Problems for the 3rd International Young Physicists' Tournament

Olympiets Youth Center, Moscow, Soviet Union; June 7–14, 1990 [1]

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

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

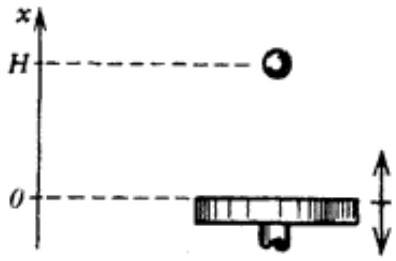
Victories do not attract him.
For him growth means: profound defeat
at the hands of ever greater adversaries.
R. M. Rilke [3]

1. Invent yourself [4] — a physical photo contest

Submit to a contest the photographs of a rapidly occurring physical phenomenon. Explain in your commentaries the physical value of these photographs.

2–4. Ball and piston

A horizontal piston oscillates up and down. The coordinate of the piston's surface is defined with an expression $x=x_0\cos\omega t$. At an arbitrary moment, a small ball is dropped without initial speed onto the piston from a height H (Fig. 1).



2. Up to what altitude will the ball bounce after the first collision with the piston? For this case, consider the collision as absolutely elastic, and $H>x_0$.

3. The system "forgets" the initial conditions after a big number of collisions. Estimate up to what maximum altitude a ball may bounce after many collisions. What is the average bounce altitude? Consider that the surfaces of the ball and of the piston are not damaged at collisions.

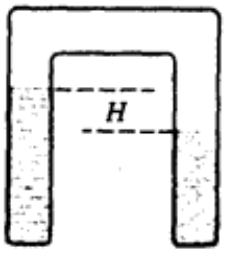
4. Let a ceiling be at a height H above the piston. In this case, stationary solutions are possible. Find some of them and research their stability. Consider $H=1$ *m*, $H\gg x_0$, $g=10$ m/s^2 for numerical estimations. Consider the restoration coefficient of ball collisions with the piston and with the ceiling, as $k=0.8$.

5. Planet

What is the maximum possible size of a cube-shaped planet?

6. Evaporation-condensation

A П-shaped soldered glass tube contains some water (Fig. 2).

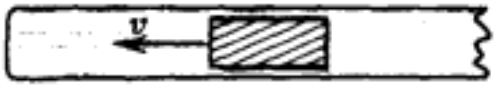


If there is an initial difference of water levels H, then the water levels will become equal after some time. Estimate the rate of this equalization for a given H and $T=const$,

a. if there is no air in the tube
b. if there is some air in the tube, at normal atmospheric pressure.

7. Cylinder in a tube

A cylinder is moving towards the closed end in a long tube filled with water (Fig. 3).



The inner diameter of the tube is D, diameter of the cylinder is d, the cylinder length is L, $D-d=h$, $L>D$, $h \ll D$. How does the resistance force depend on the speed of cylinder? Compare the theoretical estimations with the experimental results.

8. Segner's wheel

A Segner's wheel rotates due to the reactive force of streams flowing out of the nozzles, when the wheel is placed into the water. Will it rotate backwards in a reverse regime, if the water is sucked into the nozzles, not flowing out of them? It is recommended to look through the book *Surely You're Joking, Mr. Feynman!* (a partial Russian translation can be found in the "*Nauka i zhizn"* magazine, 1986, No. 12.) [5]

9. Franklin's wheel

Rotation of a little metal bar with pointed spearheads in a well-known "Franklin's wheel experiment" is explained by the existence of "electric wind". Explain why the wheel rotates if one places it between the plates of a parallel-plate capacitor and charges the capacitor with an electrostatic generator. If the Franklin's wheel is replaced with a dielectric disk, will such a disk rotate between the plates of a parallel-plate capacitor charged with an electrostatic generator?

10. Electret

150 years ago, M. Faraday predicted electrets as electrostatic analogues to permanent magnets. Manufacture an electret and research its properties.

