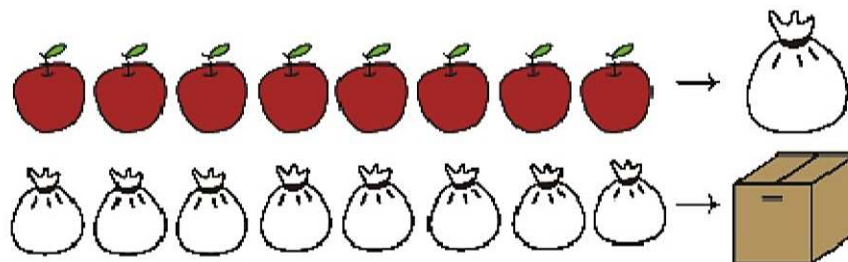Time Allowed: **150 minutes**

Tasks T1 – T10 carry 3 points each

T1. Apple Packing

A beaver family has an apple orchard. During the harvest season, the beavers try to find the best way to pack the apples to deliver them to the market. This year, they decided to pack the apples according the following rules:

i.   Apples are put in bags. Every bag contains 8 apples, no more and no less. If there are less than 8 apples, they remain outside the bags as loose apples.

ii. Bags are put in boxes. Every box contains 8 bags, no more and no less. If there are less than 8 bags, they are left outside the boxes as loose bags.
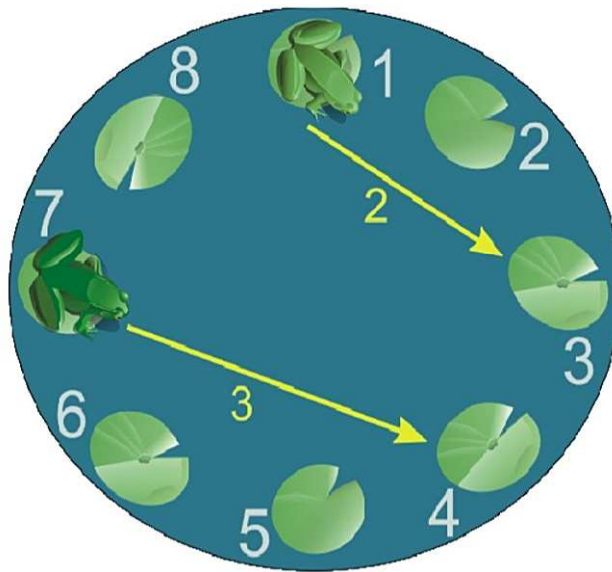
Question / Challenge

Today, the beavers harvested and packed 275 apples. How many boxes, loose bags and loose apples did the beavers pack?

T2. Jumping frogs

Two frogs are jumping on water lily leaves around a lake. Both frogs always jump at the same time. Each of them always follows the direction and length of jumping described by arrows.

Time Allowed: **150 minutes**

Question / Challenge

Starting from the position as shown in the picture, on which water lily leaf will they meet for the first time?

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

T3. Styled Texts

Beaver Ada wants to send nice messages to her friends with a new app which lets her produce styled text.

In the app, to write styled text you have to put your text between special symbols:

- * for **bold**
  example: *beaver* will produce **beaver**
- / for *italics*
  example: /beaver/ will produce *beaver*
- _ for <u>underlined</u>
  example: _beaver_ will produce <u>beaver</u>
- $ for <mark>highlighted</mark>
  example: $beaver$ will produce <mark>beaver</mark>

You can also combine the styles, for example:

- _/beaver/_ will produce <u>*beaver*</u>
- /_beaver_/ will also produce <u>*beaver*</u>
- $_beaver_$ will produce <mark><u>beaver</u></mark>

You can also put pictures by typing the name of the picture between ':'.

For example:

- :birthday: will produce

- :island: will produce

- :house: will produce
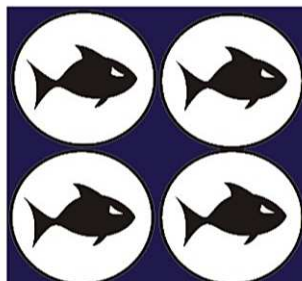
Question / Challenge

What does Ada have to type to produce the following message:

You are invited to a <u>super</u> party at **the** on the with *great music and food*. See you <u>there!</u>

A) *You* are invited to a _super_ birthday party at */the/* :house: on the :island: with $/great music and food/$. See you /there!/

B) *You* are invited to a _super_ :birthday: party at *_the_* :house: on the :island: with $/great music and food/$. See you _there!_

C) *You* are invited to a _super_ :birthday: party at */the/* :house: on the island with $*great music and food*$. See you _there!_

D) *You* are invited to a /super/ :birthday: party at *_the_* house on the :island: with $great music and food$. See you /there!/

T4. Fish

Four toy fishes are placed in a special tray as shown here:

If you turn any of the fish 45º clockwise, the fish that is diagonal to it will also turn 45º but in an anti-clockwise direction.

Time Allowed: **150 minutes**
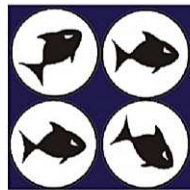
Question / Challenge

You operate as follows:

1. Turn the fish in the upper left 45° clockwise
2. Turn the fish in the lower left 90° clockwise
3. Turn the fish in the lower right 90° clockwise
4. Turn the fish in the upper left 45° clockwise
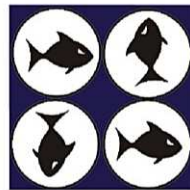
Which image shows how the fishes will appear now?
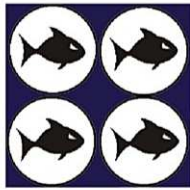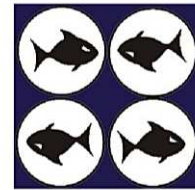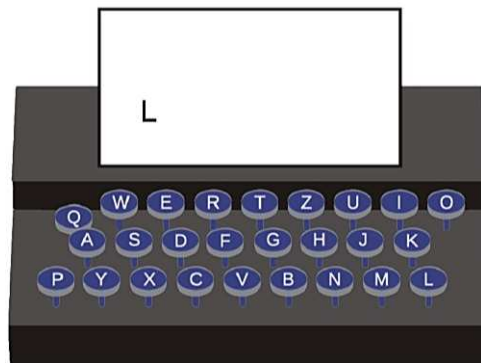
A)   B)   C)   D)

T5. Secret Typewriter

In a Normal Typewriter, when you press a key, the corresponding letter is printed.

