TASKS T1 – T7 CARRY 3 POINTS EACH

T1. THE GIFT

Gaby's dad gives her four boxes containing four different gifts to choose from: a bracelet, a notebook, a ring, or a perfume. There is only one gift per box: through logic Gaby can keep the one she likes the most. Each box has a label that does not lie.

Question / Challenge

Gaby wants the ring. What box has the ring in it?

A)

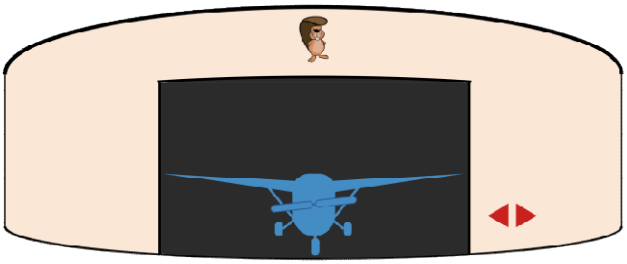
B)

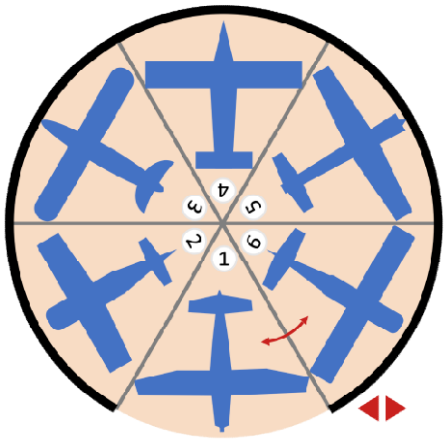
C)

D)

T2. HANGAR CAROUSEL

At Beavertown airfield, six planes are parked on a rotating turntable in the round hangar. The turntable can be rotated to the left or to the right by using a control panel with two arrows ◄►. One button press rotates the turntable exactly one parking position either left or right. The gate of the hangar is wide enough for one plane to roll out. The turntable is very slow to rotate so having fewer button presses will avoid delays.





In the mornings, when pilots come to pick up their planes, the parking position 1 is always at the gate. In the best case, arrow keys need to be pressed five times to get all planes to roll out. In this case pilots want to access the parking positions in order: 1, 2, 3, 4, 5, 6 by pressing ► five times, or in order: 1, 6, 5, 4, 3, 2 by pressing ◄ five times.
But what is the worst case? That is, what order accessing the parking positions will require the maximum number of button presses for all planes to be rolled out?

Question / Challenge

Which one of the following orders is the worst-case order for pilots to access the parking positions 1 – 6?

A) 6 2 4 1 3 5 **B)** 4 1 3 6 2 5 **C)** 3 1 2 4 5 6 **D)** 5 4 1 2 3 6

T3. ORDERING

You shall form a six-digit number, using each of these digits exactly once: 1, 2, 3, 4, 5, 6
The number must be the smallest number that satisfies all these conditions:

4→1, 1→2, 4→5, 2→3, 5→2, 3→6

Condition **a→b** means that, in the number, digit **a** must be to the left of digit **b**.

Question / Challenge

What is the number?

A) 412356 **B)** 415236 **C)** 451236 **D)** 412536

T4. LISTS

We can represent a list of numbers 3,5,2,4,1 visually as follows. (The smaller numbers in red above indicate the positions in the list.)

	1	2	3	4	5
X	3	5	2	4	1

We write (X 2) to describe the number at position 2. So (X 2) is 5. Similarly (X 5) is 1.
The positions can be indicated indirectly. For example (X (X 3)) is 5 because (X 3) is 2, so (X (X 3)) = (X 2) = 5.

Here are three lists, A, B and C.

