Tasks T1 – T10 carry 3 points each

T1. 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.

T2. Oversleeping Cost

Bob is working in the City Center train station. The working time starts at 8:00 am and for every full 15 minutes he is late, he has to pay a fine of $10. For example, if he arrives at work before 8:15 (e.g. 8:11) there is no penalty but if he arrives at 8:20, there is a penalty for the first 15 minutes of delay.

Bob overslept this morning and reached his home train station at 08:08 am.

The following table shows the schedule of different train lines from Bob's home train station:

Train lines	Schedule	Time to the City Center train station	Ticket fee
Regular	From 6:00 am Every 05 mins	**40 *mins***	$5
Shuttle	From 6:00 am Every 10 mins	**30 *mins***	$10
Light	From 7:00 am Every 15 mins	**20 *mins***	$15
Express	From 7:00 am Every 20 mins	**12 *mins***	$20

Question/Challenge:

Which train line is the most cost-effective option for Bob to reach the City Center train station this morning?

A) Regular
B) Shuttle
C) Light
D) Express

T3. National day walk

Hugo lives in the house *H* in a small village consisting of only 9 houses and one circular road around a lake. The entrances of the houses are placed exactly 10 meters apart.

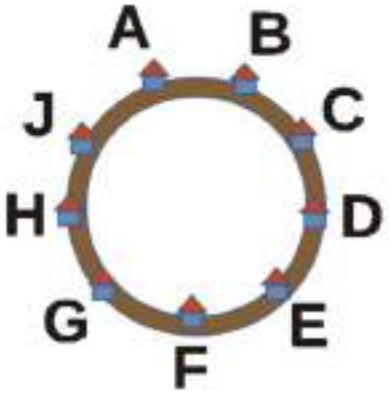
On the National day Hugo bought some sweets and went to visit his neighbors.

Hugo started from the front of his house *H*, he chose a direction and walked that direction until he decided to visit a house. After he left it, he chose a direction again and walked in that direction until he decided to visit another house, and so on. Each time he visited a house he recorded the distance he walked from the previous house.

Question/Challenge:

Finally Hugo visited house *F* and had recorded the numbers **20 10 20 40**.

What houses he must have visited during his walk before visiting house *F* ?



A) *A*, *J* and *B*
B) *D*, *J* and *G*
C) *B*, *J* and *E*
D) *B*, *A* and *C*

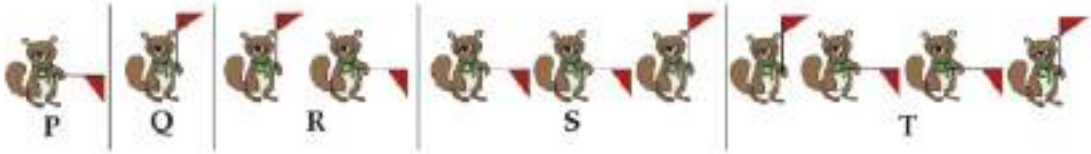
T4. Flag Semaphore

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:



Question/Challenge:

Beaver Adanma shows the following combination of flag positions:

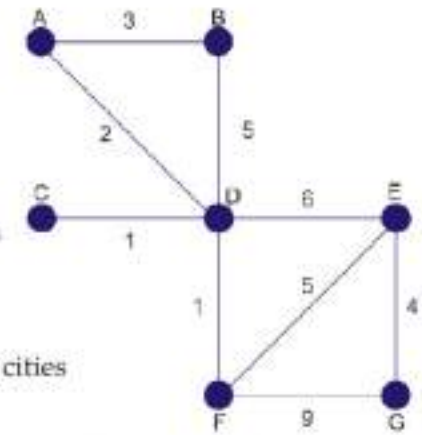
Which letters below did she send?

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

T5. Optical fiber

An internet service provider (ISP) wants to set up a new network. There are seven cities which have to be connected so that every city can send and receive messages from any other city.

The company has to pay some amount of money to setup links between cities. Those costs are shown on the lines linking cities.



