

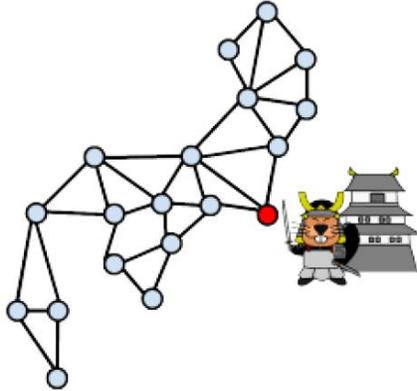
BEAVER INFORMATICS COMPETITION

STUDENT SAMPLE QUESTIONS

www.Beaver.my

01 Signal Fire (Easy)

A long time ago in Japan, some Ninjas served the shogun ate government. In case of emergency, they used smoke signals to communicate with each other.



In the above figure, the red point is the location of the shogun ate government. Each blue point is a location where a smoke signal should be lit. Also, two points are joined by a line if their smoke signals can be seen from each other. At every point, there are some Ninjas who stand on all day long. They fire a smoke when they see a signal from a point joined to theirs, just 1 minute after this signal was fired.

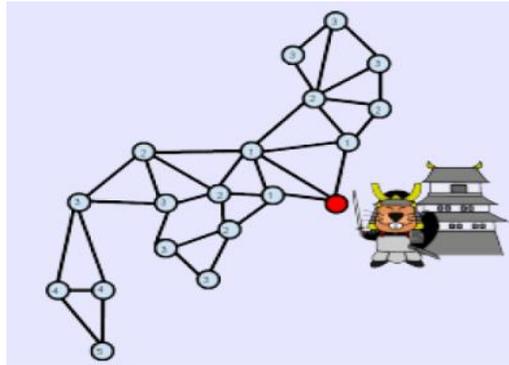
Question

How much later will there be a signal lit at all points?

- A. 4 minutes
 - B. 5 minutes
 - C. 6 minutes
 - D. 8 minutes
-

The correct answer is B

The lights in the locations adjacent to Shogun ate will be fired in 1 minute, so you can write "1" at the places next to the Shogun ate. After 2 minutes from the beginning the lights adjacent to ones already lightened are fired, so you can write "2" at the places next to the places with "1" and continue like that:



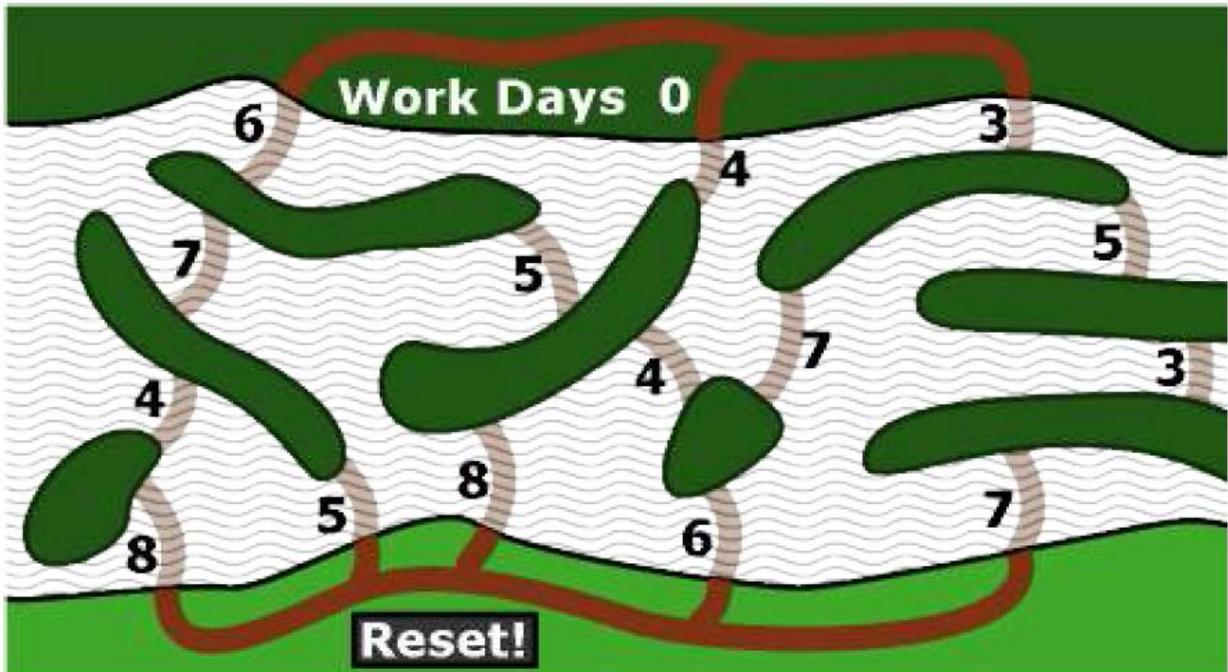
After you just have to look for the higher lit time among the points.

