

# Problems for the 6th International Young Physicists' Tournament

Protvino, Russia; June 18–25, 1993 <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. Think up a problem yourself <sup>[3]</sup>

Invent a problem in which an object is moving in some way and then changes its state of motion abruptly as a result of some influence. In this process interesting phenomena may arise which you must explain by, for example, making experiments and performing the necessary calculations. <sup>[4]</sup>

## 2–5. Gravitation

Imagine that the gravitational constant  $G$  decreases slowly from April 1, 1993 until May 1, 1994 by 10% and keeps this value afterwards. How would this process in the given time interval and up to the date of the *VI International YPT* opening affect the universe as a whole and, in particular,

2. the Sun;
3. the Earth;
4. aviation and astronautics; <sup>[5]</sup>
5. things important for you personally.

## 6. Gagarin's record

In April 1961 Yury Gagarin set a world record for the fastest round-the-world orbit space flight. Suggest the cheapest <sup>[6]</sup> way of beating this record. Note that not every record may be officially recognized.

## 7. Pressure and temperature

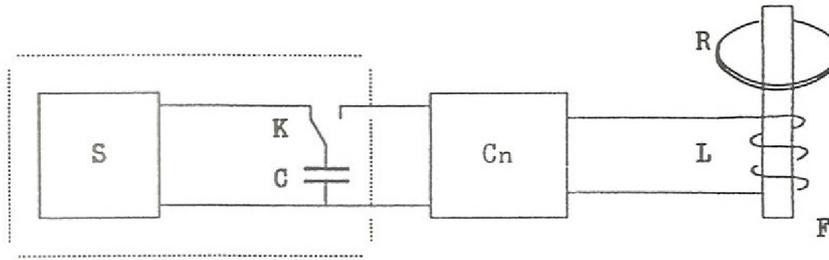
Explain why the pressure inside a house and outdoors are practically the same or become equal briefly, while the temperature may be substantially different. What is the characteristic equalizing time for pressures and temperature in- and outdoors? What is the answer to this question in the case of spacecraft?

## 8. Dominoes

Dominoes are placed vertically at a small distance from each other in a long row on a table surface. Make the first domino fall and the "wave of the falls" will proceed along the row. Calculate and measure experimentally the maximum speed of this wave.

## 9–10. Gun

The picture shows an electromagnetic gun circuit. It can launch metal rings. <sup>[7]</sup>



(S, C, K) is a power supply consisting of  
 S, a source of constant voltage in the range 10–300 V, <sup>[8]</sup>  
 C, a capacitor with  $C=1000 \mu F$ ,  
 K, a switch;

L is an induction coil;

F is a ferromagnetic core;

R is a metal ring projectile with mass from 1 to 100 g.

$C_n$  is a converter (some device that converts the energy passing from the capacitor to inductance  $L$  in a way you need.) This element does not contain energy sources. It may be completely absent from your gun.

You are to construct, make and demonstrate the electromagnetic gun. It is worth mentioning that the demonstration of your gun will take place with the power supply (elements S, C and K) presented by the Organizing Committee of the YPT. <sup>[9]</sup> Develop two variants of the gun: <sup>[9]</sup>

**9. A long-range gun** is to be constructed to shoot a ring to a maximum altitude. <sup>[10]</sup> The control parameter is the quantity  $H=kh/U^2$ , where  $k=10000 V^2$ , <sup>[11]</sup>  $h$  is the height of the projectile,  $U$  is the voltage to which the capacitor is charged.

**10. A gun-lift** is to be constructed to achieve the maximum work of lifting <sup>[12]</sup> a weight (ring). The control parameter is  $W=mgh$ , where  $m$  is the mass of the ring,  $g=10 m/s^2$ .

### 11. Recharge

You are given a capacitor  $C=1000 \mu F$  charged to 10 V and an uncharged capacitor  $C_x=1 \mu F$ . Using a self-constructed device containing no energy sources charge the capacitor  $C_x$  to the maximum possible voltage.

### 12. Transmission of energy

You are given a capacitor  $C=1000 \mu F$  charged to 300 V. Transmit without wires to a distance of 5 meters the largest possible proportion of the energy stored in the capacitor and measure it. Your device should be without energy sources.

### 13. Microwave oven

Why it is not recommended to cook eggs with unbroken shells in a microwave oven?

### 14. Boiling

A metal ball at room temperature is plunged into a thermos filled with liquid nitrogen. Describe the observed process of intense vaporization of nitrogen and find the time dependence of vaporization intensity  $q(t)$  [g/s]. We ask you to use balls from 2 to 4 cm in diameter. <sup>[13]</sup>

### 15. Fence

A picture of a moving bicycle wheel is strongly distorted by being observed through a fence. How much is the wheel distorted and why? <sup>[14]</sup>

## 16. Grand Unification

According to modern views Grand Unification is possible at energy of about  $10^{24}$  eV. <sup>[15]</sup>  
Estimate the parameters of an accelerator capable of producing particles of such energy.

