ROHS

Romanian Olympiad Hardness Scale

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What ROHS is

ROHS is a difficulty scale from 0 to 50, in steps of 5, for the problems of the three rounds of the Romanian Mathematical Olympiad: the local round (OLM), the county round (OJM) and the national round (ONM). The idea comes from Evan Chen's MOHS scale for international olympiad problems. ROHS applies the same idea to Romanian contests and has three rules. (Grades 9 to 12 are the four years of Romanian high school.)

1. **An absolute scale.** The rating says how hard the problem is, regardless of the grade. Two equally hard problems get the same rating, whether they are from grade 9 or grade 12. No allowance is made for the fact that grade 9 students are younger. A problem that appears in both grade 9 and grade 10 has the same difficulty in both, unless its solution uses material that is taught in grade 10 and not in grade 9 (then the theory rule, below, applies).
2. **A single scale for all rounds. 0** is the easiest problem ever given at OLM, and **50** is a problem that *should not have been set in a contest*, because it does not separate anyone. 50 does not mean "the hardest problem": there can be several problems rated 50, even more than four (example below, at level 50). OJM sits between them, with overlaps.
3. **The rating is a declared opinion.** Difficulty means how hard it is to find the solution, and the rating expresses the author's opinion, not a measurement.

How to use this document. The most important part is the tables on page 17: there you look up a problem by round, year, grade and position and see its rating, and that is what students work from. In the appendix, the rating of each problem is a link: if you click it, you go straight to the discussion of that problem on AoPS (Art of Problem Solving), where you find the statement and solutions. The links exist for OJM and ONM; there are no AoPS discussions for OLM. The rest explains what the rating means and how it was given. In the appendix, a problem with an asterisk uses material from higher grades.

About the name: ROHS stands for Romanian Olympiad Hardness Scale, and SDOM stands for Scara Dificultății Olimpiadelor de Matematică; they are the same name, in English and in Romanian, following the MOHS model. In this document I use the name ROHS throughout.

Where it comes from. ROHS is inspired by MOHS. Evan Chen's scale helped me a lot to know what to work on: to choose problems suited to my level and to see what I was missing. ROHS aims to do the same for Romanian olympiad problems.

The basic rule. *The rating of a problem equals the difficulty of its easiest solution.* The problem is rated by the simplest path a prepared contestant would find, not by the official solution, which may be more complicated than necessary. The simplest solution is determined by combining the official solutions, my solutions and the solutions on AoPS. "A chain is as weak as its weakest link." The rule applies to *solutions*: the difficulty of a solution cannot be lower than that of its hardest step, but it also grows with the number of steps. For example, if the simplest solution has 10 steps of 5 ROHS each, the problem is not a 5, but probably around 20 ROHS.

How theory enters the rating: five examples

The scale does **not** assume that all olympiad material is known. It takes into account what material the simplest solution uses, so that a problem which is only a special case of a big theory does not look hard. **The theory rule:** if there is an easy solution that uses a hard theory, the rating *goes down*, all the more so the better known and the easier to apply the theory is, and the final rating is an average between the case where the theory is known (where it can reach 0) and the case where it is not, weighted by how many contestants know it. If the theory is little known, the rating goes up. An idea that has to be invented from scratch (for example the pigeonhole principle) is not "easy theory". The material I consider known to a prepared contestant is the material in my olympiad mathematics books, available on Amazon in English (https://www.amazon.com/dp/B0HC7W95F6) and in French (https://www.amazon.fr/dp/B0HKGB6PJY). (The MOHS scale has a similar table, with the assumed knowledge.) Five examples, with my ratings:

Example 1 (OJM 2026, grade 12, P4). Let $f : [0,1] \to [0,1]$ be a continuous bijective function with $f(x) < x$ for every $x \in (0,1)$. For $n \in \mathbb{N}^*$ we write $f_n = f \circ f \circ \cdots \circ f$ (n functions) and $I_n = \int_0^1 f_n(x)\,dx$. a) Prove that for every $x \in (0,1)$ we have $\lim_{n\to\infty} f_n(x) = 0$. b) Determine $\lim_{n\to\infty} I_n$.

Part a) is a **15**. Part b) is a **10**: for someone who knows the dominated

convergence theorem it is a **0** (the sequence f_n converges pointwise to 0 on $(0,1)$ and $|f_n| \leq 1$), and without it it is still around **15**. Because the theorem is fairly well known, the final rating is an average between the two cases: **10**.

Example 2 (OJM 2025, grade 11, P4). Determine all triples of matrices $A, B, C \in \mathcal{M}_2(\mathbb{R})$ such that $A = BC - CB$, $B = CA - AC$, $C = AB - BA$.

Here one can actually do the computations, and the computations come out nicely: the rating is **15**. If you try to solve the problem with the Cayley-Hamilton theorem, that is, without computations, it is significantly harder; the easy solution is the one with direct computation, for which you only need the courage to do it.

Example 3 (ONM 2006, grade 10, P4). Let $n \in \mathbb{N}$, $n \geq 2$. Determine n sets A_i, $1 \leq i \leq n$, in the plane, pairwise disjoint, such that: a) for every circle $\mathcal{C}$ in the plane and every i, $A_i \cap \mathrm{Int}(\mathcal{C}) \neq \emptyset$; b) for every line d in the plane and every i, the projection of A_i onto d does not coincide with d.