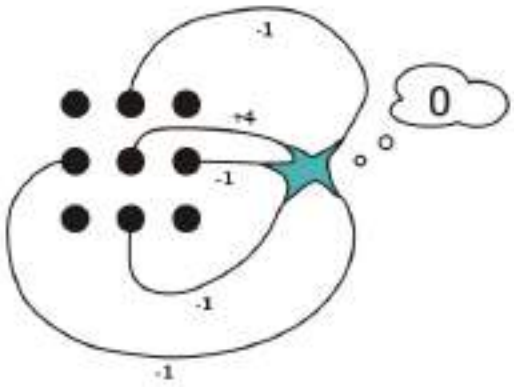
Question/Challenge:

Which connections need to be made to connect the cities with the least cost?

A) B-A, A-D, D-C, D-F, F-E and E-G **B)** B-A, A-D, D-C, D-E, F-E and F-G
C) B-A, A-D, B-D, D-E, F-E and F-G **D)** B-A, A-D, B-D, D-F, F-G and E-G

T6. Artificial Eye

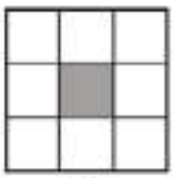
The retina of the artificial eye consists of nine light sensors. Each sensor has three possible output values: 0 (dark), 1 (medium), 2 (bright). The artificial eye is connected to an artificial brain consisting of just one neuron. The neuron is connected to some light sensors by "synapses" as shown in the image. Each connected light sensor stimulates the neuron. The stimulation value of a sensor is its output value multiplied by the number at the synapse.



The activation level of the neuron is the sum of the stimulation values from all connected light sensors. If the activation level is greater than 3, the neuron is activated. If the neuron is activated, the artificial brain recognizes the number zero.

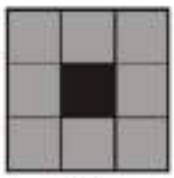
Question/Challenge:

Which of these images does the artificial brain recognize as zero?


A)


B)


C)


D)

T7. Functional computer

Beaver Bruno doesn't remember so well the table of multiplications, so he developed a basic computer to calculate some expressions.

For that purpose, he needs to execute 3 steps:

1. He needs to inform the computer of the upcoming operation by wrapping the operation in round brackets: ( ). Now the computer is ready to execute the content between brackets.
2. Then Bruno needs to tell the computer what **operation** to execute between the operands. The operations can be subtraction (–), multiplication (*) and addition (+).
3. The computer needs some **operands**, in order to compute something. The operands are natural numbers from the interval [0,9] and there can be 2, 3 or 4 operands.

If beaver Bruno wants to find the result for **(+ 3 7 2)**, he types the following expression:
(+ 3 7 2). The computer returns the number **12 = 3 + 7 + 2**. If he types the expression: **(– 12 2 5)**, the computer returns the number **5 = 12 – 2 – 5**.

Question/Challenge:

What is the result that computer returns after Bruno typed the following expression?

(+ (- (* 2 3 5) (+ 2 3 3)) (+ (+ 2 5 1 3) (- 9 3)))

A) 30 **B)** 39 **C)** 5 **D)** 22

T8. 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: A) 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

T9. Soundex

Bob wants to know how different words sound. He does the following steps in order to generate a 4-digit code for each word:

1. Retain the first letter of the word.
2. Drop all occurrences of 'A', E', 'I', 'O', 'U', 'H', 'W', 'Y'.
3. Change letters to numerals as follows:

Letters	Numerals
B, F, P, V	1
C, G, J, K, Q, S, X, Z	2
D,T	3
L	4
M, N	5
R	6

4. Replace two or more identical numerals occurring together with the same single numeral.
5. Use only the first four digits of the resulting word, adding zeros at the end as necessary.

For example

Word	Code
BOB	B100
BEAVER	B160
HEILBRONN	H416
ESSAY	E200

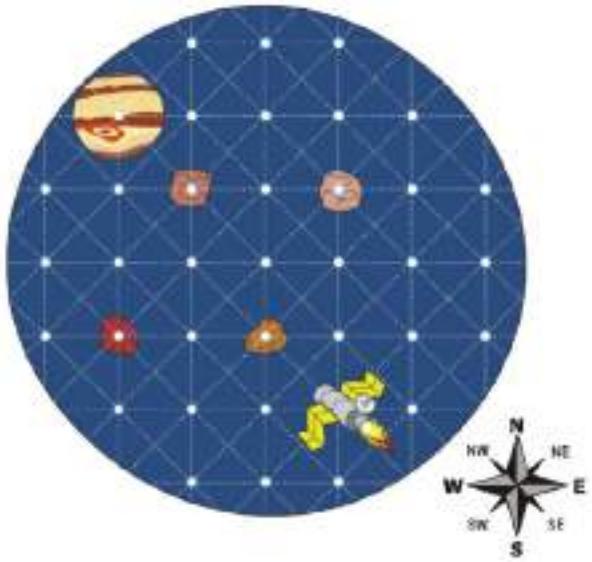
Question/Challenge:

What code will be generated by the word "*HILBERT*"?

