Problems for the 1st International Young Physicists' Tournament

Olympiets Youth Center, Moscow, Soviet Union; March 28–April 2, 1988 [1]

Critical edition: translated, restored, and commented text [2]

The sciences nourish young people,
Give consolation to the old,
They decorate a happy life,
And they protect one in misfortune...

M. V. Lomonosov [3]

1. Invent yourself [4]

Suggest original projects of technical and scientific use of high-temperature superconductivity.

2. "Eternal radio"

Develop and construct a portable radio receiver that does not use power supplies. The usability parameter is $x=P/Lm$, where P is acoustic pressure at a distance of 1 m from the receiver, L is maximum linear dimension, and m is mass of the receiver.

3. Camera obscura

Make a group portrait of your team with a camera obscura. Validate the physical principles of achieving a good quality photograph with such a device.

4. Electric circuit

Several knots ($n \leq 10$) [5] are interconnected with batteries of known EMF and r. Create a computer program to calculate the potential difference between the first and the second knot. Consider the time from the start of data input (tables of EMF and r values) to the moment of the correct result output, as the quality criterion of the program.

5. Metrology

Determine the maximum precision of length measurement with a steel ruler.

6. Seller of vacuum

An enterprising star farer decided to supply physical laboratories worldwide with vacuum from cosmic space. What are the venture's chances of being successful?

7. Sunset

The visible Sun disk is flattened at sunset. Measure these distortions experimentally and describe them. Calculate the theoretical ratio of horizontal and vertical dimensions of the Sun disk that is touching the horizon.

8. Color television

You have to construct a four-color television receiver. What colors would you choose as basic? Is it then necessary to modify the image capture equipment?

9. Ninth wave

“Before me are the waves of the sea.
There are so many. They are countless.”
B. Pasternak [6]

Does the “Ninth wave” phenomenon exist? Clarify this question. As a starting point, you can use the ideas from the article “*Troika, semyorka, tuz...*” (*Znanie — sila*, 1987, No. 1, pp. 97—104.) [7]

10. Self-ignition

“Yet also when a many-branched tree,
Beaten by winds, writhes swaying to and fro,
Pressing ’gainst branches of a neighbour tree,
There by the power of mighty rub and rub
Is fire engendered; and at times out-flares
The scorching heat of flame, when boughs do chafe
Against the trunks.”
Lucretius Carus [8]

Thus the Roman philosopher has explained the origin of forest fires. Estimate the probability of such an ignition and its role among the factors that cause fires in nature, i.e. not caused by a human activity.

11. Incandescent lamp

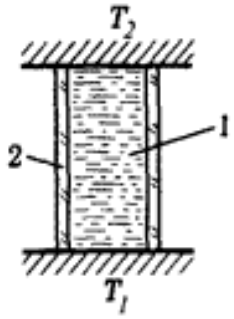
It is said that two 60 *W* light bulbs shine brighter than three 40 *W* bulbs. Is it true? Investigate how a small change in supplied voltage will affect light emission and a light bulb’s lifetime.

12. Spring in a city

Spring begins in a city earlier than in the countryside. Describe the main causes of this phenomenon and make numerical estimations. In particular, what would happen if one day all snow from Moscow is removed to the countryside?

13. Heat transfer

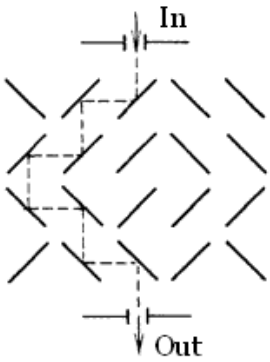
Research the heat transfer through the vertical water column in the two cases: $T_1<T_2$ and $T_1>T_2$.



"*1*" is a water column, "*2*" is a heat insulating tube.

14. Mesoscopics

One of the mesoscopic effects is a significant change of the resistance of a two-dimensional metal sample at low temperatures, if just a single atom within the crystal lattice is displaced. This effect can be visually illustrated if one considers the following model: small flat mirrors, with reflection coefficients equal to 1, are placed in the knots of a two-dimensional lattice $n \times n$, $n \gg 1$. [9] Each mirror can exist in two positions only; it can be inclined at 45° clockwise or counter-clockwise.



The states of the mirrors change chaotically, so the laser beam incident on a lattice knot reflects perpendicularly from the knot in both directions with the same probability. Estimate how the output light power will change if one of the knots is replaced by an absolute light-absorbing element.

