MINISTRY OF SCIENCE AND EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
“Kazan (Volga Region) Federal University”

Institute of Information Technology and Intelligent Systems

APPROVED BY

Vice-Rector for Academic Affairs

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__________ 2023

PROGRAM OF ENTRANCE EXAMINATION IN INFORMATICS AND ICT

2023

Entrance examination program approval sheet

Developer of the program:

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Chairman of the Examination Committee ____________________________M.M. Abramsky

The program of the entrance examination was discussed and approved at the meeting of the Department of Software Engineering of the Institute of Information Technology and Intelligent Systems Protocol No. 1 of September 29, 2023.

By the decision of the Teaching and Methodical Committee of the Institute of Information Technology and Intelligent Systems The program of the entrance examination is recommended for approval by the Academic Council, Minutes No. 1 of September 29, 2023.

The program of the entrance examination is approved at the meeting of the Academic Council of the Institute of Information Technologies and Intelligent Systems, Protocol No. 1 of September 29, 2023.

Content

Program of the Entrance Examination in Informatics and ICT

Section 1. Introduction

1.1. Purposes and objectives of entrance examinations;

1.2. General requirements for the organization of entrance examinations. Form of conducting the entrance examination: in person and/or with the use of remote technologies with the use of proctoring system.

1.3. Description of the format of entrance examinations. Written examination in the form of testing and detailed answer. Structure of the examination ticket: the examination consists of two parts, including 27 tasks. Part 1 contains 23 tasks with a short answer in the form of a test. Part 2 contains 4 tasks with detailed answers.

1.4. Duration of the exam. The duration of the examination in Informatics and ICT is 3 hours 55 minutes (235 minutes).

1.5. Criteria for evaluating the performance of each type of examination task on a 100-point scale in case of successful and unsatisfactory completion of the entrance examinations. The points received by you for the completed tasks are summarized.

In accordance with the Procedure for the State Final Attestation of the State Final Attestation of Secondary General Education Programs (Order of the Ministry of Education and Science of Russia dated December 26, 2013 No. 1400 registered by the Ministry of Justice of Russia on February 03, 2014 No. 31205) "61. Based on the results of the first and second examinations, the experts independently assign points for each answer to the tasks of the EGE examination paper with detailed answers. 62. In case of a significant discrepancy in the scores assigned by the two experts, a third check shall be assigned. A significant discrepancy in scores is defined in the assessment criteria for the relevant subject. The expert carrying out the third check shall be provided with information on the scores assigned by the experts who have previously checked the examination paper. If the discrepancy is 2 or more scores for any of the tasks 24-27, the third examiner checks answers only to those tasks that caused such a significant discrepancy.

Try to complete as many tasks as possible and score the highest number of points.

Section 2. Program content

2.1 The content of the tasks has been developed according to the basic topics of the informatics and ICT course, united in the following thematic blocks: "Information and its coding", "Modelling and computer experiment", "Number systems", "Logic and algorithms", "Elements of algorithm theory", "Programming", "Architecture of computers and computer networks", "Processing numerical information", "Information retrieval and storage technologies". The content of the examination paper covers the main content of the informatics and ICT course, its most important topics, the most important material in them, which is unambiguously interpreted in most versions of the informatics and ICT course taught at school.

The exam contains both tasks of the basic level of complexity, testing knowledge and skills stipulated by the standard of the basic level, and tasks of advanced and high levels of complexity, testing knowledge and skills stipulated by the standard of the profile level. On the one hand, the number of tasks in a variant of the testing material (KIM) must, on the one hand, provide a comprehensive test of the knowledge and skills of graduates acquired over the entire period of study in the subject, and, on the other hand, meet the criteria of complexity, stability of results, and reliability of measurement. For this purpose, the testing material (KIM) uses two types of tasks: short-answer and detailed-answer.

The structure of the examination work provides an optimal balance of tasks of different types and varieties, three levels of complexity, testing knowledge and skills at three different levels: reproducing, applying in a standard situation, applying in a new situation. The content of the examination work reflects a significant part of the subject content. All this ensures the validity of the exam results and the reliability of the measurement.

Structure of testing material (KIM)

Each variant of the examination paper consists of two parts and includes 27 tasks that differ in form and level of difficulty.

Part 1 contains 23 short answer tasks.

The exam offers the following types of short-answer tasks:

– tasks to calculate a certain value;

– tasks for establishing the correct sequence represented as a string of symbols according to a certain algorithm.

The answer to Part 1 is given in the form of a natural number or a sequence of symbols (letters or numerals) written without spaces or other separators.

Part 2 contains 4 detailed answer tasks.

Part 1 contains 23 tasks of basic, advanced and high difficulty levels. This part contains short-answer tasks, which imply independent formulation and recording of the answer in the form of a number or a sequence of symbols. The tasks test the material of all thematic blocks. In Part 1, 12 tasks belong to the basic level, 10 tasks - to the advanced level of complexity, 1 task - to the high level of complexity.

