Tasks T1 - T8 carry 3 points each

T1: Find the fake picture

An artist printed four identical copies of a picture on clear film so that each copy can be viewed from all sides. A forger paints a copy of this picture and also prints the fake on clear film. He then exchanges one of the four original copies with his fake one. **Which one is the fake copy?**

A)

B)

C)

D)

It's Informatics!

Reflection and rotation operations are used in computer graphic programs to transform images but the relative position of picture objects is not changed by reflection and rotation.

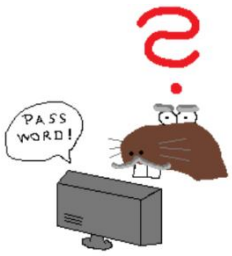
Keywords

Computer graphics
Rotation
Reflection

T2: Helping grandpa beaver creating his password

Grandpa beaver cannot use computers very well. He is asked to create a password for his e-mail account. This password has to:

- be longer than 5 characters (letters or numbers or special characters) and
- has to have at least 2 special characters: *, #, /, +



Which password would be accepted by the computer?

A) *Gommp45 **B)** v8+/ **C)** tom23456789 **D)** #aDsF+Grandpa

It's Informatics!

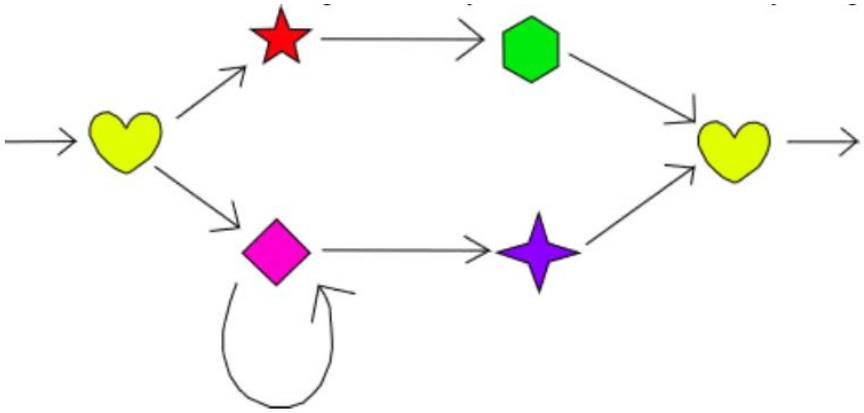
To secure the access to and the exchange of data, passwords are widely used to assure that only authorized persons are accessing data, e.g. emails. As users are often choosing very simple passwords which can be cracked easily within a very short time period, a mechanism called password enforcement can be used. If such a mechanism is active, the user's password has to fulfill a set of rules, which are set by the administrator within the password policy.

Keywords

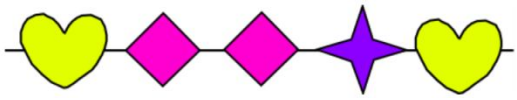
Password enforcement
Security
E-mail

T3: Mother's Day

Claire wants to make a necklace for her mum. She has a certain way to bead her hand crafted necklace, which is illustrated in the following picture. All possible necklaces that can be produced by Claire are described by this picture.

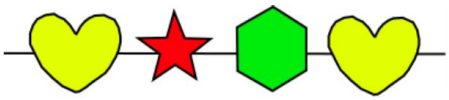


Claire is always taking the beads following the arrows in the picture.
The following necklace could be made by Claire.

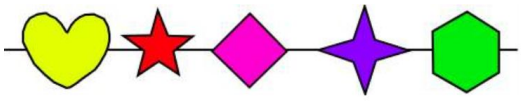


What necklace could be made by Claire too?

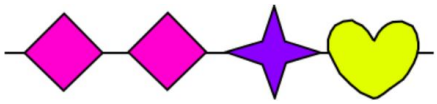
A)



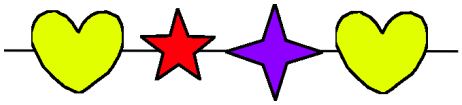
B)



C)



D)



It's Informatics!

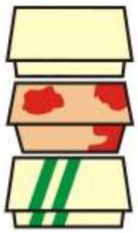
If we interpret the symbols as commands (e.g. ‚put a star on the necklace'), then this diagram is a kind of Control Flow Diagram, that is used in describing programs and algorithms.
If we interpret the symbols as states (e.g. that the actual last bead is a star) then this diagram is a kind of state diagram that is used to define the behaviour of automatic machines.