It's informatics

To solve the problem like this you can use a graph. A graph is a representation of a set of objects (in this case smoke signals) which are connected in some way. Objects are represented by vertices and connections by edges. Graphs can be used to represent any kind of networks, for example networks of communication or the structure of a website. Most known graph algorithms are graph coloring algorithms and distance finding algorithm. Here we used a Breadth-First Search algorithm.

02 Build the bridges! (Easy)

Mr. Beaver must build bridges connecting *all* islands *and both* river banks directly or indirectly. No bridge is built yet. Next to each possible bridge is the number of work days it takes to build it. You can click on any bridge to build it or remove it.



Question

How many work days are needed at least?

Answer

Open integer (number entered by student)

The answer is 39:

Removing any bridge results in unreachable islands. All built bridges use less work days (or the same number) as the not built bridges. Therefore this is the best possible solution.

It's informatics



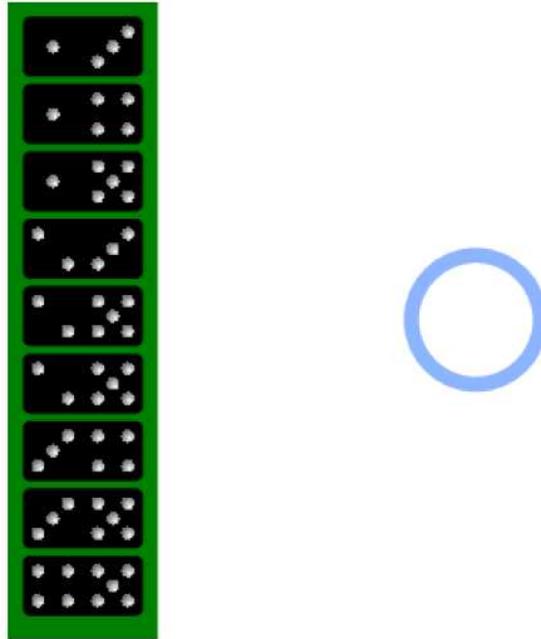
In informatics the above problem is called the “Minimum spanning tree problem”. It is a problem that can be efficiently solved with the so-called “Kruskal's algorithm”:

- Start with no bridges.
- At each step, build the bridge requiring the least work days unless this bridge is not necessary because it would connect two islands that are already joined by a path.

Of course, the problem in informatics generally is not about islands, bridges and work days, but about graphs (like networks), consisting of nodes (islands) and edges (bridge).

03 Domino circles (Easy)

Build a largest possible circle with the following dominoes such that the same numbers touch. You may use the following animation for your tests. If you click on a tile in the circle, it will flip.



Question

What is the largest number of above dominoes that can form a circle?

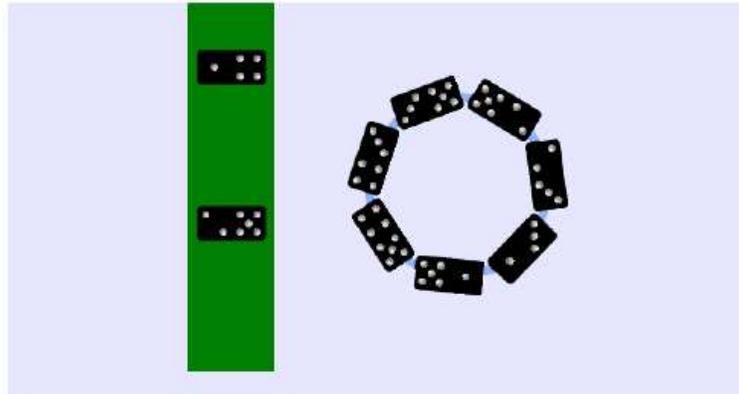
Answer

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



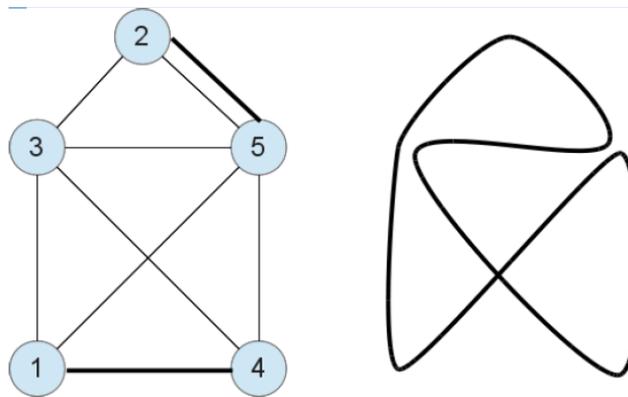
The correct answer is 7.

