

# Problems for the 5th International Young Physicists' Tournament

Protvino, Russia, June 24–July 1, 1992 <sup>[1]</sup>

*Critical edition*: corrected and commented *official translation* <sup>[2]</sup>

FINAL DRAFT. — Please do not re-publish. Suggestions and criticism welcome

## 1. Invent it yourself <sup>[3]</sup>

“Magnetic suspension” may be used in high speed trains of the future. Design and make an experimental <sup>[4]</sup> model of such a suspension.

## 2. Unicycle <sup>[5]</sup>

Circus actors often perform riding tricks <sup>[6]</sup> on unicycles. There may be a range of wheel sizes. What is the largest possible diameter of the wheel?

## 3. The dam <sup>[7]</sup>

There is a saying in Russian, <sup>[8]</sup> “money goes like water through sand.” However, sand dams hold water. What should be the thickness <sup>[9]</sup> of the dam in order to retain water whose level <sup>[10]</sup> behind the dam is 10 m?

## 4. Swing

A special swing (trapeze) is used to train air and space pilots. <sup>[11]</sup> This device is able to make a loop around the horizontal axis. <sup>[12]</sup> What minimum time is necessary to build up the motion of the swing from the rest at the equilibrium position, to an amplitude of 180°? <sup>[13]</sup>

## 5. High jumper <sup>[14]</sup>

There is a saying in Russian, <sup>[15]</sup> “one cannot jump over his own head.” But many high jumpers do this easily. Estimate the maximum height a man will be able to get over in high jumps and in pole vaulting, in the year 2000? <sup>[16]</sup>

## 6. Matches <sup>[17]</sup>

What is the minimum necessary mass <sup>[18]</sup> of “sulfur” in the head of a match to make it blaze up?

## 7. Steel rod

A steel rod 8 mm in diameter is bent at an angle of 90°. What is the position and value of the maximum local temperature rise? <sup>[19]</sup>

## 8. Boiling

A tall cylindrical vessel is partly filled with water and is put with its open end into a wide-mouthed vessel which is also filled with water. If we get the water to the boiling point and then cool it down, the level of the water in the cylinder will change. Study experimentally the

correlation between the height of the water column in the cylinder and the temperature, under repeated heating and cooling. <sup>[20]</sup> Explain the phenomena observed.

## 9. Fountain

There is a fountain called *Samson* in Peterhof. Water spurts out of it to a height of more than 20 meters. Suggest how to construct a fountain *YPTon* <sup>[21]</sup> which could provide the maximum height of the spurt at a given power of the pump. What is the height if the power of the pump is 1 kW? <sup>[22]</sup>

## 10. Fuse

A thin brass wire can be used as a fuse. Find the correlation between the critical current and the wire diameter. <sup>[23]</sup>

## 11. Hopfield model

Develop the algorithms for storing images in computer memory and for distinguishing them. <sup>[24]</sup>

## 12. Butterflies

Butterflies find each other by smell. Estimate the “transmitter” strength and the “receiver” sensitivity <sup>[25]</sup> of butterflies.

## 13. Topsy-turvy world

Some medical publications state that 0–2 months old babies see the objects <sup>[26]</sup> around them up side down. Give your arguments “for or against.”

## 14. Laser

A laser beam is directed <sup>[27]</sup> perpendicularly to the wall of a transparent glass tank <sup>[28]</sup> filled with water. If the beam passes through the tank above or below the level of the water in the tank, we can observe a spot on the screen behind the tank. If the beam passes along the level of the water we observe a vertical line. Explain the origin of the line and calculate its parameters.

## 15. Incandescent lamp

Estimate the amplitude of temperature variations of the spiral filament of a light bulb powered by alternating current. <sup>[29]</sup>

## 16. The depth of field

Find experimentally the dependence of the depth of field of a camera on the aperture diameter of the objective. Give the theoretical explanation of the dependence obtained. <sup>[30]</sup>

<sup>[31]</sup>

## 17. Rain bubbles <sup>[32]</sup>

Some people suppose that if there are bubbles on the surfaces of water pools during the rain, the rain will be long, but others think they are a sign of the close end of the rain. <sup>[33]</sup> Who is right?