Keywords

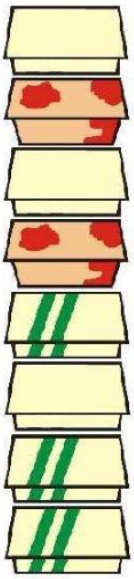
Control Flow Chart
Finite state machine
Algorithm

T4: The takeaway

Tim and Tom are working at a takeaway. Tim is the cook and prepares only one type of burgers alternately placing them into three different boxes in the order as you can see on the picture. Then he puts all three boxes on the top of the stack of not yet sold burgers. Tom is selling the burgers and takes always the uppermost box from the stack. Tim is cooking faster than Tom can sell the burgers.



How many Burgers has Tom sold at least if the stack looks like this after a while?



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

It's Informatics!

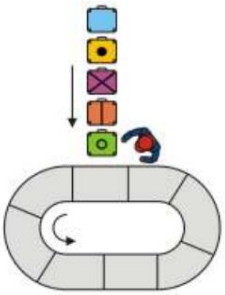
In this task the management of a datastructure, namely the stack, is shown. When using a stack, elements can be stored only at the uppermost position and can be taken only from the uppermost position.

Keywords

Stack
Memory
Datastructure

T5: Airport

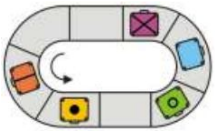
The airport porter is loading the passengers' bags on the moving luggage belt. He always puts the next bag on the third next empty place until all five bags are placed on the luggage belt.



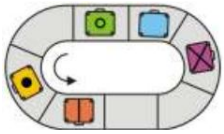
How does the luggage belt appear at the end of his work?

A)

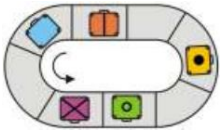
B)



C)



D)



It's Informatics!

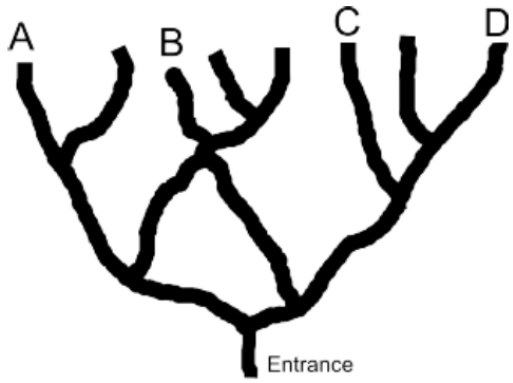
This is an example for scheduling with given structures and rules. Such situations often occur, e.g. an operating system of a computer must perform a scheduling of tasks, if more than one task or program should be executed. The scheduling mechanism then assigns computing power to each executed task or program. But one can imagine that such scheduling mechanisms involve much more tasks that are often interdependent and need different and limited resources. So scheduling mechanisms are much more complex as in the given task, where the way how to fill the luggage belt is not the most efficient one.

Keywords

Rules
Structures
Scheduling

T6: Rescue action

Rescue brigade is searching for deaf boy lost in the cave system. They start to search from the entrance to the cave (below in the map) and when there is a crossroad of the tunnels, half of men go left, and the other half go right (if there is an odd number of men, number of men turning right is one more than number of men turning left).



In which tunnel will there be the greatest number of men, knowing that there are initially 21 in the entrance tunnel?

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

It's Informatics!

Tree traversals are very important to solve a lot of different problems in informatics. In this problem, there is also a kind of recursive definition for the rule that explains how the spiders are split at each intersection. The whole tree has to be explored since we are trying to find the maximum number of men, which is an optimisation problem.

Keywords

Tree traversal
Recursion
Optimisation problem

T7: Apple in the basket

Next to you there is a basket full of apples of different sizes.

Step 1: You take an apple out of the basket and put it on the table in front of you.

Step2: You reach for the next apple out of the basket and execute the following comparisons.

C1: If the apple in your hand is smaller than the one on the table, then you put the apple from your hand into the other basket.

C2: If the apple in your hand is larger than the one on the table, then you put the apple on the table into the other basket and put the apple from your hand on the table.

You repeat the step 2 until the initial basket is empty.

Which apple remains on the table at the end?

A) The last apple out of the initial basket
B) The biggest apple out of the initial basket
C) The smallest apple out of the initial basket
D) The first apple out of the initial basket

It's Informatics!