Of every number appears an *even number* of times in the circle. The numbers 1, 2, 4 and 5 each appear an odd number of times. So we have to leave out at least 2 dominoes. The following pictures shows, that one can make a circle with 7 dominoes:



It's informatics

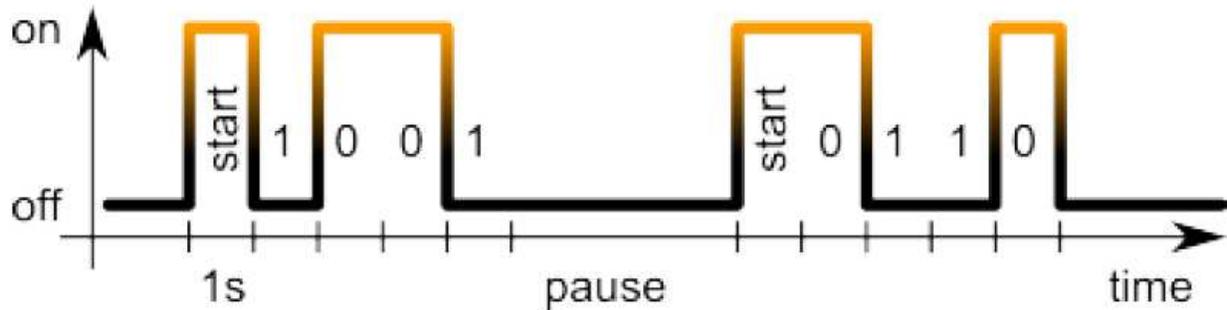
This problem can be modelled using a graph, where each number is a vertex and each domino is an edge:



A domino circle is now a closed path which can be drawn without lifting the pen. Such a path is called a “Eulerian Path”. It has the property that from any vertex an even number of edges is used (as many times).

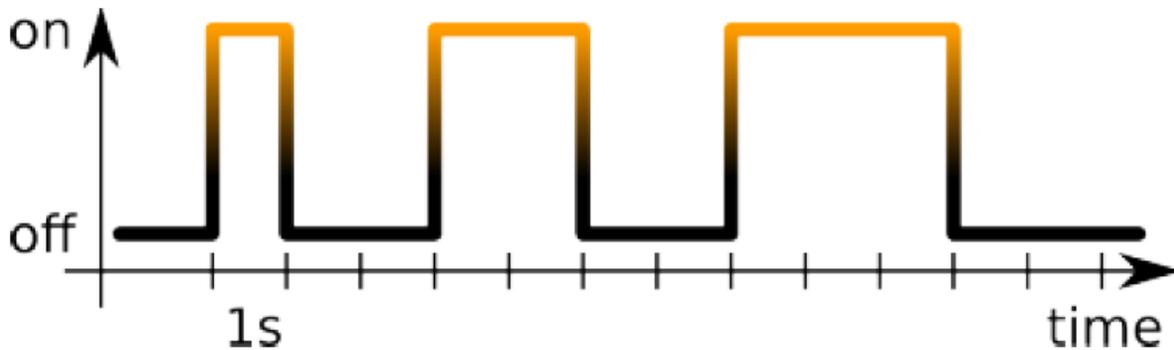
04 Serial Transmission (Easy)

Beavers Alice and Bob want to send signals in the night using a flashlight. They transmit sequences of 4 symbols '0' or '1'. Before each sequence they turn on the light for 1 second. If the symbol is '0', the light is on for 1 second and if the symbol is '1', the light is off for 1 second. After each sequence a pause of at least 1 second is made. For example, the sequences '1001' and '0110' are transmitted as follows:



Question

Which sequence or sequences are transmitted in the following diagram?



Answer

- A) 1100 and 0011
- B) 0011 and 1100
- C) 1100 and 0001
- D) 1010 and 0011

The correct answer is A

A) is correct (1100 and 0011). The pause starts 5 seconds after the flashlight is turned on the first time. 7 seconds later the second sequence starts.

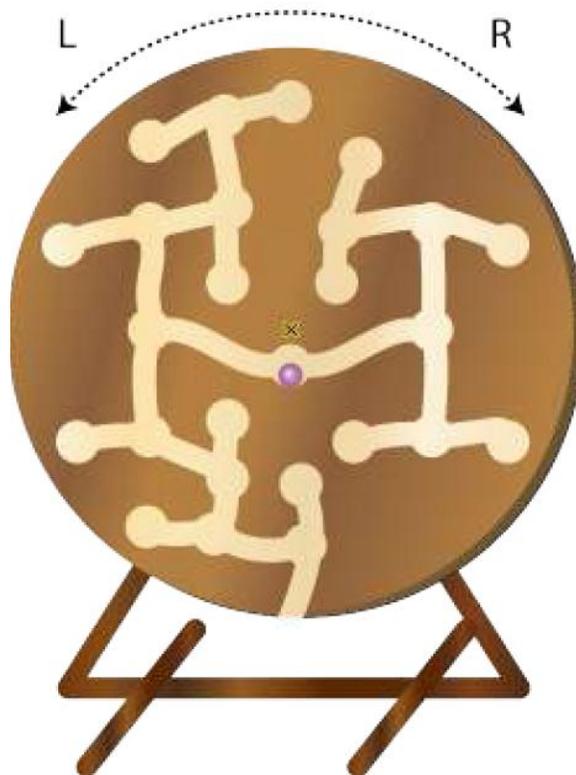
It's informatics

This task describes the core of the RS232 protocol for data exchange over a serial cable. Some GPS devices and many programmable microcontrollers use this protocol for its simplicity. Turned off corresponds to a negative voltage and turned on to a positive voltage. Normally one uses 8 Bits (Symbols '0' or '1') which make up 1 Byte (instead of only four like in this task).