Take countable dense sets, of the form $(\mathbb{Q}+a_i)\times\mathbb{Q}$ with irrational differences $a_i - a_j$: density gives a), and the projection of a countable set cannot cover a line, which gives b). For someone who knows analysis (countable versus uncountable) the rating is **20**. Someone not familiar with the concept of density would give more, around **40**.

Example 4 (ONM 2023, grade 9, P4). Let $r, s \in [1, \infty)$ be real numbers with the property that for all positive integers a, b with $a \mid b$, it follows that $[ar] \mid [bs]$. a) Prove that $\frac{s}{r}$ is a natural number. b) Show that r and s are natural numbers. ($[x]$ is the integer part of x.)

Part a) is a **15**: without analysis it is around **20**, and someone who knows analysis solves it immediately (**0**). Because few grade 9 students know analysis, the final rating is an average between the two cases. Part b) is a **30**. There is no rating for the whole problem: each part has its own rating. The simplest solution of b) uses "grade 9 analysis": the density of the fractional parts $\{nr\}$ (Kronecker's theorem) when r is irrational, and the rational case is handled separately.

Example 5 (ONM 2004, grade 12, P3). Let $f : [0,1] \to \mathbb{R}$ be an integrable function such that $\int_0^1 f(x)\,dx = \int_0^1 xf(x)\,dx = 1$. Show that $\int_0^1 f^2(x)\,dx \geq 4$.

Here "Pythagoras for integrals" appears (Theorem 4.44, the key identity, from my book *Analiză și Algebră pentru Olimpiadă*): if $f = g + h$ with g, h orthogonal, that is $\int gh = 0$, then $\int f^2 = \int g^2 + \int h^2 \geq \int g^2$. Take $g = 6x - 2$, which satisfies the same two conditions as f, and $h = f - g$ is orthogonal to 1 and to x; it follows that $\int_0^1 f^2 \geq \int_0^1 (6x-2)^2 dx = 4$. For someone who knows the theory, the problem is a **0**: you only need to know how to apply it. For someone who does not know it, the problem is not exactly easy and is around **20**. Because rather few contestants know this inequality, the final rating is an average between the two cases: **15**.

The five examples show how to read a rating: it answers the question "how hard is the easiest solution", and a solution that exploits a known theorem lowers the rating (the final rating being an average between those who know it and those who do not).

What the rating does not claim: the number of solves

ROHS does **not** make claims such as "a 50 ROHS problem should have 0 solves, a 45 between 1 and 3, a 40 between 3 and 6, a 35 between 6 and 10" and so on. The reason: students tend not to think enough about P4 at ONM, because it intimidates them. The number of solves therefore depends on the position of the problem and on time, not only on its difficulty. Nevertheless, the rating is **not** computed from the number of solves, but I also look at the official results, as an indicative signal. The best signal is a problem from P1 to P3, which many people thought about, and on which nobody got full marks (see ONM 2013, grade 12, P2, at level 50).

> **Example (ONM 2026, grade 11, P4).** Let $M = \{A_1, A_2, \ldots, A_n\}$ be a set of $n \geq 2$ matrices in $\mathcal{M}_{2026}(\mathbb{C})$ such that $AB \in M$ for all $A, B \in M$. Prove that there exist $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n \in \{-1, 0, 1\}$, not all zero, such that $\operatorname{rank}(\varepsilon_1 A_1 + \varepsilon_2 A_2 + \ldots + \varepsilon_n A_n) \leq 1013$.

I give it **35 ROHS**: it is a hard problem, but not very hard (the "very hard" level starts at 40). But it was the last problem, at a national round where, if you solved three problems, you were among the top four, so people did not really think about it. This is natural, because P4 problems are almost always the hardest problems in the paper.

What I took from MOHS and what is different

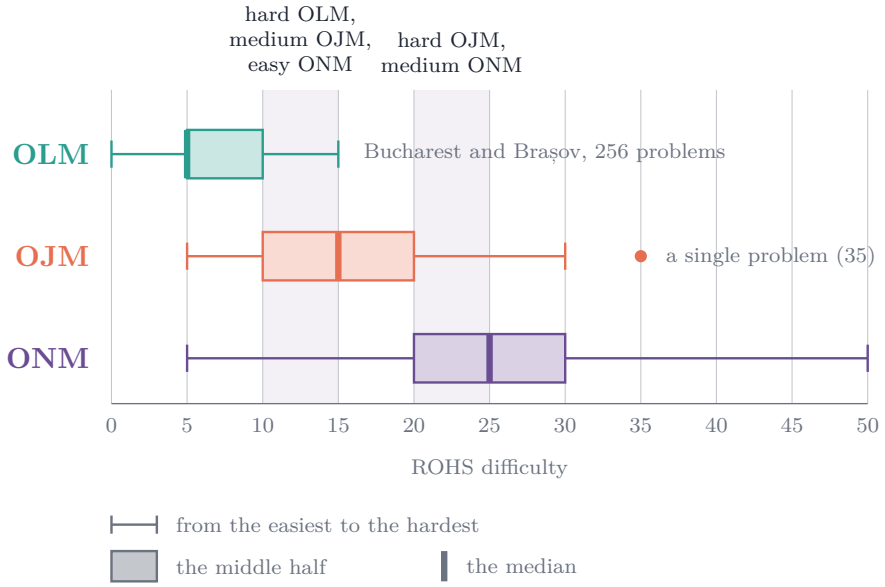
Evan Chen's MOHS scale defines each level by four things: a name (for example "very easy" or "brutal"), the slot in the contest the problem can occupy (IMO 1/4, 2/5 or 3/6), how students from the top countries fare, and a few recent examples. Evan Chen also stresses that the ratings are his personal opinion. ROHS keeps these four elements and the steps of 5, but three things change.

