Tasks T1 – T10 carry 3 points each

T1. Treasure Maps

A pirate beaver has a very large treasure map which is cut into smaller pieces. Each map piece shows a region of 8 units wide and 8 units long (shown as ***Fig. 1***). However, she has a very small boat and cannot take all the map pieces with her. Smart as she is, she finds a way to document each region (map piece) into a small chart in her note book. Here is how:

1. If all pieces in the region are in the same colour, she marks a "square" on her notebook with the same colour.
2. Or else, she marks a "circle" (shown as **Chart 1**) and divide the region into 4 subregions (shown as ***Fig. 2***) according to central point.
3. Repeat steps 1 and 2 above until all pieces are marked (shown as **Chart 4**).

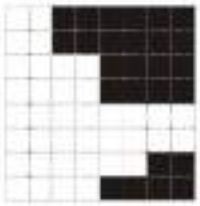


Fig. 1

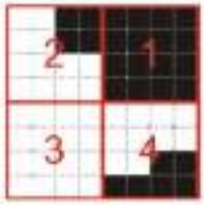


Fig. 2

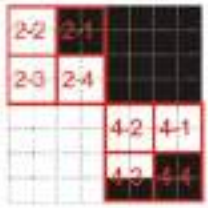


Fig. 3

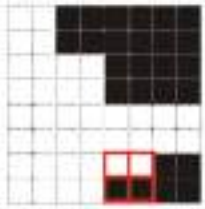
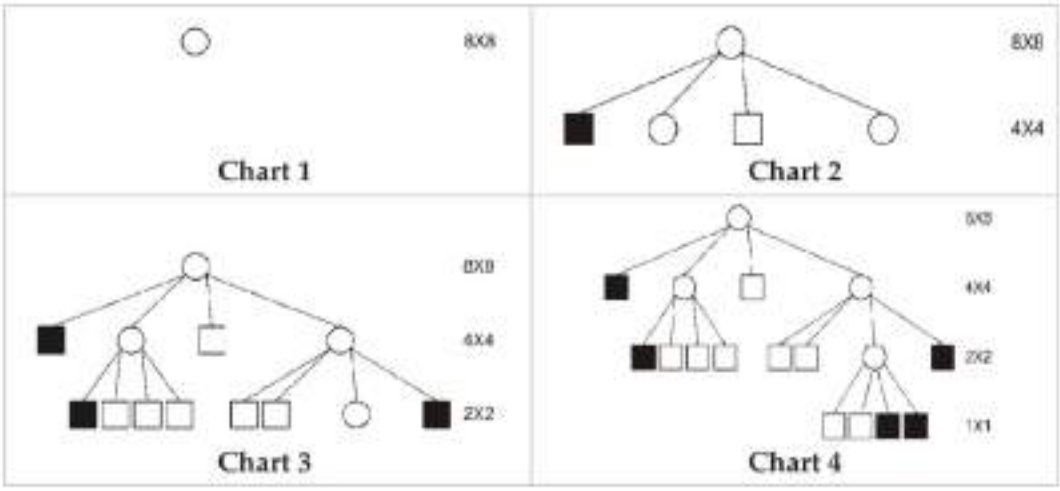
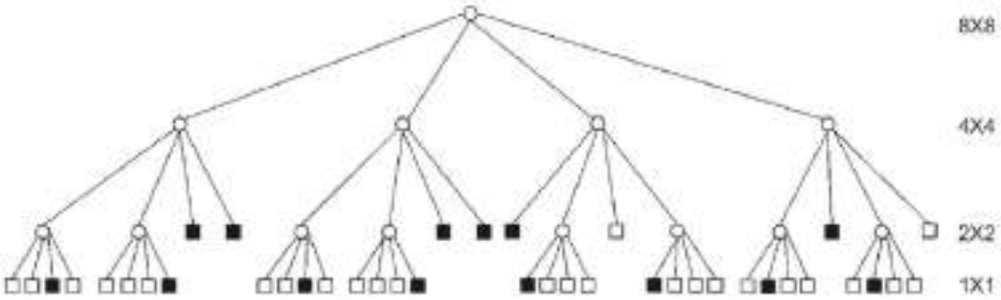


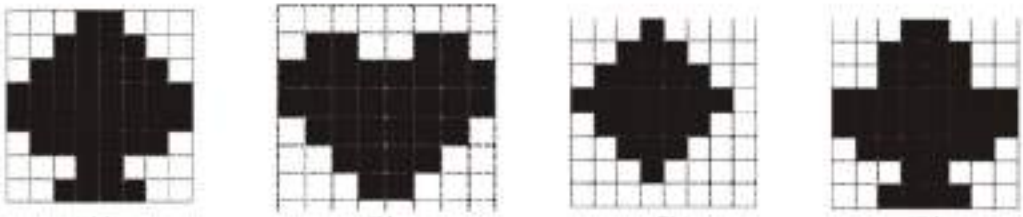
Fig. 4



Question/Challenge:

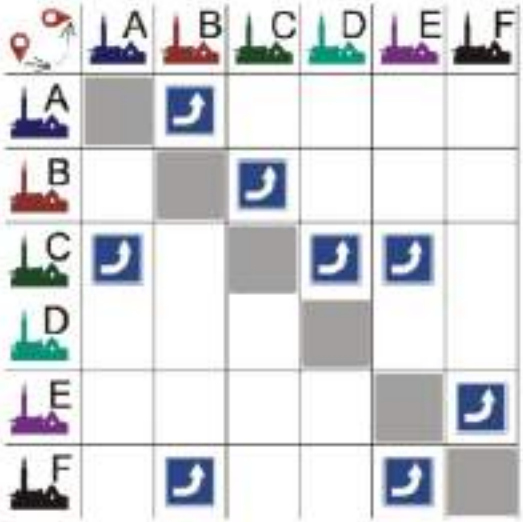
Here is a chart in the pirate beaver's notebook. Which of the following map pieces does it represent?