05 Spinning toy (Easy)

Beavers discovered a piece of wood into which worms made a system of tunnels and pits. A handy father used it to make a toy. In the beginning we put a marble in the middle. The goal is to get the marble out by turning the wheel to the left (L) and right (R). By each turn the marble runs to the next pit or at the end out of the wheel.

By which of the following sequences the marble reaches the exit?



Answer (Multiple Choice)

- A) LRRLR
 - B) RLRL
 - C) LRRLRL
 - D) LRRRRL
-

The correct answer is C

The problem is difficult to solve if one has to imagine turning the wheel left and right (unless (s)he turn the monitor or prints the image on a sheet of paper). It is, however, quite easy if we recognize that we are actually searching through a path in a tree – a common task in past Bebras competitions.

It's Informatics

Describing paths in binary trees is a common operation in computer science.

06 From A to C (Medium)

You have got a mini robot that can execute the following commands:

V - a step forward

L (angle) - rotation to the angle given within the brackets left,

R (angle) - rotation to the angle given within the brackets right

If more than one command should be executed, the commands can be strung together using the operation "+". For example "V + L(20) + V + R(2)" means that first the robot should make a step forward, then turn left 20 degrees, then make a step forward and then turn right 2 degrees.

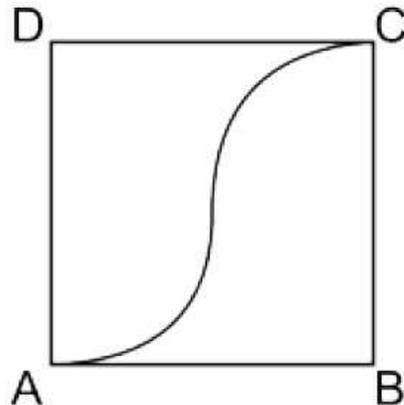
To be able to repeat a set of commands, operation "*" can be used. For example "20*(V)" means to repeat 20 times the action, which is given within the brackets after the "*", namely to make a step forward. So this example will result in 20 steps forward.

For example $180*(V+L(1))$ draws a half circle.

At the beginning the mini robot is positioned at point A and looks in the direction B.

Which of the predefined command combinations brings the mini robot from A to C along curved path?

- A) $90*(V+L(1)+V+R(1))$
- B) $90*(V+L(1))+90*(V+R(1))$
- C) $90*(V+L(1))+R(30)+90*(V+R(1))$
- D) $L(90)+90*(V+L(1))+R(90)+90*(V+R(1))$



The correct answer is B

The first part "90 *(V+ L(1))" means that the following actions are repeated 90 times: one step forward and a rotation to the left by one degree. So the robot will first move into direction B but after each step will turn to left and will finally be oriented upwards. Analogous the second part "90 * (V+ R(1))" will be executed afterwards, which causes that the robot moves to point C with the final orientation to the left.

A) is false, because due to the partial sequence "V + R (1)" the path of the robot differs from the green line.

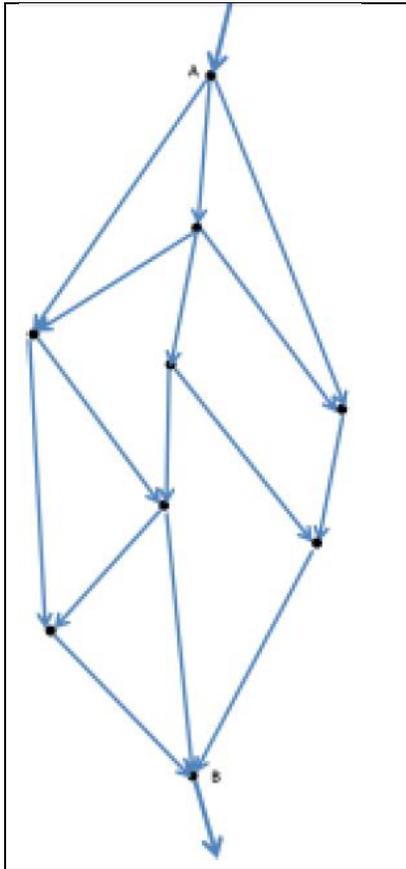
C) is incorrect because the partial sequence "R (30)" will cause a different path as the intended one.

D) is incorrect because the partial sequence "L (90)" at the beginning leads the robot in the wrong direction.

It's Informatics!

The robot starts in an initial state (point A, sight direction AB) and performs program commands until it reaches the end of the code. If you specify the correct robot code sequences, then it is possible to bring the robot from the starting-point to the finish. It could be just one wrong command in the entire code to lead the robot to a wrong way.

07 River Inspection (Medium)



A bunch of beavers need to make an inspection of the river today: at least one of them has to swim along each of the river streams.

Due to the heavy current, beavers can only swim downstream and they can only do one trip from A to B. So the inspectors start at A, end they will meet at B. Of course, every stream of the river (as you can see in the picture) has to be inspected.