- **The slot in the contest is measured in rounds and positions.** The levels are described by which position (P1 to P4) the problems occupy at OJM and at ONM, not by the IMO.
- **The same number does not mean the same thing as in MOHS.** MOHS has a single reference contest, the IMO, while ROHS puts several contests on the same scale: four grades and three overlapping rounds. That is why a 10 ROHS problem is strictly easier than a 10 MOHS one, and the two scales cannot be compared number by number.
- **The rating is not measured in solves.** For each level, MOHS gives an indicator of how contestants should fare, but it specifies that this must be read in context and that the rating and the results are not in a causal relation. ROHS does not give such an indicator: it does not say, for example, that a 50 problem should have 0 solves, because the number of solves depends both on the position of the problem and on the time available. I also look at the results, to calibrate the ratings, but the rating is not based on them (see "What the rating does not claim"). The level descriptions talk about the idea and the position, not about solves.

> **Usage warning, as in MOHS.** The ratings are a reference point, not a prohibition. Look at the rating to see roughly where to work, and always work on problems slightly above your level. Terence Tao says:
>
> *"The ideal problem to work on is one which is just outside of your reach"*
>
> Terence Tao
>
> If you skip the problems with a high rating, you will never learn to solve them, and if you only work on problems that are too easy, you will not progress.

The three rounds on the scale

The figure shows where the problems of each round lie. For OJM and ONM, the figure is based on 784 rated problems, from 196 papers, for grades 9 to 12, years 2001 to 2026. For OLM it is based on 256 local round problems from two cities: Bucharest (96 problems, years 2007, 2008, 2011, 2012, 2020 and 2024) and Brașov (160 problems, years 2010, 2013, 2014, 2016 to 2019, 2023, 2025 and 2026), rated with the same rules and with reference points taken from OJM and ONM. The thin line goes from the easiest to the hardest problem, the box contains the middle half of the problems, and the thick bar in the box is the median.



What can be seen. At OJM, the middle half of the problems has difficulty between 10 and 20, the median is 15, and the hardest problems are 30, with a single exception of 35. At ONM, the middle half is between 20 and 30, the median is 25, and 93 out of 100 problems are at most 30. The hardest ONM problems go up to 50.

The overlap is large, exactly as the idea the scale started from suspected: 18% of the ONM problems have difficulty at most 15, that is, at the level of the OJM median, and 49% of the OJM problems have difficulty at least 20, that is, almost at the level of the ONM median (25). By position, this means that, usually, a P3 or a P4 at OJM (medians 20 and 22.5) are at

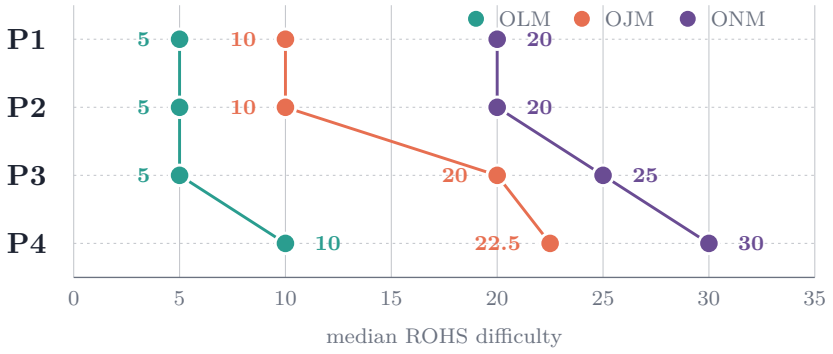
the level of a P1 or P2 at ONM (both with median 20), and a P4 at OLM (median 10) is at the level of a P1 or P2 at OJM (both with median 10). The easiest problems at the national round (55 out of 400 are at most 10, of which 34 are P1) are at the level of the local round problems.

OLM, measured on two cities. At OLM, the middle half of the problems has difficulty between 5 and 10, the median is 5, and the hardest problem is 15; 14 problems (5%) are 0. The idea the scale started from is confirmed here too: the hardest OLM problems (17 out of 256, rated 15) are at the level of the OJM median, and 47% of the OJM problems (those rated at most 10) are at the level of the hardest OLM ones. The zone 10 to 15 is common to the three rounds. Bucharest and Brașov look the same as regards the median and the ceiling; Brașov has more very easy problems (11 out of 160 are 0, compared to 3 out of 96 in Bucharest).

The OLM limitation. The sample is from two cities, over 16 years, and does not represent the whole country. Other counties may have even easier or harder problems, so the true 0 and the true ceiling may be different. The scale itself did not have to be adapted: no OLM problem exceeds 15, and the 14 problems rated 0 fix the lower end at the level of the sample.

The position in the paper

Each paper has four problems. The second figure shows the median difficulty by position, for the three rounds, and the table below it also gives the middle half of the problems in each position.