Part 2 contains 4 tasks, the first of which is of higher level of difficulty, the remaining 3 tasks of higher level of difficulty. The tasks of this part imply writing a detailed answer in free form. Part 2 tasks are aimed at testing the formation of the most important skills of writing and analyzing algorithms. These skills are tested at the advanced and high levels of complexity. The skills on the subject "Programming Technology" are also tested at a high level of complexity.

Distribution of testing material (KIM) tasks by content, types of skills and modes of action.

The selection of the content to be tested in the testing material (KIM) is based on the Federal Component of the State Standard of Secondary (Full) General Education (Basic and Profile Levels). The distribution of tasks by sections of the Informatics and ICT course is presented in Table 1.

Distribution of tasks of exam work according to content sections of the Informatics and ICT course

No.	Content sections	Number of tasks	Maximum primary score	Percent of maximum primary score for completion of tasks from this section from the maximum primary score for the whole work, equal to 35
1	Information and its coding	4	4	11
2	Modelling and computer experiment	2	2	6
3	Number systems	2	2	6
4	Logic and algorithms	6	8	23
5	Elements of algorithm theory	5	6	17

Program of the Entrance Examination in Informatics and ICT

No.	Content sections	Number of tasks	Maximum primary score	Percent of maximum primary score for completion of tasks from this section from the maximum primary score for the whole work, equal to 35
6	Programming	4	9	25
7	Architecture of computers and computer networks	1	1	3
8	Processing numerical information	1	1	3
9	Information retrieval and storage technologies	2	2	6
	Total	27	35	100

Table 1.

The testing material (KIM) for Informatics and ICT does not include tasks that require simple replication of knowledge of terms, concepts, values, rules (such tasks are too easy to perform). When completing any of the testing material (KIM) tasks, the examinee is required to solve a thematic problem: either directly use a known rule, algorithm, or skill, or choose the most appropriate one from the total number of studied concepts and algorithms and apply it in a known or new situation.

- Knowledge of theoretical material is tested indirectly through understanding of the terminology used, interrelationships of basic concepts, dimensions of units, etc. when examiners perform practical tasks on various subjects of the subject. Thus, the testing material (KIM) for Informatics and ICT tests the mastery of theoretical material from the sections:

- information measurement units;
- principles of coding;
- number systems;
- modelling;
- the concept of an algorithm, its properties, recording methods;
- basic algorithmic constructions;
- basic concepts used in information and communication technologies.

The examination work contains one task requiring direct application of the learnt rule, formula, algorithm. This task (1) is marked as a task for reproducing knowledge and skills.

The material for testing the ability to apply knowledge in a standard situation is included in both parts of the examination paper.

These are the following skills:

- analyze the unambiguity of binary code;
- generate a truth table and logic diagram for a logical function;
- manipulate bulk data;
- calculate the information volume of the message;
- find the shortest path in a graph, traverse the graph;
- convert from one number system to another;
- use standard algorithmic constructions in programming;
- formally execute algorithms written in natural and algorithmic languages, including programming languages;

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ДЕПАРТАМЕНТ ВНЕШНИХ СВЯЗЕЙ

- determination of the capacity of the address space of a computer network by subnet mask in the TCP/IP protocol;
- evaluation of the result of known software;
- formulating queries to databases and search engines.

The material for testing the ability to apply their knowledge in a new situation is also included in both parts of the examination paper. These are the following complex skills:

- analyze the environment of the algorithm executor;
- identify the base of the number system by the properties of number writing;
- describe the properties of a binary sequence using the algorithm of its construction;
- transform test conditions;
- simulate the results of a web search;
- analyze the result of algorithm execution;
- analyze the program text from the point of view of the correspondence of the written algorithm to the task at hand and modify it in accordance with the assignment;
- ability to build a game tree according to a given algorithm and justify a winning strategy;
- implement a complex algorithm using modern programming systems.

Each task of the exam paper is characterized not only by the content to be tested, but also by the skills to be tested. The codifier defines two groups of requirements to the level of graduates' preparation: on the one hand, to know/understand/skill and, on the other hand, to use the acquired knowledge and skills in practical activities and everyday life.

Although the standard of education in informatics and ICT contains quite a lot of requirements for the use of acquired knowledge and skills in practical life, the standardized form-based technology of the Unified State Exam does not allow to check the fulfilment of these requirements in full. There are only 3 such tasks in the paper, they are located in Part 1 of the paper. Their fulfilment gives less than 10% of the primary score. The remaining 90% of the primary scores can be obtained by the examinee due to the implementation of the ability to operate with the theoretical material of the subject of informatics and ICT. Table 2 characterizes the distribution of tasks in terms of the skills tested in each part of the paper.

Distribution of tasks of exam work according to content sections of the Informatics and ICT course

Basic skills and methods of action	Number of tasks		
	Whole work	Part 1	Part 2
1. Requirements: "Know/understand/be able to"	24	20	4
Modelling of objects, systems and processes	16	12	4
Interpretation of modelling results	4	4	0
Quantification of information processes	4	4	0
2. Requirements: "Use the acquired knowledge and skills in practical activities and everyday life"	3	3	0
Search and select information	1	1	-
Create and use data storage structures	1	1	-
Working with common automated information systems	1	1	-
Total	27	23	4

Table 2.