But with the Secret Typewriter if we press on a letter key, a different letter is printed. This makes it easy to write a secret message. For example, if the Q key is connected to 'L', when Q is pressed then 'L' will be printed as one letter in the secret message.

Secret Typewriter

Question / Challenge

If typing "MEET ME AT SCHOOL" prints out "NRRZ NR SZ AXGLLO", what is the connection between the letters?

A)

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

B)

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

C)

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

D)

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

Time Allowed: **150 minutes**

T6. Bread
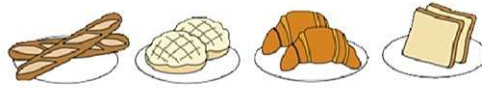
There are some different types of bread on the table:
- Two loaves of baguette
- Two buns
- Two croissants
- Two toasts

Four beavers, Alice, Bob, Charles, and Dorothy, share these breads such that each beaver has two different types of bread.

The following is known:
1. Alice and Bob do not have the same type of bread
2. Charles has a loaf of baguette
3. Dorothy has a bun but Alice does not have any bun
4. Bob has a croissant

Question / Challenge
Which types of bread does Alice have?

A) A loaf of baguette and a croissant
B) A bun and a toast
C) A loaf of baguette and a toast
D) A bun and a croissant

T7. Beaver garden
Katie is climbing a grid of tree stumps in the beaver garden. From each stump she observes the neighbouring four stumps (or fewer, if she is on the border) and follows these three orders:
i.   If there is a stump that is exactly one level higher than the current stump, go there.
ii. If not, go to a stump with the same height, but only if you haven't been there yet.
iii. Can't move? Stop!

Question / Challenge

The level and location of the stumps are shown in the table below.

```
6  7  8
5  6  9
5  5  4
6  5  4
7  3  3
9  3  5
1  2  6
```

Katie starts on the stump that is 1 level above the ground. How high will she climb?

A) 6   **B)** 7   **C)** 8   **D)** 9

T8. Flipping coins

Chris placed ten coins in a row, as in the picture below.

Each coin is golden on one side and silver on the other.
He can only flip over pairs of adjacent coins, and wants to show only gold sides.

Question / Challenge

In how many turns can he flip the coins to show only gold sides?

A) 2   **B)** 4
C) 8   **D)** It is not possible to show only gold sides.
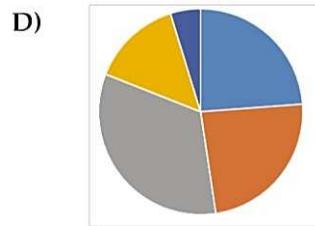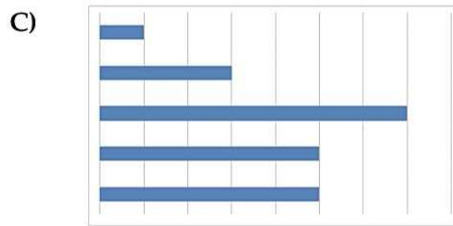
T9. Charts

Beaver Bruno has drawn charts using some values.

Question / Challenge

Which of the following charts is NOT consistent with the other charts?

A)

B)

C)   D)
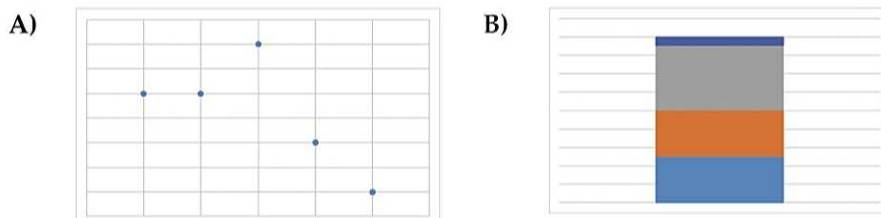
T10. Coins

In the Beaver school they care a lot about the healthy food and therefore they installed a vending machine that gives out apples. Of course, if one pays too much the machine returns the change in coins. The denominations of coins are 31, 17, 10, and 1 BEB. The machine returns the change according to the following procedure:

- Take the largest coin that is smaller or equal to the amount that needs to be returned, return the coin and decrease the amount to be returned for the vaue of the coin;
- Repeat the above step until the amount decreases to 0.

For example, the above procedure returns the amount of 33 BEB in change of one 31 BEB and two 1 BEB conis. However, the described procedure does not guarantee to return the smallest number of coins for every amount.

Question / Challenge

Find an amount of money that can be split into 3 BEB coins, while the described procedure would split it into at least 4 BEB coins.

**A)** 7   **B)** 14   **C)** 16   **D)** 21

> Tasks T11 – T20 carry 4 points each

T11. Tennis Tournament

Six beavers, namely: **Bojan, Vesna, Mile, Emil, Dejan and Marija**, take part in a tennis tournament. The tournament organizer has a serious issue to deal with: each of the beavers needs to play each of his/her games using the same racket, and the organizer is short on money, so he can provide only a limited number of tennis rackets for the tournament. Unfortunately, this number must be less than six, which means that the organizer cannot provide different rackets for all the beavers.