15. Copper coin

A 1-kopeck coin "fell out" of a space rocket and became an artificial planet. Estimate its lifetime as of a planet of the Solar System. [10]

16. Trapped electrons

Several electrons ($2 \le n \le 30$) can freely move inside a circle of a radius R. What relative position of the electrons is stable?

17. Cagliostro's resistor

Even a human being is a resistor for a school tester. Investigate the laws of parallel and series circuits with a school tester. (Traditionally, the problem No. 17 has a humorous tone.)

Notes

[1] These dates are announced in a booklet [MGU 1988] distributed among participants of the event, and are independently corroborated by participant Yury Yufryakov [Yufryakov 2008] who dated confidently the Tournament to “late March – early April, 1988”

[2] The primary “standard” source is the Russian text of the *Problems for the Correspondence Collective Competition of YPT-X* (*Задания заочного коллективного конкурса ТЮФ-X*) published in *Kvant* magazine in August 1987, but submitted for the publication before June 17, 1987 [Kvant 1987].

This edition does not include possible *Problems for Finalists*, *Problems for Captains*, or *Problems for Observers*, that might have been proposed at certain stages of the 1st IYPT for rapid, immediate solution. There is currently little to no information about such problems at the 1st IYPT, while their existence is plausible.

There were doubts whether the real problems discussed at the 1st IYPT, or at the specific stages of the *all-Soviet and International YPTs*, were identical to the problems of the *Correspondence Rounds* (it was not so in 1989.) However, participants at the final stages of the competition provide solid evidence that this very problem set was discussed at the event [Yufryakov 2008], [Mesyats 2009], [Nosov 2009], [Bachev Piperov 2010]. An almost identical set of problems was included into a booklet published in early 1988 [MGU 1988]. Various selective stages were reported to restrict the number of problems to be discussed [MGU 1988], and it may be suspected that further, completely new, problems were offered at certain stages, such as at Captains’ contests.

The problems were originally written in Russian language, the only working language at all stages and all events of 1988. Most probably, no English translation was prepared by the Organizing Committee in Moscow in 1988, and it is notable that no contemporaneous Czech translation for the 1st IYPT is known, while the problems for the 2nd IYPT were already translated into Czech.

The known late Slovak version published in 1996 [TMF 1996] is titled the direct translation of the 1987 *Kvant* publication, providing a direct reference to that source. Some minor deviations of the Slovak translation from the *Kvant* text exist:

No. 2: “source of energy" (zdroj energie), not “power supply” (источник питания)
No. 4: “*<10*”, not “*n<10”*
No. 4: “inner resistance” explicitly (vnútorný odpor), not just “*r*”
No. 4: “between [any] two knots" (medzi dvoma uzlami), not “between the first and the second knot” (между первым и вторым узлами)
No. 4: “time in which the result is obtained” (čas, za ktorý dostaneme výsledok), not “time from the start of data input (tables of EMF and *r* values) to the moment of correct result output” (время от начала ввода данных в компьютер (таблицы значений ЭДС и *r*) до момента выдачи правильного результата)
No. 5: “table ruler” (stolný metr) not “steel ruler” (стальная линейка)
No. 9: the phrase with a journal reference is omitted
No. 14: condition on the number of knots is omitted
No. 17: “Resistors” (odpory), not “Cagliostro’s resistor” (резистор Калиостро)
No. 17: “ohmmeter” (ohmmeter), not “school tester” (школьный тестер)
No. 17: the phrase on the “humorous tone” is omitted

The set of 17 problems in Czech language titled *Problems for International Young Physicists’ Tournament. 1. Russia — Moscow — 1988* (*Úlohy mezinádodního turnaje mladých fyziků. 1. Rusko — Moskva — 1988*) was published by Zdeněk Kluiber in review book *Turnaj Mladých Fyziků* in 1996 [Kluiber 1996]. This Czech version misses illustrations for problems No. 13 and No. 14, and replaces “Mesoscopics” with “Electron microscopy” in the problem No. 14. Given the available factual nuances, this version is most probably translated from the *Kvant* text, and not from the text in the 1988 booklet. Some minor deviations of the Czech text from the Russian versions exist:

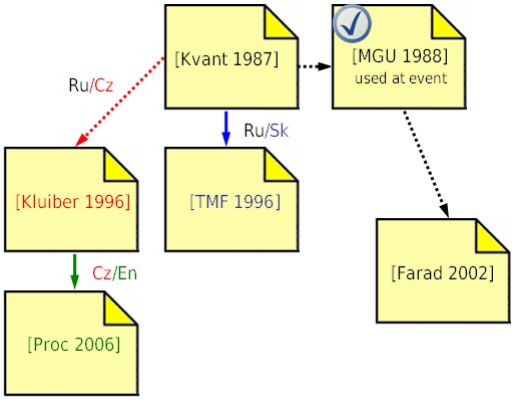
No. 4: “n_i10”, not “*n<10”* or “$n \le 10$”, which is seemingly a misprint
No. 4: “electrical resistance” (elekrický odpor) explicitly, not just “*r*”
No. 4: “between the first and the last knot" (mezi prvním a posledním uzlem), not “between the first and the second knot” (между первым и вторым узлами)
No. 4: it is proposed to use as a starting point the moment when computer begins to read the data, not when the user begins to input them: “time from the start of data reading (tables of *EMF* and *r* values) to the moment of correct result output” (doba od začátku čtení vstupní informace do počítače (tabulky hodnot *EMS* a *r*) do okamžiku výstupu správného výsledku) , not “time from the start of data input (tables of EMF and *r* values) to the moment of correct result output” (время от начала ввода данных в компьютер (таблицы значений ЭДС и *r*) до момента выдачи правильного результата)
No. 6: “astronaut” (astronaut), not “star farer” (звездоплаватель)
No. 13: no figure and no legend (“1” is water column, “2” is heat-insulating tube) are reproduced, but an additional phrase “For the experiment use a heat isolated cylindrical vessel” (K pokusu použijte tepelně izolovanou válcovou nádobu) is added
No. 14: “Mesoscopics” is replaced with “Electron microscopy”, no figure is reproduced, and the condition on the number of knots is $n \gg 10$, as in *Kvant*. The problem reads: One of the effects of electron microscopy is the significant change of the resistance of a two-dimensional metal sample at low temperatures, if the position of just a single atom within crystal lattice is changed. This effect can be evidently illustrated if one considers the following model: small flat mirrors, with reflection coefficients equal to one, are placed in the knots of a two-dimensional lattice $n \times n$, ($n \gg 10$). Each mirror can exist in two positions only; it can be tilted 45˚ either to the left, either to the right. Mirrors' states change chaotically so laser beam incident on the lattice knot can be reflected with equal probability to one or another side at 90°. Estimate how output light power will change if one of the knots is replaced by an absolute light-absorbing element.”
No. 16: “$2<a<30$”, not “$2 \le n \le 30$”

No. 17: "Resistor" (rezistor), not "Cagliostro's resistor" (резистор Калиостро)

An English version was published in 2006 by Silvina Simeonova in the *Proceedings of the 16th IYPT* on the basis of the text provided to the publishers by Zdeněk Kluiber [Proceedings 2006]. The year of translation and the source language are not reported. This version, however, is almost certainly translated *not* from the original Russian, but from the 1996 Czech text, as *all* discrepancies between the Czech and the Russian versions are reflected in the 2006 English text. Some notable similarities and differences among the 2006 English translation, the 1996 Czech text and the original Russian text include:

No. 4: "electrical resistance" explicitly, not just "*r*" as in the *Kvant* text
No. 4: "$n_i 10$", as in the 1996 Czech text
No. 4: it is proposed to use as a starting point the moment when computer begins to read the data, not when the user begins to input them: "time of the beginning of the reading of the input information in the computer (the tables with the value of emf and *r*) to the moment of the outcome of the correct result", not "time from the start of data input (tables of EMF and *r* values) to the moment of correct result output" (время от начала ввода данных в компьютер (таблицы значений ЭДС и *r*) до момента выдачи правильного результата), as in the 1996 Czech text
No. 6: "astronaut", not "starfarer" (звездоплаватель), as in the 1996 Czech text
No. 8: "scanning apparatuses", not "image capture equipment" (съёмочная аппаратура, snímací aparatura)
No. 10: "winter" instead of "wind" in the literal translation of Lucretius Carus' epigraph
No. 10: "reliability of inflammation", not "probability of such an ignition" (вероятность такого возгорания, věrohodnost takovéhoto vznícení)
No. 13: no figure and no legend ("1" is water column, "2" is heat-insulating tube) are reproduced. An additional phrase is added, "For the experiment use a heat isolated vessel", not "heat isolated cylindrical vessel" (tepelně izolovaná válcová nádoba) as the Czech text reads
No. 14: "Mesoscopics" is replaced with "Electron-microscopy", no figure is reproduced, condition on the number of knots is omitted. The problem reads: "One of the effects of the electron-microscopy consists in that the resistance of a two-dimensional metal samples can be significantly altered at low temperatures, if the position only of one atom from the lattice is changed. Visual imagine for this effect can be obtained by the observation of the following model: in the lattice points of a two-dimensional lattice is put a small mirror with the index of reflection is equal to one. The position of the mirror is chaotically changed and that's why the laser beam which strikes the lattice point with equal probability can be reflected to one or other side at 90° degree. Estimate how the intensity of light will be changed at the outlet of the system if to one lattice point instead a mirror is put an element which entirely absorbs the light."
No. 16: "$2<a<30$", as in the 1996 Czech text, not "$2\leq n\leq 30$" as it reads in *Kvant*
No. 16: "inside a ring with a radius *R*", not "inside a circle of a radius *R*" (внутри круга радиуса *R*, uvnitř kruhu o poloměru *R*)
No. 17: "Resistors", not "Cagliostro's resistor" (резистор Калиостро)

So called *Problems for the 1st IYPT* appeared in 2002 on Evgeny Yunosov's *Faraday Tournament* website [Farad 2002]. A single but significant detail (a shortened wording in the problem No. 17) indicates that this late OCR edition relied on a text identical to [MGU 1988], and not [Kvant 1987]. All illustrations are omitted therein, and there are a few marked OCR-related misprints.



The history of text transmission: colors indicate the languages of the sources (black for the Russian, red for the Czech, blue for the Slovak, green for the English); dotted lines indicate that *notable* factual inaccuracies were introduced with translation or copying; the tick indicates the version taken as "standard" for the current edition

[3] The epigraph is placed before the entire 1987 article [Kvant 1987], not directly before the problems. The booklet [MGU 1988] places the epigraph just before the list of problems. Later sources omit the epigraph. Used here is the translation from the Russian by Sibelan Forrester (*Ode: On the Day of the ascension to the throne of all Russia of her majesty the sovereign empress Elisaveta Petrovna, in the year 1747*, http://www.swarthmore.edu/Humanities/sforres1/translations/Lom.html#ODE2). Original version: *«Науки юношей питают, отраду старым подают, в счастливой жизни украшают, в несчастной — случай берегут…»* («На день восшествия на всероссийский престол ее величества государыни императрицы Елисаветы Петровны 1747 года». Отд. изд. СПб., 1747)

[4] The Russian traditional title «Придумай сам» has been internationally translated as “Think up a problem yourself” at the 6th IYPT, the 7th IYPT, and the 8th IYPT, but later most commonly as “Invent yourself” (at the 9th IYPT, the 10th IYPT, and the 11th IYPT.) “Invent yourself” is also used in the Soviet OC’s translation for the 4th IYPT. Other versions are: “Invent for yourself” (13th IYPT), “Your invention” (Soviet OC’s translation for the 3rd IYPT), “Think for yourselves” (Soviet OC’s translation of the *Kvant* text for 1989), “Invent it yourself” (1992 translations for the 5th IYPT)

[5] It was stated “$n \leq 10$” in [MGU 1988], but “$n < 10$” in [Kvant 1987]. In the temporary 2002 publication of the problems on the Evgeny Yunosov's *Faraday Tournament* website [Farad 2002], it was stated “$n > 10$”. Both 1996 Czech and 2006 English versions read here “$n_j 10$”, while the 1996 Slovak translation does not introduce the n variable at all (“< 10”.) It may be speculated that a handwritten formula in a book published shortly before the event, and most commonly used by the participants and jurors at the competition, is somewhat more *authentic*

[6] Translated from the Russian by Anesa Miller-Pogacar (Mikhail N. Epstein. *After the Future: The Paradoxes of Postmodernism and Contemporary Russian Culture.* Translated by Anesa Miller-Pogacar. Amherst: The University of Massachusetts Press, 1995, p. 23.) Original version: *«Передо мною волны моря. Их много. Им немыслим счёт.»* («Волны», 1931 // Борис Пастернак. *Второе рождение: стихи.* — М.: «Федерация», 1932)