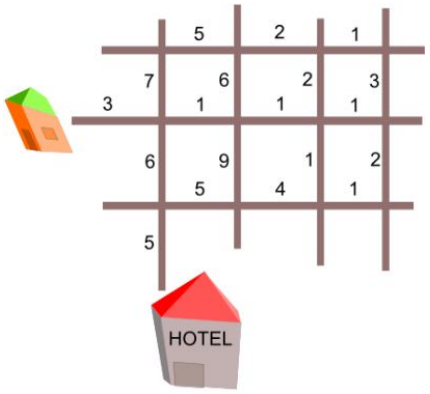
For a better understanding of algorithms a so-called invariant condition is useful. In case of this algorithm the apple on the table is the biggest apple of all taken apples so far (invariant condition). At the end of the algorithm, when all apples are taken, it must be the biggest apple of all apples.

Keywords

Maximum Search
Algorithm
Invariant Condition

T8: No turning left!

Traffic jam in a city! It is impossible to turn left in such a traffic density. My father is hurrying up home by car from the hotel he works. In the picture the travel duration for each street in minutes is given. Father uses his GPS navigation to find shortest way home in minutes.



How long will it take <u>at least</u> to go from the hotel to his home when it is not possible to turn left?

A) 35 Minutes **B)** 33 Minutes **C)** 32 Minutes **D)** 30 Minutes

It's Informatics!

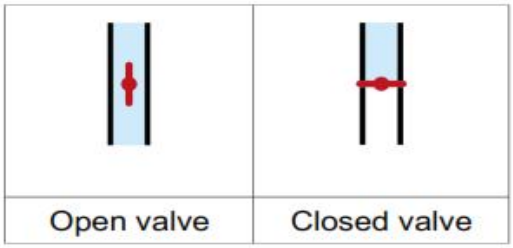
In Informatics we often try to determine a path with minimum effort which is in compliance with given conditions. The decision which path to choose is based on certain criteria (e.g. time and float damage) in every decision point (for our beavers this is at the crossing). The number of all possible paths is usually too high for considering all of them to identify the path with minimum effort. Therefore fast algorithms try to reduce the number of inspected paths.

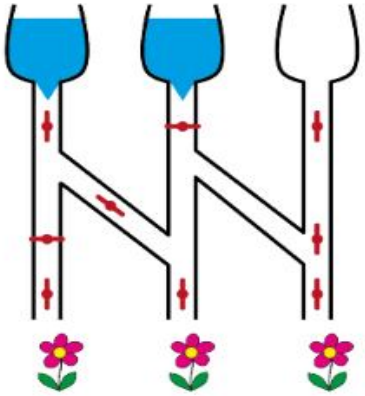
Keywords

Graph
Shortest Path
Algorithm

Tasks T9 – T16 carry 4 points each

T9: Watering





Which flowers will get the water?

A) 

B) 

C) 

D) 

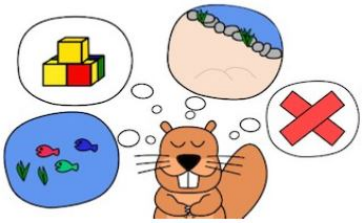
It's informatics!
Computers are composed of various chips and chips are made of smaller parts, electronic circuits which are in turn composed of logic gates. Logic gates act like valves, except that instead of water they conduct electricity and instead of pipes they have wires. This means that our modern electronic devices (including complex ones like computers and smartphones) are built up from simple logical operations.

Keywords
Logic gates

T10: Beaver's playing places

A beaver decides where to play according to the weather.
The rules are as follows:

- If it is sunny today, but yesterday it was rainy, he will swim in the river.
- If it is sunny today and yesterday it was also sunny, he will play in the sand on the bank of the river.
- If it is rainy today, but yesterday it was sunny, he will play with toy blocks in his house.
- If it is rainy today, and yesterday it was also rainy, he will not play.



The following table is the weather history during November 1st - 8th.

Date	1 Nov.	2 Nov.	3 Nov.	4 Nov.	5 Nov.	6 Nov.	7 Nov.	8 Nov.
Weather								

Where does he play on 7th Nov.?

A) in the river **B)** on the bank of the river **C)** in his house **D)** will not play

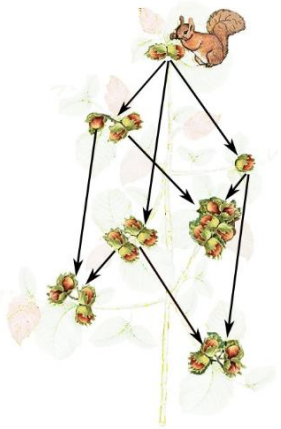
It's informatics!

This is a problem for questioning the thinking logical. As the condition 3 and 4 are exclusive for each other, so that playing place is clearly determined. However, condition 1 and 2 are not exclusive. For example, if it was fine yesterday, both condition 1 and 2 are satisfied. This is a Finite-State Automata problem. In this problem, even if today is rainy, playing place depends on the weather "state" of the previous day. This means that two certain rainy days may be in the different states. By this problem, the idea of "state transition" will be noticed. The approaches of the state transition is an important concept that is used in the design of programs, such as a vending machine.