The list of games to be played in the tournament is the following:

Bojan	vs	*Emil*
Emil	vs	*Mile*
Mile	vs	*Vesna*
Vesna	vs	*Bojan*
Dejan	vs	*Vesna*
Dejan	vs	*Mile*
Marija	vs	*Emil*
Bojan	vs	*Mile*
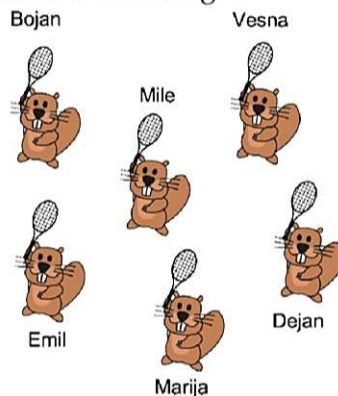
There are no two games that will be played in parallel i.e. each game will be played in a different time period and will not overlap with any other game in the tournament.

Question / Challenge

What is the smallest number of tennis rackets that the organizer needs to provide in order to be able to organize the tournament?

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

T12. Intrusion!

In the Bebras Museum of Post-Modern Wood Art there is an intelligent security system that detects intruders. An intruder is a person who has entered the museum, but not via the entrance.

Whenever a person enters or leaves a room, the system detects exactly how many people are in each room and records this in a table. The system always correctly allocates each person in the museum to a single room. It may happen that several people enter or leave a room at the same time.

The table shows the records of the intelligent security system and the image shows the layout of the rooms in the museum.

Time	Room 1	Room 2	Room 3	Room 4
10:00	2	0	0	0
10:07	3	0	0	0
10:08	2	1	0	0
10:12	4	1	1	0
10:13	2	2	3	0
10:17	5	2	2	1
10:20	4	1	2	2
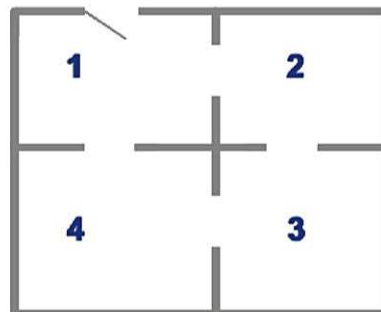
Question / Challenge
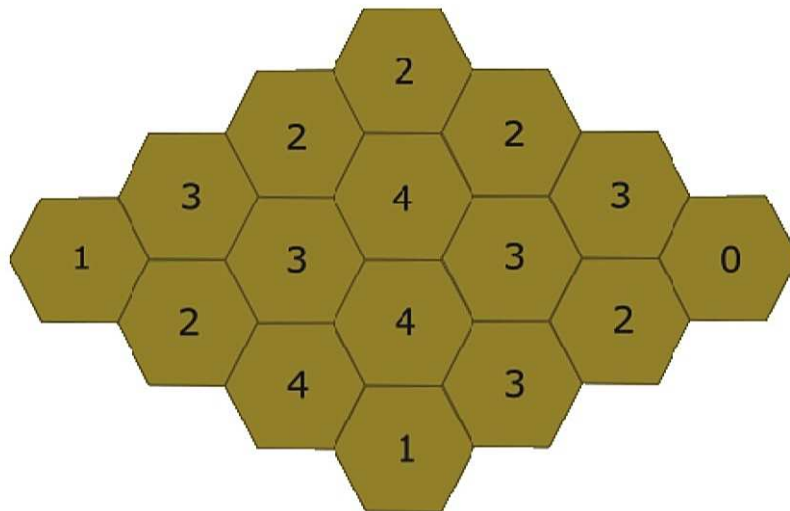
At what time did the system detect an intruder?

A) 10:13   **B)** 10:17   **C)** 10:21   **D)** 10:33

T13. Beehive

Billy is a bear who loves honey so much. His grandfather brought this big beehive for him but would give it to him only if he could tell how many units of this beehive have honey in. There is a number on each unit of the beehive that shows the number of adjacent units with honey.

Question / Challenge
How many units of the beehive have honey in?

A) 10 **B)** 9 **C)** 8 **D)** 6

T14. BikeFun

BikeFun is the new attraction in town. BikeFun bikes take you through a number of courses. Each course has a number of segments that allow you to travel downhill, uphill, or along a flat. Each segment consists from one or more sections of the same kind. The rules you need to follow are:

- Your starting speed is 0 km/h.
- On each downhill section, the bike will speed up by 10 km/h.
- On each uphill section, the bike will slow down by 10 km/h.
- On every flat section, it's up to you: you have to either speed up or slow down by 10 km/h

At the finish of the course your speed must be 0 km/h. But you cannot finish before the end of the course (you must not run out of speed).

Below is a sketch of a course that is doable according to the rules. On the flat sections you should increase/decrease speed as indicated in the circles. Note that each square represents a section.

Time Allowed: **150 minutes**
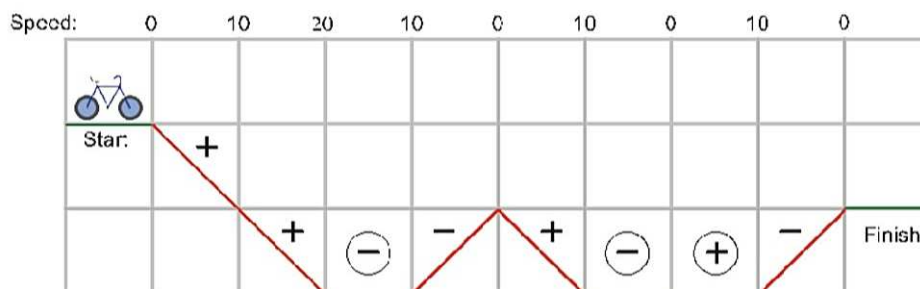
Question / Challenge

You are shown sketches of the courses you can ride. Only one of these courses is doable. Which one?