Median by position (in parentheses, the first and third quartiles, that is, the middle half of the problems in that position):

	P1	P2	P3	P4
OLM (Bucharest and Brașov)	5 (5 to 6.25)	5 (5 to 10)	5 (5 to 10)	10 (5 to 10)
OLM Bucharest	5 (5 to 10)	7.5 (5 to 10)	10 (5 to 10)	10 (8.75 to 15)
OLM Brașov	5 (5 to 5)	5 (5 to 10)	5 (5 to 10)	7.5 (5 to 10)
OJM	10 (5 to 10)	10 (10 to 20)	20 (10 to 25)	22.5 (20 to 25)
ONM	20 (10 to 20)	20 (20 to 25)	25 (20 to 30)	30 (25 to 30)

In all three rounds the difficulty increases from P1 to P4, but P1 and P2 have almost the same median. At OLM the increase is small (from 5 to 10), at OJM it is large (from 10 to 22.5), and at ONM from 20 to 30. The positions overlap across rounds: P4 at OJM (22.5) sits between P2 (20) and P3 (25) at ONM, and P3 at OJM (20) is at the level of P1 and P2 at ONM.

What each level means

The level names are the ones I gave:

Rating	Meaning	Rating	Meaning
0	below olympiad level	30	medium-hard
5	trivial	35	hard
10	very easy	40	very hard
15	easy	45	extremely hard
20	medium-easy	50	should not be used in a contest
25	medium		

Below, each level has a characteristic, the place it usually occupies in the paper, the number of problems that correspond to it and two examples, with their statements. The descriptions talk about the idea and the position, not about how many students solved the problem, because the number of solves depends on the position of the problem and on time as well.

0 Level 0: below olympiad level

A textbook exercise, a single standard step, solved in a few minutes. It appears only at OLM (14 problems). Examples:

- **OLM 2020, grade 9, P2**. Let a and b be real numbers with the property $[|a+b|] < 4$. Show that $[ab] < 4$. (For real a, $[a]$ denotes the integer part of a and $|a|$ the absolute value of a.)
- **OLM Brașov 2016, grade 9, P1**. Show that the number $a = 2n^2 + \left[\sqrt{4n^2+n}\right] + 1$, where $n \in \mathbb{N}^*$, can be written as a sum of two perfect squares. ($[x]$ denotes the integer part of the real number x.)

5 Level 5: trivial

A single standard step or a known idea, applied directly, with no traps. The usual type of very easy P1 at OJM; at ONM it appears rarely. 46 problems at OJM and ONM (33 of them P1) and 128 at OLM. Examples:

- **ONM 2003, grade 9, P1**. Determine the positive integers a and b with the property that for all $x, y \in [a, b]$ we have $\frac{1}{x} + \frac{1}{y} \in [a, b]$.
- **OJM 2003, grade 9, P1**. Determine the functions $f : \mathbb{N}^* \to \mathbb{N}^*$ with the property that, for every $n \geq 1$, $f(1) + f(2) + \cdots + f(n)$ is a perfect cube at most equal to n^3.

10 Level 10: very easy

A known idea applied with a little care: two short steps or a reformulation followed by a computation. P1 and P2 at OJM, an easy P1 at ONM. 188 problems at OJM and ONM, 97 at OLM. Examples:

- **ONM 2002, grade 9, P2**. Let ABC be a triangle with a right angle at A and $M \in (AB)$ such that $\frac{AM}{MB} = 3\sqrt{3} - 4$. Determine the measure of angle B, knowing that the reflection of M in the midpoint of the segment $[GI]$ lies on the line AC. (G is the centroid of the triangle and I the incenter.)
- **ONM 2004, grade 10, P1**. Let $f : \mathbb{R} \to \mathbb{R}$ be such that $|f(x) - f(y)| \leq |x - y|$ for all real x, y. Show that if for every real x the sequence $x, f(x), f(f(x)), \ldots$ is an arithmetic progression, then there exists a real a such that $f(x) = x + a$ for every real x.

15 Level 15: easy

A step that is not seen at first sight. This is where the rounds meet: a P3 at OJM and a P1 or P2 at ONM. 31 problems at OJM and ONM, 17 at OLM. Examples:

- **OLM 2024, grade 10, P4**. Consider complex numbers a, b, c, d such that $|a| = |b| = |c| = |d| = 1$, $|a+b+c+d| = \sqrt{2}$ and $a^2+b^2+c^2+d^2 = 0$. Show that $|a^3 + b^3 + c^3 + d^3| = 2\sqrt{2}$.
- **ONM 2001, grade 9, P1**. Let A be a set of real numbers satisfying: a) $1 \in A$; b) $x \in A \Rightarrow x^2 \in A$; c) $x^2 - 4x + 4 \in A \Rightarrow x \in A$. Show that $2000 + \sqrt{2001} \in A$.

20 Level 20: medium-easy

Two independent ideas or a less known idea. A P4 at OJM, a P2 or P3 at ONM. 217 problems (102 at OJM, 115 at ONM), the most populated level. Examples:

- **ONM 2001, grade 11, P2**. Consider a matrix $A \in M_n(\mathbb{C})$ of rank r, where $n \geq 2$ and $1 \leq r \leq n-1$. a) Show that there exist $B \in M_{n,r}(\mathbb{C})$, $C \in M_{r,n}(\mathbb{C})$, with rank B = rank $C = r$, such that $A = BC$; b) Show that the matrix A satisfies a polynomial equation of degree $r+1$, with complex coefficients.
- **ONM 2005, grade 9, P2**. Determine the functions $f : \mathbb{R} \to \mathbb{R}$ for which
$$x(f(x+1) - f(x)) = f(x),$$
for every $x \in \mathbb{R}$, and
$$|f(x) - f(y)| \leqslant |x - y|,$$
for all $x, y \in \mathbb{R}$.

