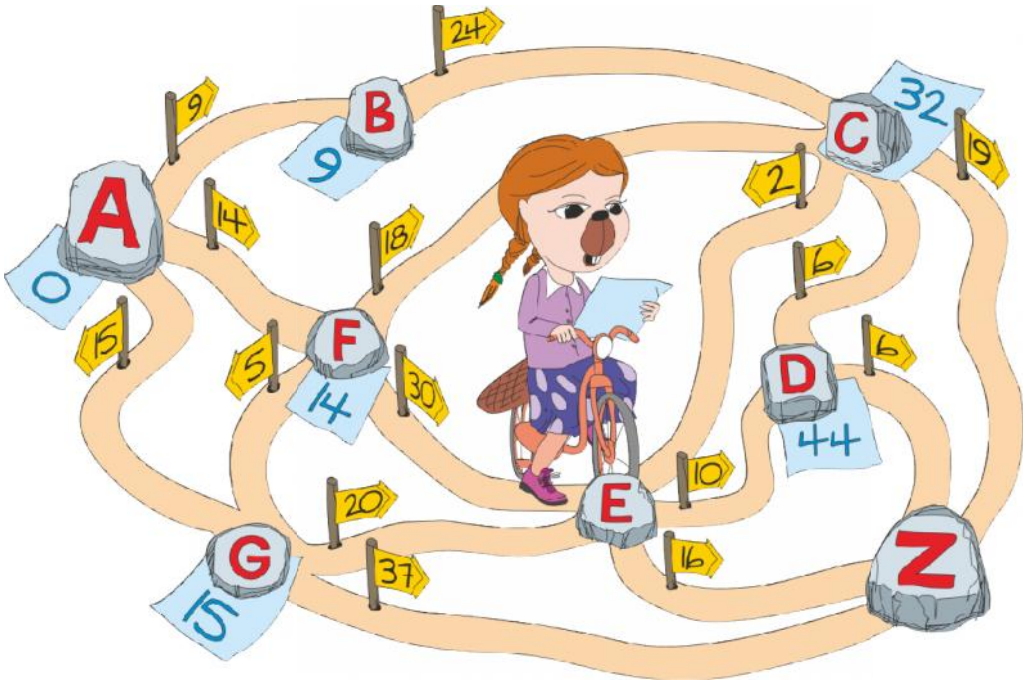
B) Beaver Bob's House → Beaver Mountains → Beavertower → Beavermarket → Beaverforest → Beaverschool → Beavertown

C) Beaver Bob's House → Beaverlake → Gas Station → Beavertower → Beavermarket → Beaverforest → Beaverschool → Beavertown

D) Beaver Bob's House → Beaver Mountain → Gas Station → Beavertower → Beaverforest → Beaverschool → Beavertown

T18. 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.



Question / Challenge

What number is she writing down for E?