A	3	2	4	1	5
B	5	4	1	3	2
C	2	5	4	3	1

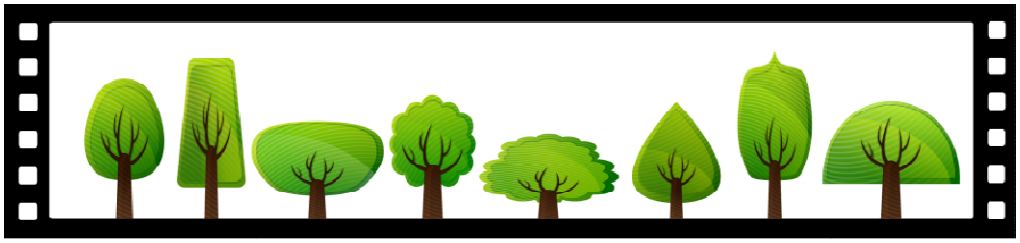
Question / Challenge

What is the number described by (A (B (C 3)))?

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

T5. FOREST PICTURES

Dai stood in the middle of a circle of eight trees and took a 360 degree photo of them.

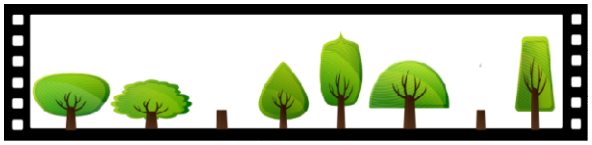


After a few days, Dai returned to the same spot in the forest and took another photo. She saw that two of the trees had been cut down.

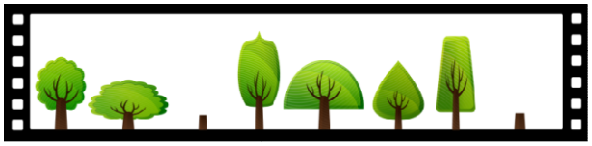
Question / Challenge

Which photo did Dai take?

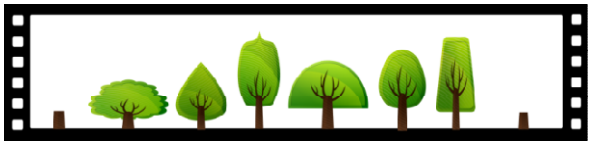
A)



B)



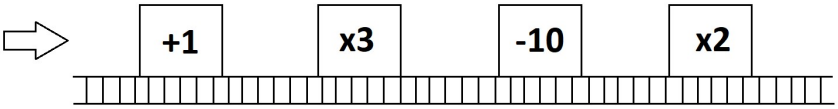
C)



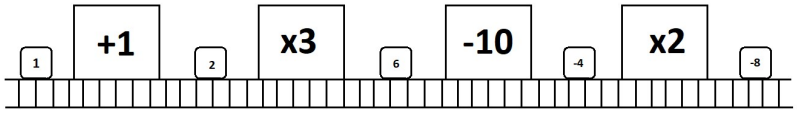
D)

T6. PIPELINE

Beaver Nick invented a machine made of a pipeline and a few computers which modify an input number by performing the operation written on each computer on the number that enters them:



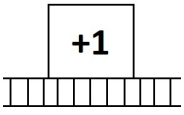
For instance, if the machine is given number 1 in the beginning, it will output -8 at the end:



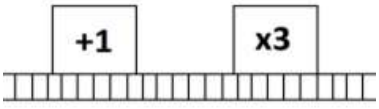
Beaver Tom found Nick's machine and wanted to create a similar machine, but he is not able to invent one himself. However, he can construct a machine by selecting parts of consecutive computers from Nick's pipeline, copying them, and linking these parts to create his own pipeline.

For instance, he can select three parts (note that the same computers can be selected in multiple parts):

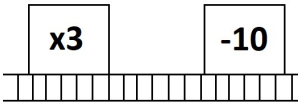
- One part made of the first computer from the pipeline made by Beaver Nick



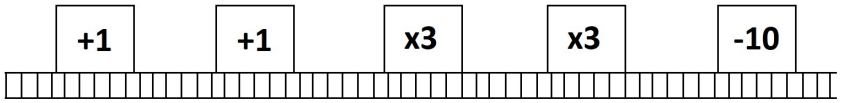
- One part made of the first two computers from Nick's machine



- One part made of the middle two computers from the pipeline



And, by concatenating these three parts, he can create his own pipeline:



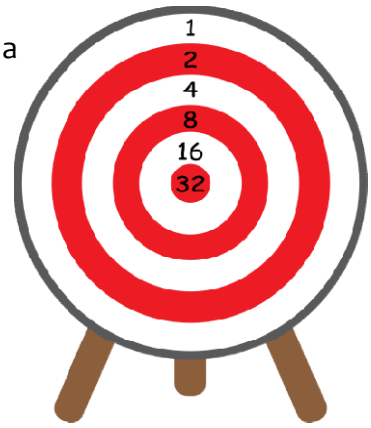
Which, if given number 1 as input, would produce a result of 17 in the end.