T2. Decryption Map

A beaver signed up to play a map game. During the game, all the roads became one-way roads, but the players were not given a map. Instead, they were given the table below.



There are six cities: *A*, *B*, *C*, *D*, *E*, and *F*. When there is an arrow in the table, it means there is a one-way road starting from the city corresponding to the row and ending at the city corresponding to the column. When there isn't an arrow, it means no road directly connects these two cities. For example, there is a one-way road from City *B* to City *C* but there is not a one-way road from City *B* to City *D*.

Question/Challenge:

Which of the following statements is true?

A) The beaver needs to use at least three one-way roads to get from City *C* to City *B*.
B) The beaver needs to use at least three one-way roads to get from City *A* to City *C*.
C) The beaver needs to use at least three one-way roads to get from City *A* to City *D*.
D) The beaver needs to use at least three one-way roads to get from City *B* to City *E*.

T3. Sorting a Set of Books

Three beavers each have their own table. Each table has two books. As you can see, the order of the books is mixed up and the beavers want to fix that by doing rounds of swapping.

There are two different types of rounds. In one type of round, each beaver may swap the two books on its table (example: Ⓐ). In the second type of round, the beavers

may swap neighboring books between two tables which are next to each other (example: (B))

In the first round, each beaver swaps the two books on their table.

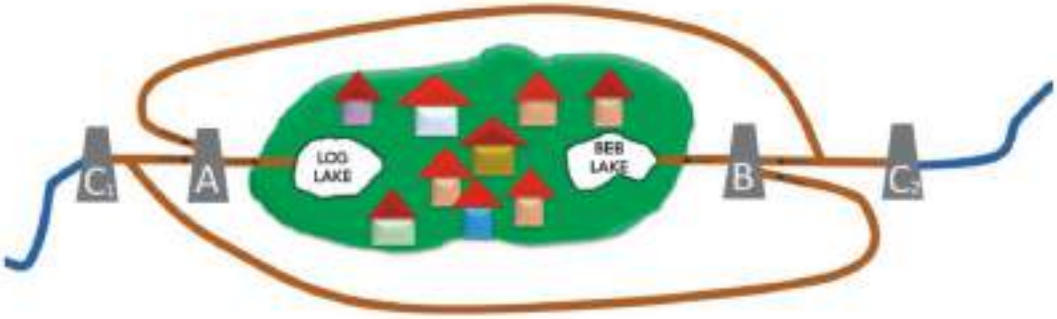
Question/Challenge:

What is the fewest number of rounds needed to swap the books into the order 1, 2, 3, 4, 5, 6?

A) three rounds **B)** four rounds **C)** five rounds **D)** six rounds

T4. Beaver inovator

Beaver Ivan is famous for his inventions. Currently he is developing different types of dams. He developed dam type **A** which has two entrance canals and one exit canal. Water will go through dam **A** to the Log lake if both entrance canals are filled with water. Type **B** dam has two entrance canals and one exit canal but it allows water to go through to the Beb lake if only one entrance canal is filled with water (no matter which one). Beaver Ivan developed whole project plan for filling the lakes for two different parts of Beavertown. In his project he is using type **A** and **B** dams and normal dams type **C** which don't allow water to go through when dam is lowered, but water can go through when dam is lifted up.



Question/Challenge:

In his project Ivan wants to avoid a situation when both lakes are empty at the same time. What positions of dams type **C** he needs to avoid?

A) Dam C_1 is lifted up, and dam C_2 is lowered.
B) Dams C_1 and C_2 are lifted up.
C) Dams C_1 and C_2 are lowered.
D) Dam C_1 is lowered and dam C_2 is lifted up.

T5. Coloured objects

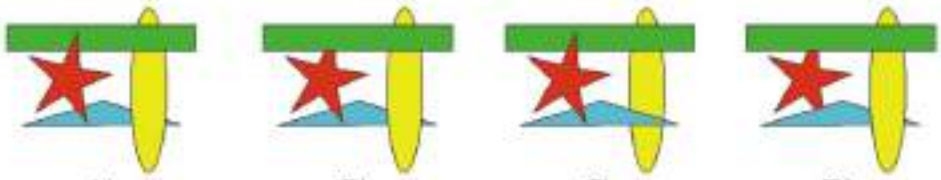
In a vector graphic editor we created four coloured objects: a rectangle, a star, an oval and a triangle.

Later we made some changes:

- we raised the yellow oval to the top
- we grouped the red star with the green rectangle
- we raised the grouped object (star + rectangle) to the top

Question/Challenge:

How did the the image look like after the changes?



A) B) C) D)

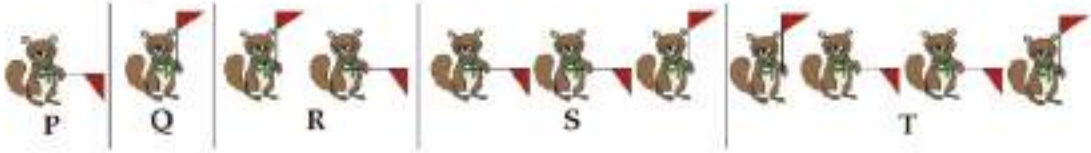
T6. Flag Semaphore

Beavers in the town of Achi communicate by holding flags. They either hold the flags horizontally or vertically.