Keywords
Probability
Exclusive event
Finite-State Automata

T11: Nuts

A squirrel picks two hazelnuts from the top of the hazel bush. She wants to collect as many hazelnuts as she can. To do this, she has to jump from one branch into another and pick them up, but she can only jump in the direction of the arrows.



How many hazelnuts can she collect after two jumps?

A) 9 nuts **B)** 10 nuts **C)** 11 nuts **D)** 12 nuts

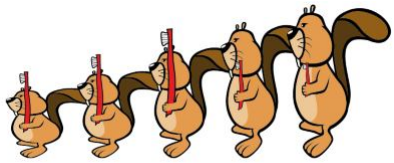
It's informatics!

The problem is reduced to a complete exhaustive search of all possible variants. It is important not to skip the correct answer. This develops skills in organizing a complete exhaustive search. With a large number of variants, one should be able to cut off obviously suboptimal branches. This problem can also be viewed as a dynamic programming problem.

Keywords

Exhaustive search
Dynamic programming

T12: Toothbrushes



"Not so fast!" says beaver Mom. "Eve and Chad, swap your brushes! Ann and Chad, swap your brushes, too!" And then she lost track.

Which pair still needs to swap their brushes so that each beaver will have its own brush?

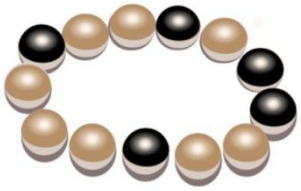
A) Ben and Chad **B)** Ben and Danny **C)** Ann and Eve **D)** Nobody

It's informatics!
Computer programmers are often like moms, except that instead of ordering beaver kids to swap brushes, they move numbers through different cells in the computer memory. This is one base operation in programming. For instance, often we get some numbers we need to sort (like here with the size of the brushes). These numbers are stored in a group of memory cells. Sorting them consist of putting the smallest number in the first cell, the second smallest in the second cell, and so on, until the biggest number in the last cell. To do that we need to exchange several times the values contained is these cells.

Keywords
Programming

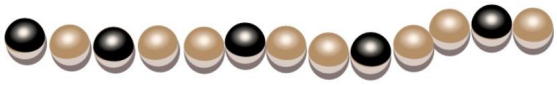
T13: Pearl bracelet

For the grand ball, a princess put on the bracelet with dark and light pearls shown to the right. After the ball, she unfastened the bracelet between two pearls and put it in a chest. The next evening, she wanted to put on the same bracelet but there were many similar bracelets in the chest.



Which of the following bracelets did the princess wear to the grand ball?

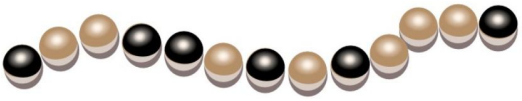
A)



B)

C)

D)



It's informatics!

The bracelet is an example of a sequence of objects. The pearls are arranged in a certain pattern. When identifying the correct bracelet you have to look for properties of this pattern. In informatics, pattern matching means finding similar objects in different sources. In image processing, the pattern matching is used for locating a small image in a bigger one. Another example is searching for a word in text using a text processor.

Keywords

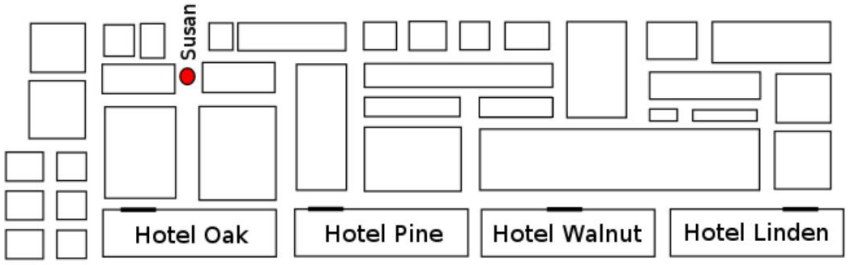
Sequences
Pattern matching

T14: Lost in a City

Susan is staying at a hotel in Beaver Town. She follows the directions below given by the hotel staff to get to the famous Beaver statue to take some pictures.

1. From the hotel's door, immediately turn to the left.
2. Go straight forward through two intersections.
3. At the third intersection, turn right.
4. Go straight forward. At the first intersection, turn left.
5. Go straight forward. At the first intersection, turn right.

A map showing the neighborhood of several hotels is given below.



In which hotel is Susan staying?

