Russian School of Math Test

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Abstract

This note reviews a small number of problems from the Russian School of Math test. Written for personal use.

1

The set S contains nine numbers. The mean of the [ILLEGIBLE] in S is 202. The mean of the five smallest of the numbers in S is 100. The mean of [ILLEGIBLE] largest numbers in S is 300. What is the median of the numbers in S?

to do

2

The parabola $f(x) = 3x^2 + 2x - 6$ intersects the x-axis and y-axis at three different points. The area of the triangle formed by these points is equal to S. Find the least whole n such that $n \geq S$.

to do

3

Find the sum of the digits in the decimal representation of the number $5^{2026} \cdot 16^{506}$.

to do

4

Let a be the sum of the numbers:

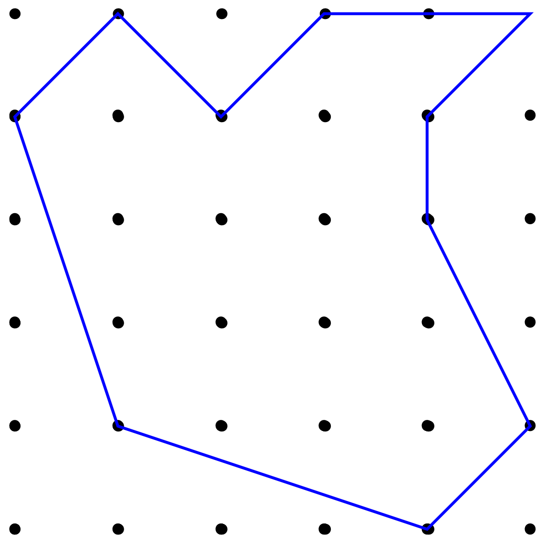
$$\begin{aligned} 99 &\times 0.9 \\ 999 &\times 0.9 \\ 9999 &\times 0.9 \\ \ldots &\times \ldots \\ 999\ldots9 &\times 0.9 \end{aligned}$$

where the final number in the list is 0.9 times a number written as a string of 101 digits all equal to 9. Find the sum of the digits in the number a.

to do

5

The grid below contains six rows with six points in each row. Points that are adjacent either horizontally or vertically are a distance of two apart. Find the area of the irregularly shaped ten-sided figure shown.



to do

6

Solve the equation

$$\operatorname{arccot} x = \operatorname{arccot}(-1) = \arctan 2 + \arctan 3 + \arctan 4$$

to do

7

Find the number of pairs of interest (m, n) for which the equality $m^2 + 2^{2024} = n^2$ holds.

to do

8

There are positive integers b and c such that the polynomial $2x^2 + bc = c$ has two real roots which differ by 30. find the least possible value of $b + c$.

to do

9

Find the sum of all such values of a, for each of which equation

$$x^2 + x + a = 0$$

has two different real roots satisfying relation

$$x_1^4 + 2x_1x_2^2 - x_2 = 19.$$

to do

10

On the side AC of triangle ABC, points M and N are marked such that $\widehat{ABM} = 15°$, $\widehat{MBN} = 45°$, $\widehat{NBC} = 75°$, and the sum and product of the areas of triangle ABM and NBC are equal to 5 and 3 respectively. Find the area of triangle ABC.

to do

11

Suppose that $2024\,x^2 + ax + b$ has 2 equal roots, where a and b are positive integers. Determine the smallest possible value of $a + b$.

to do

12

In base b, we have $r = 0.\overline{57}_b$ and $3r = 1.\overline{06}_b$. What is the value of r in base 10? Express your answer as a common fraction.

to do

13

Among the numbers greater than 2025, find the smallest integer N for which the fraction $\frac{15N-7}{22N-5}$ is reducible.

to do

14

Find the largest natural number n for which the number

$$\frac{2024!}{2024^n}$$

is whole. Here $2024! = 1 \cdot 2 \cdot 3 \cdot \ldots \cdot 2023 \cdot 2024$.

to do

15

Triangle ABC has side lengths $AB = 71$, $BC = 75$, and $CA = 80$ as shown. Median AD is divided into three congruent segments by points E and F. Lines BE and BF intersect side AC at points G and H, respectively. Find the length of segment GH.

to do