The following conventions are used in the examination tasks.

1. Designations for logical connectives (operations):

a) *negation* (inversion, logical NOT) is denoted by ¬ (e.g. ¬A);
b) *conjunction* (logical multiplication, logical AND) is denoted by ∧
c) (e.g., A ∧ B) or & (e.g., A & B);
d) *disjunction* (logical addition, logical OR) denoted by ∨
e) (e.g., A ∨ B) or | (e.g., A | B);
f) *a consequence* (implication) is denoted by → (e.g., A → B);
g) an *identity* is denoted by ≡ (e.g., A ≡ B). The expression A ≡ B is true if and only if the values of A and B coincide (either they are both true or they are both false);
h) The symbol 1 is used to indicate truth (true statement); the symbol 0 is used to indicate falsehood (false statement).

2. Two logical expressions containing variables are called equivalent (equivalent) if the values of these expressions coincide at any values of the variables. Thus, the expressions A → B and (¬A) ∨ B are equivalent, and A ∨ B and A ∧ B are inequivalent (the values of the expressions are different, for example, when A = 1, B = 0).

3. Priorities of logical operations: inversion (negation), conjunction (logical multiplication), disjunction (logical addition), implication (following), identity. Thus, ¬A ∧ B ∨ C ∧ D means the same as ((¬A) ∧ B). ∨ (C ∧ D).

4. It is possible to write A ∧ B ∧ C instead of (A ∧ B) ∧ C. The same applies to disjunction: it is possible to write A ∨ B ∨ C instead of (A ∨ B) ∨ C.

5. The designations Mbyte and Kbyte are used in the traditional sense of computer science - as designations of units of measurement, whose ratio to the unit "byte" is expressed by the degree of two.

Section 3 " Assessment Fund"

3.1 Instruction on task fulfillment.

Testing material (KIM) tasks are graded with a different number of points depending on their type.

Completion of each task of Part 1 is assessed with 1 point. The Part 1 task is considered to be completed if the examinee has given an answer that corresponds to the correct answer code. For each task, either 0 points ("task not completed") or 1 point ("task completed") is assigned (in a dichotomous grading system).

The maximum primary score that can be obtained for completing Part 1 tasks is 23 points. Completion of Part 2 tasks is assessed from 0 to 4 points. Answers to Part 1 and Part 2 tasks are checked and evaluated by experts. The maximum number of points that can be obtained for completing Part 2 tasks is 12.

The distribution of tasks by parts of the examination paper is presented in Table 3.

Part of exam	Number of tasks	Maximum primary score	Percent of maximum primary score for completion of tasks from this section from the maximum primary score	Type of tasks

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			for the whole work, equal to 35	
Part 1	23	23	66	Short-answer tasks
Part 2	4	12	34	Detailed answer
Total	27	35	100	

Table 3

The answers to tasks 1-23 are written as a number, a sequence of letters or digits, which should be written in the "answer" field after each question, without spaces, commas or other additional symbols, and then click the "next" button. Tasks 24-27 require a detailed solution. You must create a new Word document, write your answers to the questions in the document on your computer, then save it as a .pdf file and name it "ICT. Your Name" and then attach it as an attachment to the exam system. If you will not be answering Part 2, you attach a blank form and click on the 'next' button.

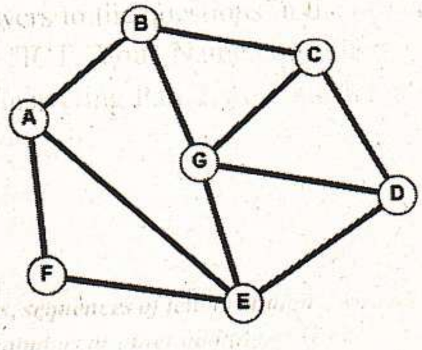
3.2. Sample tasks.

Part 1. The answers to questions 1-23 are numbers, sequences of letters or digits, which should be written in the "answer" field after each question, without spaces, commas or other additional symbols, and then click the "next" button.

1. How many natural numbersx divisible by 4 are there for which the inequality holds$650_8 \le x \le 3DC_{16}$? In your answer, write only the number of numbers, you do not need to write the numbers themselves.

2. In the image, the scheme of roads in the N-district is shown as a graph, and the table contains information about the length of each of these roads (in kilometers). Since the table and the scheme were drawn independently of each other, the numbering of settlements in the table is not connected with the letter designations on the graph. Determine the length of the road from point B to point C. Write an integer in the answer.

	P1	P2	P3	P4	P5	P6	P7
P1		19		17		15	
P2	19		1		9		
P3		1			11		12
P4	17				17	25	5
P5		9	11	17			10
P6	15			25			
P7			12	5	10		



3. The function *F*is defined by the expression $(\neg w \vee (((x \wedge y) \rightarrow \neg z) \wedge (x \vee y \vee z))) \wedge ((z \wedge w) \rightarrow x))$. The picture shows a partially filled fragment of the truth table of the function*F*, containing non-recurring rows. Determine to which column of the function's truth table *F* corresponds each of the variables *x, y, z, w*.