A)

B)

C)

D)

Time Allowed: **150 minutes**
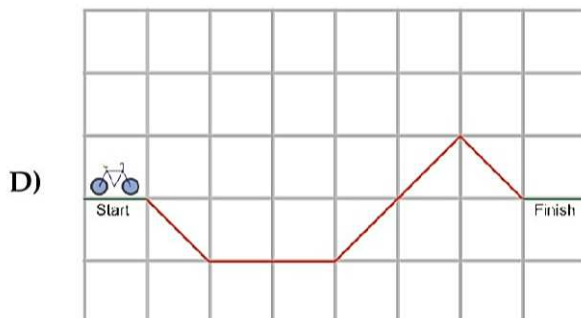
T15. Breaking the cipher

In a *prefix cipher*, letters are transformed into a *code* made up by one or more digits, and no code starts with another code. For instance, if the letter **A** is transformed into **12**, the letter **B** can be transformed into **2** (because 12 does not start with 2). In such case, the letter **C** can be transformed into **11** (because both 12 and 2 do not start with 11), but not into **21** (because 2 has been already used for B) or into **121** (because 12 has already been used for A).

The following is a sequence of codes for the word BEBRAS.

12112233321

Question / Challenge

What is the correct split of the sequence into valid codes?

A) 121_1_223_33_2_1   **B)** 1_2_1_122_3_3321
C) 1_21_1_22_33_321   **D)** 1_21_1_223_332_1

T16. Elliptical Logos

EL T-Shirts is a company that designs logos based on ellipses. On their website, you can design a logo by either adding ellipses of a fixed size in any orientation or use special rules to combine logos. There are three special rules **A + B**, **A – B** and **A * B**.

We define **A + B** to be first drawing logo **A** and then drawing logo **B**, which could be on top of **A**. For example, if **A** is a yellow solid ellipse and **B** is a blue wavy ellipse, then the following are examples of **A + B**:
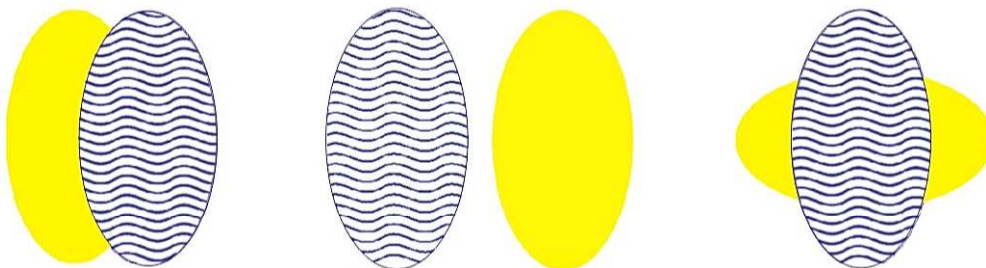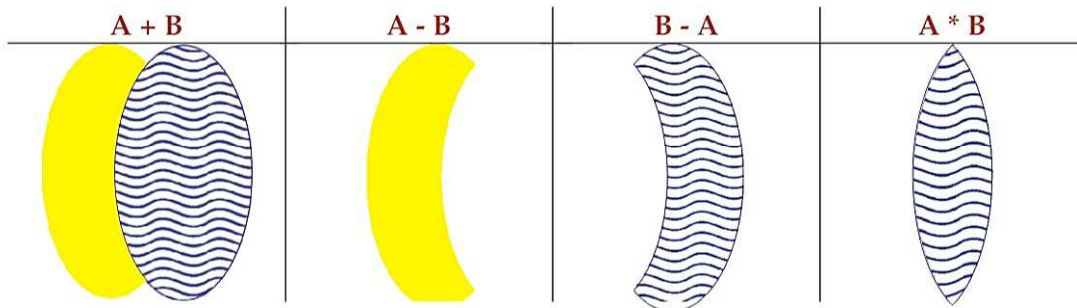

Notice however that **B+A** might be different:
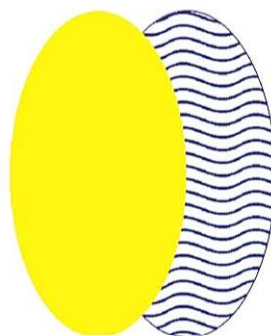
Keeping **A** and **B** as above, we define **A − B** to be the part of logo **A** that does not overlap with **B** and **A * B** to be the part of logo **B** that overlaps with logo **A**:

A + B	A - B	B - A	A * B

EL T-Shirts has a "Logo of the Month" design competition where participants take two ellipses **E** and **F** and apply the special rule of the month, which for this month is **(E + F) − (E * F)**, to make the best logo. Like with other operations, we evaluate the brackets first before doing the subtraction. However, the judges noticed in the monthly submissions that one of the submitted logos is not designed using the special rule of the month.

Question / Challenge

Which logo does not follow the special rule of the month?

A)   B)   C)   D)
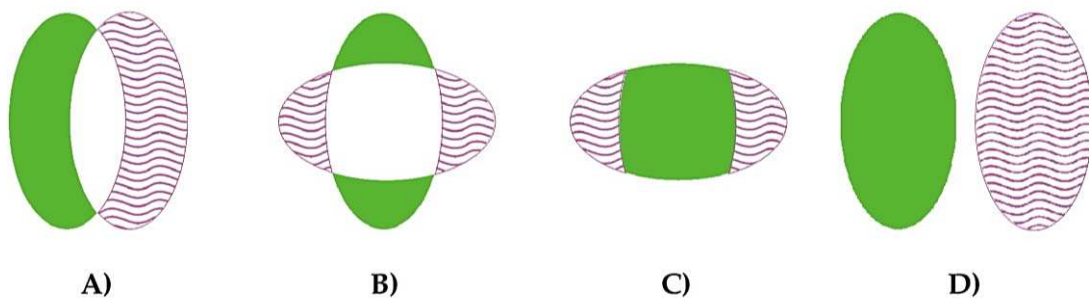
T17. Football Tournament

Five football teams, namely: Albatrosses, Beavers, Cats, Dogs and Eagles, enter a tournament. In order to make the tournament as fair as possible, the organizer has decided to organize it in such a way that **each team will play each of its games in a different city**. Every match will be played in a different time period and will not overlap with any other in the tournament However, the organizer is short on money, so she needs to organize the tournament in **as few cities as possible**. This is the list of the matches:

Albatrosses	vs	Beavers
Albatrosses	vs	Eagles
Beavers	vs	Cats
Beavers	vs	Dogs
Cats	vs	Dogs
Cats	vs	Eagles
Dogs	vs	Eagles
Albatrosses	vs	Beavers

Time Allowed: **150 minutes**

Question / Challenge

What is the smallest number of cities that the organizer needs to use in order to be able to organize the tournament?