A) Hotel Oak **B)** Hotel Pine **C)** Hotel Walnut **D)** Hotel Linden

It's informatics!

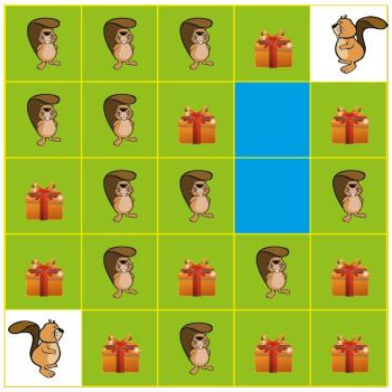
In this task Susan is given a set of instructions in order to reach a given goal. This is the basic idea of algorithms, which make up an essential part of informatics. An algorithm is a step-by-step solution to a problem. The steps involved should be as precise as possible and there needs to be a way to reach the solution. Algorithms can then be translated into computer programs by implementing them in a given programming language. As the task shows, we also deal with algorithms in our everyday life as well. Cooking recipes are a typical example. For instance, a recipe for baking a cake includes a list of steps that you need to follow in order to end up with a tasty dessert. When we read an instruction such as “pour the flour and the sugar into a bowl and stir”, we understand that we need to get a bowl from the cupboard, something to stir with and also make sure we use the correct amount of each ingredient. When we, on the other hand, create an algorithm that should be understandable by a computer, all steps need to be very precise and detailed. Everything needs to be explicitly mentioned so that there is no source for confusion or interpretation – you cannot assume that the computer has some “background” knowledge as we humans have. For instance, the instruction “pour the flour and the sugar into a bowl and stir”, would need to be divided into a list of instructions, e.g. 1) go to the cupboard to the left, 2) open the door, 3) grab the yellow bowl on the third shelf from below, 4) open the top-most drawer, 5) pull out a large spoon, … And still, this would not be detailed enough. What if we are not in the kitchen? What if there are two yellow bowls? What is a large spoon?

Keywords

Find the path
Algorithms

T15: Beavers and Gifts

Beaver Nick is traveling from the bottom left region of the forest to his friend Ann at the top right. He only moves up and right, never down or left. Today the temperature is very cold, so he must also avoid the lake. On his way he encounters gifts and beavers. When he finds a gift, he picks it up. When he meets a beaver, he gives him a gift. He must choose a path so that he always has gifts for the beavers he meets, and in the end he must also have a gift (that is, just one gift) to give it to Ann.



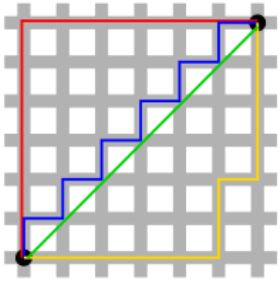
How long is the shortest valid path to Ann, counted in the number of steps (up, right) he will make?

A) 8 **B)** 9 **C)** 10 **D)** 12

It's informatics!

To determine the distance between two points we most of the time measure the length of the straight line between them. In some cases, however, we must define the distance in a different way.

Imagine a city with perfect perpendicular streets. Unless you are a bird, the minimal distance you need to cover to get from one point to another equals the number of horizontal plus the number of vertical blocks you need to pass, in whatever order. Such distance is called “Manhattan distance”.