25 Level 25: medium

A non-obvious idea, or a known one in disguise. A usual P3 or P4 at ONM, a hard problem at OJM. 151 problems (69 at OJM, 82 at ONM). Examples:

- **ONM 2002, grade 12, P2**. Let $f : [0,1] \to \mathbb{R}$ be integrable, such that
$$0 < \left| \int_0^1 f(x)\,dx \right| \leq 1.$$
Prove that there exist $x_1 \neq x_2$, $x_1, x_2 \in [0,1]$, such that
$$\int_{x_1}^{x_2} f(x)\,dx = (x_1 - x_2)^{2002}.$$

- **ONM 2003, grade 9, P2**. A natural number n, $n \geq 2$, is called "friendly" if there exists a family of nonempty subsets $A_1, A_2, \ldots, A_n$ of the set $\{1, 2, \ldots, n\}$ such that: 1) $i \notin A_i$ for every $i = \overline{1, n}$; 2) $i \in A_j$ if and only if $j \notin A_i$, for all distinct $i, j \in \{1, \ldots, n\}$; 3) $A_i \cap A_j \neq \emptyset$ for all $i, j \in \{1, \ldots, n\}$. Show that: a) the number 7 is friendly; b) n is friendly if and only if $n \geq 7$.

30 Level 30: medium-hard

A non-obvious idea, above a usual ONM P3 and below a very difficult P4. Mostly P4 at ONM; at OJM there are only 18 problems, almost all P4 or P3. In total 121 problems (18 at OJM, 103 at ONM). Examples:

- **ONM 2012, grade 10, P2**. Consider three complex numbers a, b and c such that $a + b + c = 0$ and $|a| = |b| = |c| = 1$. Prove that

$$3 \leq |z - a| + |z - b| + |z - c| \leq 4,$$

for every complex number z with $|z| \leq 1$.

- **ONM 2002, grade 10, P3**. Determine the real numbers a, b, c, d, e in the interval $[-2, 2]$ for which:

$$a + b + c + d + e = 0$$

$$a^3 + b^3 + c^3 + d^3 + e^3 = 0$$

$$a^5 + b^5 + c^5 + d^5 + e^5 = 10$$

35 Level 35: hard

A difficult idea, generally in the last problem of the paper. 23 problems (one at OJM, 22 at ONM; 16 are P4). Examples:

- **ONM 2025, grade 12, P4**. Let p be a prime number, $p \geq 3$, and k an odd number not divisible by p. Let K be a finite field with $kp + 1$ elements and $A = \{x_1, x_2, \ldots, x_t\}$ the set of elements of $K^* = K \setminus \{0\}$ that do not have order k in the multiplicative group $(K^*, \cdot)$. Show that the polynomial $P(X) = (X + x_1)(X + x_2) \ldots (X + x_t)$ has at least p coefficients equal to 1.

- **ONM 2005, grade 12, P4**. Let A be a ring with $2^n + 1$ elements, where n is a positive integer, and $M = \{k \mid k \in \mathbb{N},\ k \geqslant 2,\ x^k = x,\ \text{for every } x \in A\}$. Prove that the following statements are equivalent: (a) A is a field; (b) M is nonempty and its smallest element is equal to $2^n + 1$.

40 Level 40: very hard

Only P4 at ONM (5 problems), too hard for a usual P2 or P3. Examples:

- **ONM 2019, grade 11, P4**. Let p be a prime number. For every permutation $\sigma \in S_p$, consider the matrix $A_\sigma = (a_{ij})_{i,j=1}^{p} \in \mathcal{M}_p(\mathbb{Z})$, with entries $a_{ij} = \sigma^{i-1}(j)$, where σ^0 is the identity permutation and $\sigma^k = \sigma \circ \sigma \circ \cdots \circ \sigma$, k times. Show that the set
$$D = \{|\det(A_\sigma)| : \sigma \in S_p\}$$
has at most $1 + (p-2)!$ elements.
- **ONM 2013, grade 10, P4**. a) Show that
$$\frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \ldots + \frac{1}{2^m} < m,$$
for every $m \in \mathbb{N}^*$. b) Let $p_1, p_2, \ldots, p_n$ be the prime numbers less than 2^{100}. Show that
$$\frac{1}{p_1} + \frac{1}{p_2} + \ldots + \frac{1}{p_n} < 10.$$

45 Level 45: extremely hard

Above a very difficult P4. There is only one in the data:

- **ONM 2015, grade 12, P4**. Determine the nonconstant polynomial functions $f : [0,1] \to \mathbb{R}^*$, with rational coefficients, which have the following property: for every x in the interval $[0,1]$, there exist two polynomial functions $g_x, h_x : [0,1] \to \mathbb{R}$, with rational coefficients, such that $h_x(x) \neq 0$ and
$$\int_0^x \frac{1}{f(t)}\,\mathrm{d}t = \frac{g_x(x)}{h_x(x)}.$$

50 Level 50: should not be used in a contest

The rating 50 does not mean "the hardest problem", but a problem that **should not have been set in a contest**, because it does not separate anyone: whoever solves it does so rather out of luck at grading. There can be several problems rated 50. There is only one in the data, with a) 50 and b) 30. On it, out of 54 contestants nobody got more than 4 points out of 7, although, being a P2, many people thought about it:

- **ONM 2013, grade 12, P2**. Let $(A, +, \cdot)$ be a ring which simultaneously satisfies the following two conditions: (1) A is not a field, (2) for every non-invertible element x of A, there exists an integer $m \geq 1$, depending on x, such that

$$x = x^2 + x^3 + \cdots + x^{2^m}.$$

  Show that: (a) $x + x = 0$ for every $x \in A$, (b) $x^2 = x$ for every non-invertible element $x \in A$.