## Notes

[1] Dates are confirmed in [Markovich 1992] and in Ivan Štoll's report preceding [RMF 1992], both published shortly after the event

[2] The problems for all Rounds of the 5th IYPT were originally prepared and distributed to most participants in Russian language, the primary working language at the entire event (non-Russian speaking teams were assisted by interpreters.) This original Russian version has been acquired and preserved by Belarusian participant Sergei Katsev, who found and shared in September 2009 the document printed with a dot matrix printer [Katsev 1992].

An English translation, plausibly performed by the Organizing Committee in Protvino, has been typeset and printed before the event, and seemingly provided to the non-Russian speaking teams, such as the Dutch team. An original copy of this text has been preserved by Russian LOC volunteer Grigory Kopelevich and found in December 2010 [Kopelevich 1992]. The translation is quite close to the Russian text and includes cartoon-style illustrations, but has some factual discrepancies, e.g. in problems Nos. 4, 7, 9, 15, 16.

A version titled *Problems for the 5<sup>th</sup> international YPT*, signed by participant Jan Tichý, was published in *Rozhledy mat.-fyz.* in the issue dating to June–July 1992 [RMF 1992]. The publication was, however, made after the event, as the problems were placed after the Czech-language article by Ivan Štoll *Great success of Czechoslovak team at the 5th International Young Physicists' Tournament (Velký úspěch československého družstva na 5. mezinárodní Turnaji mladých fyziků)* reporting the results of the 5th IYPT. No details are reported, but the RMF version appears a copy of [Kopelevich 1992] with multiple editorial corrections, not necessarily aimed at approaching the Russian text.

An English translation is known to have circulated even among Russian-speaking participants, as the interpretation was undergone even at the Finals in 1992 [Morozov 2008], [Markovich 1992].

The list of 17 problems for *Correspondence Collective Competition of the 5th International Young Physicists' Tournament* (Завочны Калектыўны Конкурс V Міжнароднага Турніру Юных Фізікаў) was included into a detailed article by Leonid Markovich published shortly after the competition in *Nastaŭnickaja Hazieta* (Belarus) on October 28, 1992 in Belarusian language [Markovich 1992]. The Belarusian text appears an authentic and extremely accurate translation of the Russian source text, while Russian is linguistically very close to Belarusian.

The Slovak version [TMF 1996] claims to rely on the text published in RMF, but has a considerably different problem sequence from Jan Tichý's publication. It appears unlikely that a different translation was published in RMF and included e.g. provisional problems. In comparison to the 1992 English, Russian and Belarusian texts, the Slovak text has an entirely different problem No. 3 and an additional 18th problem, placed between No. 16 and No. 17 of the respective 1992 English, Russian and Belarusian problems.

The Russian and the Slovak language versions have mutual discrepancies in word order, in details and in style that are more important than between largely literal Russian-Slovak translations of 1988, 1989, and 1990. This may cause additional uncertainty in identifying the source document for the Slovak translation. The 1996 Czech version is quite distant from both of them in terms of details, style, and terminology. The Slovak text may not be considered a literal translation from the 1996 Czech text, or vice versa.

The list of 17 problems in Czech language titled *Problems for International Young Physicists' Tournament. 5. Russia — Protvino — 1992 (Úlohy mezinárodního turnaje mladých fyziků. 5. Rusko — Protvino — 1992)* was published by Zdeněk Klüber in review book *Turnaj Mladých Fyziků* in 1996 [Klüber 1996]. This Czech version, in comparison to 1992 English, Russian, Belarusian, and Slovak texts, has an entirely different problem No. 6 and factual discrepancies in the problems Nos. 3, 9, 12, 17.