Question

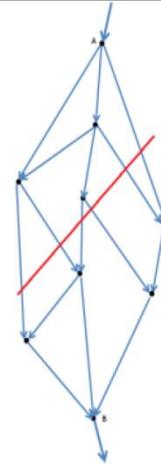
What is the minimum number of beavers needed for a full inspection?

Answer

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

Explanation

As one can see, the red line in the picture crosses six different streams. No beaver will be able to take more than one of these streams. When you place one beaver on each of these streams, it is possible to cover all streams. The line is not unique, but has to cross as much lines of the graph as possible. This give the informatics idea of “sweeping line”.

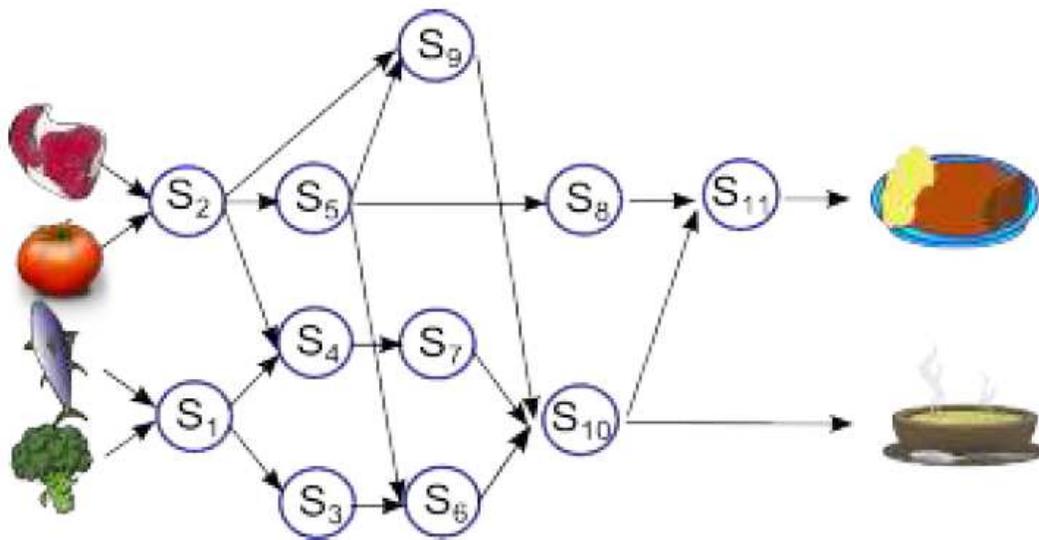


It's informatics

The river with all its streams is an example of a planar directed graph. It means a graph where the edges have directions and do not cross each other. Analyzing the flow in such a directed graph is often needed, for instance when you want to investigate the flow in a computer program. The algorithm used, making a cut through as many streams as possible, is suited for these flow problems. Studying these kinds of algorithms is a large topic in computer science.

08 Delicious Dinner (Medium)

Mama beaver Anny will prepare the dinner for her little beavers. When she checked the fridge, she found four ingredients: broccoli, mackerel, tomatoes and beef. And she decided to make two dishes out of them. Each dish is cooked in several steps S_i , where each of them takes 5 minutes. The product of one step is ingredient to one or several other steps. Moreover, the result can be ingredient of steps for different dishes. To make things more clear for herself, she draw the following diagram showing the product of which step is an ingredient of a subsequent step:



Obviously, would her stove have a single ring, it would take her 55 minutes (11 steps times 5 minutes) to prepare both dishes.

Question

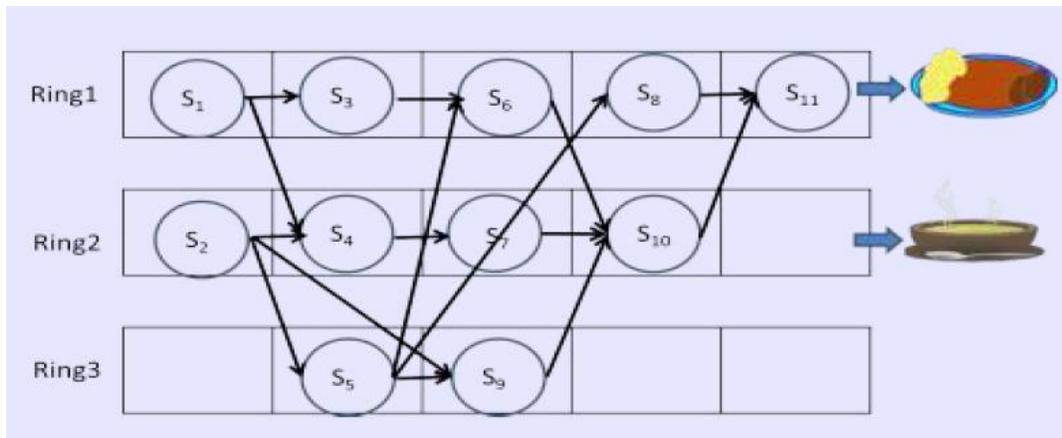
However, Anny's stove has three rings. How much time at least will need Anny to prepare both dishes?