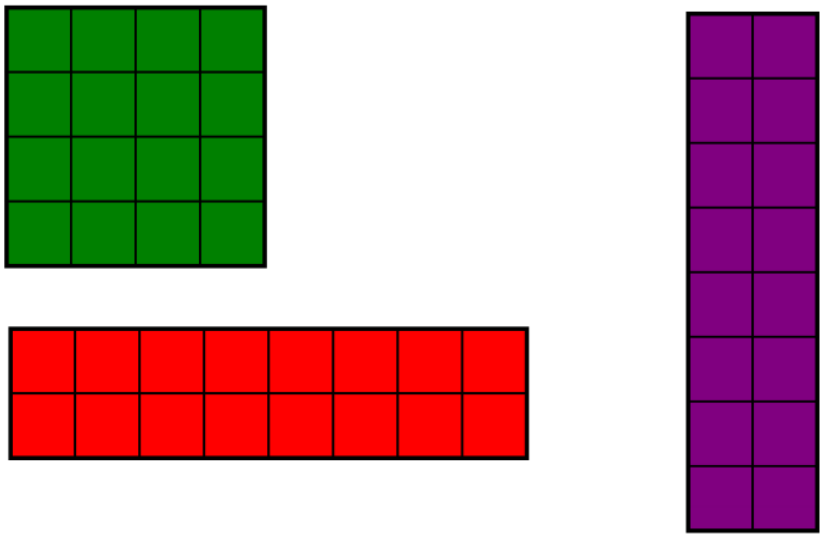


Keywords

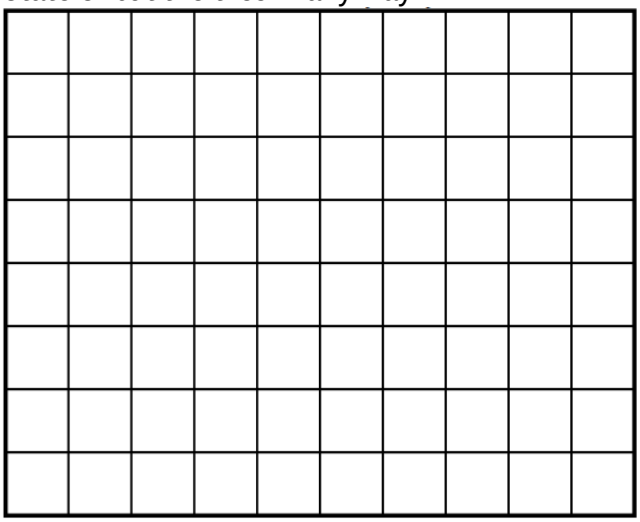
Manhattan distance

T16: Colourful Table

A little beaver would like to pave his new room with different coloured tiles:



He decided that he will not rotate or cut the tiles in any way.



He wants to make his room as colorful as possible.

What is the maximum number of different colors he can use to pave the room in the picture?

A) It is impossible **B)** 1 **C)** 2 **D)** 3

It's informatics!

The partition on the subsets of given sizes is one of the classical problems in the Algorithms theory. It is packing problem, where we have an area and we decide how to cover the area with certain shapes.

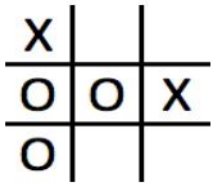
Keywords

Partition,
Graphical algorithm

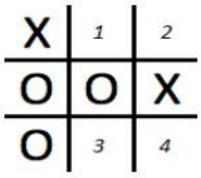
Tasks T17 – T24 carry 5 points each

T17: Tic-tac-toe

You are playing a Tic-tac-toe game with your friend on a 3×3 grid. First, your friend has to place "O", then it is your turn to put "X". You continue playing this way. The player who succeeds in placing three respective marks in a horizontal, vertical or diagonal row wins the game. Here is a picture of the actual board:



It is your turn to put "X". At which position would you put it, in order to be sure to win the game?



A) The 1st position **B)** The 2nd position **C)** The 3rd position **D)** The 4th position

It's informatics!
In the artificial intelligence domain, it is often necessary to explore a states space, a numerous ways to perform actions. From a current state, the strategy is to find the succession of states which will lead to the goal. The program has then to consider several states in advance, in order to make the right choice in the current state.

Keywords
Optimisation
Logic
State space exploration

T18: Non-ordered stars

Lucy has 4 plastic stars. Every star has its own **size, colour, thickness of contour** and **number of corners** and she likes to order them by these properties. Stars on the picture above are ordered from thickest contour line to thinnest one.

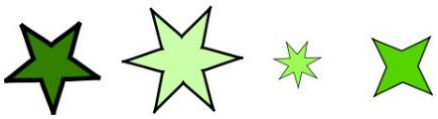
Order stars so that they were **not ordered according to any of the described properties.**
For example, they should not be ordered neither from the lightest to the darkest one nor from the darkest to the lightest one.

A)

B)

C)

D)



It's informatics!

Sorting objects according to their properties is using in databases. For example, school inventory could be sorted by age, place in different rooms, its function or price. Computers can work with database very quickly. Databases are core of normal shops and e-shops, lists of patients in hospitals and lists of bus stations and connections in timetables. Even search services as Google must use huge databases. Using best searching algorithms brings big advantage. Arrangement of things in database could help to effectivity of searching. e. g. It is easier to find the name in a list of pupils when they are sorted by alphabet.

Keywords

Database
Sorting

T19: Crossing the river

Beaver Pierre wants to cross a river. He carries a lot of objects and want to take with him the greatest number of those objects. To do this, he has 2 small boats that can each carry a maximum of 10 Kg. Beaver Pierre will only be able to make one traversal of the river. Each object has a weight and a happiness value (the more the value is high, the more Beaver Pierre is happy!).

Here is the list of objects that Beaver Pierre carries with him:

Object	Weight	Happiness value
Log	10 Kg	5
Computer	5 Kg	7
Telephone	4 Kg	3
TV	3 Kg	4
Hammer	8 Kg	6

Which objects can Beaver Pierre take with him, in order to maximize his happiness?