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 Klüber [Proceedings 2006]. The source language and the year of translation are not reported. This version, however, may be considered translated from the 1996 Czech text as the problem No. 6 matches the Czech version, Zdeněk Klüber is directly acknowledged by Silvina Simeonova as the source, and many linguistic nuances are similar in both versions.

The Hungarian version [Rajkovits 2003], in comparison to all other texts, includes 24 problems, enumerated as 1; 2.1; 2.2; 3.1; 3.2; 4; 5; 6.1; 6.2; 7; 8; 9; 10; 11; 12; 13; 14; 15.1; 15.2; 15.3; 16.1; 16.2; 17.1; 17.2. Many of them repeat the problems from the earlier IYPTs.

Nothing on the 5th IYPT has been published in the *Kvant* magazine and on the Evgeny Yunosov's *Faraday Tournament* website (2002.)

It was a matter of concern of what problem set was discussed at the real stages of the 5th IYPT. Similar discrepancies among versions were the case e.g. in 1989. Four different sets could have possibly matched the ultimate problems discussed in June 1992:

- set of 17 problems as they appear in Russian, Belarusian, and the two 1992 English texts
- set of 17 problems as they appear in 1996 Czech and 2006 English texts
- set of 18 problems as they appear in the Slovak text

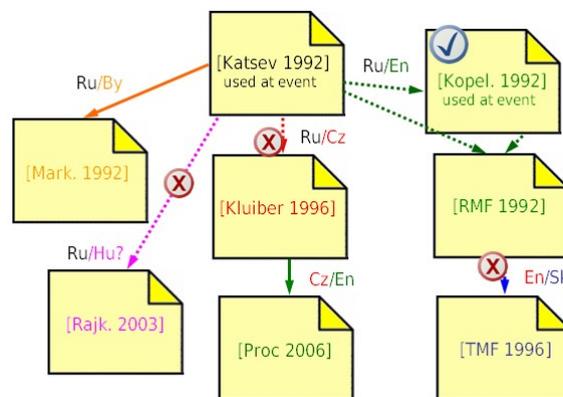
- set of 24 problems as they appear in the Hungarian text.

There is, however, direct and conclusive evidence [Katsev 2009], [Markovich 2009] that the problems discussed during the 5th IYPT matched the Russian text and both 1992 English translations, with the problem No. 3 “Dam” and with the problem No. 6 “Matches”. There is additional evidence [Morozov 2008] that during the tournament between post-Soviet teams held at the *Lesnye Polyany* resort facility (outside Moscow, Russia) the problem No. 3 was “Dam”, reported then in the Finals by the team of Odessa.

The 17 problems in the list (not 18, not 24) has always been a *de facto* standard for IYPT and was unlikely to be questioned in 1992. It seems to be grounded to assume that additional problems presented in Slovak and Hungarian sources were not included in the “core list” of 17 problems and were either preliminary drafts, either proposed in reality as extra tasks (e.g., at Captains’ Contests.)

This edition does not include possible *Problems for Captains*, or *Problems for Observers*, that might have been proposed at certain stages of the 5th IYPT for rapid, immediate solution. There is currently little to no information about such problems at the 5th IYPT, while their existence is plausible. The challenge procedure across “standard” 17 problems is virtually confirmed [Markovich 1992].

The current document reproduces closely the “official” English translation available to the participants of the event. Although the English translation [Kopelevich 1992] might have been recognized by LOC as *official*, it is now felt appropriate to make minimum editorial changes to the text, due to the following reasons: a limited number of teams was using the English text before and during the 5th IYPT, serious corrections were freely done in publications like [RMF 1992], and the version thus had a limited *social* impact as of a “standard English edition”. The current edition, however, follows the [Kopelevich 1992] as closely as possible, with every minimum discrepancy from the Russian source and from other translations, being commented. An early draft, now retracted, of the translation has been performed in July 2008 from Belarusian and Slovak texts.



