UNIVERSITY OF WATERLOO

The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

2024 Beaver Computing Challenge (Grades 9 & 10)

Questions

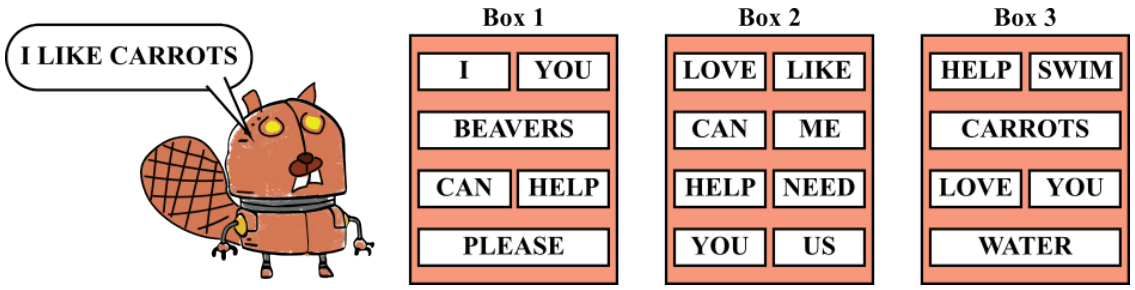
Part A

Beaver Robot

Story

Beaver Robot can say sentences containing exactly 3 words.

- The first word must be chosen from Box 1.
- The second word must be chosen from Box 2.
- The third word must be chosen from Box 3.



Question

Which sentence below **cannot** be said by Beaver Robot?

(A) CAN YOU HELP

(B) BEAVERS CAN SWIM

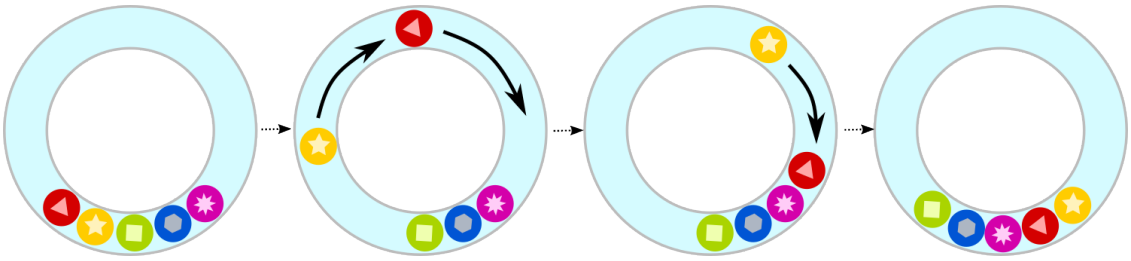
(C) I LOVE YOU

(D) YOU NEED ME

Rattle

Story

A baby's rattle is made of a clear circular tube with colourful balls inside. When the baby shakes the rattle, some balls can move through the tube. An example of the rattle before and after it is shaken is shown.



While there is room for the balls to move, there isn't room for one ball to move past another ball.

Question

Which of the following could be the baby's rattle after it has been shaken again?

(A) 

(B) 

(C) 

(D) 

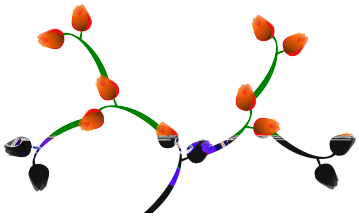
Miracle Plant

Story

A miracle plant seedling has a stem and two buds. It looks like this: 