A) Computer + Telephone + TV + Hammer
B) Log + Computer + Telephone
C) Computer + TV + Hammer
D) Computer + Telephone + Hammer

It's Informatics!
The knapsack problem is a well-know problem in combinatorial optimisation. Such problems are difficult to solve, but for small instances it is possible to explore that whole state space to find the best solution. This problem is a variant with two containers.

Keywords
Optimisation
Combinatorics
States' exploration

T20: Secret number reminder

Maciej carries a bookmark with this table on it to help him remember his secret four digit number.

1	2	3	4	5	6	7	8	9	0
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				

If his secret number is 8526, all he has to do is to remember the word HELP. To retrieve his number, he looks up the letters of the word HELP and finds the corresponding digits in the top row of the table. Another example: The word LOVE can be used to help Maciej remember the secret number 2525.

Maciej has to remember a new secret number. Only three of the following words produce this new number. Which one does not?

A) DOME **B)** NEMO **C)** NONO **D)** NEWY

It's informatics!

Secret numbers are used a lot and some people find it hard to remember them. Using a table or another tool to remember your secret number using a simple algorithm is a way to retrieve the secret information without writing it down. There are many ways of finding the word that produces a different number. One way is to convert each word to a number and check which is different. Another way is to compare the words position by position. As long as all letters at a position correspond to the same digit the words will produce the same number. For example D, N, N and N all correspond to 4, while M, M, N and W does not correspond to the same digit. Since M, M and W correspond to 3 and N corresponds to 4 we know that C is different. The benefit of the second approach is that you do not have to check every letter of every word.

Keywords

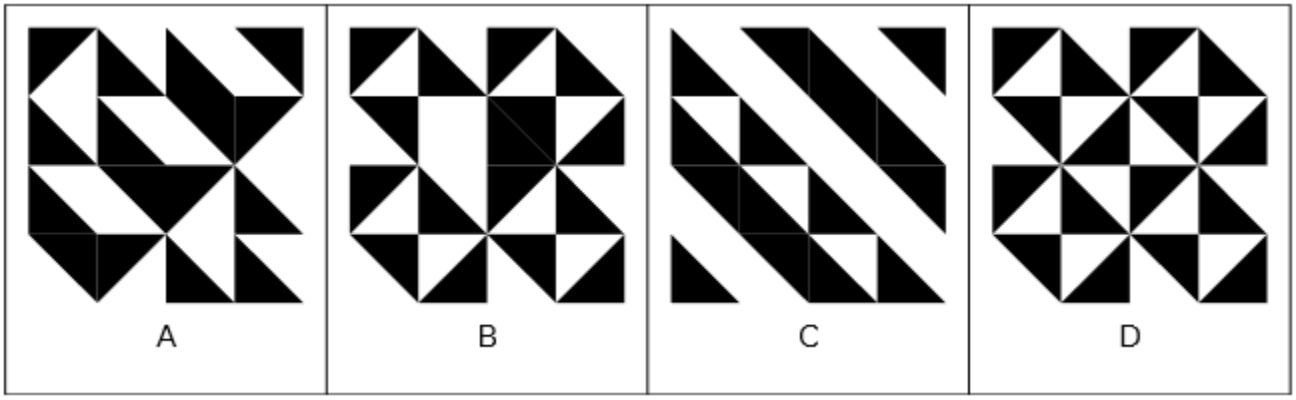
Information hiding

T21: Truchet

A beaver has 16 tiles of the same type. By rotating them he can form different looks.

He wants to decorate his bathroom wall by filling a square area with these 16 tiles. Now he is planning the design.

Which of the following patterns can NOT be made with these tiles?



It's informatics!

Information can not only be represented by bits or letters. You can use pictures too. The tile is the basic form of Truchet tiles. These are square tiles decorated with patterns that are not rotationally symmetric. When placed within a square tiling of the plane, they can form varied patterns, and the orientation of each tile can be used to visualize information associated with the tile's position within the tiling. There are more kind of Truchet tiles.