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, pink for the Hungarian, orange for the Belarusian); 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; the cross indicates that the amendments were *major* (a few or many problems replaced or misattributed)

[3] 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 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.) The version “Invent it yourself” is used in the known English versions of the problems for the 5th IYPT [RMF 1992], [Kopelevich 1992]

[4] Just “model” in [RMF 1992], plausible misprint

[5] “Monocyles” in the known English versions of the problems for the 5th IYPT [RMF 1992], [Kopelevich 1992]

[6] Just “often perform riding one-wheel bicycles” in [RMF 1992]

[7] The Slovak text places here an entirely different problem No. 3 that reads:

### 3. Floating ball

A ping-pong ball floats up from a depth  $x$  in a vessel with water.

- Finally, the ball will jump out of water. What will be the altitude of the jump?
- Describe the process of ascending if the vessel rotates about a vertical axis

[8] Literally, “There is an expression, “money leaks out like water leaks through sand” in the 1992 Russian text

- [9] “How long has to be the barrier in order to retain the water with height 10 *m* above the surface”, according to the 2006 English version
- [10] “Depth” in [Kopelevich 1992], “level” in the 1992 Russian text
- [11] A special term *looping* («лопинг») is omitted in all translations. This term, a noun, is not colloquial in Russian language and describes a rotating swing driven solely by the person who uses it
- [12] “This device is able to make a loop around horizontal axis around which it swings”, according to [Kopelevich 1992]
- [13] The last part of the phrase, introducing the distance *L*, is in the Russian text, “for a person who is trained on the swing with a distance *L* between the axis of revolution and the deck?”
- [14] “High jumps”, according to the original Russian text
- [15] Just “a proverb”, according to the Russian and Belarusian versions, without mentioning the language
- [16] “In your opinion, what will be the World records”, in the 1992 Russian text. The [Kopelevich 1992] and [RMF 1992] English versions read, “Estimate the maximum height a man [men] will be able to get over in the year 2000 both with a pole and without one”, while the Russian text is not mentioning “men” or “women” and indirectly implies that both categories of the World records are to be predicted. Literally, “jumps without a pole and with one” in all translations
- [17] The 2006 English version places here an entirely different problem No. 6 that reads:

## 6. Flame

By what the height of flame depends on?

- [18] “Minimum amount”, according to [RMF 1992]. The Russian text reads literally, “With what minimum quantity of “sulfur” a match is still valid for igniting?”
- [19] “Specify the place and the temperature of the maximum warming”, according to the 2006 English version. Literally, “To what maximum temperature was the bent segment heated?” in the originally Russian text
- [20] “Find experimentally the correlation between the height of the water column in the cylinder and the temperature at repeated heating and cooling”, in [Kopelevich 1992]
- [21] A game of the words. *TYuFon* («Тюфон») rhimes nicely to Samson, the name of a real fountain in Peterhof. *TYuF* (ТЮФ), meantime, is the Russian abbreviation for *Young Physicists’ Tournament*. Similar games of the words are reproduced in Slovak and Belarusian translations, but omitted in the Hungarian, in the Czech and in the 2006 English versions. The city of Peterhof is not mentioned in the 2006 English version and is spelled *Petrodvorets* in the Slovak text; the Belarusian version calls the fountain “famous”
- [22] The Russian text implies that the power of the pump can be tuned. “Which could provide the maximum height of the spurt if the power of the pump is 1 *kW*”, not mentioning that the power is not fixed, in both 1992 English translations. In the 2006 English version, the problem reads, “Design construction of a fountain, which at a constant capacity gives a maximum height of the water jet. What will be the reached height to the power 1 *kW*?”
- [23] “A thin copper filament”, according to the 2006 English version; “dart”, according to the Belarusian text. The Russian and Belarusian texts are the most straightforward, just saying “Investigate the dependence of the current at which the dart burns out on the dart diameter”. [Kopelevich 1992] reads here, “Find the correlation between the current of the wire and its diameter”, not saying directly that the wire burns out
- [24] The original Russian text reads literally, “Develop the algorithms for inputting any images into computer memory and for recognizing them”, implying an OCR algorithm. “For distinguishing them”, according to the 1992 English texts. Wording varies slightly across versions.
- [25] With no quotation marks in both 1992 English versions
- [26] “The world around them”, in both 1992 English versions
- [27] “Directed horizontally”, in the Russian text
- [28] “Flat transparent cuvette with water”, not mentioning the material of the walls, in the Russian text. “Glass tank (aquarium)” in the 1992 English text.
- [29] “Determine the amplitude of temperature oscillations of the coil of an incandescent lamp connected to AC circuit”, literally in the Russian text. No AC circuit is mentioned in the 2006 English version where the problem reads: “*Electrical bulb*. Estimate the amplitude of the change of the temperature of the filament of the electrical bulb”
- [30] The [Kopelevich 1992] English version reads, “*The depth of focus*. Find experimentally the dependence of the depth of focus of a camera on its aperture diameter (or the stop number: 16, 8, etc). Give theoretical explanation of the dependence obtained.” The original Russian text reads literally, “*Depth of field*. Study the dependence of the depth of field for a photo camera on the aperture diameter of the objective”.