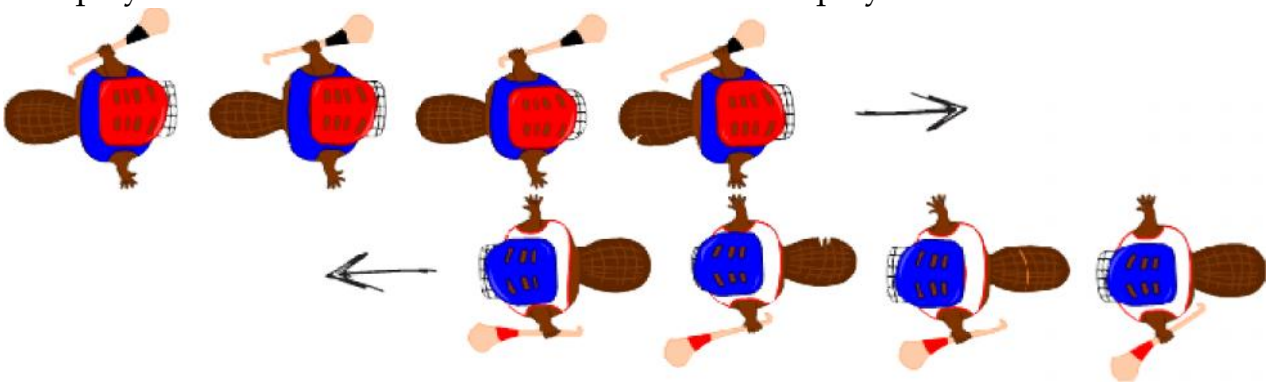
A) 14 **B)** 15 **C)** 30 **D)** 34

Time Allowed: **180 minutes**

T19. Hurlers shake hands

Beavers are very good at the Irish game called hurling. Whenever a game of hurling ends, beavers in each of the two teams line up in a row, one after another, and walk past the other team. As they pass each other, they shake hands and say "Thanks for the game!"

At the beginning, only the first player on each team shakes hands. Next, the first two players shake hands (see picture below). This continues until each player on one team has shaken hands with each player on the other team.



Question / Challenge

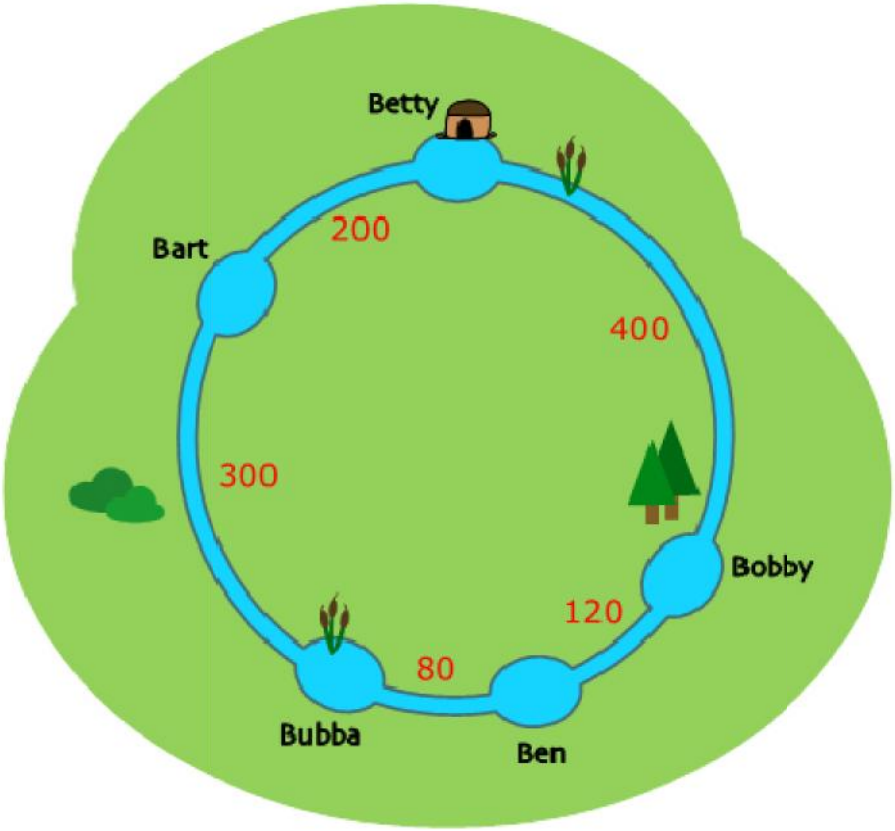
In a game of hurling, there are 15 players on each team. If each player takes one second to shake hands and move to the next player, how many seconds of shaking hands will there be?

A) 15 **B)** 29 **C)** 30 **D)** 45

T20. Meeting

Five beavers happily live around a circular canal. They decided to have regular meetings at one of their places. They want to minimize the total swimming distances for them to get to the meeting place.

Time Allowed: **180 minutes**



Question

At who's place will the meeting take place?