Answer

a)20 minutes b)25 minutes c)30 minutes d)35 minutes e) 40 minutes

The correct answer is B

The correct answer is b). The assignment for each cooking step is as the following:

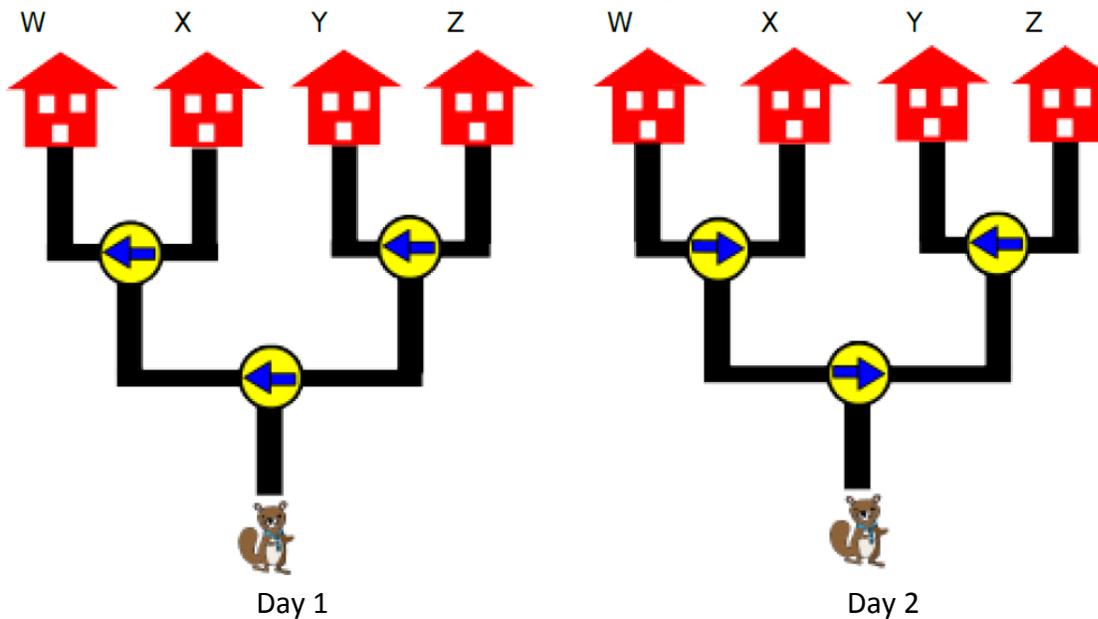


It's informatics

Non-periodic job ob scheduling on a limited number of processors (three in this case). Also, the jobs are of the same complexity (5 minutes).

09 Visiting Friends (Medium)

Mr. Beaver has 4 friends living in different villages, and he plans to visit one of these friends every afternoon. Initially, all arrows point to the left road. When passing the intersection, Mr. Beaver would switch the arrow to the opposite direction. For example, on day 1, Mr. Beaver takes the road on the left at the first intersection, takes the left road on the second intersection, and reaches Village W. On day 2, Mr. Beaver turns right at the first intersection, then left at the second intersection, and arrives Village Y.



Question

Which village will Mr. Beaver visit on day 30?

Answer

- a) Village
- b) Village X
- c) Village Y
- d) Village Z

The correct answer is C

Village Y. When encountering an intersection, he takes the road on the left for odd number encounters, and the road on the right on even number encounters. Day 30 is an even number encounter at the first intersection, so Mr. Beaver will take the road on the right and the other hand, the second intersection will be Mr. Beaver's odd number encounter, so he will take the road on the left. Another way to look at it: 4 days later, the state will be the same as it was. So day 1 is the same as day 5 and day 9 and so on, and day 30 is the same as day 2.