Question / Challenge

What is the maximum number Beaver Tom can reach at the end of his pipeline by copying a maximum of 3 parts from Beaver Nick's pipeline, if the initial input is 1?

A) 112 **B)** 118 **C)** 66 **D)** 243

T7. TARGET PRACTICE



Maryam is shooting arrows at the target shown. The number in a ring indicates how many points Maryam scores if an arrow hits that ring.

Maryam shoots three arrows and they all hit *different* rings.

Question / Challenge

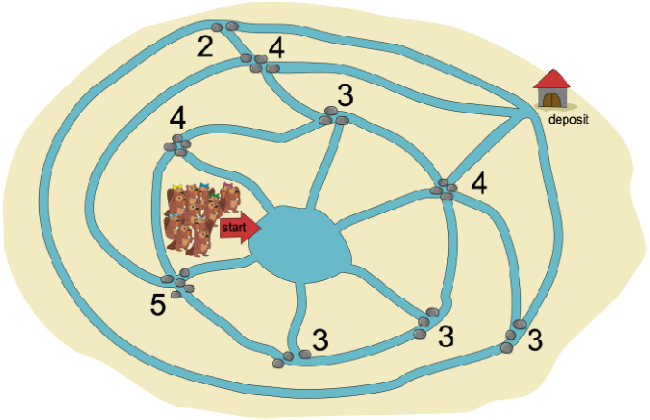
Which total score is **not** possible for Maryam to obtain?

A) 56 points **B)** 21 points
C) 10 points **D)** 7 points

TASKS T8 – T14 CARRY 4 POINTS EACH

T8. COLLECTING STONES

The beaver's family lodge consists of 21 canals. 31 stones need to be removed. The beavers go for a swim to collect the stones and bring them to the deposit.



The stones are heavy. A beaver can only carry one or two of them at the same time, but no more. To get from one intersection to the following, beavers surprisingly always swimexactly one hour. After starting simultaneously the beavers have to collect all stones within four hours.

Question / Challenge

How many beavers do we need at least?

A) 14 beavers **B)** 18 beavers **C)** 20 beavers **D)** 24 beavers

T9. THE BEAVER DATABASE

A dozen families live in the beaver village. The computer scientist Beaver Jeffrey created the database of villagers, recording data about each beaver in the form of a 16-bit sequence, from b15 (left) to b0 (right), as follows:

b15 _ b12: four bits for the family number;

b11: one bit for the gender (0 = female, 1 = male);

b10 _ b4: seven bits for the weight (a natural number of pounds);

b3 _ b2: two bits for "skilled worker in" (00 = construction of lodges, 01 = construction of dams, 10 = food cache, 11 = education of young beavers);

b1 _ b0: two bits for favorite food (00 = tree bark, 01 = aquatic plants, 10 = grasses, 11 = sedges).

For example, the sequence 0100 0 0100101 10 01 denotes a beaver belongs to family 4, is a female, weights 37 pounds, is a skilled worker in a food cache and likes aquatic plants.