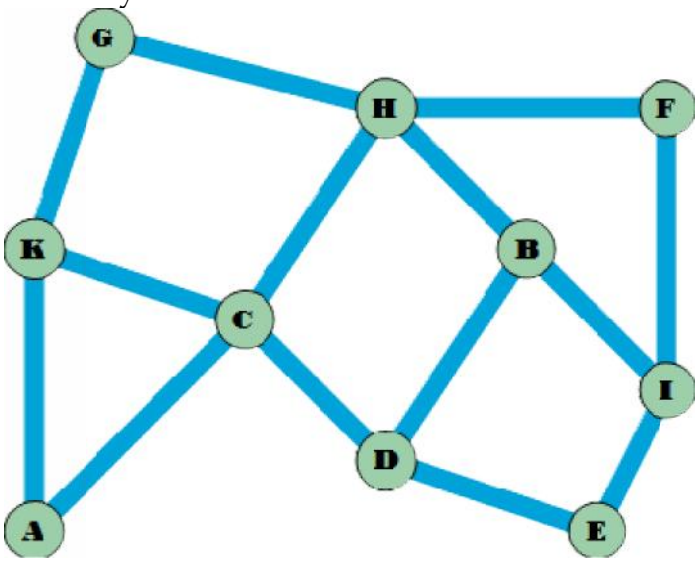
A) Bobby **B)** Ben **C)** Bubba **D)** Bart

Tasks T21 – T30 carry 5 points each

T21. Primary Health Care

Time Allowed: **180 minutes**

The beaver doctor wants to build three stations for primary health care for his fellow beavers. He wants to position the stations so that the beavers have to swim at most through one water canal to reach the next station, regardless of which intersection they are at.



Question / Challenge

Which of the places above cannot be chosen to position a station, while at the same time satisfying the requirements of reaching a station within one water canal at most?

A) A **B)** B **C)** F **D)** G

T22. Food Storage (1)

Beavers hide their logs well, so they need to record the instructions to find them again...

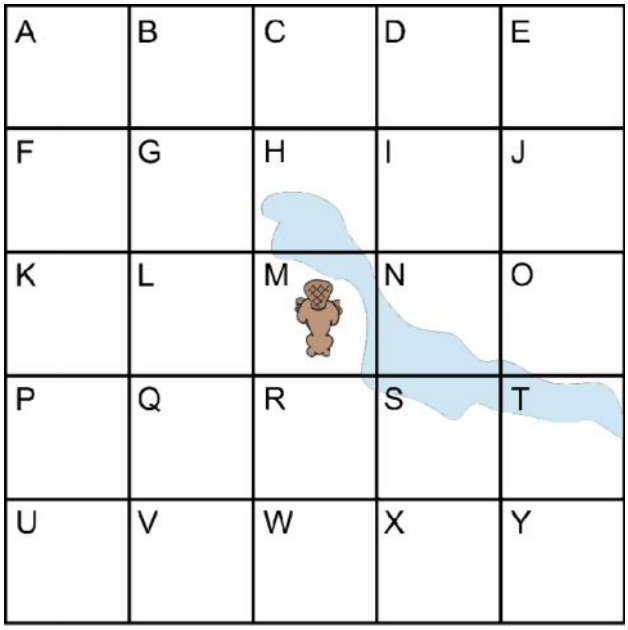
Time Allowed: **180 minutes**

Beaver Nick wrote an instruction sequence that tells him how to find again his logs and to pick up *exactly* six logs (which is his daily diet). The instruction sequence is based on a map of the area that is divided into squares. It describes a path from Nick's home (square M) to another point on the map (square N).

Nick used four instructions:

- "jump one square forward",
- "pick up a log at the current square",
- "put down a log at the current square", and
- "turn left (90 degrees counterclockwise)".

To ease writing, Nick used the following symbols to encode the instructions:
x, o, +, -



He takes a look at his instruction sequence:
+-++oo---+---oo+++oooo---+-+---++xxx---+-+---+---xxx++oooo---+---+

But... unfortunately Nick forgot which symbol encodes which instruction! He just recalls that the path had no U-turns.

Question / Challenge

Which is the symbol for "one square forward"?

