UNIVERSITY OF WATERLOO

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

2018 Beaver Computing Challenge (Grade 9 & 10)

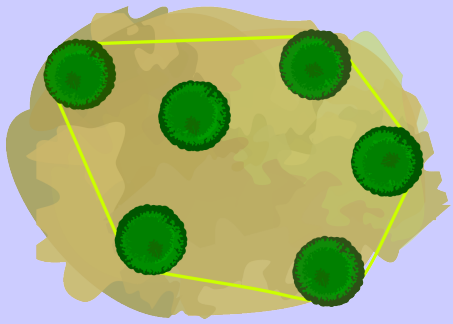
Questions

Part A

Roped Trees

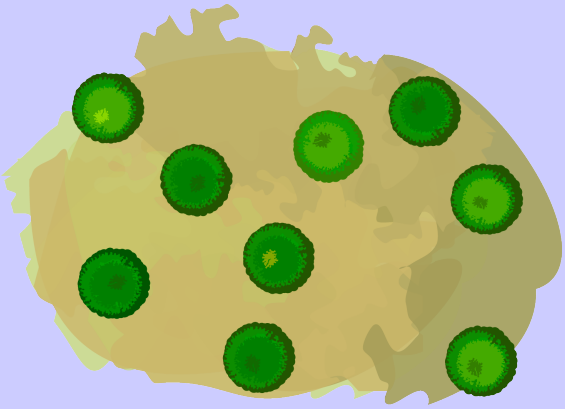
Story

Joni Beaver uses rope to mark groups of trees. The rope forms a very tight loop so that each tree either touches the rope or is entirely inside the loop. Below is an example where the rope touches exactly 5 trees when viewed from above.



Question

How many trees will the rope touch if the trees are arranged as follows (when viewed from above)?



(A) 4

(B) 5

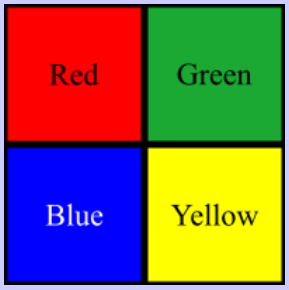
(C) 6

(D) 7

Rotation Game

Story

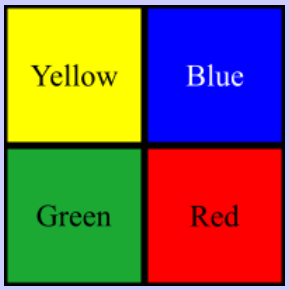
Beavers play a simple game. The game always begins with this starting position:



From this starting position, rotation instructions are followed. All the rotations are clockwise and one quarter of a complete turn. The possible instructions are:

- 1R – meaning rotate the squares one time,
- 2R – meaning rotate the squares two times,
- 3R – meaning rotate the squares three times.

For example, if the first instruction is 2R, the top-left square will be Yellow as shown below.



Question

From the starting position, what colours will the top-left square be after each of the instructions 1R, 2R, 2R, and 3R are followed in order?

