

Rules of the Math Blitz Tour Cup ISIJ

The math blitz tour is part of the JUNIOR ISIJ International School of Informatics Cup rounds. The purpose of the tour is to motivate the participants of the School to study sections of mathematics as part of the preparation for Olympiad computer science, as well as check the preparation of participants for the main topics of mathematical computer science.

Tour specifications

The competition is held on the platform `Yandex.Contest`, participants solve 12 or 15 problems in accordance with the distribution into groups: B — basic (7-9 grades) and A — advanced (high school). Each group has a separate rating and awards for winners and awardees.

Tour tasks are designed to be resolved quickly. 2 hours are allotted for the solution of all tasks. The math competition scoring system uses an automatic online solution check, which implies *unambiguous answer* for each problem in the round. The participant's response is sent for review as an entry in the output line.

In each problem, this is one number or a sequence of numbers (possibly strings). This is a significant difference from the usual mathematical competitions, in which various advances in solving a problem are assessed, and solutions with minor flaws are also allowed. This test format is the closest to evaluating problem solutions at computer science Olympiads.

A description of the output format is embedded in the statement of each task.

Problems can be solved in any order. During the competition, questions about the conditions of the problems are resolved, the answers to them are given in the form adopted at the programming competition.

Evaluation of participants' decisions

For the correct solution of each problem, from 5 to 10 points are awarded, depending on the complexity. Three attempts are allowed for each problem. If none of them leads to the correct answer, the task is considered unsolved. No penalty points will be awarded for unsuccessful attempts. For the correct solution, points assigned by the jury for solving this problem are added to the participant's result.

Methodical characteristics of the tour tasks

Each task is a small mathematical Olympiad problem on one of the topics of the school curriculum of the course "Mathematical Foundations of Informatics": logic, combinatorics, set theory, graphs, elements of probability theory, chess, numerical laws and sequences, number systems, computational, geometric algorithms and strategies, etc.

The set of tasks includes such a number of tasks on various topics, which, according to the developers, should take an average of 2 hours for their complete solution. According to the complexity of the problem, the jury takes into account the approximate time for the blitz. Blitz solution orients the student towards a creative approach and solving the problem "in the mind".

The examples of tasks on specific topics below show how a task is presented to a participant and how he should submit a response for review.

The participant receives the text of the problem and a description of the format of the response. An automatic check system records his correct answer. After the end of the round, the participants of the competition are given access to solving problems.

Example. Task “Cake”. The cake has the form of a parallelogram with vertex coordinates (0; 0), (4; 0), (6; 6), (2; 6). Rabbit and Fox share the cake as follows. Rabbit points to a point on the surface of the cake, and the Fox cuts the cake into two pieces in a straight line passing through this point and takes one for himself. Everyone wants a bigger piece. Where should the Rabbit put the dot?

Output the answer — *the coordinate of this point as two numbers separated by spaces.*

Answer: 3 3.

Solution. This is the center of the parallelogram, i.e. intersection point of diagonals. Rabbit can't get more than half of the cake. Any straight line passing through the center of a parallelogram divides it into two equal parts

Note. This is a simple geometric problem on the properties of a parallelogram and on the topic “Game strategies”. The approximate time for solving the problem is 3-5 minutes.

Example. Task “Sum of permutations”. Find the sum of all five-digit numbers that are obtained by permuting the numbers from 12345.

Print one integer that is the answer to the problem.

Answer: 3 999 960.

Solution. There are only $5! = 120$ ways to rearrange numbers in the number 12345. Among these methods, exactly in the fifth part (i.e. in 24 cases), the number 1 is in the first place. The same is true for any number and for any place. Therefore, the required sum is equal to: $24(10\,000 + 1\,000 + 100 + 10 + 1 + 20\,000 + 2\,000 + 200 + 20 + 2 + 30\,000 + 3\,000 + 300 + 30 + 3 + 40\,000 + 4\,000 + 400 + 40 + 4 + 50\,000 + 5\,000 + 500 + 50 + 5) = 24(11\,111 + 22\,222 + 33\,333 + 44\,444 + 55\,555) = 24 \cdot 11\,111 \cdot (1 + 2 + 3 + 4 + 5) = 3\,999\,960$.

Note. This is a combinatorial problem on the topic “Permutations”, “Number systems”. The approximate time for solving the problem is 10-15 minutes.

Example. Task «Chess». In position on the chessboard, White has the only move that does not checkmate for Black.

The coordinate of a cell on a chessboard is given by a capital Latin letter and a number without a space between them. In the response line *enter the required move in the format of cell coordinates: cell coordinate “from” and cell coordinate “where” separated by a space between them.*

Answer: G6 C6.

Solution. After the move ♖g6-c6! the rook blocks the diagonal of the white bishop on a8, and now black has protection from mate ♜b7: h7.

Note. The approximate time for solving a chess problem is 8-12 minutes.