## 17. Karate

Karate is power, speed, force and beauty! <sup>[16]</sup> Develop objective quantitative criteria making it possible to confer a “black belt” to a karate fighter. Maybe, you’ll become the inventor of a BB (black belt) device badly needed by referees or you’ll create a KM (karate meter) complex which is even more necessary for karate fighters for improving their skill.

## Notes

[1] Printed schedule, diplomas preserved by Wei Ji Ma together with the problems [Whee Ky Ma 1993]

[2] The problems for the 6th IYPT were most likely originally written and distributed to most participants in Russian language, the basic working language at the entire event (non-Russian speaking teams were assisted by interpreters [Morozov 2008], [Wei Ji Ma 2008].)

As of May 2011, this original Russian *archetype* text has not been yet found.

An English translation, titled *Problems for the VI International Young Physicists’ Tournament*, seems to have been first published in Czech journal *Rozhledy mat.-fyz.* in late 1992 [RMF 1992]. The source document and the author of translation are not reported, while the translation is made most expectedly from the Russian. This translation was provided at least to the team of the Netherlands [Whee Ky Ma 1993].

Texts those acquired and preserved by Wei Ji Ma and those published in *Rozhledy mat.-fyz.* are fully identical.

The known Slovak translation claims to rely on the text published in *Rozhledy mat.-fyz.* in 1992 [TMF 1996], providing a direct reference to that source.

The set of 17 problems in Czech language titled *Problems for International Young Physicists’ Tournament. 6. Russia — Protvino — 1993 (Úlohy mezinárodního turnaje mladých fyziků. 5. Rusko — Protvino — 1993)* was published by Zdeněk Kluíber in review book *Turnaj Mladých Fyziků* in 1996 [Kluíber 1996].

A three-page typeset Dutch translation [Jordens 1993] was presumably performed from either English either Russian texts, and was circulating within the Dutch community.

A fully different English version was published in 2006 by Silvina Simeonova in the *Proceedings of the 16th IYPT* on the basis of a text provided to the publishers by Zdeněk Kluíber [Proceedings 2006]. The year of translation and the source language are not reported. This version, however, is almost certainly translated from the 1996 Czech text because *all* notable distinctive details of the Czech text are reproduced in the 2006 English text, Zdeněk Kluíber is directly acknowledged by Silvina Simeonova as the source, and many linguistic nuances are similar in both versions.

The Hungarian version [Rajkovits 2003], of uncertain background, but plausibly translated from the Russian, remains available.

Nothing on the 6th IYPT has been published in the *Kvant* magazine and on the Evgeny Yunosov's *Faraday Tournament* website (2002.)

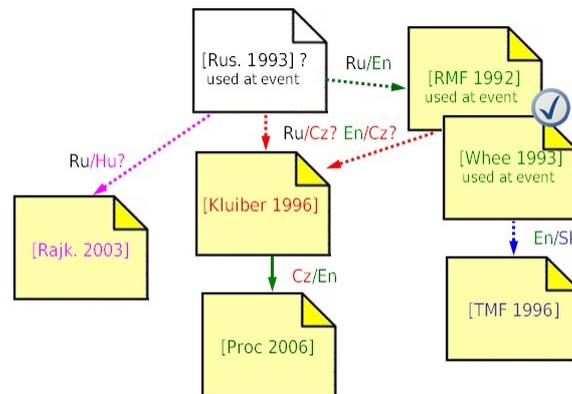
The current edition reproduces the contemporaneous English translation [RMF 1992], [Whee Ky Ma 1993] with the most notable discrepancies against Slovak [TMF 1996], Hungarian [Rajkovits 2003], 1996 Czech [Kluíber 1996], 2006 English [Proceedings 2006], and Dutch [Jordens 1993] translations being discussed.

Although the English translation might have been recognized by LOC as *official*, it is now felt appropriate to make a few minimum editorial changes to the text, for the following reason: a limited number of teams was using the English text before and during the 5th IYPT, and the version thus had a limited *social* impact as of a “standard English edition”. The current edition, however, follows the early English text as closely as possible, with every discrepancy against other translations being commented. An early draft, now retracted, of the translation has been performed in July 2008 mainly from the Slovak text.

This edition does not include possible *Problems for Captains*, or *Problems for Observers*, that might have been proposed at certain stages of the 6th IYPT for rapid, immediate solution. There is currently little to no information

about such problems at the 6th IYPT, while their existence is plausible. The challenge procedure across the “standard” 17 problems is virtually confirmed [Morozov 2008].