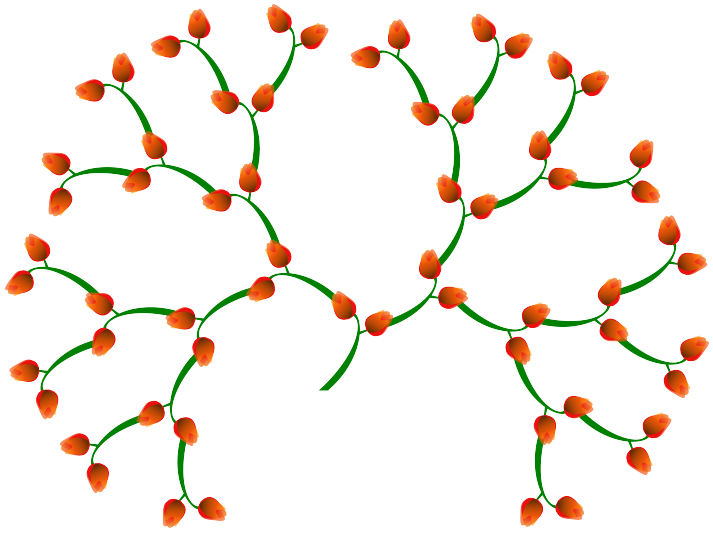
It takes one day for a bud to sprout a new stem and two new buds.

For example, two days after a seedling is planted, the miracle plant looks like this:



Question

Over time, the miracle plant becomes quite large and magnificent. How many days ago was the seedling planted?



(A) 4

(B) 6

(C) 8

(D) 16

Typos

Story

Luisa is typing a list of countries that border Argentina but her custom keyboard has malfunctioned. For most keys, when she presses the key, the character on the key to its right is displayed instead. The one exception is that when she presses the rightmost key in a row, the character on the leftmost key in that row is displayed.

For example, if she presses D, then F is displayed. If she types P, then # is displayed.

@	Q	W	E	R	T	M	O
#	A	S	D	F	G	I	P
Z	X	C	V	B	K	Y	$
Ñ	H	N	U	J	L	.	

Question

If Luisa wants to press keys so that BRAZIL is displayed, what keys should she press?

(A) V E # X G J

(B) V E # $ J G

(C) V P S X T K

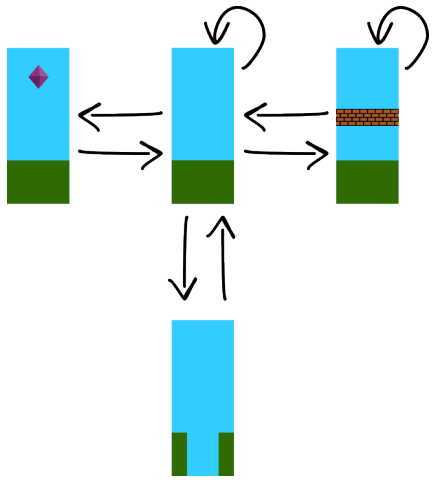
(D) V E # $ G J

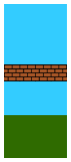
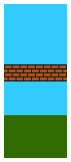
Superbebras

Story

In the computer game Superbebras, the background and the illusion of motion is created using a sequence of tiles.

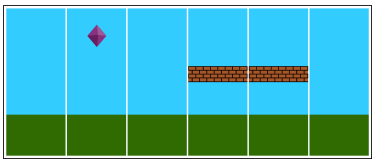
Tiles added to the right end of the sequence are chosen according to the rules in the diagram below. Arrows point directly from each tile to the only tile(s) that can be added immediately to the right of it.

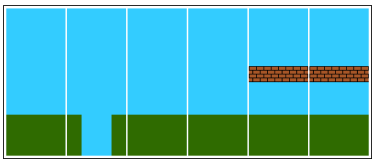


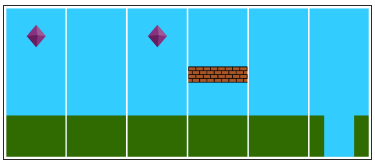
For example, a tile immediately to the right of the tile  can only be tile  or  .

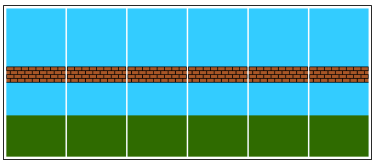
Question

Which of the following images is **not** a possible Superbebras background?

(A) 

(C) 

(B) 

(D) 

Part B

Book Return

Story

At the Hardwood Library, there is usually a long line of beavers waiting for the librarian to help them return their books. At this particular library, book returns are processed by quantity. That is, the beaver with the fewest books to return is helped first.