				F
		1	0	**0**
	1	0		**0**

	0	0		0
				0

In your answer, write the letters x, y, z, w in the order of the columns (first the letter that corresponds to the first column; then the letter that corresponds to the second column, etc.). Write the letters in the answer in a row without any separators between the letters.

Example. The function F is given by an expression $\neg x \lor y$, depending on two variables, and the fragment of the table has the following form.

		F
0	1	0

In this case, the first column corresponds to the variable y, and the second column – corresponds to the variable x. The answer should be: *yx*.

4. Below, there are two table fragments from the neighborhood unit residents database. Each row in Table 2 contains information about the child and one of the parents. The information is represented by the ID field value in the corresponding row of Table 1.

Based on the data given, determine the number of people who have two children of different sexes. When calculating your answer, consider only the information from the table fragments given.

Table 1

ID	Surname_initials	Sex	Year_of_birth
14	Ivanova M. A.	F	1942
24	Skanavi I. P.	M	1943
25	Skanavi P. I.	M	1973
26	Skanavi P. P.	M	1996
34	Kushchenko A. I.	F	1964
35	Kushchenko V. S.	F	1987
36	Kushchenko S. S.	M	1964
44	Lebed A. S.	F	1941
45	Lebed V. A.	M	1953
46	Gross O. S.	F	1992
47	Gross P. O.	M	2009
54	Klemenko A. P.	F	1993
64	Krot P. A.	F	1964
68	Sergeev A. P.	M	1958
…	…	…	…

Table 2

Parent_ID	Child_ID
24	25
44	25
25	26
64	26
24	34
44	34
34	35
36	35
14	36
34	46
36	46
25	54
64	54
46	47
…	…

5. Messages containing only letters from the set: Е, С, О, Л, А, П, Р are transmitted over the communication channel. A binary code satisfying the direct Fano condition, according to which no code word is the beginning of another code word, is used for transmission. This condition ensures that the encoded messages can be unambiguously decoded. Code words for some letters are known: С – 0, П – 111. For the five remaining letters Е, О, Л, А, Р the code words are unknown. What number of binary characters is required to encode the word ЛЕСОПОЛОСА if it is known that it is encoded with the minimum possible number of binary characters?

6. The algorithm receives a natural number N > 100 as input. The algorithm builds a new number R from it as follows:

1. A binary notation of the number N is built.
2. The number of 0 and 1 in the resulting notation is counted. If their number is the same: a 0 is added to the end of the notation if the last digit of the number is 1; a 1 is added if the last digit of the number is 0. If the number of 0 and 1 are not equal, the digit that occurs less frequently is added to the end of the notation.
3. Step 2 is repeated one more time.
4. The result is converted to decimal number system.

At what smallest initial number N the algorithm will give a number that, when divided by 4, has a remainder of 3?

7. The executor Turtle acts on a plane with a Cartesian coordinate system. At the initial moment, the Turtle is at the origin of coordinates, its head is pointing along the positive direction of the ordinate axis, and its tail is down. With its tail down, the Turtle leaves a line-shaped mark on the field. At any specific moment, we know the position of the executor and the direction of its movement. There are two commands for the executor:

Forward *n* (where ***n*** is an integer), causing the Turtle to move ***n*** units in the direction its head is pointing, and

Right *m* (where ***m*** is an integer), causing the direction to change by ***m*** degrees clockwise.

Repeat *k* [Command1 Command2 ... CommandS] means that the sequence of **S** commands will be repeated ***k*** times.

Turtle was given the following algorithm:

Repeat 31 [Forward 9 Right 60 Right 120 Forward 9 Right 36].

Determine how many line segments will have the figure given by this algorithm.

8. The musical piece was recorded in mono, digitized and saved as a file without using data compression. The size of the resulting file is 112 MB. The same piece of music was then recorded again in stereo (dual-channel recording) and digitized at resolution 3.5 times higher and sampling rate 2 times lower than the first time. No data compression was done. Specify the size of the resulting rerecorded file in MB. Write only an integer in your answer; do not write the unit of measurement.

9. Determine how many five-digit numbers, not divisible by 3, written in the senary numeral system, have only one digit "2", with no even and odd digits next to each other.

10. A fragment of a spreadsheet is given. A formula was copied from cell C2 to cell D3. When copying, the cell addresses in the formula automatically changed. What is the numerical value of the formula in cell D3? In your answer, write down only the number.

	A	B	C	D	E
1	6	15	830	700	4500
2	55	88	=MAX(A$1:A$4)	2500	4200
3	46	15	925	784	7500
4	15	70	50	690	555

Note. $ means absolute addressing.

11. In TCP/IP terminology, the netmask is a binary number that determines which part of the IP address of a node refers to the network address and which part refers to the address of the node itself on that network. Typically, the mask is written using the same rules as the IP address: 4 bytes with each byte written as a decimal number. In this case, the mask firstly (in the high-order digits) contains 1, and then from a certain order - 0. The network address is obtained by applying a bitwise AND to a given IP address of a node and mask. For example, if the IP address of a node is 231.32.255.131, and the mask is 255.255.240.0, then the network address is 231.32.240.0. For a node with the IP address 55.102.221.201 the network address is 55.102.221.192. What is the highest value of the last (rightmost) byte of the mask? Write the answer as a decimal number.