[7] There are actually two articles concerning the Ninth Wave phenomenon in the January 1987 issue of Soviet popular science journal *Znanie — sila*. They are “*Troika, semyorka, tuz...*” («Тройка, семёрка, туз...», *Three, Seven, Ace...*) by G. Rozenberg (pp. 97—102) and *“Opyat troika...”* («Опять тройка ...», *Three again...*) by S. Meien (pp. 102—103, *sic!*) which is a critical response to the G. Rozenberg’s communication. The page numbers are not corrected here for historical authenticity

[8] Translated from the Latin (*De rerum natura*) by William Ellery Leonard (*Of the Nature of Things*. E. P. Dutton & Co., Inc., New York, 1921, p. 180.) The Russian text quotes the translation by F. A. Petrovsky (Лукреций, Тит Кар. *О природе вещей*; Пер. с латин. Ф. А. Петровского. — М.: Худож. лит., 1983)

[9] It was stated “$n \gg 1$” in [MGU 1988], but “$n \gg 10$” in [Kvant 1987] and in [Farad 2002]. The 1996 Czech versions read here “$n \gg 10$”, while the Slovak and the 2006 English texts fully omit this detail. It may be speculated that a handwritten formula in a book published shortly before the event, and most commonly used by the participants and jurors at the competition, is somewhat more *authentic*

[10] The problem appears shortened in [MGU 1988] and is reprinted in this shortened form in [Farad 2002], not mentioning explicitly the interaction with sunlight. The earlier *Kvant* edition is, “1-kopeck coin “fell out” of a space rocket and became an artificial planet of the Solar System. Estimate its lifetime as a planet, taking into account its interaction with sunlight.” A particular ambiguity in the word “planet” («планета»), while a coin is not a large massive body necessarily revolving around the Sun, is clearly intended to mean how long the coin will remain in orbit around the Sun.

Sources

[Kvant 1987] Т. П. Корнеева, Е. Н. Юносов, И. В. Яминский. *X Турнир юных физиков* // Квант, №8, 1987. — стр. 59—60

[MGU 1988] Турнир юных физиков: правила и задания X Московского, Всесоюзного и Международного турниров юных физиков. — М.: МГУ, 1988. — стр. 2, 7—12

[Farad 2002] Evgeny Yunosov's *Faraday Tournament* official website (http://www.farad.ru, in Russian, retrieved in 2002)

[TMF 1996] *I. medzinádodný TMF (1987 — 1988)* // Juraj Braciník, Jozef Brestenský, Miroslav Helbich, Karol Macák. Turnaj mladých fyzikov : štatút a úlohy. Iuventa, Bratislava (1996), s. 24—26

[Yufryakov 2008] Private communication with Yury Yufryakov, Soviet participant in 1988

[Mesyats 2009] Private communication with Svetlana Mesyats, Soviet participant in 1988

[Nosov 2009] Private communication with Igor Nosov, Soviet participant in 1988

[Bachev Piperov 2010] Private communication with Rumen Bachev and Stefan Piperov, Bulgarian participants in 1988

[Kluiber 1996] *Úlohy mezinádodního turnaje mladých fyziků. 1. Rusko — Moskva — 1988* // Zdeněk Kluiber. Turnaj Mladých Fyziků. Informace o nádodní i mezinádodní soutěži studentů výrazně talentovaných pro fyziku. Gaudeamus-MAFI, Hradec Králové, 1996, s. 21—22

[Proceedings 2006] *Problems for the 1st IYPT*. In: Proceedings of the 19th IYPT 2006 (eds Silvina Simeonova, Myeung Hoi Kwon, Zvezdi, Sofia 2007), pp. 231–232

Translated, edited, and commented by Ilya Martchenko. Originally translated from the Russian and released in October 2007, revisions made until May 2011. This edition would never have been prepared without the evidence provided by Yury Yufryakov, Svetlana Mesyats, Igor Nosov, Rumen Bachev, and Stefan Piperov, on the problem set discussed at the 1st IYPT, without assistance in retrieving sources by numerous volunteers, and without final proofreading and valuable suggestions made by Matej Ftáčnik, Tymofii Nikolaienko, Timotheus Hell, and Dahl Winters.

Authors of the IYPT problems were often reported in late 1980s and early 1990s. While no known source names the authors for 1988, Evgeny Yunosov, Tatyana Korneeva and Igor Yaminsky, who authored the 1987 *Kvant* text, are most certainly among them.

Everyone who may shed more light on the early IYPTs is kindly invited to contribute.