Question / Challenge

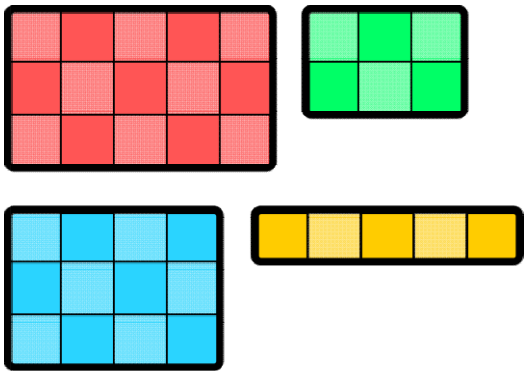
Beaver Jeffrey queries the database by formulating Boolean expressions (in positive logic: 0 = false, 1 = true). Which set of beavers denotes the following expression?

b11 **and not** (b10) **and** b9 **and** b7 **and not** (b3 **and** b2)

A) Females weighing at least 16 pounds, skilled worker in food cache.
B) Males weighing at least 64 pounds, skilled worker in construction of lodges or dams.
C) Males weighing 39 to 63 pounds, skilled worker in construction of something or food cache.
D) Males weighing 39 pounds maximum, skilled worker in construction of dams.

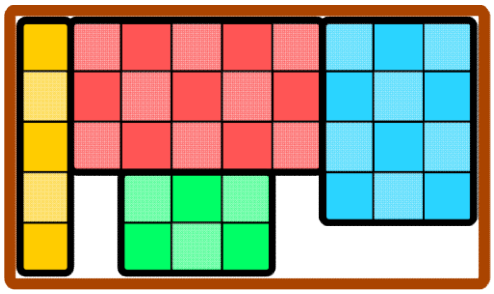
T10. A GIFT FOR THE PRESIDENT

A factory produces 4 types of juice. For each type they use a special crate of a different size. We see these crates from above in the picture. Observe that the biggest crate contains 15 bottles.



You have to prepare a special gift for the president containing one crate of each flavor. These four crates have to be placed in a *rectangular* container. Crates cannot be stacked on top of each other and we want to leave as few gaps as possible (which we then will fill with single bottles).

For example, if we use the container below, we have to add 7 single bottles for the container to be full.



Question / Challenge

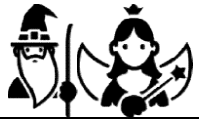
In a rectangular container that holds the four gift crates with as few gaps as possible, how many single bottles need to be added for this container to be full?

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

T11. MYSTERIA

In a castle called Mysteria there lives a single wizard. This wizard can turn themselves into a fairy, or create a fairy beside them (to the right). The fairy can turn into a potion (on the left) and a dragon (on the right), or turn into a potion (on the left), a wizard (in the center) and a dragon (on the right).

The following table shows the contents of Mysteria both before and after each of the four possible transformations:

Before	After
	
	
	
	

These magical transformations can happen any number of times, in any order. That is, any wizard and any fairy can transform at any time.

Question / Challenge

Starting with the single wizard, which state of Mysteria is **not** possible to obtain?

A) 

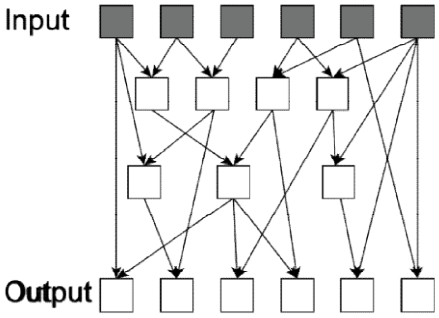
B) 

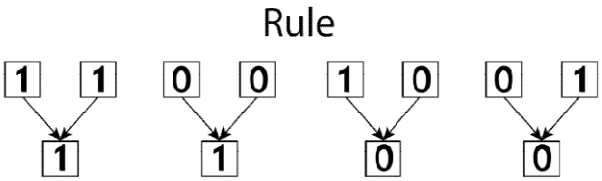
C) 

D) 

T12. CRYPTOGRAPHY

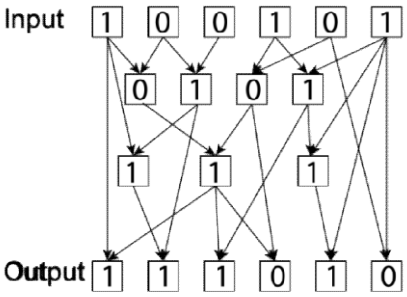
Cryptography is a graph made of squares and arrows. Here is a simple cryptography below.





Six input squares contain numbers 0 and 1. Then each other square would be written by the number 0 or 1 according to the rule.