(A) Red Green Blue Green Yellow

(B) Red Blue Green Blue Red

(C) Red Blue Yellow Red Green

(D) Red Red Yellow Red Blue

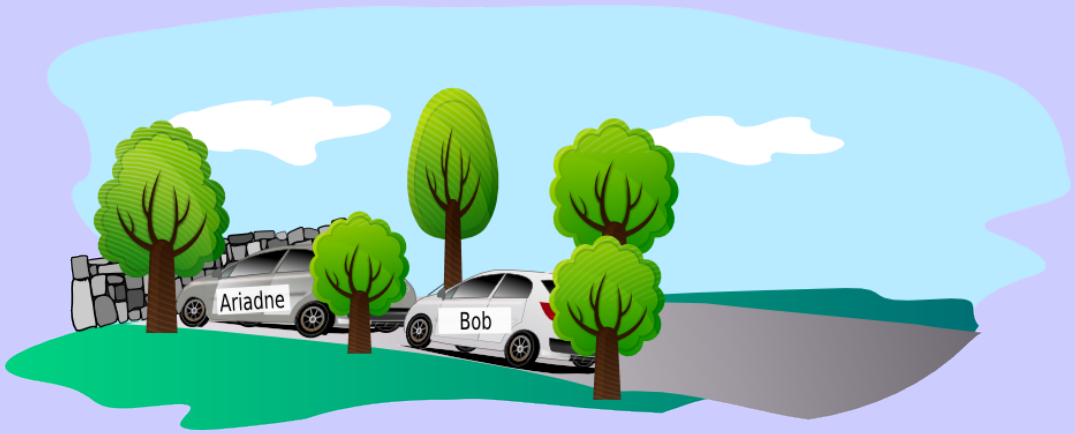
Sharing a Driveway

Story

Neighbours share a very long and narrow driveway. Cars parked in the driveway can only leave by backing out. A schedule has been created so that nobody is ever blocked in when they need to leave the driveway. On each day, any cars which need to leave do so before any other cars enter. Before Monday, there are no cars in the driveway. The table below gives details of how the driveway is shared over one week.

Day	**Number of cars leaving**	**Number of cars entering**	**Owners of cars and order they enter**
Monday	0	2	Ariadne, Bob
Tuesday	1	3	Kate, Ben, Roy
Wednesday	2	1	Daisy
Thursday	0	2	Finn, Rose
Friday	3	1	Vincent

The driveway at the end of Monday is shown below:



Question

Whose cars will be parked on the driveway at the end of Friday?

(A) Bob, Vincent, Daisy

(B) Vincent, Ariadne, Rose

(C) Ariadne, Kate, Vincent

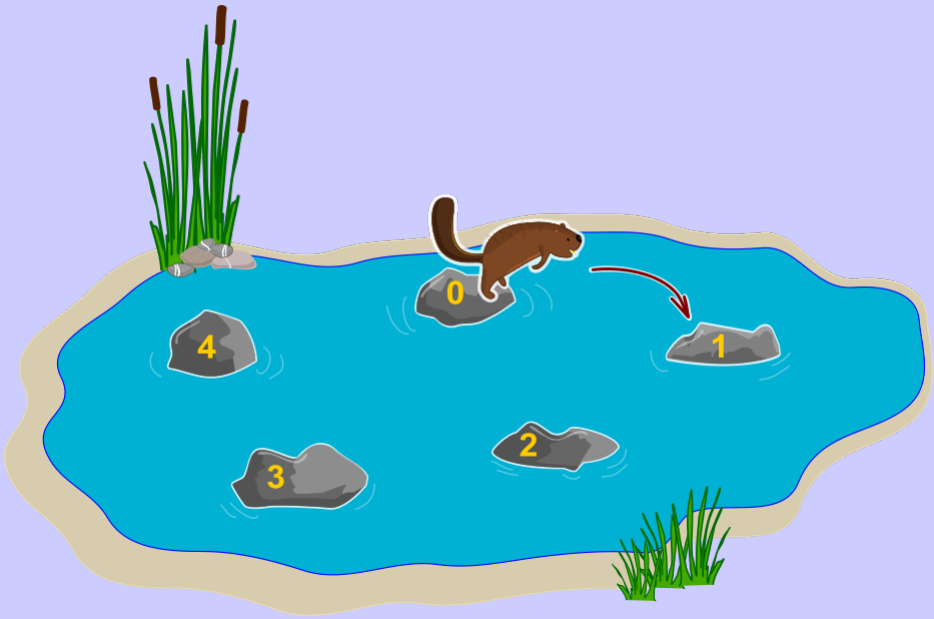
(D) Ariadne, Daisy, Vincent

Beaver Jump Challenge

Story

Beavers take part in an annual challenge. Starting from rock number 0, they jump clockwise from rock to rock. For example, if a beaver jumps 8 times, it ends up on rock number 3:

$$0 \to 1 \to 2 \to 3 \to 4 \to 0 \to 1 \to 2 \to 3$$



Question

One of the beavers showed off and jumped an astonishing 129 times. On which rock did it end up?

(A) 4

(B) 3

(C) 2

(D) 1

Lemonade Party

Story

James made 37 litres of lemonade at home and now he wants to bring it to a celebration at school. He has several empty bottles of various sizes but he wants to use the smallest number of them to bottle exactly 37 litres of lemonade.