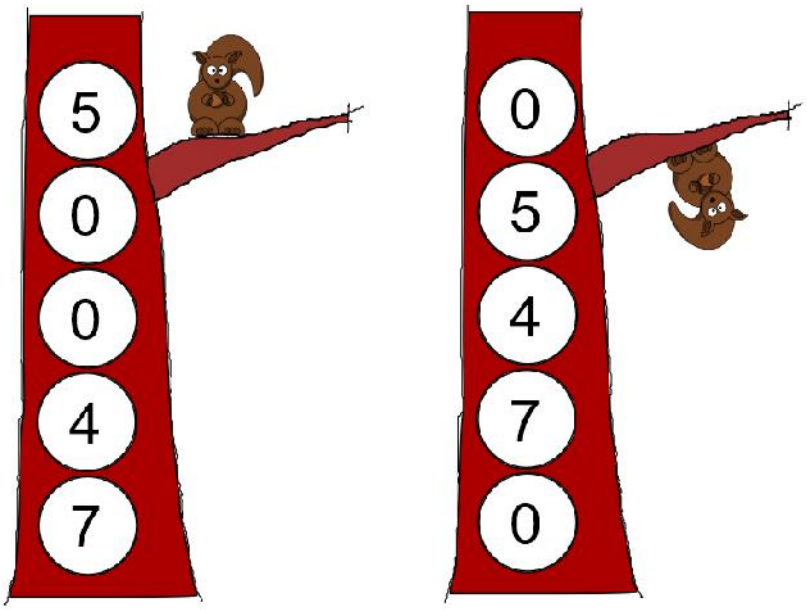
A) + **B) o** **C) x** **D) –**

T23. Selfish squirrels

Time Allowed: **180 minutes**

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

Time Allowed: **180 minutes**

T24. 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.

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.

T25. Alphabetical names

A name is called alphabetical when it can be assembled from the alphabetically sorted list of its letters by following this algorithm:

- Create the sorted list of letters.
- Start with the first letter from the list.
- Take the next letter from the list and add it to the left or to the right of the name.
- Continue till the list is empty.

The name HENRY is alphabetical: its alphabetical list of letters is EHNRY and we can put it together:
E -> **H**E -> HE**N** -> HEN**R** -> HENR**Y**

Time Allowed: **180 minutes**

The name LUCY is not alphabetical: its alphabetical list of letters is CLUY. It is impossible to add second letter **L** to the first letter **C** because letters C and L are not adjacent in the word LUCY.

Question / Challenge

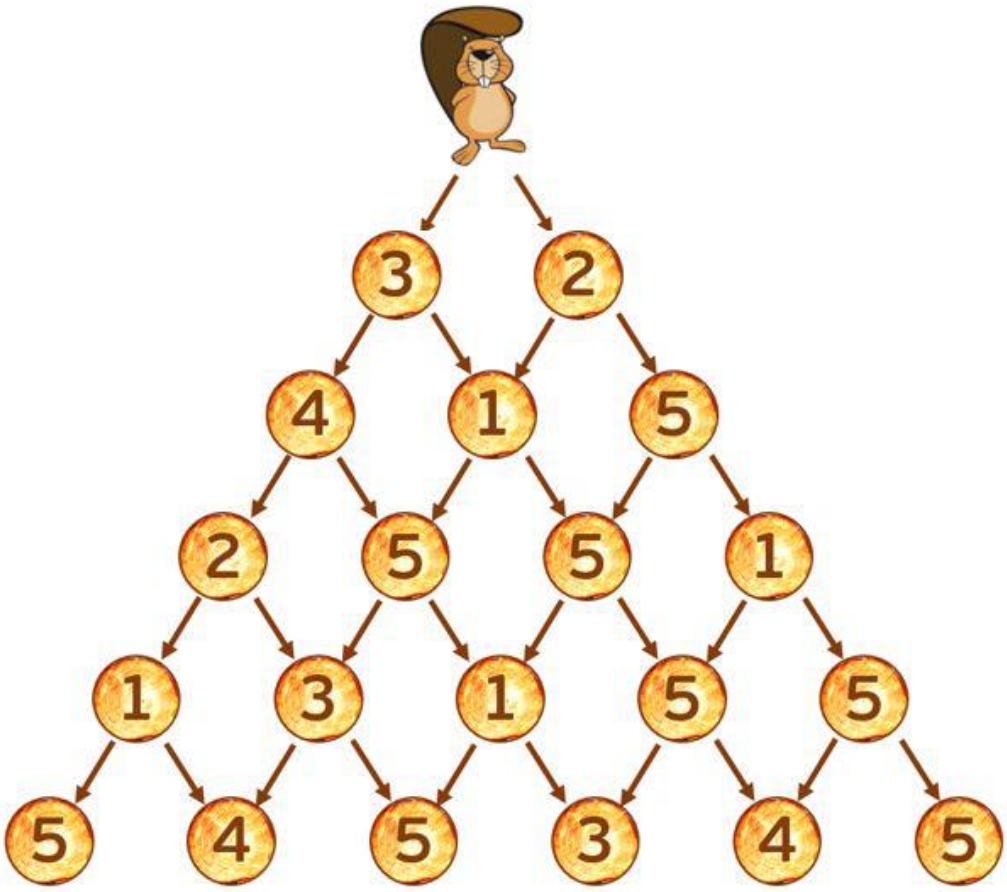
Which of these names is alphabetical?