Position 1: horizontal

Position 2: vertical

The beavers send five different letters, *P*, *Q*, *R*, *S*, and *T* to their friends. They send each letter by showing the flag in different positions one after the other in the following way:



P Q R S T

Question/Challenge:

Beaver Adanma shows the following combination of flag positions:

Which letters below did she send?

A) *TSQ* **B)** *RPQSR* **C)** *RPSP* **D)** *QPPTP*

T7. The big migration of beavers

A colony of beavers are going to migrate to a new place across the river. Since it is impossible for all beavers to migrate at the same time, the beavers' Immigration Bureau made four rules for beavers who want to migrate:

1. Build a boat with one forward and two backward connections and then request a unique boat ID number from the Immigration Bureau (**Figure 1**).

2. Take the boat and wait in the middle of river. If you are the only boat then connect to the waiting dock directly. Otherwise, your boat has to connect to one specific boat among the others by applying Rule 3.

3. Search the specific position to connect. Start from the boat that connects to the waiting dock. If ID of that boat is greater than yours, go to the backward connection on the left. Otherwise go to the backward connection on the right. Repeat the comparing process until there is an empty backward connection and then connect your boat to it (**Figure 2**).

4. Each day, the Immigration Bureau will announce a lottery number and search whether any boat has the same ID using Rule 3. If so, the boat can migrate to the new place.

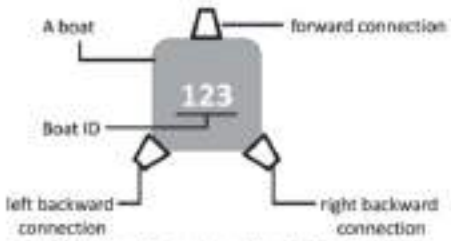


Figure 1. A standard boat

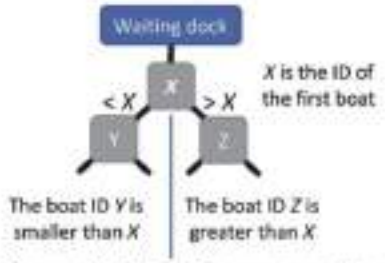
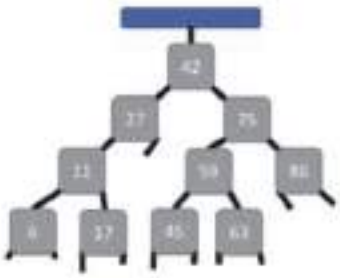


Figure 2. Rule 3 for connection

Question/Challenge:



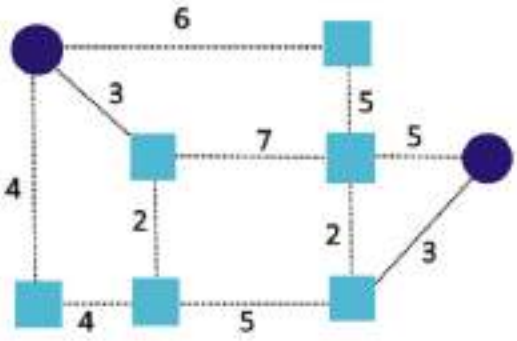
There are 10 boats waiting to migrate as shown in the left figure. If today's lottery number is 78, how many boats at least should the Immigration Bureau check to know whether any beaver can migrate?

A) 3 **B)** 4 **C)** 10 **D)** 11

T8. Last letter

Beaver Anna delivers the mail in the city. She just got back from work, but seems to have forgotten one letter. She is now at her house, in the circle on the left, and the letter is meant for Charley, who lives at the circle on the right.

There are a few paths Anne can take. The numbers in the picture show how long the roads are.



Question/Challenge:

What is the least number of kilometers Anna has to walk to deliver the letter?

A) 5 **B)** 7 **C)** 13 **D)** 16

T9. Medical lab

A diagnostic device in a medical lab must repeatedly shake specimens taken from patients. The device works according to a computer program, which is written on numbered lines. The device reads the program line by line. It always reads one line and executes it immediately. If the line contains the command go to *X*, the device jumps to the line *X* and continues reading and executing.

The program is able to store a number *A*, to add *1* to the number stored in *A*, and compare its value with another number.

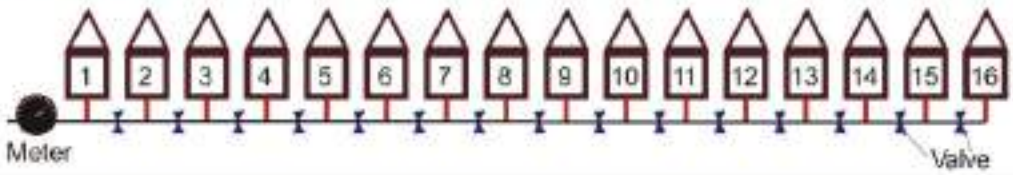
Question/Challenge:

How many times will the device shake the specimens according to this next diagnostic procedure?

```
1 set A to 0
2 add 1 to A
3 go to 6
4 if A equals 60 go to 8
5 set A to 0
6 add 1 to A
7 go to 2
8 repeat A times to shake the specimens
9 end
```

A) The specimens will be shaken 60 times.
B) The specimens will be shaken once.
C) The specimens will never be shaken.
D) The diagnostic procedure will not stop shaking the speciments.

T10. Find the leaks



A water pipe connection to one of **16** houses along the same street has a leak. The officials are trying to find where the leak is. To help in the search, all households on the street have turned off their water.