A) H410 **B)** B540 **C)** H041 **D)** H416

T10. Spaceship Juno

A spaceship Juno is aiming to reach the Jupiter. The autopilot can lead Juno from point to point in 8 different directions. For example a command 1*N* means 1 step in North direction, and 2*NE* means 2 steps diagonally in North-East direction.



Question/Challenge:

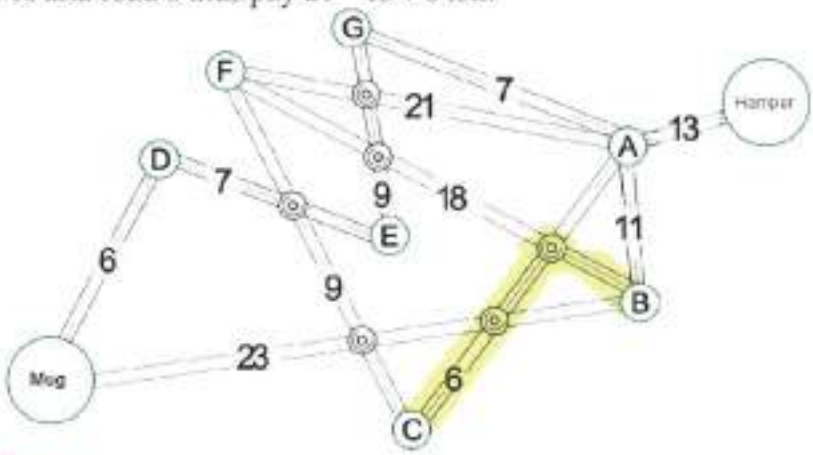
Which of the following set of commands complete a shortest path to the Jupiter avoiding collision with the asteroids?

A) 3*NW* 1*N*
B) 1*NE* 3*NW*
C) 2*N* 3*W* 2*N*
D) 1*W* 3*NW* 1*NE*

Tasks T11 – T20 carry 4 points each

T11. Toll roads

Bob decided to drive from Hamper to Mug. In the map below, circles with letters are cities and lines are two-way roads. Roads have junctions in places of intersections. The numbers beside any road is the toll that cars must pay every time they enter the road. Cars can change the path at junctions but they need to pay the full toll for the road they enter. For example, to drive from city *B* to city *C* you can take road 18 and road 6 thus pay 24 = 18 + 6 toll.



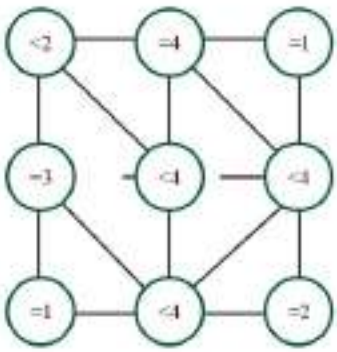
Question/Challenge:

How much toll should Bob pay at least to drive from Hamper to Mug?

A) 24 **B)** 28 **C)** 41 **D)** 47

T12. Connections

Your job is to fill in some of the circles in the picture below. The circles have connections to some of their neighbours: for these 9 circles, there are 16 connections between pairs of circles. The numbers inside each circle indicate the number of neighbours which are filled in. For example, the circle marked with "=3" must have exactly 3 of its 4 neighbours filled in. Similarly, the circles marked with "<4" must have less than 4 of their neighbours filled in.



Question/Challenge:

How many of the circles must be filled in?

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

T13. Sin Nombre

Roni has a cave where he has hidden all his treasures. Unfortunately, he has forgotten the code for the alarm. Roni thought he may forget the 3 digits code and so wrote himself the following hints.

Hint-1:	**1 7 2**	Only one of these digits is correct, but is in the wrong position.
Hint-2:	**8 5 4**	Two of these digits are correct, but are in the wrong position.
Hint-3:	**9 8 6**	Only one of these digits is correct, but is in the wrong position.
Hint-4:	**7 5 1**	Only one of these digits is correct and is in the correct position.