A) 2   B) 3   C) 4   D) 5

T18. Barbecue

The beavers at Beaver Academy are organising the celebration of the school year ending. At each moment between 10:00 and 20:00 they need one beaver for checking at the entrance. Some of the beavers have volunteered to help out and have given times when they are available.

However, the list below still has a time slot where no beaver is available. **Find that gap.**

11:00-12:00	15:30-16:30	19:00-20:00
10:00-10:30	10:15-11:15	19:15-19:30
17:15-17:45	14:00-15:00	16:15-17:30
18:15-19:00	17:30-19:00	12:00-13:30
13:45-14:30	14:45-16:00	

Question / Challenge

What is the time slot where no beaver is available?

A) 18:30-18:45   B) 19:30-19:45
C) 14:30-14:45   D) 13:30-13:45

T19. Celebrity

Beaver Town is proud to have a celebrity among its inhabitants. A celebrity is a beaver who is known to all other beavers in town and who knows no other beaver in town. Below is a list with statements of the form "beaver X knows beaver Y". There are many more inhabitants in Beaver Town, but it is known that the celebrity is one of the names in the list and that there is only one celebrity in town. This is the list:

Anna knows Jasper	Jasper knows Dina	Chris knows Jasper	Katrijn knows Els
Bart knows Katrijn	Chris knows Els	Hans knows Dina	Chris knows Fien
Dina knows Bart	Katrijn knows Jasper	Geert knows Chris	Geert knows Anna
Chris knows Hans	Anna knows Chris	Katrijn knows Fien	Els knows Hans
Jasper knows Fien	Hans knows Fien	Bart knows Fien	Anna knows Fien
Bart knows Hans	Bart knows Els	Geert knows Jasper	Els knows Anna
Geert knows Fien	Els knows Chris	Dina knows Fien	Katrijn knows Chris
Dina knows Geert	Anna knows Geert	Hans knows Anna	
Hans knows Katrijn	Els knows Fien	Jasper knows Bart	

Question / Challenge

Who is the celebrity beaver?

A) Geert   B) Jasper   C) Els   D) Fien

Time Allowed: **150 minutes**

T20. Vacuum Cleaner

A robotic vacuum cleaner needs to clean the room at night. The room is a rectangle with 5 x 4 tiles. The robotic vacuum cleaner is a cheap one and it has four operations: Forward, Left (turn 90° left), Right (turn 90° right), Pick (pick the trash from the floor).

Only the Forward operation moves the robot. Orientation of the robot is given by a compass. It has eight sensors to perceive adjacent tiles. The robotic vacuum cleaner cannot go into the dark tile and it can perceive if the current tile has junk. After the room is clean, the robot will stay in that tile. The robotic vacuum cleaner knows when the room is clean. The initial orientation of robot is to East.

Question / Challenge

What is the minimum number of operations required for the robot to clean the whole room from the picture?

A) 11   **B)** 18   **C)** 10   **D)** 13

Time Allowed: **150 minutes**
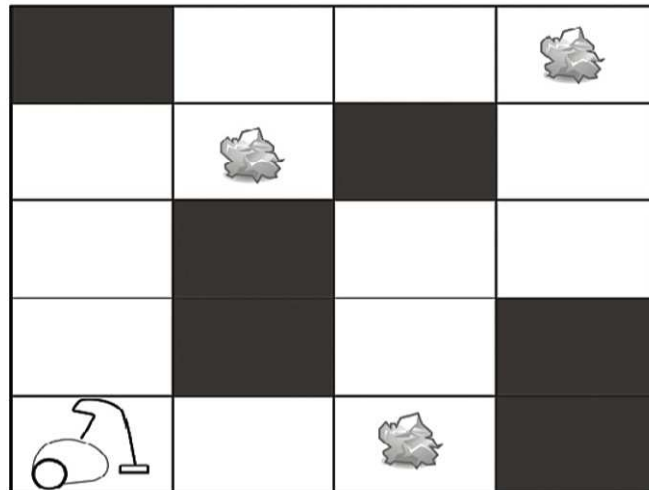
Tasks T21 – T30 carry 5 points each

T21. Icon Image Compression

Look at the following 4x4 black and white pixel images:
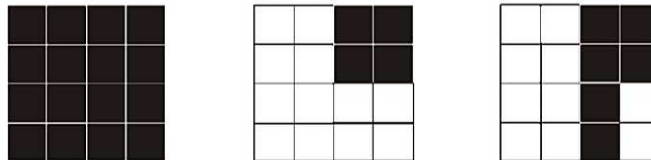
This could be stored using binary digits: "1" for white pixels and "0" for black pixels. For a 4x4 image we would have to store 16 digits.