11. Color of a cloud

“Clouds in the skies above, heavenly wanderers,
Long strings of snowy pearls stretched over azure plains!
Exiles like I, you rush farther and farther on...”
M. Yu. Lermontov [6]

Explain the observed colors of white clouds and rain bearing clouds.

12. Border of a cloud

An observed border of a cloud is often sharp. It is especially evident from onboard an airplane. Evaluate the “diffuseness” of the cloud’s border.

13. Cosmonauts cloud (a fantasy with physical sense)

A large number of cosmonauts form a “cosmonauts cloud” in the outer space. Initially each of them has a football with him. Starting from a certain moment, cosmonauts begin throwing these balls one to another (without losing them). Describe the evolution of the “cosmonauts cloud”. In order not to limit your imagination, we offer you to choose on your own the initial conditions, the rules of throwing the balls, and other parameters of the “cloud”. The only important aspects are that the choice of model should be logically validated; the conclusions should be supported with quantitative estimations; the number of described evolutions should not exceed two.

14. Fractal?

A grandmother is winding woolen thread into a spherical thread ball. How does the mass of the ball depend on its diameter?

15. Light in a tube

Look through a glass tube at a light (tube diameter is ca. 5 *mm*, length is ca. 25 *cm*.) Explain the origin of the observed circles.

16. Interference

Take two photo plates (9×12 *cm*), well-washed from emulsion. If they are tightly pressed (lapped) one to another, the interference bands can be observed in the reflected light. If the plates are laid on the table and the upper one is pressed in the middle part with a finger, the interference pattern looks like concentric circles. When the finger is removed, the circles “run away” from the centre. Carry out such an experiment and explain the observed phenomena. Evaluate theoretically how fast do the circles “run away” as the loading is removed.

17. Scientific Organization of Labor — SOL

You have to hammer 1989 similar nails (l=50 *mm*, d=2.5 *mm*) into a wooden bar. What hammer would you choose to perform this job quicker and better? (More specifically: what are the mass of the hammer and the length of its handle?)

a. for a pine bar
b. for an oak bar.

Notes

[1] These dates are announced in an invitation letter sent on March 15, 1990 to Hungarian team leader Lajos Skrapits [Letter 1990] and confirmed by a booklet giving the schedule of the event [Schedule 1990]

[2] The problems for all Rounds of the 3rd IYPT were initially completed in the Russian language, the primary working language at the entire event (the non-Russian speaking Dutch team, and possibly further teams, were assisted by interpreters [Yufryakov 2008].)

The primary "standard" source for this translation is the Russian version of the *Problems for the Correspondence Collective Competition of YPT-XII* (*Задания заочного коллективного конкурса ТЮФ-XII*) published in *Kvant* magazine in August 1989 [Kvant 1989], but submitted for publication before May 26, 1989. The early draft of this translation has been performed in November 2007 from this Russian text.

An English translation has been prepared by the Organizing Committee and distributed to non-Soviet teams, at least to the Dutch team. A two-page OCR typeset document titled *Third International Young the Physicists' Tournament / YPT-problems for collective competition by mail* coming from Evgeny Yunosov was preserved by Hans Jordens [Jordens 1990].

A textually close, edited, version has been published by Tatyana Korneeva in English-language journal *Gifted Talented International* [GTI 1991] in 1991, although the contents of the article clearly shows that it was written, and possibly submitted, before the 3rd IYPT held in 1990.

A Czech translation titled *Problems for Young Physicists' Tournament 1989—1990* has been published in *Rozhledy mat.-fyz.* in September 1990, shortly after the competition [RMF 1990]. The source document is not reported, while the translation is made most probably from the Russian *Kvant* text. It may be speculated, with no solid grounds, that the editorial board of the journal might have contributed to the translation.