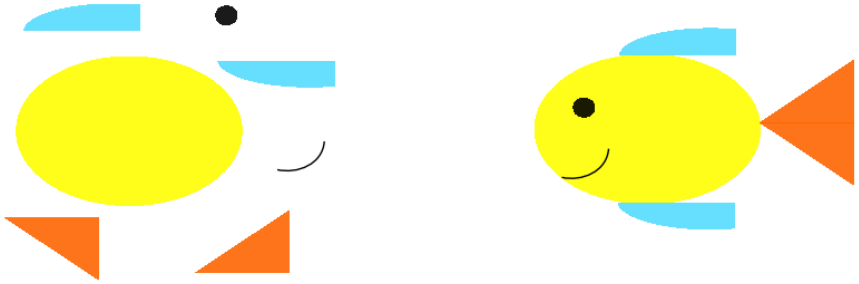
Keywords

Pattern
Visualisation

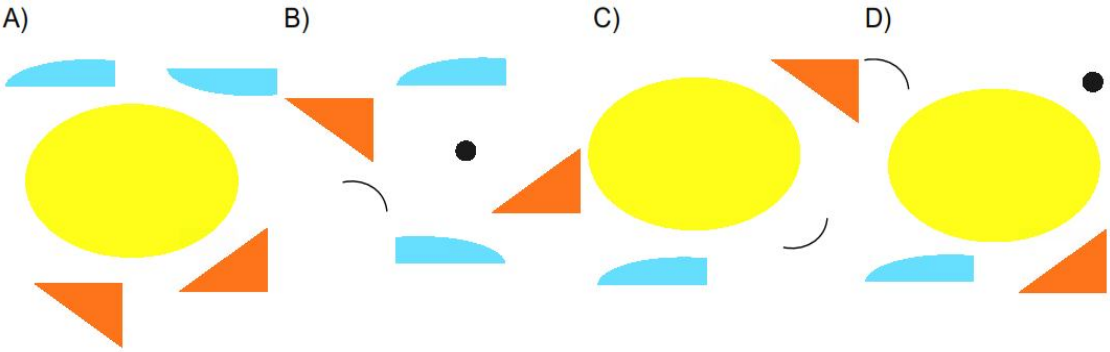
T22: Assemble the Fish

Students were learning how to use a graphics editor. They learned how to cut parts off a picture, copy them and move the copies to different places.

They used the seven parts shown in the picture on the left to assemble the fish in the picture to the right.



In the next lesson, pupils will be introduced to flipping parts of a picture horizontally and vertically.
From which set of parts will the students be able to assemble the same fish as above during the next lesson by using the skills learnt in both lessons?



It's informatics!
The basic operations of a graphics editor is part of school informatics (in many countries). The operations involved when cutting, copying and assembling pictures from parts can also be considered as a type of logical puzzles that enhance algorithmic thinking (finding the sequence of operations that results in solving a task).

Keywords
Graphics Editor
Sequence of operations

T23: Broken Clock

A beaver has a digital clock which uses a seven-segment display for each of four digits. Each seven-segment display represents decimal numerals as shown below:

He breaks his clock and realizes that one of segments does not light up.

Which is a possible time that the above display represents?

A)

B)

C)

D)

It's informatics!

This task expects logical thinking ability. Digital clocks use seven-segment displays which are concerned with internal representation of numerals. This task is also concerned with error correcting methods.

Keywords

Numeric representation
Error correcting

T24: Forest monitoring

Ranger Olivier is monitoring a forest. Every year, he counts the total number of trees. If the total is:

- even, he cuts half of the trees;
- odd, he plants new trees in the forest so that the total number of trees has tripled, plus one.

For example, if there are 10 trees the first year, Ranger Olivier will cut half of them which will reduce the size of the forest to 5 trees. Then, the next year, Ranger Olivier will plant new trees so that the size of the forest grows to (5 × 3) + 1 = 16 trees.

After how many years will the size of the forest be reduced to a single tree, knowing that the initial number of trees is 15?

A) 16 **B)** 17 **C)** 18 **D)** Never

It's Informatics!

The background of this task is the Collatz conjecture, one of the open problems in mathematics. It is defined as f(n)=n/2 for even n and f(n)=3n+1 for odd n. In this case the amount of steps needed until f(n)=1 is reached are compared for different start values n. Linked below is a graph of some more complex ways to 1.

This is an example of a seemingly simple problem with a set of just two simple rules that shows a very complex behaviour. Unfortunately this happens quite often in computer science, especially if it comes to how long it takes to calculate something. Linked below is a graph presenting pairs of n and length of the way from n to 1 for values of n up to 9999.

Keywords

Recursion
Algorithm
Program execution

CORRECT ANSWERS

Task #	Answer	Task #	Answer	Task #	Answer
1.	**C**	9.	**B**	17.	**B**
2.	**D**	10.	**D**	18.	**D**
3.	**A**	11.	**C**	19.	**C**
4.	**A**	12.	**B**	20.	**C**
5.	**B**	13.	**B**	21.	**B**
6.	**B**	14.	**C**	22.	**D**
7.	**B**	15.	**A**	23.	**A**
8.	**D**	16.	**D**	24.	**B**