The following image compression method allows to store images using less space, especially for simple patterns:
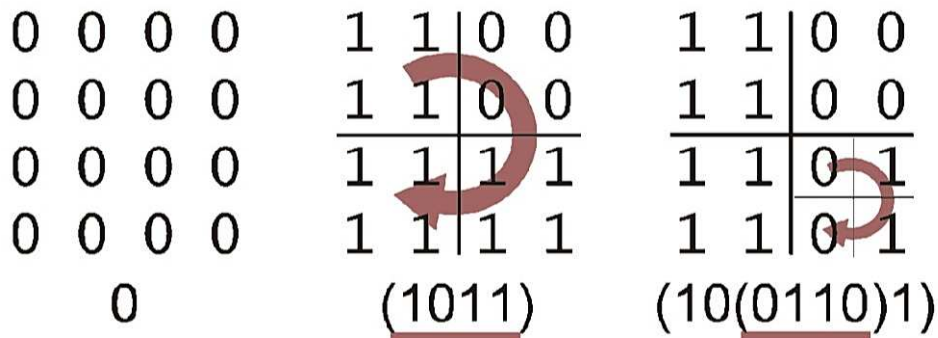
The binary digits are arranged in a grid like the pixels in the images.

The compression method is applied to this grid as follows, producing a result string:

i.   If all digits of the grid are 0, the result is "0" (see left image). If all digits of the grid are 1, the result is "1".

ii. Otherwise, the grid is divided in quarters. The compression method is applied to each quarter sub-grid from the top left in clockwise order. The results are combined and surrounded by brackets "(" and ")". For two different examples see the center and right images.

Note that a sub-grid may consist of one digit only; see right image, bottom right corner. In this case, the method will use step 1 only.

Question / Challenge

Below, see the binary digit grid for an 8×8 image. The compression method is applied to this grid.
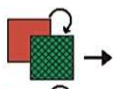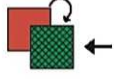
```
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1
1 1 1 0 1 1 1 1
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1
```

Which result string does is produce?

A) (1110)   B) (11(1011)1)
C) (111(1(1101)11))   D) (111(1(1011)11))

T22. Robot

Milan has built a robot that reads coloured squares, changes their colours and moves one square to the left or one square to the right. The robot acts according to rules like these:

 If you see a red square, change its colour to green and move one square to the right

 If you see a red square, change its colour to green and move one square to the left

At the beginning, the robot is standing on the leftmost square. It detects the colour of the square, finds the rule that starts with this colour, changes the colour of the square according to the rule and moves according to the rule. Then, the robot repeats the same procedure for the square that it is standing on, and so on. If it doesn't find an appropriate rule or it goes outside of the squares, it stops.

The robot was given this sequence of squares

and these rules:

Time Allowed: **150 minutes**
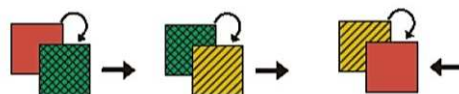
Question / Challenge

What will the squares look like when the robot stops?

A)

B)

C)

D)
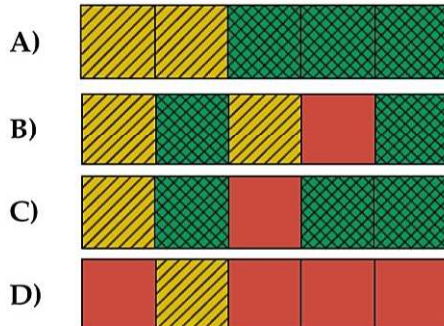
T23. Tunnels of the Homestead Dam

"Homestead Dam" has tunnels that connect four rooms (A, B, C, F). The first three rooms (A, B, and C) are living rooms, the fourth room (F) is where food is stored (see figure).
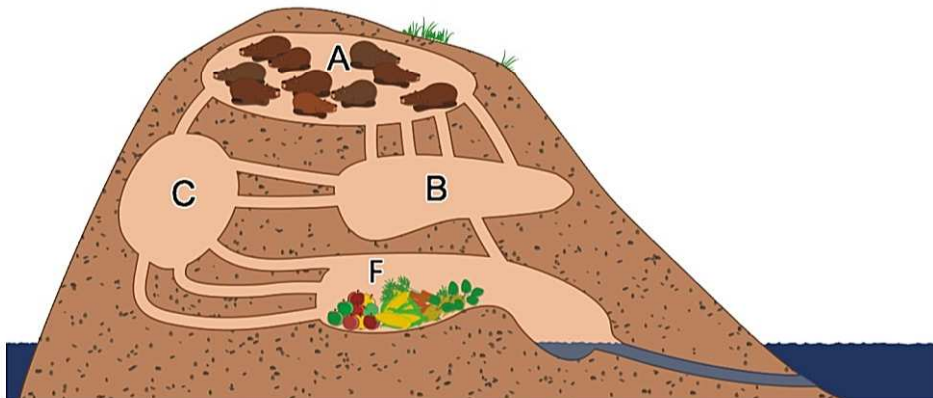
10 beavers are staying in room A, they are becoming hungry and they want to go to room F to eat. Since all beavers are very hungry, they all want to arrive in the food storage as soon as possible.

It takes 1 Minute to traverse a tunnel and only one beaver may traverse a tunnel at the same time (not several beavers following each other).

The connections between the rooms are composed by a certain number of tunnels:

- Between A and B: 4 tunnels.
- Between A and C: 1 tunnel.
- Between B and C: 2 tunnels.
- Between B and F: 1 tunnel.
- Between C and F: 3 tunnels.

The rooms have no capacity limits, that is in all rooms there can be as many beavers as want to be there.

Time Allowed: **150 minutes**

Question / Challenge

In the best case, after how many Minutes can all beavers be in the food storage?

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

T24. Tandems

We will call a sub-string "TANDEM" if it represented by two identical character sequences, one after another. The number of characters in a *tandem* is named as its *length*. For example the string AABABA has three tandems AA (length 2), ABAB and BABA (length 4).