A) JOHNNY **B)** SUSAN **C)** ISIDOR **D)** ROBERT

T26. Collecting Wood

During his descend from mountain top, the beaver Theseas is collecting wood for his lodge from several stations. Every station holds different amount of wood. While he is descending he cannot change direction and start climbing again.

The paths with stations of wood are given in the image below. Every circle is a station and the number in it represents the amount of wood Theseas can collect.



Question / Challenge

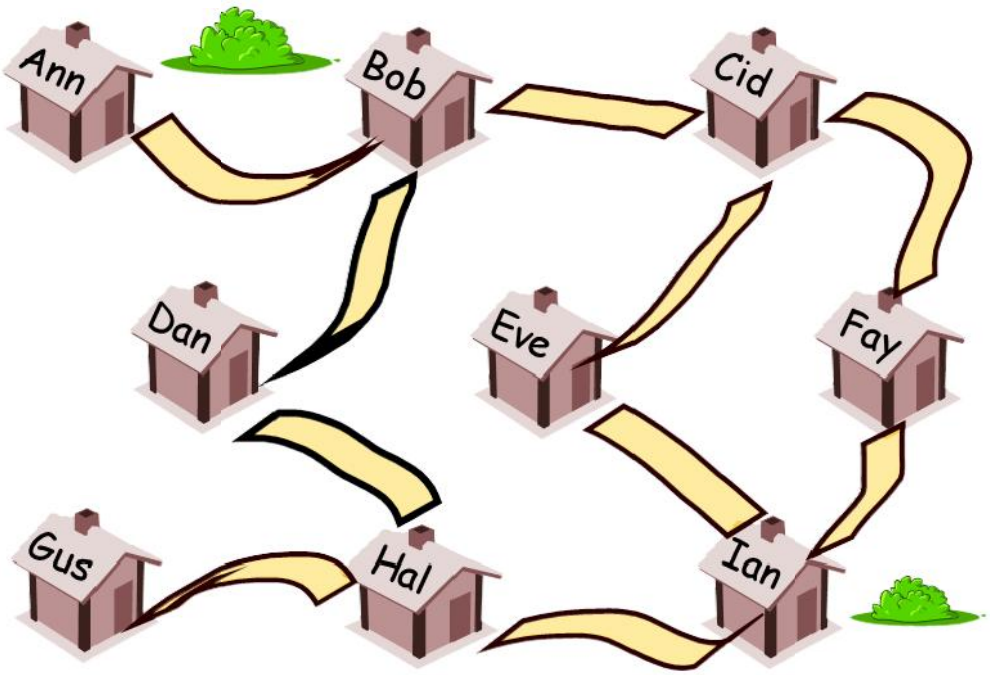
What is the maximum total amount of wood that Theseas can collect during his descent ?