Current distribution of ratings by round (number of problems).

Round	0	5	10	15	20	25	30	35	40	45	50	Total
OJM	0	41	138	15	102	69	18	1	0	0	0	384
ONM	0	5	50	16	115	82	103	22	5	1	1	400
OLM	3	41	42	10	0	0	0	0	0	0	0	96
OLM Brașov	11	87	55	7	0	0	0	0	0	0	0	160

The tables with all the problems

The tables below contain all 1040 rated problems: 784 from OJM and ONM, one table per grade, and 256 from OLM (96 from Bucharest and 160 from Brașov), in two separate tables at the end. Each cell shows the ROHS rating (0 to 50), the letter of the topic, **an asterisk** if the simplest solution uses material from higher grades (for example a grade 10 problem solved simply with derivatives). The colour is the more intense the harder the problem is. If a problem has separate ratings for its parts, they appear in the order a, b, c, and the colour follows the largest one.

Topics: A algebra, G geometry, C combinatorics, T number theory, L analysis, S algebraic structures (groups, rings, fields, matrices). **Gaps:** 2000 (no source), 2020 (contest not held), OJM 2021 (ONGM, different format). For OLM, the years with published high school papers are covered: Bucharest (2007, 2008, 2011, 2012, 2020, 2024) and Brașov (2010, 2013, 2014, 2016 to 2019, 2023, 2025, 2026); 2009, 2015, 2021 and 2022 are missing.

easy **0** **5** **10** **15** **20** **25** **30** **35** **40** **45** **50** hard

cell with ratings per part: **5/15*** A asterisk: material from higher grades at OJM and ONM, the rating is a link to the discussion of the problem on AoPS (there are no AoPS discussions for OLM)

empty cell: · unrated problem

Grade 9

Year	OJM				ONM			
	P1	P2	P3	P4	P1	P2	P3	P4
2001	5/10 A	5* G	15 A	20/5/5* A	15 A	15 G	25 G	20 T
2002	10 A	10/5 G	5/20 G	5/20 A	5 A	10 G	15 T	20 A
2003	5 A	10 T	10 G	10/25 C	5 A	20/25 C	25 G	30 G
2004	5 A	5* G	10/10 T	20 C	15 T	20 A	30 G	5/10/30C
2005	0/5 A	10 G	10/10 G	20/5 C	20 G	20 A	20 T	30 A
2006	20 A	25 C	20 G	20 T	10 A	20 G	10/20 G	25 C
2007	5/10/5A	10/5 G	10 T	20/5 G	20 A	25 G	20 C	5/30 C
2008	10 A	10 C	10 T	25 G	20 A	10/10 A	20 A	25 G
2009	5 G	20 C	10/5 A	20 A	20 G	5 A	25 A	25 C
2010	5/10/10G	10 A	25 A	20 A	10/20 G	10 G	5/20 A	35 A
2011	5 G	10 C	10 A	20 A	20 A	25 T	30 G	25 T
2012	5 A	10 A	10/5 G	25 T	20 G	25 L	25 A	30 C
2013	0/5 A	10/10 G	20 A	10 C	10 T	30 A	20/30 G	25 T
2014	5 A	20 G	25 G	20 T	20 T	5/30 T	10 G	20 G
2015	10 G	10 A	10 T	25 T	25 T	25 A	35 G	35 A
2016	5 G	20 T	25 A	10 T	20 G	30 A	20/5 T	25 A
2017	10 G	25 G	5/10 T	25 A	20 G	10 G	10/25 T	10/25/30A
2018	10 A	10 G	10 G	20 L	30 G	25 A	35 A	35 C
2019	5/0 A	10 G	5/20 A	20 T	20 G	30 G	25 T	30 A
2021	*ONGM, excluded*				10 G	30 G	25 A	20 A
2022	10/5 A	5/20 A	5/10 T	5/30 G	20 T	20 G	25 A	30 A
2023	0/10 G	5/5 A	5/25 A	20 T	0/20 A	25 A	30 C	15/30 T
2024	5 G	5/10 A	20 T	25/10 G	10/20 G	20 T	30 A	30 A
2025	10 G	10 A	20 A	20 C	10 C	30 G	10/30 A	25/35 L
2026	5/20 A	10 G	10 T	25 T	20 A	30 A	35 T	40 G