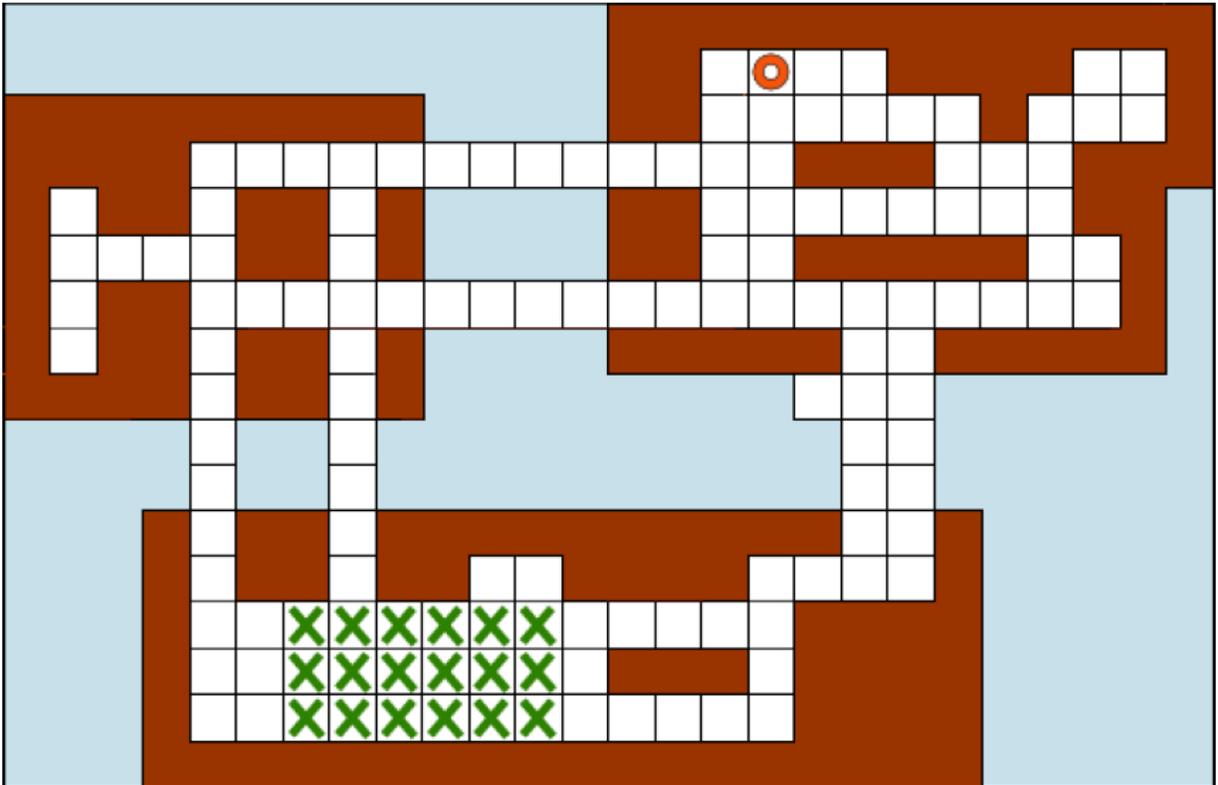
It's informatics

This task can be solved with top-down analysis that determines which road to take for each intersection. Also, this task can be solved by observing the periodicity from the simulation, which is a common skill to solve problems in informatics. It is about modulo counting.

10 Beaver back home (Hard)

Little beaver John lives in a wonderful land with Islands and bridges. The picture reproduces the structure of the land. John uses a Bicycle to move over it, and it takes 20 seconds for him to move from one cell to an adjacent.

John called for his mother and said that he is now somewhere on the field (marked with crosses) and is going home right now. (Home is marked with a circle).



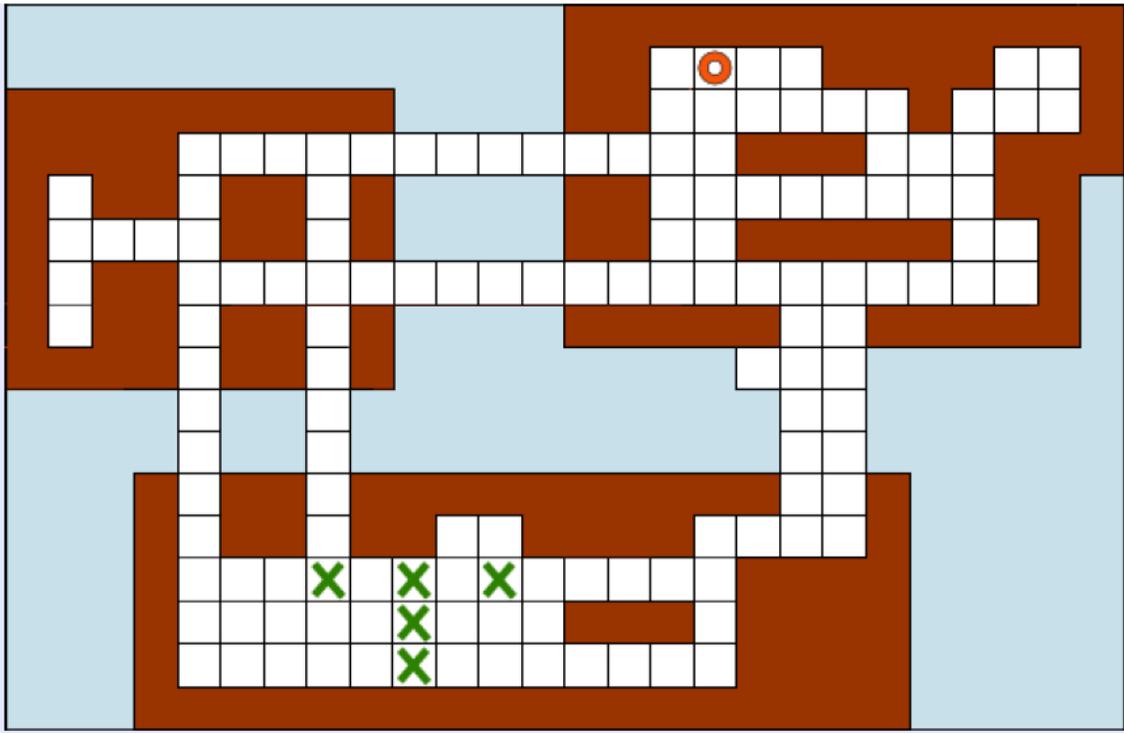
Question

John always uses the fastest path to the home. How long will mother wait for John?