12. When registering in a computer system, each user is assigned a fixed-length two-part identifier. The first part includes 19 capital and uppercase Latin letters; each character is encoded separately using the minimum possible number of bits. The second part is an integer from 0001 to 3000, and the minimum number of bits is used to encode it. An integer type of bytes is given to encode the entire identifier. In addition, additional information is stored for each user (also integer bytes, the same for each user). Determine how many bytes are occupied by the additional information for one user if the data for 72 users occupies 4536 bytes. *Note*: Latin alphabet has 26 letters.

13. The executor Editor receives a string of digits as an input and converts it. Editor can execute two commands, in both commands ***v*** and ***w*** represent string of digits.

A) **replace (*v*, *w*).**
This command replaces the first left occurrence of the string ***v*** in the line with the string ***w***. For example, execution of the command **replace** (111, 27) converts string 05111150 to string 0527150. If the line does not contain any occurrences of the string v, then execution of the **replace (*v*, *w*)** command does not change this string.

B) **found** (***v***).
This command checks if the string ***v*** occurs in the Editor's line. If it occurs, the command returns "true", otherwise the command returns "false". The executor's row will not be changed in this case.

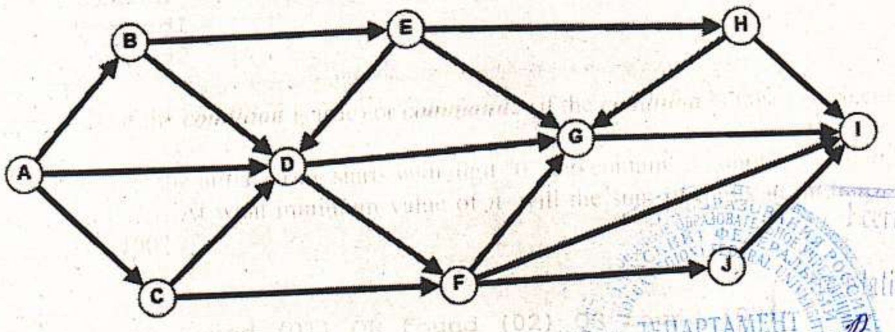
Loop
```
WHILE condition
      command sequence
END WHILE
```
is executed as long as the condition is true.

In construction
```
IF condition
THEN command1
ELSE command2
END IF
```
command1 (if the ***condition*** is true) or ***command2*** (if the ***condition*** is false) is executed.

It is known that the initial string starts with digit "0" and contains 25 digits "1", 30 digits "2" and n digits "3", placed in random order. At what minimum value of n will the sum of digits in the line resulting from the algorithm be divisible by 100?

```
START
      WHILE found (01) OR found (02) OR found (03)
          replace (01, 1103)
          replace (02, 201)
          replace (03, 20)
      END WHILE
END
```

14. The figure shows a roads map connecting cities A, B, C, D, E, F, G, H, I, J. It is possible to move along each road in only one direction, indicated by an arrow. How many different paths are there from city A to city I that pass through city G?



15. The value of the arithmetic expression

$$6 * 49^{30} + 42 * 7^{22} + 27 * 7^{14} - 13$$

is written in 7-base number system. How many 6 are contained in this notation?

16. Three-line segments are given on the number line: A = [5; 42], B = [77; 120] and C = [21; 97]. Specify how many integer values of x, for which the Boolean expression

$$(\neg(x \in A) \rightarrow (x \in B)) \vee ((x \in C) \rightarrow (x \in B)) \vee \neg ДЕЛ(x, 7)$$

is false (i.e., takes on value 0). Logical statement ДЕЛ(n, m) means "natural number n is divisible by natural number m leaving a zero remainder".

17. A recursive algorithm F is written below in three languages. Write in a row, without spaces and separators, all the numbers that will be displayed on the screen when the F(6) is called. The numbers should be written in the same order in which they are displayed on the screen.

Pascal	Python	C++

`procedure F(n: integer);`
` begin`
`if n > 0 then`
`if (n mod 2 <> 0) then`
`begin`
`F(n + 1);`
`writeln(n + 3)`
`end`
`else begin`
`writeln (n + 2);`
`F(n - 3)`
` end;`
`end;`
	`def F(n):`
	`if n > 0:`
	`if (n % 2 != 0):`
	`F(n + 1)`
	`print(n + 3)`
	`else:`
	`print(n + 2)`
	`F(n - 3)`
		`void F(int n) {`
		`if (n > 0)`
		`if (n % 2 != 0){`
		`F(n + 1);`
		`std::cout << n + 3 <<`
		`std::endl;`
		`}`
		`else {`
		`std::cout << n + 2 <<`
		`std::endl;`
		`F(n - 3);`
		`}`
		`}`

18. In the query language of the search engine, the symbol "|" is used to denote the logical operation "OR" and the symbol "&" is used to denote the logical operation "AND". The table shows the queries and the number of pages of some Internet segment found upon them.