He has one bottle of each of the following sizes:

- 1 litre
- 2 litre
- 4 litre
- 8 litre
- 16 litre
- 32 litre

Question

What is the least number of bottles James needs to use?

(A) 1

(B) 2

(C) 3

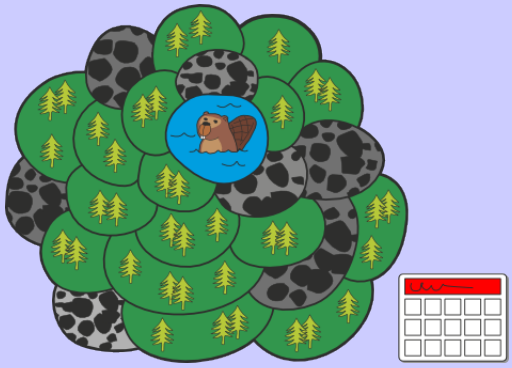
(D) 4

Part B

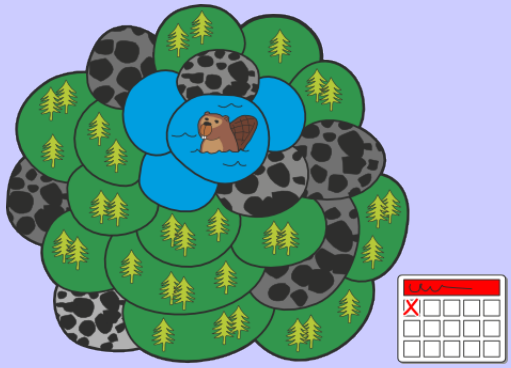
Beaver Lake

Story

Beavers live in a valley surrounded by mountains. In the valley, there is a lake. The lake is surrounded by fields with either trees or stones.



Every day, beavers flood all those fields with trees that are next to the lake or flooded fields. Fields with stones are not flooded.



For example, after one day, three fields will be flooded, as shown above.

Question

After how many days in total will all the fields with trees be flooded?

(A) 4 days

(B) 5 days

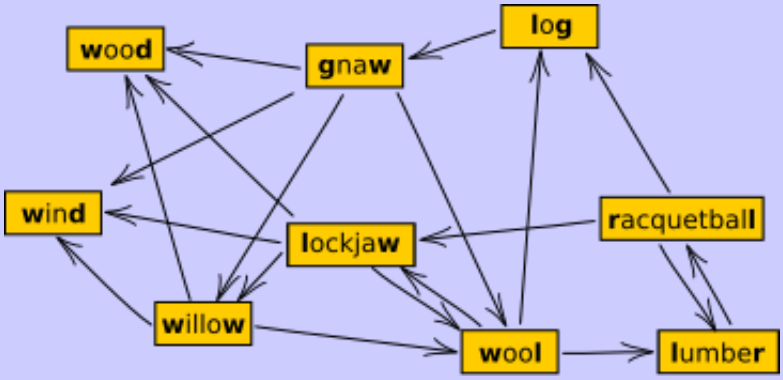
(C) 6 days

(D) 7 days

Longest Word Chain

Story

Beavers play a word chain game. One beaver starts by saying a word. The other beaver must say a different word which begins with the last letter of the previous word. Then the first beaver says another word (which was not said yet) using this same rule, and so on. If a beaver is unable to say a new word, that beaver loses the game. These beavers do not know many words. In fact, they can draw their entire vocabulary like this:



Notice that an arrow out of a word points at the next possible word(s) that can be said.

Question

What is the largest possible number of words that can be said in one game?

(A) 6

(B) 7

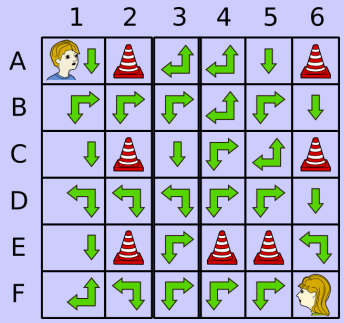
(C) 8

(D) 9

Twists and Turns

Story

Tom lives in a city with a lot of twists and turns. His mom forgot her phone at home and asked Tom to bring it to her at work. She sent Tom the following street map to help him find his way.