- a) at least 6 min 20 sec, at most 8 min 40 sec
- b) at least 6 min 20 sec, at most 9 min 20 sec
- c) at least 7 min, at most 8 min 20 sec
- d) at least 7 min, at most 9 min 00 sec

Answer

c) at least 7 min, at most 8 min 20 sec



There are two possibilities to get home, either to go over the top-left island or not. We will call the paths that go over this Island as type-1 paths, and the paths that do not go over it as type-2 paths.

On the picture we left just several crosses on the field. Three crosses in a column are crosses which shortest paths of type-1 are equal to the shortest paths of type-2. The bottom one is thus the cross that is most distant from the destination. One needs 25 steps to reach the destination; it is 8 min 20 sec.

Two other crosses are the crosses that are the most close to the destination. It takes 21 steps to reach destination from them that is 7 min.

It's Informatics

The task is about the shortest path problem and also contains a max-min optimization problem; it means that one should find some maximum (the longest waiting time) over minimums (shortest paths).

The correct answer is C.

The idea to lead the machine to a deadlock is to take all the beans towards the bubble on the left. Triggering three times button B and then button C (or other possible interleaving) transfers the beans there.

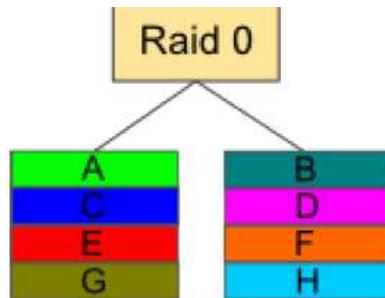
All the other proposed scenarios do not lead the machine to a deadlock.

It's Informatics!

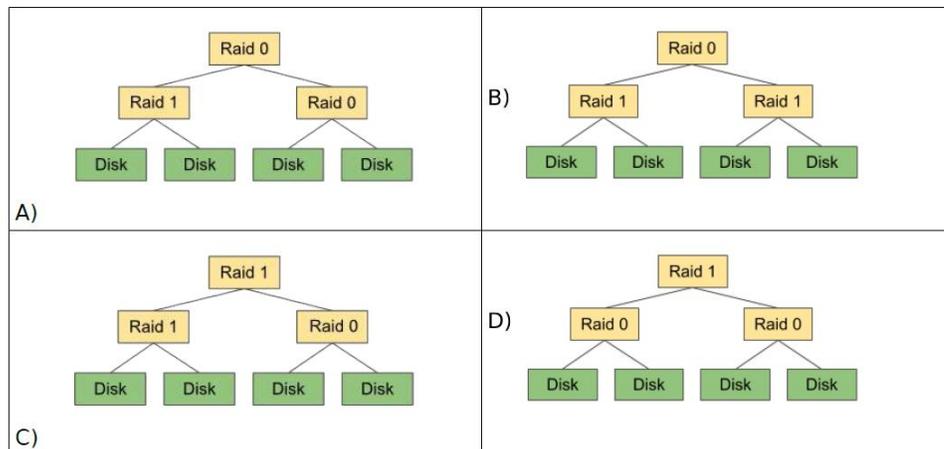
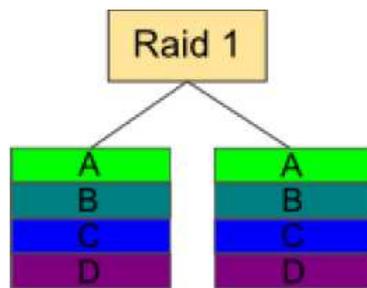
This problem is an illustration of Petri nets, a formalism that is used to describe concurrent reactive systems and that can be used to simulate their behaviour or to perform analyses on them. Being able to simulate a Petri net helps to understand how the behaviour of complex concurrent reactive systems can be modelled.

12 Raid Array (Hard)

RAID (redundant array of independent disks) is a storage technology that combines multiple disk drive components into a logical unit. Data is distributed across the drives in one of several ways called "RAID levels". Raid 0 – distributes data across multiple drives to increase performance but any drive failure destroys the array (see the picture below).



Raid 1 - mirrors data across multiple drives to increase redundancy. The array continues to operate as long as at least one drive is functioning (see the picture below).



Questions

Which of these Raid arrays will sustain stability after losing two disks?

The correct answer is C

Image A is incorrect – losing first two disks from the left causes the Raid 0 array above them to fail which causes the top Raid 0 array to fail.

Image B is incorrect – losing first two disks from the left causes the Raid 1 array above them to fail which causes the top Raid 0 array to fail.

Image D is incorrect – losing the second and third disks from the left causes both Raid 0 array above them to fail which causes the top Raid 1 array to fail.

Image C is correct – this array actually can lose any three disks and still sustain stability.

It's informatics

The task is about data storage technologies which increase storage performance and redundancy. These disk array connections are easily displayable in model diagrams. So this task can be considered as the structure task. This could be a hard task for the students this technology isn't taught in school.