Query	Found pages (in hundreds of thousands)
Logic & Informatics	150
Programming	750
Logic	375
Informatics & Programming	230
Informatics | Programming | Logic	1265
Logic & Programming	0

What is the number of pages (in hundreds of thousands) that will be found for the query *Informatics?*

19. The program uses a one-dimensional integer array mas with indices from 0 to 9 . The values of the elements are 34, 29, 28, 3, 9, 6, 40, 7, 50, 4 respectively, i.e. $mas[0] = 34$, $mas[1] = 29$, etc. Determine the value of the variable s after executing the following program fragment (given below in three programming languages).

Pascal	Python	C++

`s := 0; n := 0;`
`for i := 0 to 8 do`
`if mas[i] >= mas[i+1]`
`then`
`begin`
`t := mas[i + 1];`
`mas[i + 1] = mas[i];`
`mas[i] := mas [n];`
`mas[n] := t;`
`s += mas[i]`
`end;`
	`s = 0`
	`n = 9`
	`for i in range(9):`
	`if mas[i] >= mas[i + 1]:`
	`t = mas[i + 1]`
	`mas[i + 1] = mas[i]`
	`mas[i] = mas[n]`
	`mas[n] = t`
	`s += mas[i]`
		`s = 0, n = 9;`
		`for (int i=0; i<9; i++)`
		`if (mas[i] >= mas[i+1]){`
		`int t = mas[i + 1];`
		`mas[i + 1] = mas[i];`
		`mas[i] = mas[n];`
		`mas[n] = t;`
		`s += mas[i];`
		`}`

20. The algorithm is written below in three programming languages. Give the smallest value of *a* greater than 100, upon entering which the algorithm will print 17.

Pascal	Python	C++

`var a, b, t :integer;`
`begin`
`readln(a);`
`b := a - 34;`
`while (a <> b) do begin`
`a := a - b;`
`if b > a then`
`begin`
`t := a;`
`a := b;`
`b := t;`
`end`
`end;`
`writeln(a);`
`end.`
	`a = int(input())`
	`b = a - 34`
	`while a != b:`
	`a -= b`
	`if b > a:`
	`t = a`
	`a = b`
	`b = t`
	`print(a)`
		`int a, b, t;`
		`std::cin>>a;`
		`b = a - 34;`
		`while (a != b){`
		`a -= b;`
		`if (b > a){`
		`t = a;`
		`a = b;`
		`b = t;`
		`}`
		`}`
		`std::cout<<a<<std::endl;`

21. The algorithm is written below in three programming languages. Write in your answer the number that will result from it.

Pascal	Python	C++

`var a,b,M,R,t:integer;`
 	
`function`
`F(x:integer):integer;`
`begin`
`F:= -2*(x*x-4)*(x*x-4)+5;`
`end;`
 	
`begin`
`a := -3;`
`b := 3;`
`M := a;`
`R := F(a);`
`for t:=a to b do`
`if F(t) <= R then`
`begin`
`M := t;`
`R :=F(t)`
`end;`
`writeln(R+200);`
`end.`
	`def F(x):`
	`return -2*(x*x-4)*(x*x-`
	`4)+5`
	
	`a = -3`
	`b = 3`
	`M = a`
	`R = F(a)`
	`for t in range(a, b +`
	`1):`
	`if F(t) <= R:`
	`M = t`
	`R =F(t)`
	`print(R+200)`
		`#include <iostream>`
		`using namespace std;`
		`long F(long x) {`
		`return -2*(x*x-4)*(x*x-`
		`4)+5;`
		`}`
		
		`int main() {`
		`long a, b, t, M, R;`
		`a = -3;`
		`b = 3;`
		`M = a; R = F(a);`
		`for (t = a; t <= b; t++) {`
		`if (F(t) <= R) {`
		`M = t;`
		`R = F(t);`
		`}`
		`}`
		`cout << R+200<< endl;`
		`return 0;`
		`}`

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22. The table provides information about a set of N computational processes that can be executed in parallel or sequentially. We shall say that process B depends on process A if the results of execution of process A are necessary for the execution of process B. In this case processes can be executed only sequentially.
The first column of the table contains the process identifier (ID), the second column of the table contains its execution time in milliseconds, and the third column lists the IDs of the processes (separated by ";") on which this process depends. If the process is independent, the table indicates 0.

Process B ID	Process B execution time (msec)	Process(es) A ID
1	4	0
2	4	0
3	2	0
4	8	2
5	10	1;2;3
6	4	0
7	7	4;6
8	6	5;7
9	6	3;5;8
10	8	8;9;

Determine the **minimum** time after which the execution of the entire set of processes will be completed, provided that all independent processes can be executed in parallel.

23. The Executor converts the number on the screen. The Executor has three commands that have been assigned the following numbers:

1. **Add 2**
2. **Add 3**
3. **Multiply by 5**

A program for the Executor – is a series of commands. How many programs are there for which at initial number 1 the result is the number 25, and at the same time the computation trajectory contains the number 8 and does not contain the number 20?
The program computation trajectory – is the sequence of results of execution of all program commands. For example, for program 123 with the initial number 5, the trajectory will consist of numbers 7, 10, 50.