Question/Challenge:

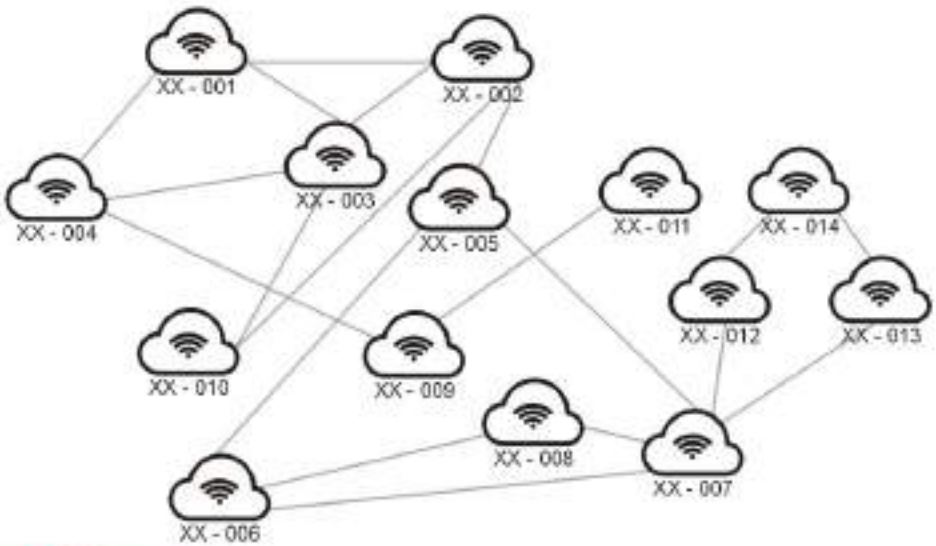
What is the code?

A) 1 8 6 **B)** 4 6 8 **C)** 6 7 9 **D)** 7 4 8

T14. Key points

This is a Wi-Fi network in a small company that contains 14 intranet access points. In this network some of the access points are called "key points". It represents access points which, once eliminated (will be broken), they determine the loss of access to the intranet for other access points.

For example, access point XX-009 is a "key point". If XX-009 was broken, XX-011 will no longer have access to the intranet.



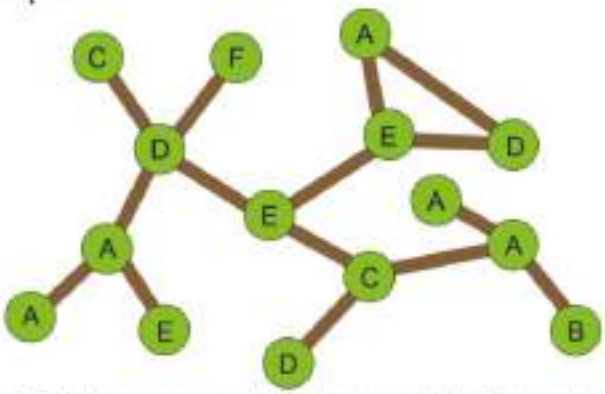
Question/Challenge:

Which access points are the "key points" ?

A) XX- 001, XX-003, XX-005, XX-007, XX-009
B) XX- 002, XX-003, XX-006, XX-009, XX-012
C) XX- 002, XX-004, XX-005, XX-007, XX-009
D) XX- 003, XX-005, XX-007, XX-009, XX-012

T15. 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

T16. 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 1·8 + 1·4 + 0·2 + 1·1 = 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:

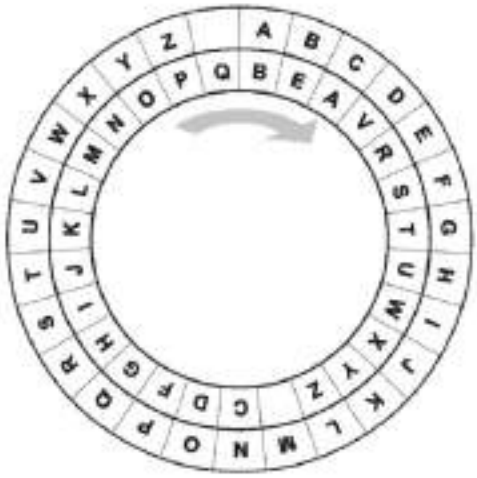
What is the time that Bruno sent to his friends as 1110101111101110?