To trace the leak, officials will close a valve between two houses and see if the meter on the pipe still shows water being used. If they start, for example, by closing the valve between No **8** and No **9**, and the meter shows that water is still being used, they know the leak is between No **1** and No **8** (and there is no leak between No **9** and No **16**).

Question/Challenge:

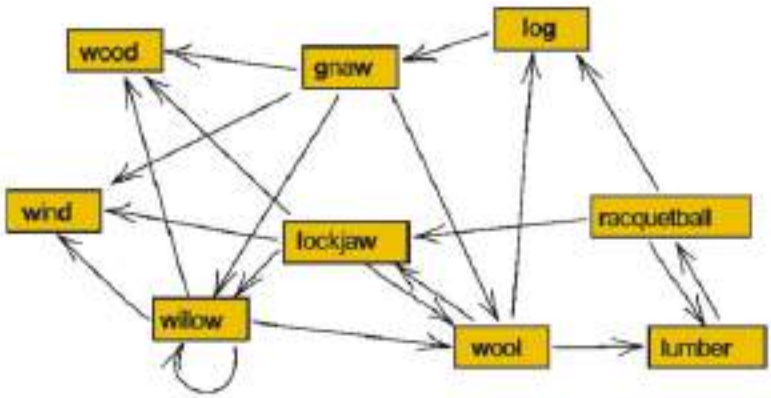
Assume there is only one leak in the pipe connections (the vertical red segments in the picture). What is the least number of valves they have to close to make sure they have identified the leaking pipe?

A) 3 **B)** 10 **C)** 1 **D)** 4

Tasks T11 – T20 carry 4 points each

T11. Longest word chain

Beavers play a word chain game. One beaver starts by saying a word. The other beaver must come up with another word which begins with the last letter of the previous word. Then the first beaver finds another word (which was not used yet), and so on. Sadly, these beavers do not know many words. In fact, they can draw their entire vocabulary like this:



Question/Challenge:

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

A) 4 **B)** 8 **C)** 9 **D)** 10

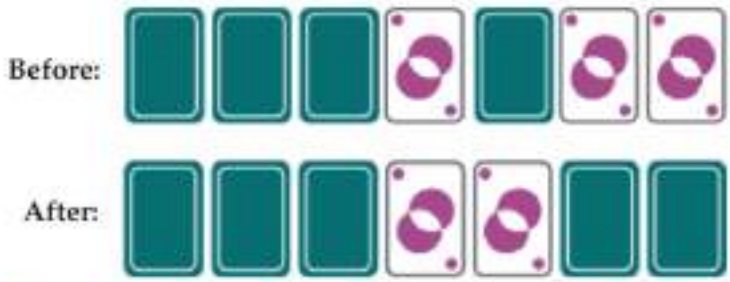
T12. Flipping cards

We play the following 'game'. A row of cards is laid out in front of you. The cards may lie face up  , or face down  .

For one *step* in the game you do the following:

- You examine the cards *from right to left*.
- If the current card is *face down*, you turn it *face up* and stop.
- If the current card is *face up*, you turn it *face down* and proceed to the next card.
- When you run out of cards, you stop.

The picture below shows the effect of such a step: you first turn over the rightmost card, then the card to the left of it and then the card to the left of that. At that point you must stop, because the third card ends facing up.



Question/Challenge:

If you start the game with 7 cards lying face down:

how many steps will it take before you first encounter the pattern below (with all 7 cards facing up)?

A) It will take 10 steps or less.
B) It will take more than 10 steps but at most 100.
C) It will take more than 100 steps but at most 1000.
D) It will take more than 1000 steps.

T13. Equivalence

Beaver Bob has a computer that knows some operations on concepts:

- ⊓ intersection of concepts.
- ⊔ union of concepts.
- ¬ complement of concepts.
- ≡concept equivalence.
- ⊥ empty concept

A concept is an idea or a piece of information. Example: woman, person, male.
The statement "**A** ⊓ **B**" is the intersection between **A** and **B**.
Example: Woman ≡Person ⊓ Female.

"**A** ⊔ **B**" is the union of concepts **A** and **B**. Example: Parent ≡Mother ⊔ Father.
¬**A** is the complement of **A**. Example: Male ≡¬Female.
Bob wants to define new concepts with the simple concepts Person and Female, as in the examples above.
Beaver Bob also knows the following rules:

$$\mathbf{A} \sqcap \neg\mathbf{A} = \neg\mathbf{A} \sqcap \mathbf{A} = \bot$$
$$\mathbf{A} \sqcup \bot = \bot \sqcup \mathbf{A} = \mathbf{A}$$
$$\neg(\mathbf{A} \sqcap \mathbf{B}) = \neg\mathbf{A} \sqcup \neg\mathbf{B}$$

(where *A* and *B* are concepts).

Question/Challenge:
How would Bob define the Man concept with the simple concepts and the Woman concept?

A) Man ≡ Person ⊓ ¬Woman
B) Man ≡ Person ⊓ Woman
C) Man ≡ Person ⊓ Female
D) Man ≡ Person ⊔ Woman

T14. Atomic shelters

A beaver family has five different food locations on various parts of the river. The travel times (in minutes) from one food location to the next are shown in the picture. The family will build lodges in two of the food locations.
When the weather gets bad, a beaver travels from a food location to the nearest lodge. The time to do this trip is called the escape time.
The beavers wish to build their lodges so that the longest escape time is as small as possible.

Question/Challenge:
Which two locations must they choose to build their lodges?