For example: If the input numbers are 1 0 0 1 0 1 respectively, then the output numbers is 1 1 1 0 1 0.



Question / Challenge

Which input sequence below gives an output sequence of 1 1 0 1 0 0?

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

T13. COLOURFUL CANDLES

Simon owns candles in the shape of the numerals 0 to 9. There are two of each numeral. The candles come in three colours: orange, red, and blue. All 0 candles are orange, all 1 candles are red, and so on (see table). Each year for his birthday, Simon places candles on his cake to spell out his new age.

Today is Simon's 11th birthday and because both candles are the same colour his family gives him an extra birthday present. He must wait three years until he is 14 before both of his candles will have the same colour again. Then there is a three year wait until he is 17, and a further five year wait until he is 22.

Number	Colour
0	Orange
1	Red
2	Blue
3	Orange
4	Red
5	Blue
6	Orange
7	Red
8	Blue
9	Orange

Question / Challenge

If Simon uses this system from today until he is 99 years old, what is the maximum number of years he has to wait between any two birthdays where two candles of the same colour are used to spell out his age?

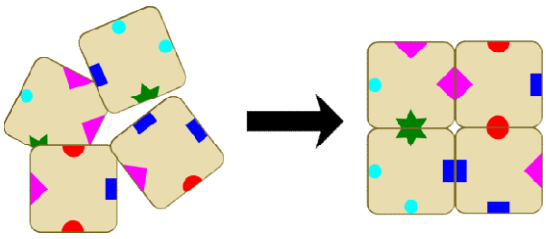
A) 5 **B)** 6 **C)** 7 **D)** 8

T14. FOUR TILES

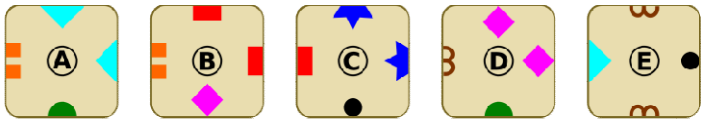
You are asked to arrange four tiles into a 2 x 2 square, according to the following rule:

- Tiles may only touch each other at sides that carry exactly the same symbol!

The picture below shows an example:



You are now given the following 5 tiles.



You must arrange four of these five tiles into a 2 x 2 square that follows the rule above. (In this case there is only one possible choice of four tiles that allows this.)

Question / Challenge

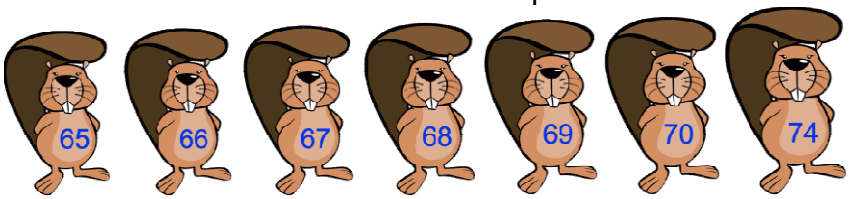
Which tile will you **NOT** use?

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

TASKS T15 – T21 CARRY 5 POINTS EACH

T15. BEAVER AI

The beavers construct an "astonishingly intelligent" (AI) system; the system is to measure an animal's size and, based only on that, to decide whether the animal is a beaver or not. The AI system learns to make its decision from examples.



At first, the AI system learns from example animals with these sizes:

- 65, 66, 67, 68, 69 => beaver
- 11, 101, 110, 120, 130 => no beaver

Then, the beavers let the AI system decide. The outcome is as follows:

- 70, 74 => beaver
- 86, 38 => no beaver
- 40, 80 => beaver

AI made a mistake as the two animals of sizes 40 and 80 are in fact not beavers! The AI observed that an animal with size 11 **is not** a beaver, and an animal with size 65 **is** a beaver. Looking at the difference in sizes, the AI decided that only animals with sizes greater than 38 and less than 85 are beavers.
Therefore, in order to improve the AI, the beaver gives a new example to it: an animal with size 42 is **not a beaver**.

Question / Challenge

After the new training, how does the AI classify two animals of size 48 and 84?