Part 2

Use the ANSWER SHEET No. 2 to record your answers to this part (25-27). First, write the number of the task (25, 26 etc.) then write the complete solution. Answers should be written down clearly and legibly.

24. A natural number greater than 100 and not exceeding 10^9. is received for processing. Write a program that displays the number of digits of a number that are greater than or equal to the previous digit in the number (if the previous digit exists). The programmer wrote the program incorrectly. Below this program is given in three programming languages for your convenience.

Pascal

```
var n,d1,d2: longint;
begin
readln(n);
d1 := n mod 10;
n := n div 10;
count := 0;
while n div 10 > 0 then
begin
d2 := n mod 10;
if d2 <= d1 then
count += 1;
```

Python

```
n = int(input())
d1 = n % 10
n //= 10
count = 0
while n // 10 > 0:
d2 = n % 10
if d2 <= d1:
count += 1
d2 = d1
n //= 10
print(count)
```

C++

```
#include <iostream>
using namespace std;
int main() {
int n,d1,d2;
cin >> n;
d1 = n % 10;
n = n / 10;
count = 0;
while (n / 10 > 0){
d2 = n % 10;
if (d2 <= d1)
```

`d2 := d1;`
`n = n div 10;`
`end;`
`writeln(p)`
`end.`
		`count += 1;`
		`d2 = d1;`
		`n = n / 10;`
		`}`
		`cout << count << endl;`
		`return 0;`
		`}`

1. Write what this program will display when a number is entered 123.
2. Specify the maximum three-digit number, at the input of which the given program, despite the errors, gives the correct answer.
3. Find the errors made by the programmer and correct them. The error correction should involve only the line in which the error is found. For each error:

1) write out the line where the error was made;
2) specify how to correct the error, i.e. give the correct variant of the line.

It is known that you can correct exactly two lines in the program text so that it will work correctly.
It is enough to specify errors and the way to correct them for one programming language. Note that it is required to find and correct exactly two errors in the existing program, not to write your own, possibly using a different solution algorithm.

25. An integer array of 50 elements is given. The array elements are numbered from 0 to 49 and can take natural values from 1 to 10000 inclusive. Describe using one of the programming languages an algorithm that finds the number of pairs of array elements in which both numbers in the pair are divisible by 2 and exactly one ends in 6, and then replaces each element that is not divisible by 6 with the value found. As a result it is necessary to output the modified array, each element shall be output on a new line. A pair refers to two adjacent array elements.

For example, for an original array of six elements:

```
2
6
8
11
36
15
```

the program should output the following array:

```
2
6
2
2
36
2
```

Pascal	Python	C++

`const N = 50;`
`var a: array [0..N-1]`
`of longint;`
`i, j, k: longint;`
`begin`
`for i := 0 to N-1 do`
`readln(a[i]);`
 	
`...`
`end.`
	`# is also allowed`
	`# use two`
	`# integer variables j and k`
	`a = []`
	`n = 50`
	`for i in range(n):`
	`a.append(int(input()))`
	`...`
		`#include <iostream>`
		`using namespace std;`
		`const int N = 50;`
		`int main(){`
		`long a[N];`
		`long i, j, k;`
		`for (i = 0; i < N; i++)`
		`cin >>  a[i];`
		`...`
		`return 0;`
		`}`

As an answer you need to give a program part that should be in the place of ellipsis points. You can also write the solution in another programming language (specify the name and version of the programming language used, e.g. Free Pascal 2.6). In this case, you must use the same original data and variables as suggested in the specification.

26. Two players, Petya and Vanya, play the following game. Two piles of stones lie in front of the players. Players take turns, the first move is made by Petya. In one move a player can either add **three** stones to one of the

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piles (at his choice) or multiply by **four** the number of stones in the pile. For example, let there be given 10 stones in one pile and 5 stones in the other; we will denote this position in the game as (10, 5). Then in one move you can get any of the four positions: (13, 5), (40, 5), (10, 8), (10, 20). To make moves, each player has an unlimited number of stones.

The game ends when the total number of stones in the piles becomes at least 105. The winner is the player who made the last move, i.e. the first to get the position with 105 or more stones in the piles. At the starting moment there were 2 stones in the first pile, and S stones in the second pile, 1 < S < 103.

We shall say that a player has a winning strategy if he can win at any moves of the opponent. To describe a player's strategy – means to describe what move he should make in any situation that he may face with a different opponent's playing. The description of a winning strategy should not include the moves of the player playing this strategy which are not certainly winning for him, i.e. which are not winning regardless of the opponent's play. Complete the following tasks. In all cases, justify your answer.

1) Specify S, at which Petya cannot win in one move, but at any move of Petya Vanya can win with his first move.

2) Find the minimum and maximum values of *S* at which Petya has a winning strategy, and two conditions are simultaneously satisfied:

- Petya can win in one move;
- Petya can win with his second move no matter how Vanya moves.

Describe Petya's winning strategy.

3) Find the value of S at which two conditions are simultaneously satisfied:

- Vanya has a winning strategy that allows him to win the first or second move no matter how Petya plays;
- Vanya does not have a strategy that will allow him to win with his first move.