The list of 17 problems in Czech language titled *Problems for International Young Physicists' Tournament. 3. Russia — Moscow — 1990* (*Úlohy mezinádodního turnaje mladých fyziků. 3. Rusko — Moskva — 1990*) was published by Zdeněk Kluiber in review book *Turnaj Mladých Fyziků* in 1996 [Kluiber 1996]. This Czech translation is found to be fully independent from the 1991 version, with quite different style, wording and factual nuances.

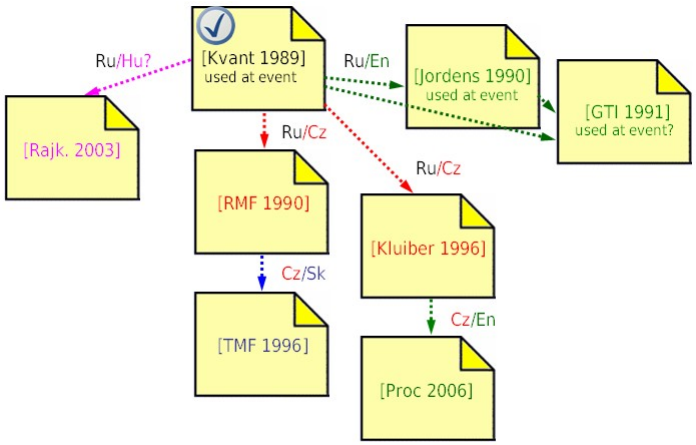
A different English version was published in 2006 by Silvina Simeonova in the *Proceedings of the 16th IYPT* on the basis of a text provided to the publishers by Zdeněk Kluiber [Proceedings 2006]. The year of translation and the source language are not reported. This version, however, relies on the 1996 Czech text (because *all* factual discrepancies between Czech and Russian versions are kept intact), but relies on the figures from *Kvant*, directly reproduced from [Kvant 1989].

The known Slovak version [TMF 1996] is titled the Slovak language translation of the *RMF* text, published in Czech language. There is furthermore all linguistic evidence that the Slovak text follows the 1991 Czech text, as all distinctive features (omitted epigraph in problem No. 11, style of the formulae etc.) are as in the 1991 Czech, not as in the Russian text. The same details confirm that the Slovak text is not related to the 1996 Czech text. The Slovak is linguistically very close to Czech and, to a lesser extent, Russian.

The list of the problems for 1990 was not released on the Evgeny Yunosov's *Faraday Tournament* website in 2002. The Hungarian version [Rajkovits 2003] is available as well.

As it was explicitly stated in the *Kvant* publication, the problems of the all-Soviet rounds and International rounds in 1990 were expected to be identical to the problems of the Correspondence Rounds, presented in this document (it was not the case for 1989, when problems at the 2nd IYPT were not the same as at the Correspondence Rounds for Soviet teams.) There is solid evidence from the participants of the competition in June 1990 that this very problem set was discussed at real stages of the 3rd IYPT [Nosov 2009], [Mashkov 2009], [Yufryakov 2008].

Although the English translation made in 1990 might have been recognized by LOC as *official*, it is now felt appropriate to rely on the original Russian text for the sake of coherence and completeness of the reconstruction; probably only single team was using the English text before and during the 3rd IYPT, and that version thus had a limited *social* impact as of a "standard English edition".



The history of text transmission: colors indicate the languages of the sources (black for the Russian, green for the English, red for the Czech, blue for the Slovak, 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] Translated from the German by Michael M. Metzger (*A companion to the works of Rainer Maria Rilke,* Boydell & Brewer, 2004, p. 61.) Original version: *„Die Siege laden ihn nicht ein. Sein Wachstum ist: der Tiefbesiegte von immer Größerem zu sein"* ("Der Schauende", 1901, *Buch der Bilder*.) Other known English translations: "*This is how we grow: by being defeated, decisively*"; "*The purpose of life is to be defeated by greater and greater things.*" The Russian text quotes the translation by Boris Pasternak («Созерцание», пер. Б. Пастернака / Рильке, Р. М. Новые стихотворения. — М.: Наука, 1977). This epigraph is present only in the original *Kvant* text