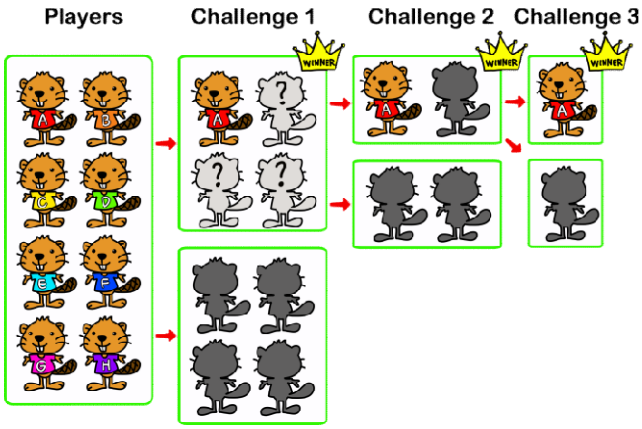
A) beaver, beaver
B) beaver, not beaver
C) notbeaver, beaver
D) notbeaver, not beaver

T16. BEAVER GAMES

The Beaver Games are an annual competition consisting of three challenges. The first and second challenges are played in teams, where team members are decided by lottery. The team with the higher sum of points wins and advances to the next challenge. The last challenge is an individual match. If you win three challenges in a row, you are the winner.

Beaver Ada was the lucky winner of the this year's Beaver Games. For each challenge the individual points are given in the table.

Name	Ada	Brown	Candy	Daisy	Eden	Funny	George	Hough
Challenge 1	15	16	19	18	17	20	19	19
Challenge 2	20	27	30	24	28	24	30	30
Challenge 3	10	14	11	15	16	13	9	12



Question / Challenge

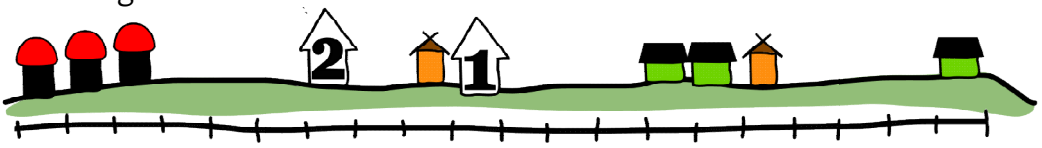
Which three beavers were in Ada's first team?

A) Eden, Funny and George
B) Daisy, Funny and George
C) Brown, Candy and George
D) Candy, Daisy and Hough

T17. OVERLAPPING VILLAGES

As years went by, the villages of Cabbageville, Strawberrton and Carrotford grew and started to overlap. Whenever a new house is built, the villagers use the following rule to decide which village the house is assigned to:

The new house belongs to the village assigned most often among the X nearest houses. Ties are broken by assigning the new house to the same village as its nearest neighbor.
Now, two new houses are built and assigned to villages using the same value of X. House 1 is built and assigned before House 2.



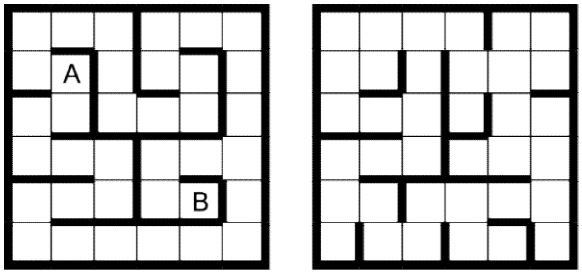
Question / Challenge

What is the smallest value of X so that House 2 is assigned to Strawberrton?

A) 3 **B)** 4 **C)** 5 **D)** 6

T18. MAZE

The Little Beaver is in a maze. The maze is made up of two floors, each with its own grid of obstacles.



The Little Beaver can move between two adjacent cells within one floor if there is no obstacle between the cells; this takes one second. The Little Beaver can also use her magic wand to move to the corresponding cell of the other floor; this takes five seconds.
For example, if the Little Beaver is in cell A, there are three possible moves:

1. Move left. This move takes 1 second.
2. Move down. This move takes 1 second.
3. Move to the corresponding cell of the other floor. This move takes 5 seconds.

The Little Beaver starts at cell A and wants to reach cell B as soon as possible.