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

T15. Beaver Bar Code (*BBC*)

For transferring messages in the wood the beavers developed a code system (the Beaver Bar Code – *BBC*) that is unreadable for other animals. They scratch marks varying in breadth which alternate with bark streaks also varying in breadth. There are small scratches and bark streaks with a certain breadth, middle ones are twice as broad as small ones and broad ones are triple as broad as small ones. Below they are termed with single, double and triple. Codes in *BBC* can be constructed according to the following rules:

R1: A CODE is constructed by chaining up one, two or three PAIRs and a SCRATCH.
R2: A PAIR is made by chaining up a SCRATCH and a BARK.
R3: BARKs and SCRATCHes can be single, double or triple.

Question/Challenge:

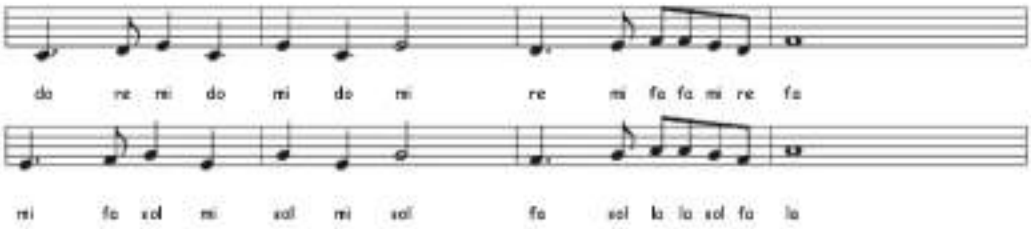
Which of the following patterns is a CODE according to the rules above?

A) B) C) D)

T16. Express the Song in Rainbow

In Beaver Elementary school, students sing "Do-Re-Mi" together to start a joyful morning of the day. After that, Do-Re-Mi song became the most popular song in the school. The teacher planned to find a new way to play Do-Re-Mi song.

The new method was to match each note in the song with bricks with different sizes and different rainbow colors. For example, the note which follows as Do-Re-Mi-Fa-Sol-La-Si are matched with bricks that are color-coded as Red-Orange-Yellow-Green-Blue-Indigo-Violet. The first 7 notes of the song will be shown as Red Orange Yellow Red Yellow Red Yellow.



	Colors of rainbow bricks
Red	
Orange	
Yellow	
Green	
Blue	
Indigo	
Violet	

Question/Challenge:

When expressing the first 28 notes in Do-Re-Mi song with the rainbow bricks, who used the brick encoding with smallest total size?

	Colors of rainbow bricks	A) Bob	B) Tom	C) Alice	D) Lucy
Red		mi	sol	mi	si
Orange		sol	mi	fa	fa
Yellow		fa	do	sol	do
Green		la	la	re	re
Blue		re	fa	do	la
Indigo		do	re	la	sol
Violet		si	si	si	mi

T17. A toy game

The young beavers of Bebraria love playing with their toys, but don't really like having to put them away. To make the process more fun, they invented a fun little game to help them get through it. First of all, they give an integer value to each toy, meaning how much they like to play with it.

The following image contains all the 16 toys the young beavers own and the integer values they gave to each one.

Then, each beaver picks any number of toys they want with a single restriction: for any two of the toys that are picked, either the value of the first must be a multiple of the value of the second or the value of the second must be a multiple of the value of the first. For example, a beaver can never pick both a toy with value 2 and 5, since 2

is not a multiple of 5 and 5 is not a multiple of 2, but he or she can pick both 4 and 16, since 16 is a multiple of 4 (16 equals 4 times 4).

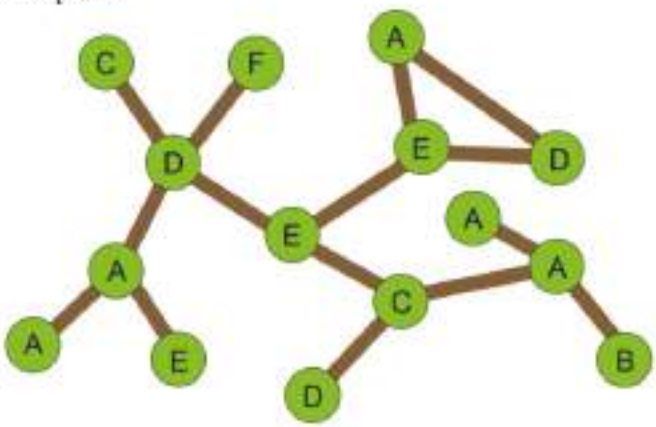
Question/Challenge:

What is the most toys a beaver can pick, following the game's restriction?

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

T18. Park walk

This is the map of a park:



The green circles with letters represent the trees and the brown lines are paths. Note that some letters are used to label more than one tree. A walk from tree **F** to tree **B** will be described as **F D E C A B**. Last Sunday two families walked in the park.
The Wide family's walk was **B A A A C E D E E D A**.
The Gide family's walk was **F D C D A E A D E D A.**

Question/Challenge:

Let's assume that both families started their walk at the same time and walking from one tree to another tree takes the same time. How many times did the two families meet at a tree?

A) Once **B)** Twice
C) Thrice **D)** They never met during their walks last Sunday

T19. Gamma code

Bruno organizes a meeting with his friends. He decides to send the meeting time to his friends in the Gamma code, which uses both binary and unary systems.

In *binary* system, numbers are written using the digits 0 and 1.The rightmost position is units, as in decimal system. Moving to left, the value of each next position is twice that of the previous position. For example, the value of the binary number 1101 is $1 \cdot 8 + 1 \cdot 4 + 0 \cdot 2 + 1 \cdot 1 = 13$.