Grade 10

Year	OJM				ONM			
	P1	P2	P3	P4	P1	P2	P3	P4
2001	15 A	10 A	15 G	25 A	15 A	20 G	20 C	30 A
2002	15 A	15 A	20 A	5/20 C	20 G	15 A	30 A	30 L
2003	10 C	10/20* A	15/10 G	25 A	10 G	15 A	25 G	20/30 A
2004	5 C	10 T	10 G	25 A	10 L	20 G	25 A	20/15 C
2005	10 A	10 A	30 G	20 C	25 A	30 G	10/20 T	10/15 T
2006	10 A	10 G	20/10 C	20/25 A	5 C	20 L	20 T	20 L
2007	10 A	0/5 C	20 G	25 A	10 A	5 A	10 T	5/30 C
2008	10 A	10 A	5/5 A	20 A	20 G	20 A	25 C	35 T
2009	5/0 A	10 A	5/20 A	5/20 A	5/20 A	20 A	30 A	35 C
2010	5/5 A	10 A	20 A	10/20 A	10 A	20 A	10/20 C	30 G
2011	10 A	10/20 A	25 A	10/20 A	20/10 A	20 A	20 L	5/30 T
2012	10/25 L	10/20 A	5/15 A	25 A	25 A	30 G	20/5 A	20 C
2013	10/5 A	10 A	10 L	20 A	10 A	25 A	15 A	40 T
2014	10 A	10 A	20 A	30 A	20 T	30 T	20 C	30 A
2015	20 A	10 A	25 A	20 A	10 A	10/20 C	15 A	30 C
2016	5 A	25 A	5/10 A	5/10 A	20 L	5/30 L	5/25 G	25 C
2017	5/10 T	20 A	5 A	5/5 A	10 A	20/20 A	10 A	25 C
2018	5 A	10 A	25 A	10 A	10 L	25 G	15 A	30 A
2019	10 A	10/20 A	10 G	30 A	10 A	25 C	35 A	30 C
2021	*ONGM, excluded*				20 A	10 A	20 C	30 A
2022	10 A	20 G	10 A	25 A	10 A	20 A	25 A	20 C
2023	10 A	5/10 G	25 A	25 A	20* L	30 L	30/30 G	35 C
2024	10 A	10/20 G	10 A	20 A	20* A	25 G	10/25 C	20/30 S
2025	10 A	10 A	20 A	10/30 G	10/25 G	30 C	25 A	35 A
2026	5/5 A	10 A	10 A	30 A	30 A	25 A	30 A	30 C

Grade 11

Year	OJM				ONM			
	P1	P2	P3	P4	P1	P2	P3	P4
2001	10 A	5/20 A	25 L	5/30 L	10 L	5/20 A	5/20 L	25/5 L
2002	5/15 L	0/20 G	5/20 A	25 L	10/10/5G	5/10 L	5/20 A	20 L
2003	15 A	10/20 L	5/10 A	10/25/30L	20 G	30 A	20 L	10/25 A
2004	5/10 L	5/20 A	5/20 L	5/10/25A	10 G	10/20 A	15/10 L	20/10/30L
2005	5/20 A	25 L	10/25 A	20/20 L	10/25 A	10/20 L	30 A	5/30 L
2006	10 A	10/20 A	10/5 L	10/10 L	20 A	10/20 A	25 G	20/30 L
2007	10 L	5/10 A	10/20 L	20 A	25 A	20 L	25 A	30 L
2008	10 A	20 A	5/20 L	30 L	20 L	35 A	15 L	25 A
2009	10 A	5 A	30 L	5/35 L	5/10 L	20 L	30/10 A	25 L
2010	5 L	10 A	20 L	25 L	10 A	10 A	20 L	25 L
2011	5/10 L	0/10 A	25 A	20 L	30 A	25 L	20 L	20/5 A
2012	10 L	5/25 A	5/10 A	5/25 L	10/20 L	20 A	25 A	30 L
2013	10 L	10/10 A	30/20 A	0/10 L	20 A	25 A	30 L	10/30 L
2014	5/10 A	5/10 L	5/5 A	20/25 L	25 L	20 L	25/10 A	40 A
2015	5/5 L	10/20 A	25 A	25 L	10 L	25* A	30 L	20 A
2016	10 A	25 A	20 L	30/20 L	10 A	10/20 A	10 L	30 L
2017	10/20 L	10/10 L	20/5 A	10 A	30 L	25 A	25 A	20 L
2018	20 A	20/30 A	25 L	20 L	30 A	30 L	25 L	25 A
2019	10 L	20 A	30 A	10/20 L	20 A	10 L	10/25 L	40 A
2021	*ONGM, excluded*				10 L	20 A	25 L	30 A
2022	10 L	20 A	10/10 L	25 A	5/20 L	20/25 A	30 L	20 A
2023	10 L	10/5 A	25 L	25/5 A	25 L	20 A	30/20 A	40 L
2024	10 A	20 L	5/20 A	10/30 L	30 L	5/25 A	10 A	25/30 L
2025	5 L	10/5 A	20/10 L	15 A	30 L	20 A	30 L	30/30 A
2026	5 A	10/25 L	20 A	25 L	20/20 L	20 A	30/10 L	35 A