[31] The Slovak text places here an extra problem:

### 17. Superpreserves

Find a way of how to place cucumbers into a 3-liter-jar with a maximum density

[32] “Weather forecast” in the Russian and Belarusian versions, “Rain bubbles” in the Slovak and the 1992 English texts, “Figures” in the 2006 English version

[33] Wording varies across versions. The Russian text uses the word «лужа», standing for shallow rain puddles, not larger water pools. “On the surface of a puddle there are figures”, according to the 2006 English version, not mentioning the bubbles at all

## Sources

[RMF 1992] [Jan Tichý.] *Problems for the 5<sup>th</sup> international YPT*. *Rozhledy matematicko-fyzikální*, ročník 70, č. 3 (červenec-spreň 1992), 1992, s. 134—135

[Kopelevich 1992] *Problems for the V-th International YPT*, a four-page English text of the problems, provided by LOC to Russian volunteer Grigory Kopelevich in 1992

[Katsev 1992] A two-page Russian text of the problems, without title, printed with a dot matrix printer, provided by LOC to Belarusian participant Sergei Katsev in 1992

[Katsev 2009] Private communication with Sergei Katsev, Belarusian participant in 1992

[Markovich 1992] Л. Г. Маркович. *У фізбой гуляюць сапраўдныя мужчыны* // *Настаўніцкая газета*, 28 каст. 1992 г.

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[Proceedings 2006] *Problems for the 5th IYPT*. In: *Proceedings of the 19th IYPT 2006* (eds Silvina Simeonova, Myeung Hoi Kwon, Zvezdi, Sofia 2007), pp. 240–241

Edited and commented by Ilya Martchenko. Originally translated from Belarusian in July 2008, the authoritative English translations shared by Jaroslav Zhouf in October 2009, by Grigory Kopelevich in December 2010, revisions made until May 2011. This edition would never have been prepared without the early work in copying, translating, publishing and preserving problems, made in different years by Evgeny Yunosov, Ivan Štoll, Jan Tichý, Leonid Markovich, Sergei Katsev, Gena Koltun, Jozef Brestenský, Zsuzsanna Rajkovits, Jaroslav Zhouf, Martin Plesch and others, without cornerstone information from Sergei Katsev, Leonid Markovich and Alexander Morozov on the ultimate problem set at the 5th IYPT, without 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. The 1992 official English text names them: G. Kopelevits, D. Mamontov, M. Nikolaev, A. Olchack, E. Sokolov, S. Varlamov, I. Yaminsky, E. Yunosov.

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