Question / Challenge

What is the length of the longest tandem in the string below?
TCTACTAACCTACTAACAC

A) 4 **B)** 6 **C)** 8 **D)** 10 or more

T25. Robot paths

A robot can travel through a grid on the floor, by making North or East steps. Diagrams (like the one in the first figure below) are used to direct the robot movements, since they specify which paths (i.e., sequence of North and East steps) the robot may travel.
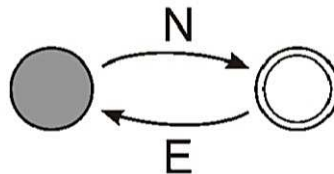
Allowed paths are obtained following the arrows in the diagram:

- an arrow with N represents the fact that the robot must execute a North step;
- an arrow with E represents the fact that the robot must execute an East step;
- the filled circle represents the starting point of the path
- the double circle represents the possible final point of the path
- if the robot is in the double circle and there is an arrow leaving it, the robot may continue moving
-

For instance, if the robot follows the diagram in the figure above, then it starts with a North step, then executes alternating East and North steps, and stops after an North step; thus, for instance NENENEN, NEN, or NENENENENENEN are allowed paths, but NENNE, NENE or ENE are not.

Time Allowed: **150 minutes**

Question/Challenge

The robot is now directed by the diagram in the figure below.
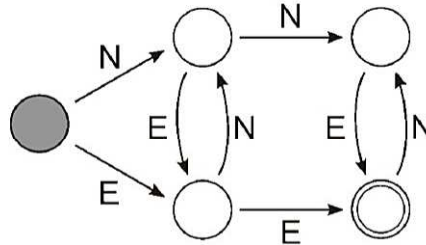
In any allowed path, what is the difference between the number of E's and the number of N's?

A) equal to 2   B) equal to 3
C) at most 2   D) we cannot tell

T26. Wash the uniforms

All uniforms used at a tomato festival need to be washed using a single washing machine. The washing machine can wash up to three uniforms at the same time during each machine cycle.

- The number of hours it takes to wash a *single* uniform is exactly the same as the number of tomato stains on that uniform.
- The number of hours it takes to wash *two* uniforms at the same time is the same as the number of tomato stains on the dirtier uniform of the two.
- The number of hours it takes to wash *three* uniforms at the same time is the same as the number of tomato stains on the second dirtiest of the three.
-

The following table shows possible examples of a laundry process that takes three hours.

1 uniform	2 uniforms	2 uniforms	3 uniforms	3 uniforms

Time Allowed: **150 minutes**

Question / Challenge

How long does it take to wash the 14 uniforms (shown below) in the quickest way?
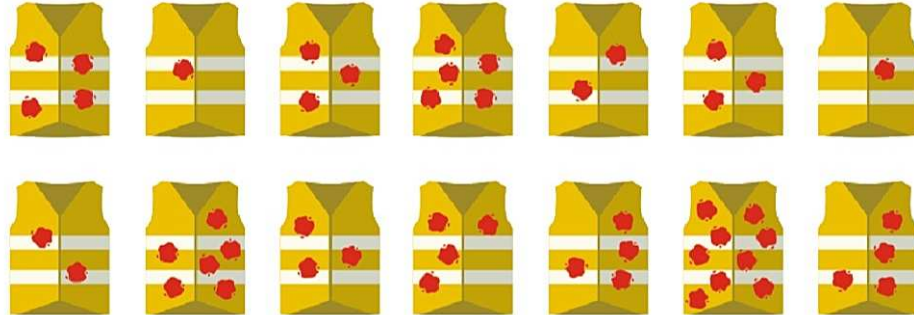
A) 8   **B)** 12   **C)** 14   **D)** 16

T27. Downloads List

When downloading files from a server, the download speed is limited. For example, when 10 files are downloaded simultaneously, the download speed for each file is 10 times slower than it would be for only one file.

A user downloads three files from a server, simultaneously. The picture to the right shows the current download state. The remaining time is computed based only on the current speed and does not depend on any history.

Time remaining   1 min

Time remaining 10 min

Time remaining 4 min
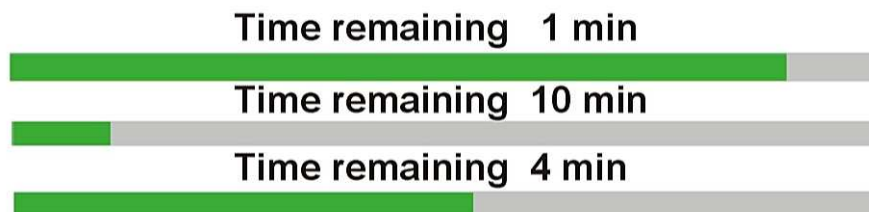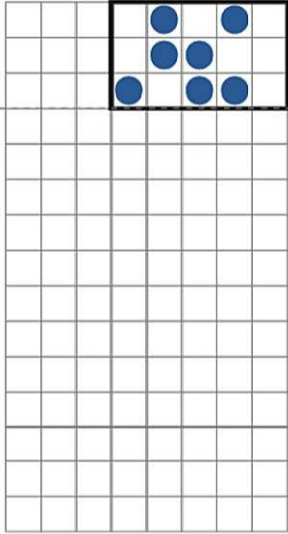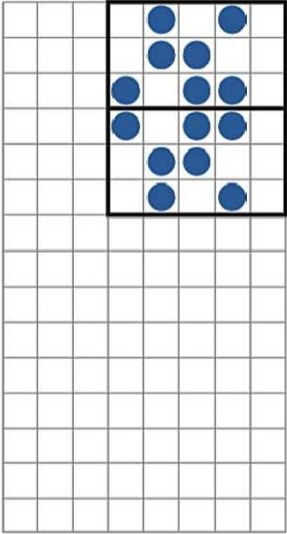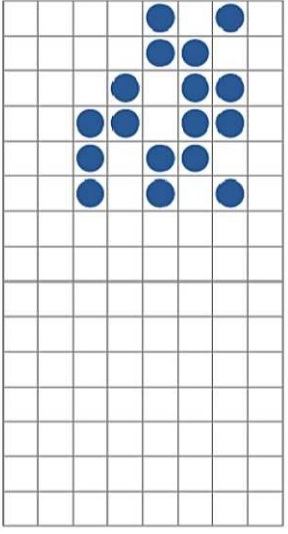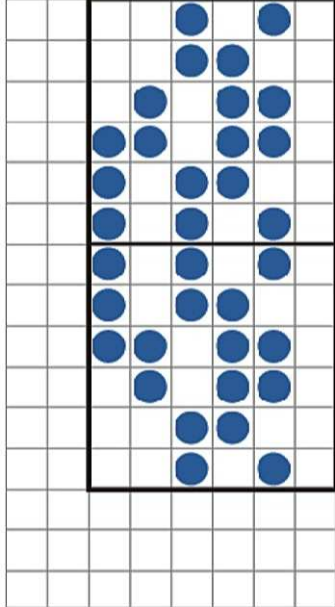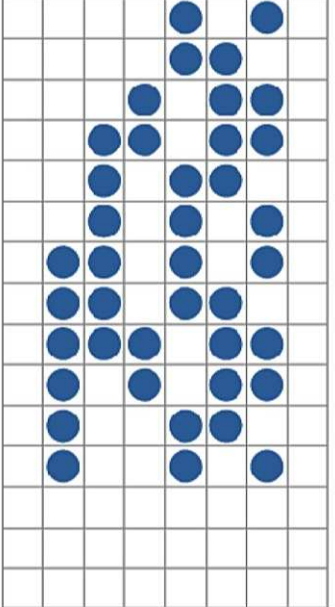
Question / Challenge