A) 19 **B)** 20 **C)** 21 **D)** 22

Time Allowed: **180 minutes**

T27. Firefighter

The mayor of Beaverville is looking for volunteer firefighters . A map showing the possible volunteers' homes and how they are connected by roads is shown below. He wants to ensure that every home is either the home of a volunteer or is connected by a single road to a home of someone who is a volunteer.



Question / Challenge

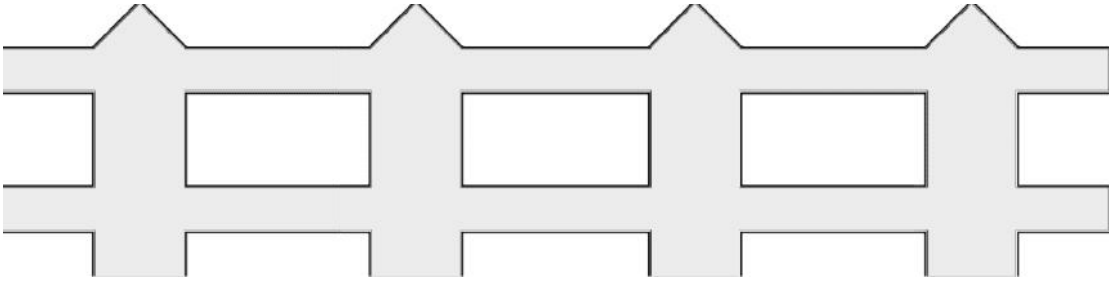
What is the minimum number of volunteers Frank needs?

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

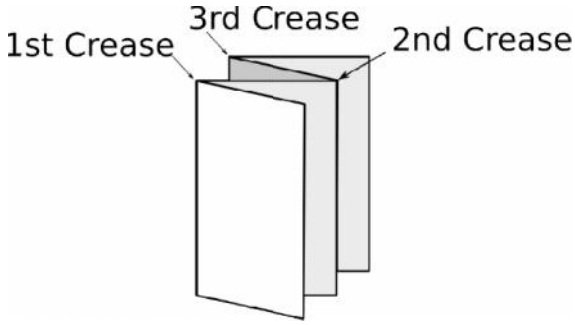
Time Allowed: **180 minutes**

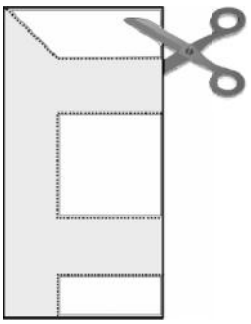
T28. The fence

A little beaver is trying to create a paper fence like the following figure:



To make this fence, he first folds a strip of paper like a zigzag shape (as shown in the left figure) and then cuts out a shape with a pair of scissors





(exactly as shown in the right figure).

For example, there are three creases in the left figure.

Question / Challenge

How many creases will the piece of paper have before using scissors to cut out the fence?