The map is a table with rows A, B, C, D, E, F, and columns 1, 2, 3, 4, 5, 6. Tom starts in the first row and column (location A1) and his mom is located in the last row and column (location F6).

There is one symbol at each location on the map. The symbols have the following meanings:

-  means Tom can only go down from this location
-  means Tom can go either down or right from this location
-  means Tom can go either left or down from this location
-  means Tom can go either up or left from this location
-  means Tom hits an obstacle and cannot move beyond this location

Question

According to the map, which of the following is a valid route from Tom to his mom?

(A) A1 B1 B2 B3 C3 D3 E3 E4 F4 F5 F6

(B) A1 B1 B2 B3 B4 C4 D4 D5 D6 E6 F6

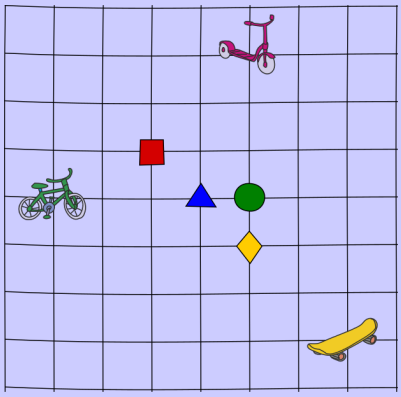
(C) A1 B1 B2 B3 C3 D3 E3 F3 F4 F5 F6

(D) A1 B1 B2 B3 C3 D3 D4 D5 D6 E6 F6

Three Friends

Story

Bob  , Alice  , and Jenny  are each playing at a different intersection in the 8-by-8 grid below. They want to choose an intersection where they can all meet to show off their different vehicles.



They will each travel to the chosen location moving only horizontally and vertically along grid lines.

Question

Which intersection should be chosen, so the three friends travel the shortest total distance?

(A) the intersection marked by a green circle (●)

(B) the intersection marked by a red square (■)

(C) the intersection marked by a blue triangle (▲)

(D) the intersection marked by a yellow rhombus (◆)

Timetabling

Story

Bebras Tech offers the following evening classes:

- Computing (C),
- Geography (G),
- Language (L),
- Math (M), and
- Science (S).

Three beavers would like to sign up for these courses:

- Xavier wants to take C, L, and M;
- Yvette wants to take C, G, and S;
- Zoey wants to take L, M, and S.

Bebras Tech wants to squeeze these courses into as few evenings as possible such that:

- each course is offered on exactly one evening, and
- beavers can take at most one course per evening.

Question

What is the least number of evenings needed for Bebras Tech to schedule these courses?