How long will it take to download all the files?

A) 4 min   **B)** 5 min   **C)** 6 min   **D)** 15 min

Time Allowed: **150 minutes**

T28. Seven Folds of Gray

Take a piece of graph paper and mark a rectangular area at the top right, say three rows and five columns. Put ink blots at randomly chosen squares.	Now, fold just below the area. Ink is still wet and you get a mirror image of the area.	Add blots to the square at the left of each row in the mirror image. The numbers in the right side shows the different places in consecutive rows.
Fold again, this time below the mirror image. You get a new mirror image.	Add blots to the left of each row; these blots are one column to the left from where you put the new blots in the previous step.	
		What you get is a pattern of rows. Some are similar to each other, like the 3rd and the 4th row which differ only in a single place. Some are quite different, like the 2nd and the 3rd which differ in three places.

Time Allowed: **150 minutes**

Question / Challenge

Now, let us start with a simpler initial pattern in a 2x1 rectangle:
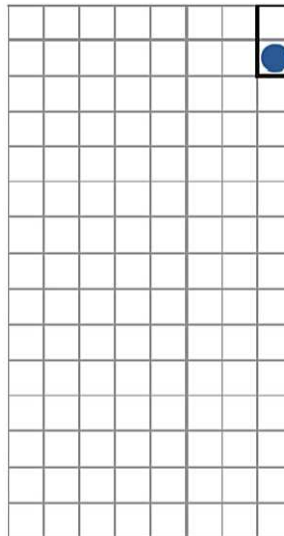
Repeat folding and adding blots for seven times to get a nice long pattern. After you have done (or, hint: before you are done!) find the most different consecutive rows. In how many places do the differ?

A) 1   B) 2   C) 7   D) 8

T29. Broken Necklace

Beaver Andrea has the neckless with the following sequence of beads: a diamond shaped bead, a square shaped bead, a circle shaped bead, and again a diamond shaped bead, a square shaped bead, a circle shaped bead and so on:

The necklace contains an odd number of beads.Andrea first removes the middle bead in the necklace obtaining two shorter necklaces of equal and again odd lengths. She puts the left necklace aside. She repeats the same operation three more times: each time she removes the bead from the middle obtaining two shorter necklaces with an odd number of beads, and putting aside the left neckless.
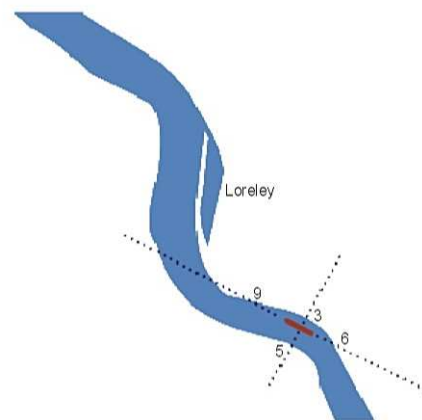
Question / Challenge

Knowing that at the end she is left with a   bead, what were the beads that she removed from the necklace and in what order?

Time Allowed: **150 minutes**

A) First: [green square] , Second: [red circle] , Third: [green square] , Fourth: [red circle]

B) First: [blue diamond] , Second: [red circle] , Third: [blue diamond] , Fourth: [red circle]

C) First: [blue diamond] , Second: [green square] , Third: [blue diamond] , Fourth: [green square]

D) First: [red circle] , Second: [green square] , Third: [red circle] , Fourth: [green square]

T30. Ship on the Rhine River

An automatically controlled ship is travelling along the Rhine River from South to North (bottom to top on the map) while keeping a safe distance from the banks. Four sensors are constantly measuring the distance to the next object above the water surface in front, on the right hand side, in the back and on the left hand side. The computer uses the sensor data to control the engine and the rudder. Every minute the data are logged in a table. The image depicts the position of the ship in minute 120.

Minute	Front	Back	Left	Right
120	9	6	5	3
121	16	10	6	2
122	12	8	4	4
123	24	10	6	4
124	5	14	4	6
125	28	16	5	5
126	16	28	6	4
127	12	16	7	4
128	8	14	6	4

Loreley

Question / Challenge

At a certain time a ferry crossed the river in front of the ship. The ship automatically turned to that side at which there was more space on the river. In which minute did the ship encounter the ferry?

A) 124   **B)** 125   **C)** 126   **D)** 127

Well done!