In *unary* system, numbers are written by repeating the digit 1 as many times as the value of the number, followed by a 0. For example, the value of the unary number 1110 is 3.

In *Gamma code* a number is represented as length followed by offset. The *offset* is the number in binary, but with the leftmost 1 cut off. For example, the number 13 in binary is 1101, so the offset is 101. The *length* is the length of the offset in unary. Thus, the Gamma code of the number 13 is the length 1110, followed by the offset 101: 1110101.

To send the meeting time, Bruno just sends the hours and minutes of the time (two numbers) in Gamma code one after the other.

Question/Challenge:

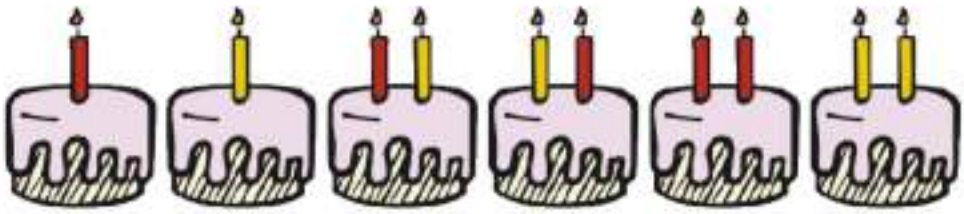
What is the time that Bruno sent to his friends as 1110101111101110?

A) 13:30 **B)** 13:14 **C)** 6:30 **D)** 6:14

T20. Happy Binary Cake

Beavers are decorating cakes. They want to make each cake different. Therefore they will place a different combination of candles on each cake. They have two colors of candles, red and yellow. All cakes must have at least one candle, and the order of the colors of the candles does matter. For example the combination red-yellow is different from yellow-red, even though they each have one red and one yellow candle.

Examples:



The beavers want to use the lowest total number of candles possible, so they start decorating cakes with 1 candle first, then move on to cakes with two candles, then cakes with three candles, etc.

Question/Challenge:

If the beavers have 14 cakes to decorate, how many candles will they need to use?

A) 14 **B)** 24 **C)** 34 **D)** 36

Tasks T21 – T30 carry 5 points each

T21. Secret Siblings

Janet and Dave like to write secret messages to each other in their own encryption system. One day, John found a small note that Dave left Janet on the floor.

Wicw mx lvz col? – Pnjt

John remembered that Dave once said that their encryption system only uses the English alphabet, no symbols. He also knew Dave's habit of ending every message with his name.

Question/Challenge:

Using the same encryption system, what is the encoding for the word *eggs* ?

A) sgge **B)** ehhi **C)** ehiv **D)** acrg

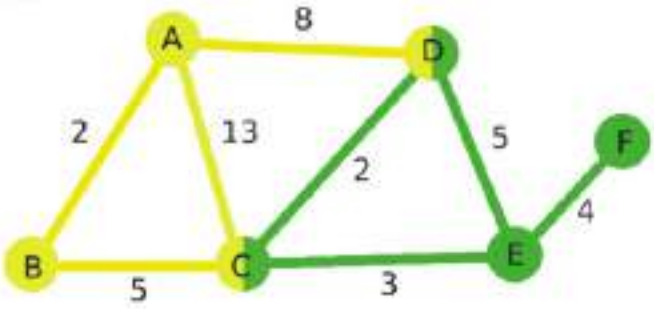
T22. Telegraph networks

An international data network is shown in the figure below. Each network has nodes of the same color. Nodes with two different colors indicate connections between different networks. There is a roaming charge in the connections, so if a message is transmitted from a node of a network to another network, the cost of the transmission is:

(the value of the path that the message has to cross within the first network) + (the value of the path of all other networks to get to the recipient) * 2 .

Each branch of the networks has it´s own cost, shown in the graph.

An example is shown:



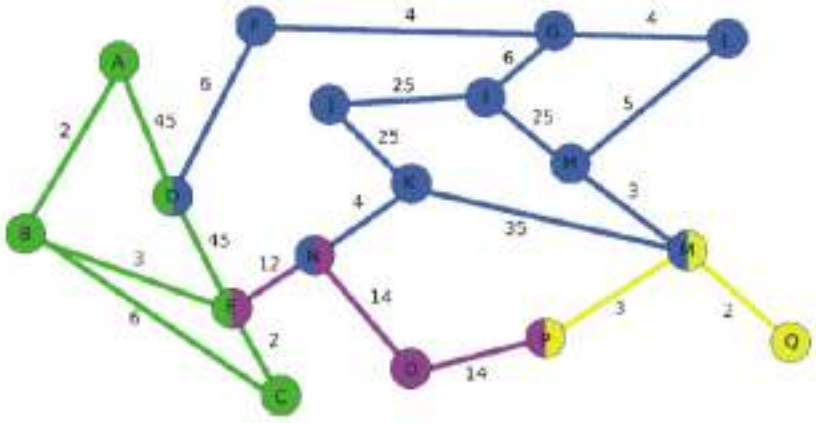
The cheapest path to transfer information from A to F is 21:

A→B	B→C	C→E	E→F
2	5	3	4

2+5+(3+4)*2=21

Question/Challenge:

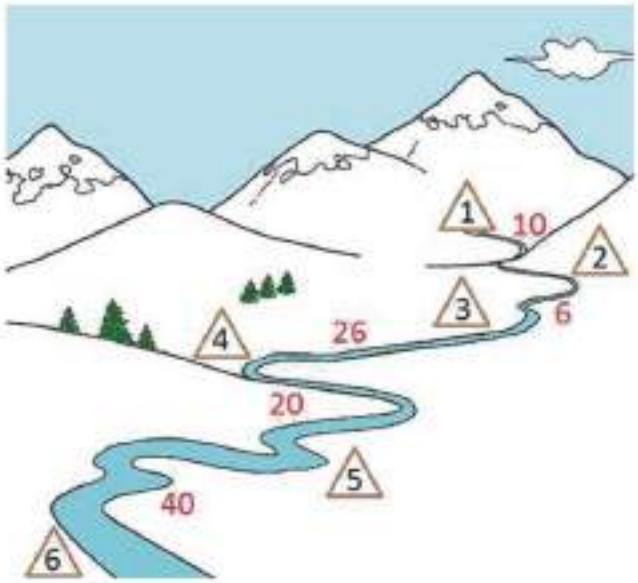
What is the minimum cost to send a message from point **A** to point **Q**?



A) 60 **B)** 111 **C)** 95 **D)** 93

T23. Atomic shelters

The beavers' village includes six lodges, located along the river.



The picture shows the travel times (in minutes) from one lodge to the next, when the beavers descend the river from the mountains to the valley. Instead, to swim up the river, the time increases by 50 percent; so, for example, to go from lodge 2 to lodge 1, the beavers take 15 (= 10 x 1.5) minutes, since going from lodge 1 to lodge 2 takes 10 minutes.

The beavers have sufficient building materials to readjust only three of the six lodges to snow shelters, where all the beavers of the village can find hospitality when the weather is very bad. If necessary, the beavers that are in the other three lodges will swim to the nearest shelter, i. e., the one that can be reached in the shortest time.

Question/Challenge:

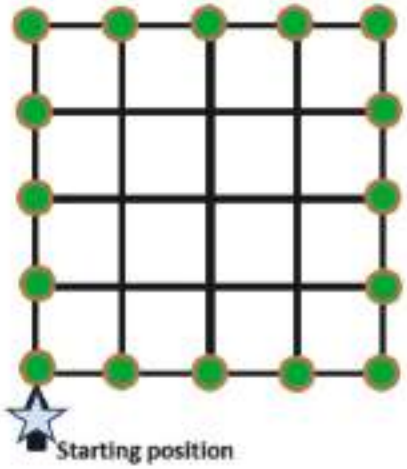
Which three lodges must become snow shelters, so that the maximum time to reach a shelter from any of the other three lodges is minimal?

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

T24. Robo-Woodcutter

Angelo the beaver bought a robot to help him plant small trees to make a garden. The robot programming language consists of the following commands:

Start: Turns the robot on.
Forward(X): Moves the robot forward by **X** meters.
Backward(X): Moves the robot backward by **X** meters.
Left(X): Turns the robot **X** degrees to the left.
Right(X): Turns the robot **X** degrees to the right.
Plant: Plants a small tree.
Repeat X {commands}: Repeats the commands in the brackets **X** times.
Stop: Turns the robot off.



There are 16 places for trees located at the perimeter of a field. Each side of the field is 8 meters long and consecutive trees will be separated by a distance of 2 meters.

The robot starts at the starting position looking at the direction of the arrow. Initially the robot is turned off and must be turned off after it finishes its job.

Once a tree is planted, there is nothing in that location to obstruct or interfere with the robot.

Question/Challenge:

Which of the following programs will allow the robot to plant all trees as in the figure?

A)
```
Start
Repeat 4{
    Repeat 4{Forward(1), Plant},
    Right(90)}
Stop
```

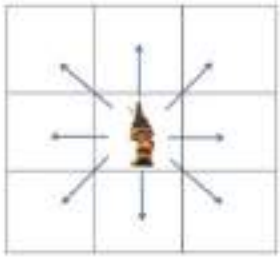
B)
```
Start
Repeat 4{
    Repeat 4{Plant, Forward(2)},
    Left(90)}
Stop
```

C)
```
Start
Repeat 4{
    Repeat 4{Plant, Forward(2)},
    Right(90)}
Stop
```

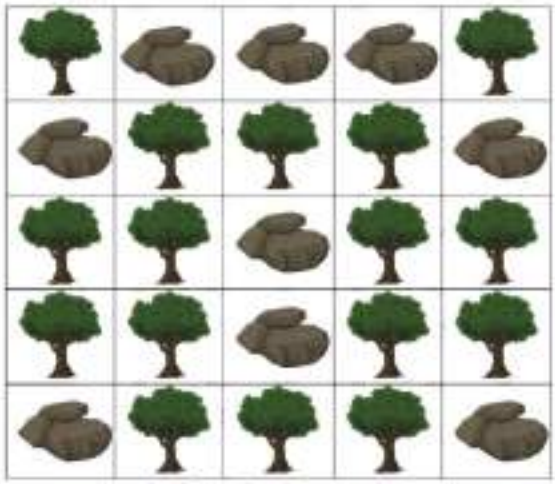
D)
```
Start
Repeat 4{
    Repeat 4{Forward(2), Plant},
    Left(90)}
Stop
```

T25. Buried treasures

There are 5 dwarfs living in a forest. Each dwarf wants to bury his treasure into the forest. They all have a map with the forest divided into squares, each square containing a tree or a rock. It is well known that the dwarfs are burying their treasures only under trees and that they can see all the way through the whole map (except through rocks), in any direction (North, South, East, West, North-East, North-West, South-East, South-West), as described in the picture:



The forest map is:



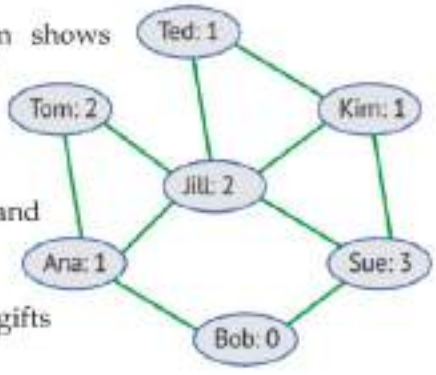
Question/Challenge:

In how many ways the 5 dwarfs can bury their treasures on the forest map without seeing each other?