The librarian can process one book per minute. After processing all of the books returned by a particular beaver, the librarian next helps the beaver waiting in line with the fewest books to return.

One morning, five beavers come to the library to return their books. Their time of arrival and their number of books are shown in the table:

Name	Time of Arrival	Number of Books
Luciano	9:00	4
Rui	9:02	6
Cene	9:03	3
Manuel	9:05	4
Priscilla	9:12	1

Luciano arrives right when the library opens, so the librarian processes Luciano's books first.

Question

In which order will the beavers be helped?

(A) Luciano, Rui, Cene, Manuel, Priscilla

(B) Luciano, Cene, Rui, Manuel, Priscilla

(C) Luciano, Cene, Manuel, Rui, Priscilla

(D) Priscilla, Cene, Luciano, Manuel, Rui

Magical Fruit

Story

A magician can transform one type of fruit into another. The magical transformations are denoted by **M**. The fruit that the transformation is applied to is put inside brackets and the fruit that the transformation produces is put on the right after an equals sign. Six magical transformations are shown in the table below. For example, the top-left entry in the table describes a magical transformation that can be applied to an  to produce a  .

M  = 	**M**  = 
M  = 	**M**  = 
M  = 	**M**  = 

Transformations can be combined. For example, since we know **M**  =  , we can write the following combined transformation:

$$\mathbf{M}\left(\mathbf{M}\left(\text{  }\right)\right) = \mathbf{M}\left(\text{  }\right) = \text{  }$$

Question

What fruit is produced by the following combined magical transformation?

$$\mathbf{M}\left(\mathbf{M}\left(\mathbf{M}\left(\mathbf{M}\left(\mathbf{M}\left(\text{  }\right)\right)\right)\right)\right)$$

(A) 

(B) 

(C) 

(D) 

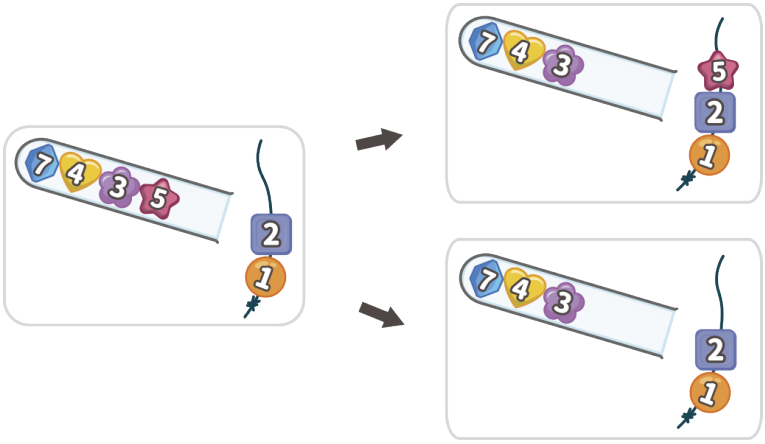
Bebracelet

Story

Rory is making Bebracelets. He takes numbered beads from a tube, one at a time. For each bead, he is allowed to put it on the string if:

- the string is empty, or
- the number on the bead is larger than the number on the last bead put on the string.

For each bead that Rory is allowed to put on the string, he then chooses whether to put it on the string or discard it. For example, if bead 2 is the last bead on the string, and bead 5 is the next bead from the tube, then Rory may put bead 5 on the string or discard it.



Now, Rory is making a new bracelet from the beads in this tube:

Question

What is the largest number of beads that Rory can put on the string?