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

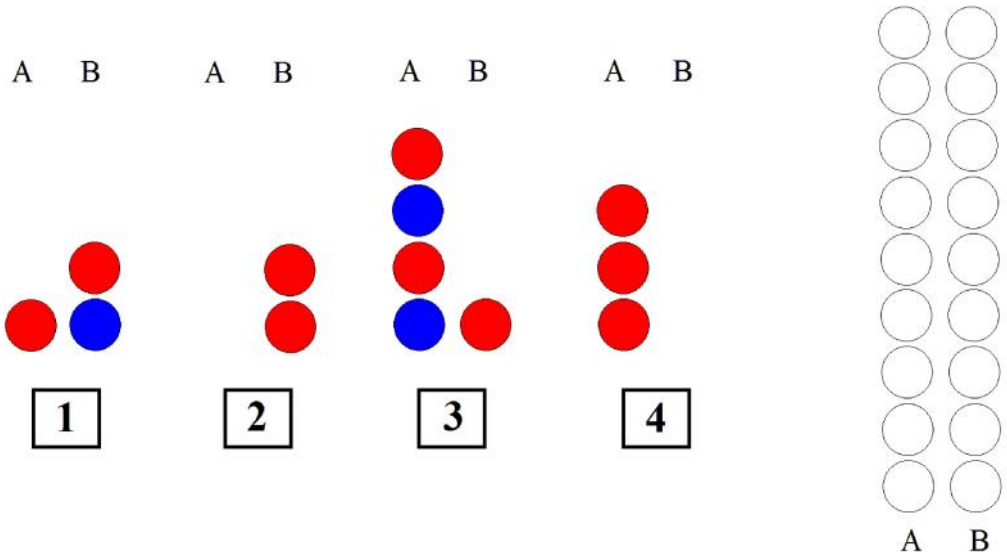
Time Allowed: **180 minutes**

T29. Falling marbles

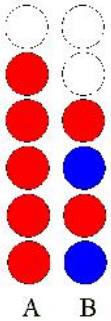
Beaver Leon is trying a new puzzle that he has just implemented on his computer.

When a game begins, four pairs of stacks of colourful marbles appear on the left of the screen.

Whenever Leon clicks a numbered button, the corresponding pair of stacks falls, from above, into the two cylinders A and B (initially empty) on the right.



For example, in the case shown in the picture above (where buttons 2 and 4 drop marbles into only one of the two cylinders, B and A respectively), if Leon clicks button 1, then 4, and then 1 again, the resulting two stacks in the cylinders A and B are not equal, because they do not have the same height and at least one pair of marbles at the same level have a different colour.



The puzzle is successful when the two cylinders contain two *identical* non-empty stacks.

Question / Challenge

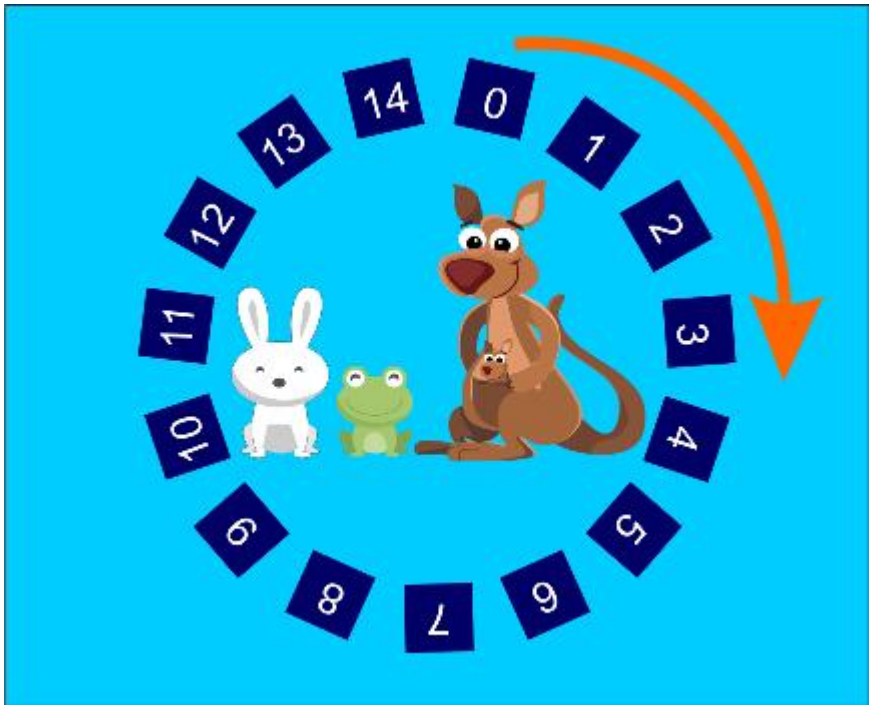
In the case shown in the first picture, Leon begins clicking button 2 and then button 1. From the following options, which is the WRONG continuation of clicks to solve the puzzle?

Time Allowed: **180 minutes**

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

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

Time Allowed: **180 minutes**