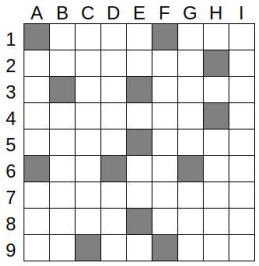
Question / Challenge

What is the shortest time needed for the Little Beaver to reach cell B, if starting from cell A?

A) 16 **B)** 17 **C)** 18 **D)** 20

T19. ROBOT'S PATH

A drone starts on a white cell of the grid shown. It faces one of four possible directions.



Then it visits exactly 8 other white cells as follows:

1. Move 2 cells forward.
2. Turn 90 degrees left (in its current cell).
3. Move 4 cells forward.
4. Turn 90 degrees right (in its current cell).
5. Move 2 cells forward.

Question / Challenge

How many possible starting cells are there?

A) 2 **B)** 4 **C)** 8 **D)** 10

T20. ORDERING

Yuno has 11 cards with numbers from 1 to 9 and letters A, B on them. He uses rule 9 < A < B. He wants to put them into one row following the rules of the type **a** → **b** This rule means that card with number **a** must be somewhere to the left to the card with number **b**. At the same time he wants the placement to be the smallest possible lexicographic sequence.
Lexicographically, the smaller of the two sequences is the one where in the first position (from the left) with different cards is the smaller number.

Consider the following two sequences:

1) **5 6 5 7 9 9 B**
2) **5 6 5 8 0 0 0**

The first sequence is lexicographically smaller, because the first three pairs of cards are correspondingly the same, and in the fourth position first sequence has 7 while the second has 8, and **7 < 8**.

Question / Challenge

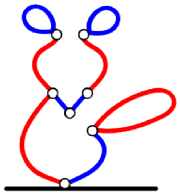
Arrange 11 cards in the lexicographically smallest sequence with respect to the following rules:

1) 1 →2	**4) 6 →5**	**7) 5→7**	**10) 1→ B**
2) 1 →6	**5) 3 →5**	**8) 7→8**	**11) B → A**
3) 2→3	**6) 3 →4**	**9) 7 → 9**	**12) A →7**

A) 123456BA789 **B)** 123465789BA **C)** 123465BA789 **D)** 123456789AB

T21. A GAME OF CUT AND MOUSE

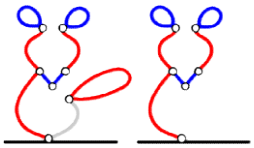
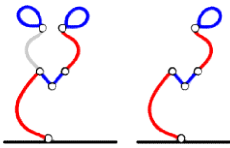
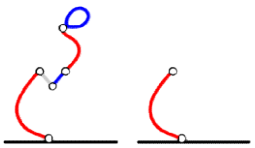
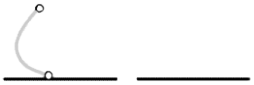
Two friends, Bob and Ralph, are playing a game. They start by drawing a thick black line at the bottom of the paper, calling it the "ground." Afterwards, they draw several blue and red segments, creating the mouse-shaped figure shown below:



The rules of the game are as follows:

- They take turns to cut any segment of their choice. However, Bob is only allowed to cut blue segments while Ralph is only allowed to cut red segments.
- Cutting a segment removes that segment and all other segments that are no longer connected to the ground.
- The first player who no longer has any segment to cut is considered the loser.

A possible sequence of moves is given in the table below. Two figures are displayed for each turn: the first figure marks the segment that the player intends to cut while the second figure displays the result of cutting this segment.

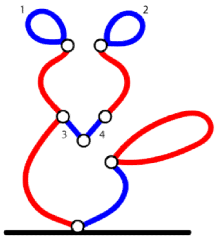
Bob's Turn	Ralph's Turn	Bob's Turn	Ralph's Turn
			

Since Bob no longer has any segment to cut, he loses the game, and Ralph is declared the winner.

Question / Challenge

If Bob is the first to move and he always plays the best possible move at each turn, which segment should he cut first to guarantee his victory — no matter what move Ralph makes?

Refer to the figure below for the numbering of the segments:



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