A deeper insight and possible corrections will be possible when the *archetype* Russian text is found.



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); 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 Russian traditional title «Придумай сам» has been internationally translated as “Think up a problem yourself” at 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” appeared also 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)

[4] The Hungarian version adds here a phrase “Formulate all additional details on your own”

[5] The original Russian text read most likely “*cosmonautics*” (космонавтика). The 1996 Czech text reads “*kosmonautika*”

[6] “Simplest”, according to the Slovak text

[7] The abbreviations used in the legend are identical in 1993 English, in Slovak, in 1996 Czech and in 2006 English versions. The figure is apparently re-drawn in the Slovak and the 2006 English texts. The abbreviations used in the legend are different in the Hungarian version. The 1993 English figure and characters are reproduced in this document

[8] “ $V$  is source of constant voltages of 10 V and 30 V, that you can switch between”, according to the Hungarian text

[9] These two sentences are missing in the Slovak text

[10] “To achieve the maximum height of the ring”, according to the 1993 English text

[11] “where  $k$  is the proportionality factor equal to 10000  $V^2$ ”, according to the Hungarian text. It should be noted that no comments on what is  $V$  is anywhere given

[12] “To perform maximum work when moving a projectile (a metal ring)”, according to the Slovak text

[13] In the Hungarian text, it is stressed to use buttons with the diameter of 2...4 cm “in the experiment”

[14] According to the 1993 English text, “How much and why?”

[15] “10 eV”, according the 1996 Czech and the 2006 English text, an evident misprint

[16] There is no introduction Karate is power, speed, force and beauty!” in the Slovak text. The Hungarian text reads: “The karate is talent, speed, strength and beauty!”

## Sources

[RMF 1992] *Problems for the VI International Young Physicists’ Tournament*. *Rozhledy matematicko-fyzikální, ročník 70, č. 5—6, 1992, s. 266—268*

[Whee Ky Ma 1993] *Problems for the VI International Young Physicists' Tournament*, a four-page typeset English translation of the problems, printed with a dot matrix printer, provided by LOC to Dutch participant Whee Ky Ma (Wei Ji Ma) in 1993

[TMF 1996] *VI. medzinárodný TMF ( 1992 — 1993 ) // Juraj Braciník, Jozef Brestenský, Miroslav Helbich, Karol Macák. Turnaj mladých fyzikov : štatút a úlohy. Iuventa, Bratislava (1996), s. 31—32*

[Jordens 1993] *De opgaven van het toernooi*, a three-page typeset Dutch translation of the problems, circulating among Dutch participants in 1993

[Morozov 2008] Private communication with Alexander Morozov, Ukrainian participant in 1993

[Wei Ji Ma 2008] Private communication with Wei Ji Ma, Dutch participant in 1993

[Kluiber 1996] *Úlohy mezinárodního turnaje mladých fyziků. 6. Rusko — Moskva — 1993 // Zdeněk Kluiber. Turnaj Mladých Fyziků. Informace o národních i mezinárodních soutěžích studentů výrazně talentovaných pro fyziku. Gaudeamus-MAFI, Hradec Králové, 1996, s. 28—30*

[Proceedings 2006] *Problems for the 6th IYPT*. In: *Proceedings of the 19th IYPT 2006* (eds Silvina Simeonova, Myeung Hoi Kwon, Zvezdi, Sofia 2007), pp. 242–243

[Rajkovits 2003] Zs. Rajkovits, L. Skrapits, P. Kenesei. *Ifjú Fizikusok Nemzetközi Versenye: problémái (1989—2003)*. Retrieved at <http://metal.elte.hu/~dlab/ifnv.doc>

Edited and commented by Ilya Martchenko. Originally translated from Slovak and Hungarian in July 2008, the authoritative English translation found, shared by Wei Ji Ma in November 2008, an independent copy of translation kindly shared by Jaroslav Zhouf in October 2009, 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, Wei Ji Ma, Jaroslav Zhouf, Jozef Brestenský, Zsuzsanna Rajkovits, Martin Plesch and others, without important factual details on the 6th IYPT provided by Wei Ji Ma, Alexander Morozov and Yaroslav Chinskiy, 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 1993 English text names them: S. Varlamov, H. Kissinger, T. Korneeva, E. Pikersgill, E. Surkov, E. Yunosov, and A. Yarov. The presence of Henry Kissinger among the problem authors was revealed by Zdeněk Kluiber and Ivan Štoll to be a joke of the Organizing Committee linked to the problem No. 8 (Henry Kissinger had promoted the concept of *domino effect* in international relations.) It is so far unclear if E. Pikersgill was a genuine problem author or, plausibly, *Mr. Pikersgill*, a character in James Herriot's *All Things Bright and Beautiful* who was proud of having attended a two-week scientific workshop when a teenager.

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