(A) 4 beads

(B) 5 beads

(C) 6 beads

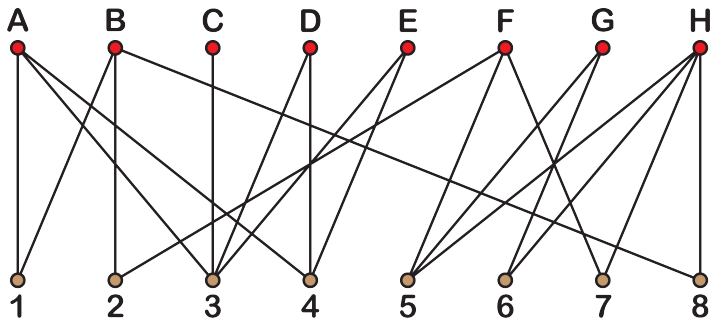
(D) 7 beads

Hermit Crabs

Story

Hermit crabs wear shells in order to protect themselves. As hermit crabs grow, their shells become too small and the hermit crabs need to look for larger shells to wear.

An assortment of new shells has just been washed ashore. Several hermit crabs have gathered to try on these new shells. In the following diagram, the letters represent the hermit crabs and the numbers represent the new shells. A single line connecting a letter to a number means that the hermit crab has determined that the shell is a good fit. If there is no line connecting a letter to a number then the hermit crab has determined that the shell is not a good fit.



Question

If a shell can only be worn by one hermit crab, and a hermit crab can only wear one shell, then what is the maximum number of hermit crabs that can wear one of these new shells?

(A) 8

(B) 7

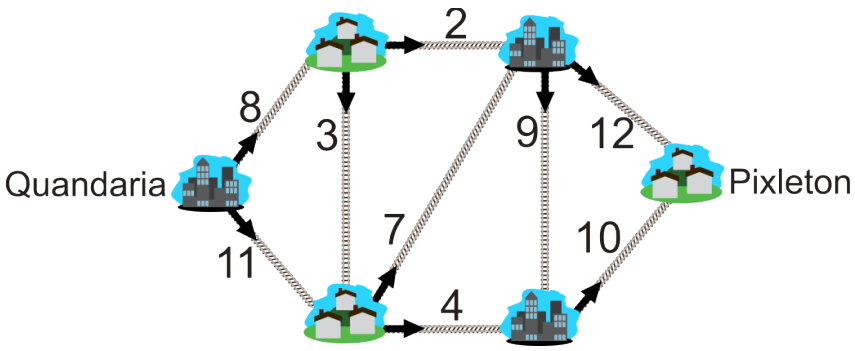
(C) 6

(D) 5

Railway Network

Story

In the land of Bebravia, there are six towns. All food is grown in Quandaria and transported by train to the other towns. The train routes are indicated by lines drawn between towns in the diagram. The arrow on each line indicates the direction in which trains carrying food are allowed to move.



Bebravia is not large so there is more than enough time for many trains to travel between any two towns. The only limitation is the daily capacity on each train route: the number on each line indicates the maximum number of trains that can travel along that route on one day.

Question

In one day, what is the largest number of trains that can travel from Quandaria to Pixleton?

(A) 13

(B) 16

(C) 19

(D) 12

Part C

Card Values

Story

Five types of cards are labelled with the letters P, Q, R, S, and T on one side. On the opposite sides, the cards are labelled with exactly one of the numbers 1, 2, 4, 8, and 16, in some random order. For each letter, all cards with that letter have the same number on the opposite side (e.g. all cards with P on one side have the same number on the opposite side.)

Multiple copies of each type of card are gathered to form a deck. Fala, Grace, and Hari each draw the smallest possible number of cards from the deck so that the numbers on their cards add up to their own age.

- Fala is 17 years old. One of the cards she is holding has an R on it.
- Grace is 18 years old. One of the cards she is holding has a Q on it. Another card she is holding is the same type as one of Hari's cards.
- Hari is 15 years old. He is the only one holding a card with a P on it. The largest number on a card he is holding has a T on the opposite side.

Question

Which number is on the cards that have the letter S on them?