A) 1 **B)** 3 **C)** more than 3 **D)** 2

T26. Gifts

The kids are planning a party. The diagram shows friendships among the kids of the neighborhood: two kids are friends with each other if a line connects their names.



For each pair of friends, one of them is to buy and bring a gift for the other.

The number in the diagram shows how many gifts each kid can buy.

No kid is supposed to buy more gifts than that number.

Question/Challenge:

Which is incorrect about the gifts the kids will receive?

A) Tom and Sue will not receive any gifts.
B) Jill will receive a gift from Sue.
C) Ana and Kim will receive two gifts each.
D) Tom will receive a gift from Jill.

T27. Helping the Store

Sarah helps her father in his grocery shop. One of her tasks is to help him control the product's expiration date. For example, in some situation, he can ask her: "Sarah, do you know if we have any product that will expire exactly in the date *X*?", where X represents any future possible date. The store does not have any computer.

Each one of the 64 products stored has a record sheet that contains its data, including the expiration date. When Sarah started working with her father, she organized the record sheets on a pile and sequentially looked each one of the sheets to find if existed any product with the expiration date asked by her father. On the best case, the first product sheet would have the expiration date desired.

On the worst case, she would have to look on each one of the 64 products sheets to find if a specific expiration date existed. To optimize this process, Sarah sorted the recorded sheets by expiration date so that the closest expiration date would be at the top of the pile and the farthest at the bottom. She then employed the following strategy:

1) Get the product sheet that is in the middle of the pile. If the pile has only one element, get it.
2) Divide the pile into two piles: upper pile (with the product sheets that were above the sheet got on step 1) and lower pile (with the product sheets that were below the sheet got on step 1). It is possible for a pile to be empty.

3) Look on the sheet gathered at step 1 and:

- If the expiration date is exactly the date she is looking for, tell her father the product was found. End the search.
- If the expiration date is early than the date she is looking for, discard the lower pile and start the step 1 of this strategy considering only the upper pile.
- If the expiration date is later than the date she is looking for, discard the upper pile and start the step 1 of this strategy considering only the lower pile.
- If the last product sheet does not match with the date she is looking for, tell her father that there is no product with the expiration date required.

Question/Challenge:

Using this strategy, how many product sheets Sarah will have to check in the worst case?

A) 64 products **B)** 32 products **C)** 12 products **D)** 6 products

T28. Scheduling Rehearsals

A ballet school is planning a performance, where the ballerinas will dance some duets. There are 6 ballerinas: Alessa, Birgit, Chloe, Dorien, Evelien, Fleur.
They will dance the following duets:

- Alessa - Birgit
- Evelien - Dorien
- Alessa - Evelien
- Birgit - Chloe
- Dorien - Alessa
- Fleur - Birgit
- Chloe - Evelien
- Birgit - Dorien
- Dorien - Fleur
- Fleur – Evelien

Thet ballet teacher wants to schedule the rehearsals for this afternoon with a time slot for each duet in such a way that, when changing from one rehearsal to the next, one of the dancers can remain for the next rehearsal.
E.g. When Alessa and Evelien have the first rehearsal slot, then the next rehearsal could be Chloe and Evelien.

Question/Challenge:

Which ballerina can *not* be in the first duet with whatever schedule the ballet teacher comes up with?

A) Alessa **B)** Birgit **C)** Chloe **D)** Dorien

T29. The Code Plank

For securing their beaver lodge the beavers developed a code system. They use wooden planks with slots. The planks have equidistant areas, each of them with or without a slot. The gate of their beaver lodge has a spy hole. The guard looks through this spy hole, the arrival has to move the coded plank in front of this spy hole with a certain velocity. The guard opens the gate only if the code is accepted based on the following rules:
A: *look at the current area: if there is a slot continue with rule* ***B****, otherwise carry on using rule A.*
B: *look at the current area: if there is a slot continue with rule* ***A****, otherwise carry on using rule* ***B****.*
Accept the code only if you use rule ***B*** *after working on the last area.*

Question/Challenge:

Which of the following codes are accepted:

A) 

B) 

C) 

D) 

T30. Secret secrets

Xavier, Ylenia and Zoe each play a lottery that has at most one winner. They do not tell each other or anyone else whether or not they win. Instead:

1. Xavier and Ylenia secretly flip a coin.
2. Xavier and Zoe secretly flip a coin.
3. Ylenia and Zoe secretly flip a coin.
4. Each person will announce whether the two coin flips they witnessed were the **"same"** or **"different"**.

    - Those who did NOT win the lottery will tell the truth.
    - However, those who won the lottery will lie in their announcement.

For example, if the coin flips are as shown below and Zoe won the lottery, each person announces **"different"**.

Question/Challenge:

If Xavier says "same", Ylenia says "same" and Zoe says "different", then which of the following statements is true?

A) We can be certain that nobody won the lottery.
B) We can be certain that somebody won the lottery but we don't know who won.
C) We can be certain that somebody won the lottery and we know who won.
D) We do not know whether or not anybody won the lottery.