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

T17. Crypto-Beaver

To accomplish safe data transmission the beavers developed the following encryption system. They use two rings, each of which contains all characters of the alphabet.

For encoding the character of a message, the character is located in the outer ring and replaced by the corresponding character of the inner ring. After encoding a character of the message, however, the inner ring is turned clockwise, by one character. That is:



The first letter of a message is replaced according to the initial positions of the rings (see figure). For instance, a first letter '**H**' is encoded by '**U**'. A second letter '**H**' is replaced by '**T**', a second letter '**N**' is replaced by ' '. A third letter '**H**' is replaced by '**S**', a third letter '**N**' is replaced by '**Z**'). An example: The message YES is encoded by OVG.

Question/Challenge:

Encode the following message according to the beavers' encryption system:

START NOW

A) ACYEMMCDC
B) AFDUVSPTB
C) IIPDFLUUD
D) NZYEQHMTO

T18. 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

T19. Chemist Maja

The beaver Maja, a world-famous chemist, is trying to perform a sequence of chemical experiments and using available chemical compounds create as many new compounds as possible.

At the beginning she has unlimited quantities of A, D and E compounds. She performs the experiments in the following order:

1. From the compounds B, C and D she can obtain by a secret reaction the compounds A and F
2. From the compounds D and E she can obtain by a secret reaction the compounds A, E and F
3. From the compounds A and C she can obtain by a secret reaction the compounds B and D
4. From the compounds A and F she can obtain by a secret reaction the compound B

Question/Challenge:
Which compounds will the beaver Maja eventually have?

A) A, B, C, D, E
B) A, B, C, D, E, F
C) A, B, D, E, F
D) A, D, E, F

T20. Passcode

Beaver Daniel received a chest of gold that is locked with an electronic lock. The lock can be opened by entering a code of 9 digits.
Danial has received the following hints about the code:

- The only digits in the code are 2, 6, 7 and 9
- The digit with the highest value is used the lowest number of times in the code.
- The digit with the lowest value is used the highest number of times in the code.
- The code looks the same in reverse.
- All consecutive digits are different.
- The last digit entered is odd.

Question/Challenge:

With the information given above, can you determine the pass code?

A) 627292729 B) 226292927 C) 926762927 D) 726292627

Tasks T21 – T30 carry 5 points each

T21. 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.

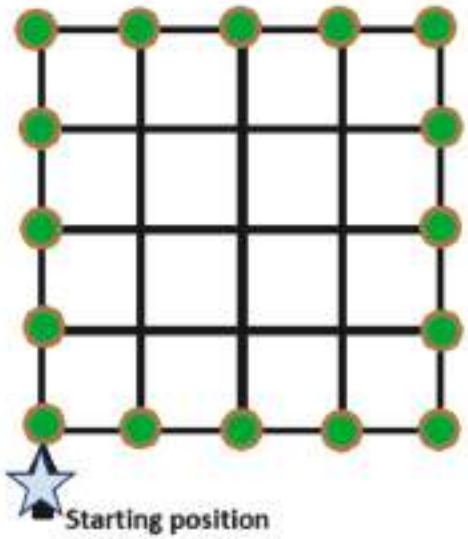
Left(X): Turns the robot **X** degrees to the left.