[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) and "Think for yourselves" (Soviet OC's translation of the *Kvant* text for 1989), "Invent it yourself" (1992 translations for the 5th IYPT.) "Your invention" is used in the Soviet OC's translation for the 3rd IYPT [Jordens 1990]

[5] Translations by M. Shifman and O. L. Tikhodeeva of *Surely You're Joking, Mr. Feynman!* were published in the Soviet popular science magazine *Nauka i zhizn* in Nos. 10—12 (1986), Nos. 2—8 (1987) and in *Uspekhi fizicheskikh nauk* in No. 148, issue 3 (March 1986)

[6] Translated from the Russian by Irina Zheleznova (*Mikhail Lermontov: Selected Works*, Progress Publishers, Moscow, 1976.) Original version: *«Тучки небесные, вечные странники! Степью лазурною, цепью жемчужною мчитесь вы...»* («Тучки», 1840 / *Стихотворенія М. Лермонтова*. СПб., 1840, стр. 167—168)

Sources

[Kvant 1989] *XII Турнир юных физиков* // Квант, №8, 1989. — стр. 76—78

[RMF 1990] *Úlohy Turnaje mladých fyziků 1989 — 1990.* Rozhledy matematicko-fyzikální, ročník 69, č. 1 (žáří 1990), 1990—1991, s. 24—27

[Letter 1990] Invitation letter to the 3rd IYPT, dated March 15, 1990, sent to Hungarian delegation leader Lajos Skrapits

[TMF 1996] *III. medzinádodný TMF (1989 — 1990)* // Juraj Braciník, Jozef Brestenský, Miroslav Helbich, Karol Macák. Turnaj mladých fyzikov : štatút a úlohy. Iuventa, Bratislava (1996), s. 27—29

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

[Yufryakov 2008] Private communication with Konstantin Yufryakov, Russian participant in 1990

[Nosov 2009] Private communication with Igor Nosov, Turkmen participant in 1989

[Mashkov 2009] Private communication with Ilya Mashkov, Russian participant in 1990

[Kluiber 1996] *Úlohy mezinádodního turnaje mladých fyziků. 3. Rusko — Moskva — 1990* // Zdeněk Kluiber. Turnaj Mladých Fyziků. Informace o nádodní i mezinádodní soutěži studentů výrazně talentovaných pro fyziku. Gaudeamus-MAFI, Hradec Králové, 1996, s. 24—25

[Proceedings 2006] *Problems for the 3rd IYPT*. In: Proceedings of the 19th IYPT 2006 (eds Silvina Simeonova, Myeung Hoi Kwon, Zvezdi, Sofia 2007), pp. 235–237

[Jordens 1990] *Third International Young the Physicists Tournament / YPT-problems for collective competition by mail*, an English translation of the problems provided by LOC to Hans Jordens in 1989 or 1990, OCR

[GTI 1991] T. D. Korneeva *et al*. Young Physicists' Tournament (YPT): A collective competition. Gifted Talented International, 7, 1–2, 86–95 (1991)

[Schedule 1990] III Международный турнир юных физиков. Москва. Молодежный центр "Олимпиец" (7—14 июня 1990 г.)

Translated, edited and commented by Ilya Martchenko. Originally translated and released in November 2007, 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, Zdeněk Kluiber, Jozef Brestenský, Zsuzsanna Rajkovits, Hans Jordens, Jaroslav Zhouf, Martin Plesch and others, without important factual details on the 3rd IYPT provided by Konstantin Yufryakov and Ilya Mashkov, 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 *Kvant* and the *Gifted Talented International* texts name them: S. D. Varlamov, T. P. Korneeva, A. Yu. Kusenko, M. Yu. Nikolaev, A. V. Rakhmanov, M. V. Stolyarov, M. M. Tsypin, E. N. Yunosov.

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