(A) 1

(B) 2

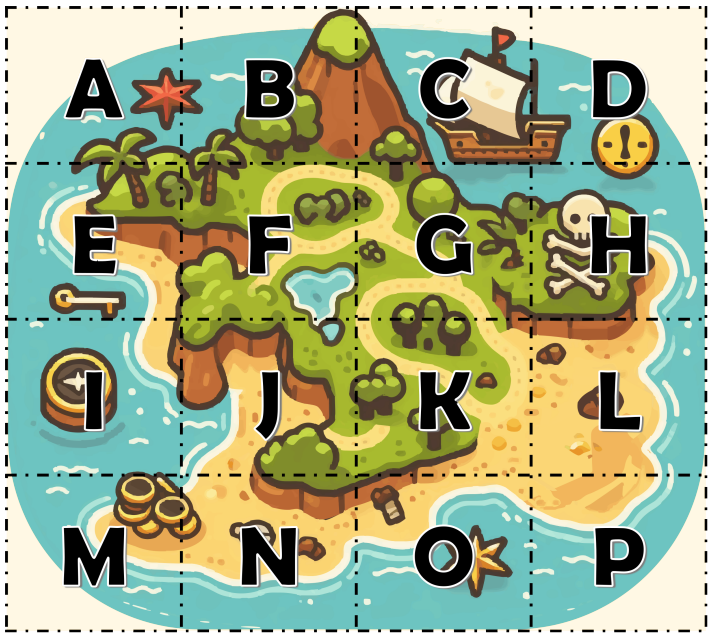
(C) 4

(D) 16

Finding Treasure

Story

Captain Bojana is looking for a treasure hidden on an island. The island is divided into 16 regions, each marked with a letter from A to P as shown.



Captain Bojana can enter any number of regions into a special device and the device will tell her whether or not the treasure is in one of those regions. For example, if she enters regions A, C, and D into the device and the device shows "yes", then the treasure is in exactly one of regions A, C, or D.

Question

What is the least number of times Captain Bojana needs to use the device to guarantee she will determine which region contains the treasure?

(A) 4

(B) 6

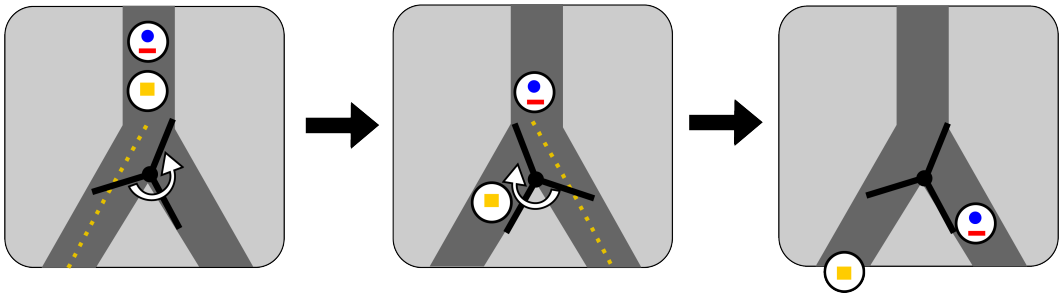
(C) 8

(D) 12

Floor Patterns

Story

A machine uses gates to redirect a sequence of balls in order to produce a pattern on the floor when viewed from above. Each ball follows a path directed by the gates. After a ball passes through a gate, the gate switches direction, sending the next ball the other way, as shown below.

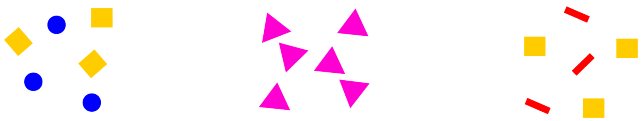


In the example above, the gate initially opens to the left, sending the first ball left. As the first ball goes through the gate, it causes the gate to switch so that it will send the next ball to the right. As the second ball goes through the gate, it causes the gate to switch back again.

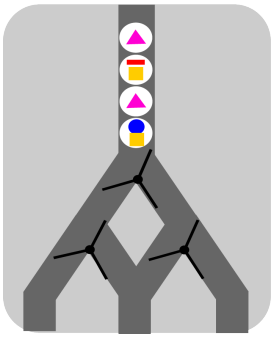
Every ball is labelled with one or more shapes. When a ball hits the floor, the pattern produced on the floor is triple the shape(s) shown on that ball. When two or more balls land at the same location, their patterns will combine on the floor. The pattern created on the floor by the example above is shown below.