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
```

T22. 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.

Before: 

After: 

You start the game with 32 cards all lying face down:

Question/Challenge:

How many cards will lie face UP after you do exactly 32 steps in the game?

A) 1 **B)** 4 **C)** 9 **D)** 16

T23. 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.

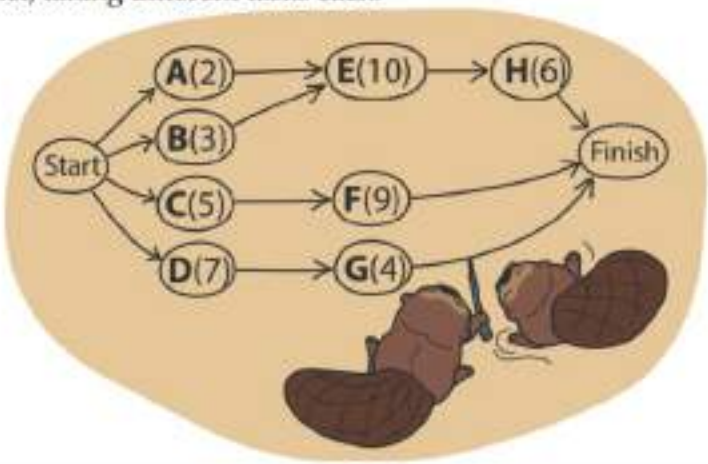
Question/Challenge:

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

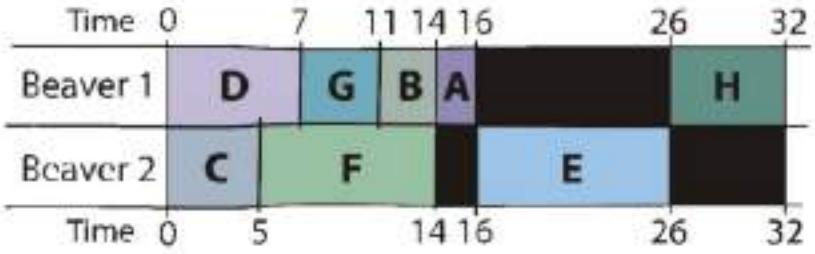
A) Alessa **B)** Birgit **C)** Chloe **D)** Dorien

T24. Two beavers are working

Two beavers are building a dam and need to do 8 tasks (cut trees, remove branches, float wood, assemble trunks, etc.): A(2), B(3), C(5), D(7), E(10), F(9), G(4), H(6). Each number in brackets indicates the number of hours to do that task. Some tasks must be completed before others can be started, as shown by the arrows. The beavers work in parallel, taking different tasks each.



The beavers use the following plan: from among the tasks that are available at any moment they choose the biggest one. The beavers work on these tasks in this order:



From this picture the beavers complete the dam in 32 hours. However, it is possible to complete the dam in a shorter time with a different plan.

Question/Challenge:

What is the shortest time for two beavers to build a dam?

A) 7 **B)** 14 **C)** 16 **D)** 23

T25. 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.

T26. 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.

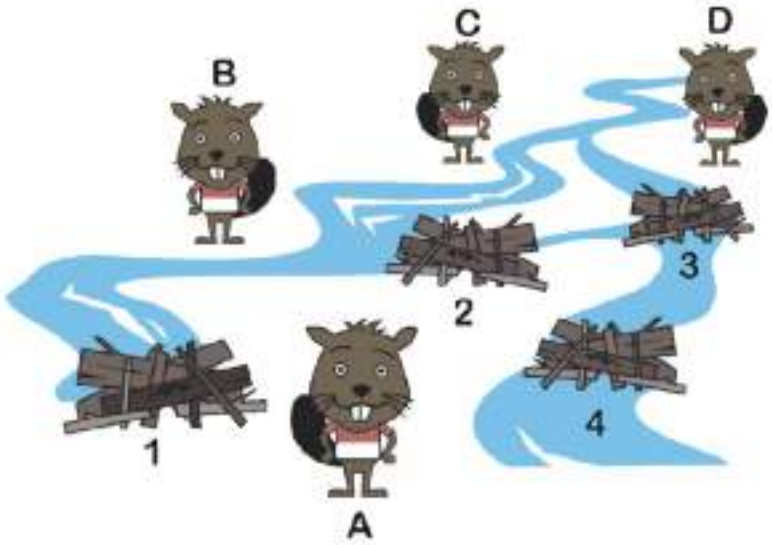
Question/Challenge:

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

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

T27. Dams 2

The major of Beaverton has tasks for maintaining four dams everyday. The dams are randomly located in town. There are four beavers about to be assigned to the tasks. Meanwhile, the beavers' houses are also randomly located in town. The major wants to assign one beaver for one dam exclusively. As an illustration, the following figure illustrates the case.



The wages related to the tasks will be based on the distances from their house to respective assigned dams. Hence, the major wants to find out the optimal assignments that requires the smallest total distances (or wages). Fortunately, the major has already had a table that lists the distances from each beaver's house to every dam's location as in the following table (in meters).

	Dam 1	Dam 2	Dam 3	Dam 4
A	185	145	143	190
B	130	125	175	225
C	50	50	100	75
D	220	186	185	225

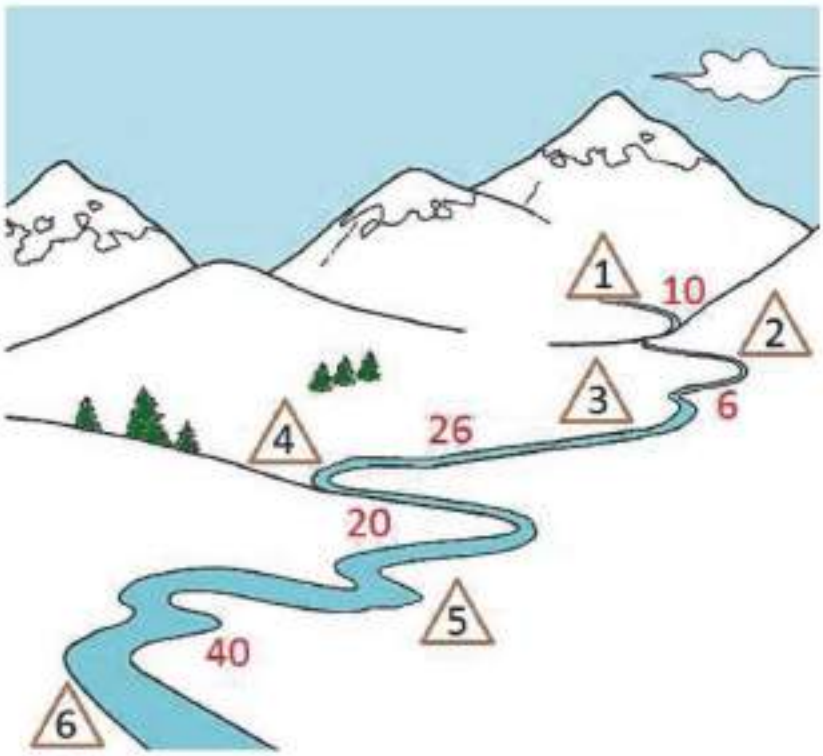
Question/Challenge:

According to this table the major has asked you to find out what is the smaller total distances (in meters).

A) 385 **B)** 475 **C)** 534 **D)** 578

T28. 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 two 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 four lodges will swim to the nearest shelter, i. e., the one that can be reached in the shortest time.

Question/Challenge:

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

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

T29. Building Trust

Beavers' trunk market introduced the next transactions validation process:

1. After one-on-one negotiation, the seller and buyer publicly announces their transaction details.

2. All the Beavers are invited to validate this transaction by recording it in their own notebooks in a given format:
([Transaction No], [buyer ID], [seller ID], [Number of traded trunks])

3. If at least half of the Beavers records a transaction before the end of the market time, and seller had number of traded trunks for this transaction, it is considered valid. Otherwise, it and all of its dependent sequential transactions are invalid and discarded.

Today 8 Beavers (named A, B, C, D, E, F, G, and H) entered the market whereas each of them had 100 trunks available for trade. The following chart shows a summary of the market's transactions.

Transaction Record	Beavers who Recorded
(01, F, B, 80)	A – B – C – D – E – F – G – H
(02, C, G, 60)	A – B – C – D – G – H
(03, A, F, 90)	A – F – G
(04, B, F, 120)	B – D – F – G
(05, H, A, 140)	A – B – C – D – E – G – H

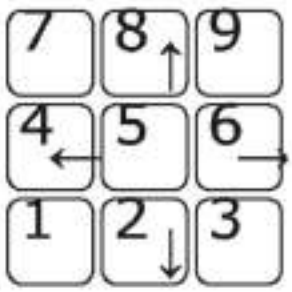
Question/Challenge:

Who possessed the largest number of trunks at the end of the market today?

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

T30. Double mode keyboard

Beavers use one keyboard to both enter numbers 1 through 9 in a table, and to move the pen writing these numbers. To achieve this, keyboard can be switched between two operating modes: the Enter mode and the Move mode.



In Enter mode, each key enters (or overwrites) the corresponding number in the current cell and then moves the pen one cell to the right.

In Move mode, keys with arrows move one cell in the direction of the arrow. Keys without arrows do nothing in this mode.

Starting from an empty table, beaver Tammy pressed keys marked 1, 2, 3, 4, 5, 6, 7, 8, and 9, in that order. She also changed keyboard modes a few times and ended up with these numbers in the following table:

1			**9**	
	6	**7**		

Question/Challenge:

Which keys were pressed in the Enter mode?

A) 1, 5, 7 and 9
B) 2, 3, 6 and 9
C) 1, 3, 6, 7 and 9
D) 1, 2, 4, 5, 6 and 9