(A) 2

(B) 3

(C) 4

(D) 5

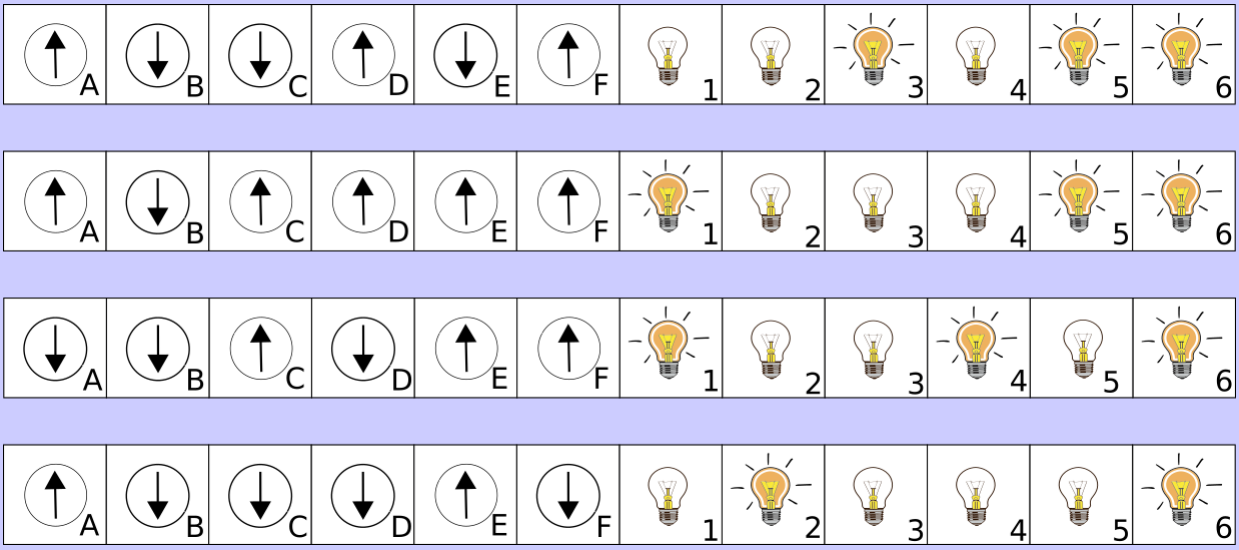
Part C

Bulbs

Story

An amateur electrician connected 6 bulbs (numbered 1, 2, 3, 4, 5, and 6) to 6 switches (labelled A, B, C, D, E, and F). Each switch operates exactly one bulb but nobody knows which one. Each switch can be either up or down, but we don't know which position corresponds to the bulb being on and which position corresponds to the bulb being off. To make matters worse, this could be different for different switches.

Four experiments were conducted to determine which switch is connected to which bulb. The results of these experiments including the position of the switches and on/off status of the bulbs are shown below.



Question

Which switch is connected to which bulb?

(A) C → 1, E → 2, D → 3, A → 4, F → 5, B → 6

(B) C → 1, F → 2, E → 3, A → 4, D → 5, B → 6

(C) C → 1, F → 2, D → 3, E → 4, A → 5, B → 6

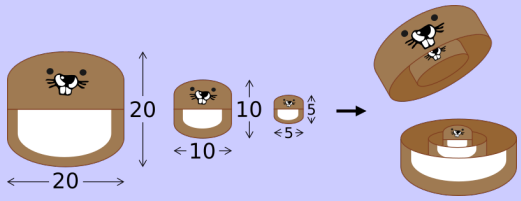
(D) C → 1, F → 2, B → 3, A → 4, D → 5, B → 6

Nesting Dolls

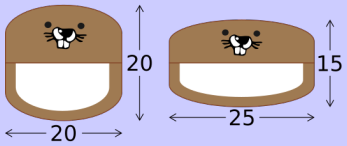
Story

Wooden toy dolls have different widths and heights. They are hollow and can be separated into two parts. This means that a doll can be nested inside any other doll that is both wider and higher.

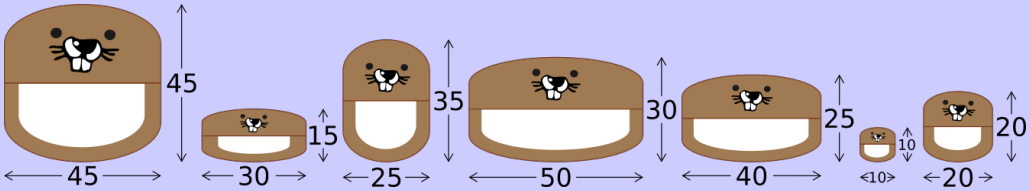
For example, a doll with width 5 and height 5 fits inside a doll with width 10 and height 10, which in turn fits inside a doll with width 20 and height 20. After this, only one doll is visible.



On the other hand, a doll with width 20 and height 20 cannot fit inside a doll with width 25 and height 15. Also, a doll with width 25 and height 15 cannot fit inside a doll with width 20 and height 20. So, if these are the only two dolls, they will both always be visible.



Ian has the following collection of dolls and starts fitting them inside each other.



Question

What is the fewest possible number of dolls that are visible after Ian is done?

(A) 1

(B) 2

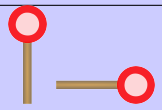
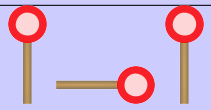
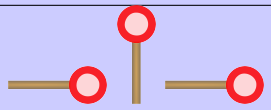
(C) 3

(D) 4

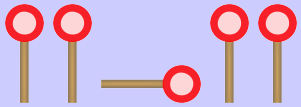
Plane Signals

Story

Jana and Robin play outside with their toy plane. Jana stands on a hill and Robin collects the plane after each landing. The plane always lands in long grass, which means, after landing, it is only visible from the hill and not up close. So, Jana uses a beacon and the following code to send Robin signals guiding her to the plane.