Question

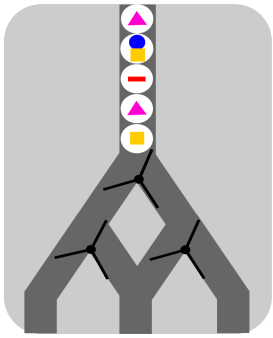
Which sequence of balls will create the following pattern on the floor?



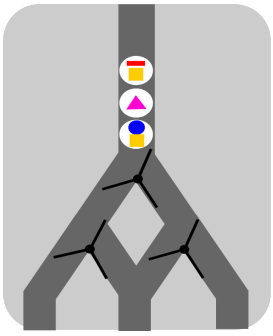
(A)



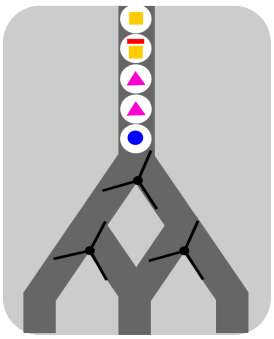
(B)



(C)



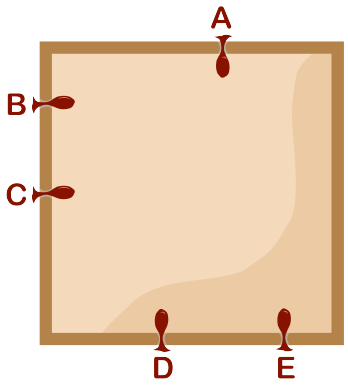
(D)



Balloon Machine

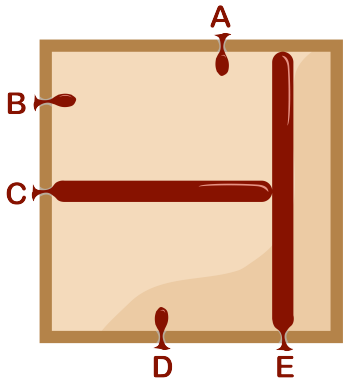
Story

A machine creates different designs by inflating long, skinny balloons attached to the edges of a square frame. There are five balloons labelled A, B, C, D, and E, arranged around the frame as shown.



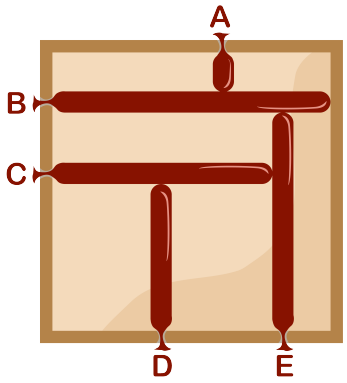
All balloons start deflated. To create a design, the machine reads a sequence of letters, from left to right, and inflates the corresponding balloons in that order. When a particular balloon is inflated, it will continue to extend until it reaches either another balloon or the opposite edge of the frame.

For example, starting with all balloons deflated, if the machine reads the sequence E C, then it will create the following design.



Question

Starting with all balloons deflated, the machine reads a sequence consisting of the five letters A, B, C, D, and E in some order and creates the design shown. How many different possibilities are there for the sequence?



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

Word Chains

Story

Mr. Castor is teaching his students how to read. To help them learn he creates word chains, which are sequences of words in which exactly one letter in a word is changed in order to create the next word. For example, MUG $\rightarrow$ MUD $\rightarrow$ MAD $\rightarrow$ FAD is a word chain.

Mr. Castor has the following nine words: BOT, SAD, BAT, CAB, COT, BAD, COB, CAT, and SAT. He groups them into three word chains, each with three words, so that each of the nine words is used in exactly one of the word chains.

Question

Which of the following **cannot** be one of Mr. Castor's three word chains?

(A) SAD $\rightarrow$ BAD $\rightarrow$ BAT

(B) COT $\rightarrow$ COB $\rightarrow$ CAB

(C) BAT $\rightarrow$ CAT $\rightarrow$ COT

(D) CAT $\rightarrow$ CAB $\rightarrow$ COB