If several values of S are found, write the maximum value in your answer. For the value of S given in answer, describe Vanya's winning strategy. Give a game tree possible with this winning Vanya's strategy (in the form of a figure or a table). Indicate moves on the edges of the tree and positions on its nods.

27. A sequence of *N* natural numbers is given. Numbers in the sequence can take values from 1 to 10000. All its continuous subsequences such that the sum of the elements of each of them is divisible by 13 and the product is divisible by 6 are considered. Find the subsequence with the maximum sum and its length. If you find several such subsequences, write the number of elements in the longest of them in your answer.

Description of input and output data

The first line of the input file contains *N* numbers (1 < *N* < 10000000). Each of the following *N* lines contains one natural number in the range from 1 to 10000. The program should print two numbers as the result: the maximum sum of the continuous subsequence, and its length.

An example of organizing original data in an input file:

```
10
1
97
68
11
46
96
7
29
41
12
```

Example of input data for the input data example above:

```
325 6
```

Explanation: The sum equal to 325, is the result of summing the elements 97, 68, 11, 46, 96, 7.. Among these elements, there is a number that is divisible by 6, which is 96.

You need to write a time-efficient program to solve the described problem. A program is considered to be time-efficient if, when the number of sequence elements *N* increases by *k* times, the time of program operation increases by no more than *k* times. The maximum score for a correct (with no syntax errors and the correct answer with any

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acceptable input data) time-efficient program is 4points. Maximum score for a correct program that does not meet the performance efficiency requirements is – 2 points.
You may turn in one or two problem solving programs (e.g., one of the programs may be less effective). If you turn in two programs, each program will be graded independently of the other, with the higher of the two grades will be the final grade. Before the program text, be sure to briefly describe the solution algorithm. Specify the programming language used and its version.

Check that each answer is written next to the corresponding task number.

Section 4. The list of literature and information sources to prepare for entrance examination

- Educational Information Portal. Documents, materials, manuals, probes to Unified State Exam (EGE), State Final Examination (GIA). [Electronic resource]. - Access mode: http://egeigia.ru/;
- Official website of Federal Education and Science Supervision Agency (Rosobrnadzor) "Unified State Exam (EGE) Portal. We Know Everything About Unified State Exam". [Electronic resource]. - Access mode: http://4ege.ru;
- Methodological materials and software on Informatics - Access mode: http://kpolyakov.spb.ru
- Ugrinovich N. D. Informatic and ICT. Specialized Level: Grade 10 Textbook - BINOM. Knowledge Laboratory, 2012
- Ugrinovich N. D. Informatic and ICT. Specialized Level: Grade 11 Textbook - BINOM. Knowledge Laboratory, 2012
- V. G. Davydov. Programming and Basics of Algorithmizing - Moscow: Higher School, 2003

MINISTRY OF SCIENCE AND EDUCATION OF THE RUSSIAN FEDERATION

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Director of the Institute of
Information Technology and
Intelligent Systems

_____________ M.M. Abramskiy

“___” _____________ 2023.

ASSESSMENT CRITERIA FOR THE ENTRANCE EXAMINATION IN INFORMATICS AND ICT

Criteria for evaluating the performance of each type of examination task on a 100-point scale in case of successful and unsatisfactory completion of the entrance examinations. Entries in the draft paper are not taken into account when assessing the work. The points received by you for the completed tasks are summed up.

Tasks are assessed with different numbers of points depending on their type.

Completion of each task of Part 1 is assessed with 1 point. The Part 1 task is considered completed when the examinee has given an answer that matches the correct answer code. Each task is awarded either 0 points ("the task is not completed") or 1 point ("task is completed").

The maximum primary score that can be obtained for completing Part 1 tasks is 23 points.

Completion of Part 2 tasks is assessed from 0 to 4 points. Answers to Part 1 and Part 2 tasks are checked and evaluated by experts. The maximum number of points that can be obtained for completing Part 2 tasks is 12.

The total number of tasks is 27, including 23 tasks in Part 1 and 4 tasks in Part 2.

Scale for converting scores from primary to final.

Primary score	Final score
1	7
2	14
3	20
4	27
5	34
6	40
7	42

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Primary score	**Final score**
8	**44**
9	46
10	48
11	50
12	51
13	53
14	55
15	57
16	59
17	61
18	62
19	64
20	66
21	68
22	70
23	72
24	73
25	75
26	77
27	79
28	81
29	83
30	84
31	88
32	91
33	94
34	97
35	100

<table>
<tr><td colspan="2">Maximum score</td></tr>
<tr><td>Primary scores</td><td>Final scores</td></tr>
<tr><td>35</td><td>100</td></tr>
<tr><td colspan="2">The entrance examination shall be deemed to have been passed if the applicant has scored more than</td></tr>
<tr><td>Primary score</td><td>Final score</td></tr>
<tr><td>8 and higher</td><td>44 and higher</td></tr>
<tr><td colspan="2">The entrance examination is considered as NOT passed if the applicant has received</td></tr>
<tr><td>Primary score</td><td>Final score</td></tr>
<tr><td>7 and lower</td><td>42 and lower</td></tr>
</table>

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