Grade 12

Year	OJM				ONM			
	P1	P2	P3	P4	P1	P2	P3	P4
2001	5/15S	20S	10L	0/15L	0/20A	15S	15/30L	30/25L
2002	5/15S	5/10S	10/25L	5/25L	0/15S	25L	25L	10/30S
2003	5/5/10S	10/15L	5/25S	5L	5/10S	20L	5/20L	10/5/30S
2004	5/20A	20L	5/0/25S	10/20L	20L	0/20S	15L	10/20/5S
2005	20C	10/5L	10S	10/25S	10S	5/20S	20L	35S
2006	5L	10S	25S	10L	10S	20L	25S	30L
2007	5/5S	10L	10L	10/25S	10L	5/10L	20S	10S
2008	20L	5/10L	25S	5/30S	25L	20L	10/25S	30/30S
2009	0/10L	10S	25/10L	20S	10L	5/25S	25S	35L
2010	10S	10/20S	25L	10/20L	10L	25/10S	30S	10/20L
2011	5L	0/10S	5/10L	10/25S	20S	10L	25S	30L
2012	10L	20S	10S	20L	10L	20/10S	5/30L	30A
2013	5L	10/10/20S	5/10L	20/25S	20L	50/30S	25L	30S
2014	5L	25L	5/20S	30S	10/25S	25L	10/30L	30/35S
2015	0/10S	0/10L	10L	25S	10/25S	25S	35L	45A
2016	5/10S	10/5L	25S	5L	5/20L	20/30S	20L	25S
2017	10L	20S	20L	20/30S	5/10L	20/30A	30S	10/30L
2018	5/5L	20S	10L	25S	25S	10L	5/25L	30S
2019	5/5S	20L	10S	25L	30L	30S	5/35L	25/35A
2021	*ONGM, excluded*				10L	20S	20T	30L
2022	0/5/5S	10S	25L	20L	25/5L	30S	5/20L	30S
2023	20L	25S	5/10L	25/20S	10/30S	5/30S	30L	35L
2024	10S	0/5/10L	5/20S	25L	20L	25S	10L	10/30S
2025	5/5S	10/25S	5/20L	5/20L	20/5S	10L	20/30L	35S
2026	5/25L	0/20S	20/10/10S	15/10L	10L	30/10S	20S	30L

OLM Bucharest (local round, all grades)

Year	Grade 9				Grade 10			
	P1	P2	P3	P4	P1	P2	P3	P4
2007	5/5 A	5/0/5 G	5/10 C	15 T	0/10 A	0/5 A	10/15 G	10/15 C
2008	5/5 A	5/5 A	5 A	5 G	10 A	5/10 A	5/5 A	5/5/0 C
2011	5 T	10 A	5/10 G	10 C	5 G	10 A	0/10 A	10 A
2012	0/5 T	10 L	5/10 G	5 A	5 A	10 A	10 A	10/15 A
2020	5 T	0 A	5 T	5 G	5 A	5 A	10 L	10 L
2024	0/5 A	5 A	0/5 G	10 A	5/10 A	5 A	5 T	15 A

Year	Grade 11				Grade 12			
	P1	P2	P3	P4	P1	P2	P3	P4
2007	5/10 A	5/10 A	10/10 L	5/10/15 L	5/0 L	0/5/5 L	5/10 S	5/15 S
2008	5 A	5 L	5/5 L	5/10 L	0/5 S	0/5/10 S	0 L	10 L
2011	0/5/10 L	5/10/5 L	5 A	5/5/0 A	5 L	15 L	10 S	0/5/5 S
2012	5/0 L	5/10 A	0/10 L	15 A	5/10 L	0/5 S	5/10 S	5/15 L
2020	5/10 A	5 A	10 L	5/10 L	0 L	5 L	5/10 S	5/5 S
2024	5 A	0/10 A	5/5 L	10/5 L	5 L	5/10 S	0/10 L	10 S

OLM Brașov (local round, all grades)

Year	Grade 9				Grade 10			
	P1	P2	P3	P4	P1	P2	P3	P4
2010	10/5 A	10 G	0/5/10A	0/5 A	5/10 A	5/5/5A	5 A	10 T
2013	0/10 A	5 A	10 G	0 G	5 A	10 A	10 A	15 A
2014	10 T	5/10 A	5 A	0 A	0 A	5 A	5 A	10 L
2016	0 T	5 G	10 A	10 T	5 A	10 A	10/5 A	5 A
2017	0/5 A	5/5 A	5/5 T	0/10 G	0/5 A	5 G	0/5 A	5/10 A
2018	0/0 A	10 A	5 A	10 G	5 A	5/0/5A	5 A	10 A
2019	5 A	0/10 G	0/5 A	0/5 A	5 A	10 A	10 A	5 A
2023	5 T	10 G	5 A	5/10 A	0/5 A	5 A	0/5 A	0/5/10L
2025	0/5 A	0 A	5 G	5 G	5 A	10 A	10 A	5 A
2026	10 T	0/5 A	0 A	0 G	5/0 A	5 A	5 C	5/10 A

Year	Grade 11				Grade 12			
	P1	P2	P3	P4	P1	P2	P3	P4
2010	10 A	15 L	0/5 S	10 S	10 S	15/5 S	10 L	5 L
2013	10 C	5 S	5/5/10L	5/5 L	5 L	5 L	5/5 S	0/5 S
2014	5 S	10 A	5/10 L	10 L	5 S	10 L	5/10 L	5 S
2016	5/5 A	10 A	5/10 L	0/5 S	0/5 L	5 S	5/0 S	15 L
2017	5/5 A	0/5/10A	0/5 L	5/10/15L	5 L	5 S	5/10 L	5 S
2018	5 A	10 A	0 L	10 L	5 L	5 L	0 S	5 S
2019	5 A	5/5 A	10 L	5/5/15L	5 S	5 L	10 L	5/5 S
2023	5 A	5 A	10 L	5/5 L	5/5 S	5 L	0/5 S	0/5 L
2025	5/5 A	10/5 L	5/5 A	0/10 L	0/5 S	5 S	5 L	10 L
2026	10 A	5 A	0 L	5/0/15* L	0/0/5S	0/5 S	0/5 L	0/5 L