Left	**Right**	**Towards the hill**	**Away from the hill**
			

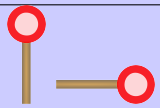
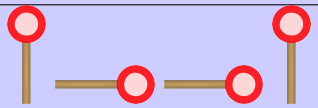
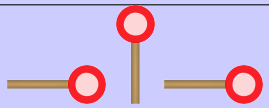
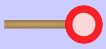
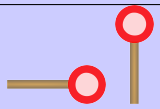
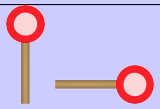
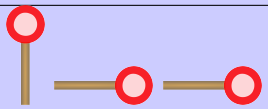
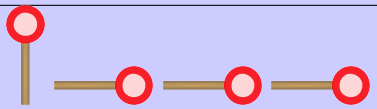
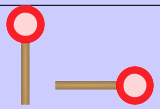
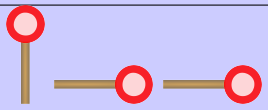
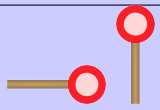
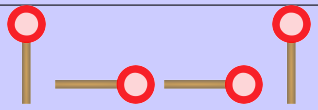
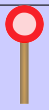
Unfortunately, there is a problem. Some signals received by Robin have multiple meanings. For example, suppose Jana sent the following signal to Robin:



Jana could mean either **Left, Towards the hill, Left** or she could mean **Left, Right, Left, Left**. Jana and Robin have to revise the code to fix this problem.

Question

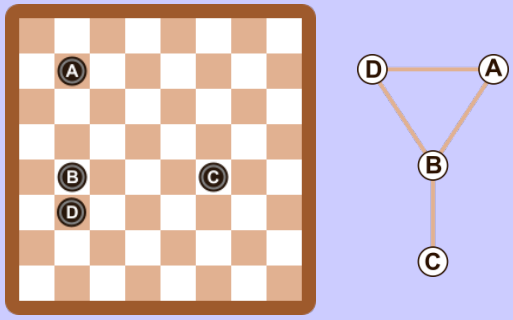
For which of the following codes do all signals have only one meaning?

	Left	**Right**	**Towards the hill**	**Away from the hill**
(A)				
(B)				
(C)				
(D)				

Rows and Columns

Story

A game board with four pieces on it is shown below together with a diagram representing it.



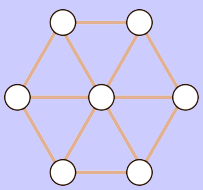
The diagram is drawn in the following way

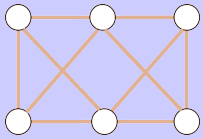
- One circle is drawn for each piece on the game board. (Letters have been shown in this example so you can see the correspondence between game pieces and circles on the diagram.)
- Whenever two pieces are in the same row or in the same column, a line is drawn between the corresponding circles. (No other lines are drawn.)

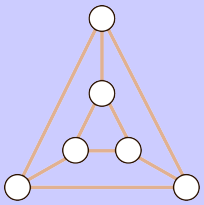
Rich draws a diagram for the following board in the same way.

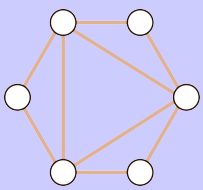
Question

Which of the four diagrams might Rich have drawn?

(A) 

(B) 

(C) 

(D) 

Find the Prize

Story

Your friend is thinking of an integer between 1 and 63 (inclusive).

They offer to give you money if you guess the integer they are thinking of.

If you guess the number on your first guess, you win \$1000. Every time you guess incorrectly, your friend will take \$10 away from the prize money, but also tell you whether your guess was above or below the integer they were thinking of.

You find a strategy that *guarantees* you win at least \$N, regardless of the number your friend is thinking of.

Question

What is the largest possible value of N?

(A) \$990

(B) \$950

(C) \$500

(D) \$370