# Problems for the 2nd International Young Physicists' Tournament

## Moscow, Soviet Union, 1989

### Translated from Russian, Slovak and Belarusian in October 2007 [1]

One hunts a kurdl from inside. S. Lem. [2]

## 1. Invent yourself

Develop and construct a setup for illustrative demonstration of the wave properties of sound propagation in air. [3]

## 2. Midday

Is it correct to call "midday" the moment in the middle of the time interval between sunrise and sunset? Using a calendar, you will easily notice that throughout the year this moment "drifts" relatively to a certain time. Explain the cause of this effect.

## 3. Tide

Evaluate the height of the tide in Black sea on April 1, 1989. [4]

## 4. Rolling friction [5]

Investigate how does the friction force depend on speed. For example, study the rolling of a wooden disk on the wooden surface of a table.

## 5. Clock [6]

You have visited a planet and you want to return on it in ten thousand or in million years. What clock would you leave on this planet so it would measure precisely the time of your absence on the planet?

## 6. Rainbow [7]

Is it possible that three or more rainbows appear on the sky simultaneously?

**7. Sparks [8]**

When your feet slide on a skating rink, sparks fly away. Most often, a spark flies apart in all directions at the end of its flight. Explain this phenomenon.

**8. Underground**

Suggest methods and measure the speed of an underground train between stations. [9] The same can be done in a bus in which you are going, if there are no reliable distance signs on the route.

**9. Astronaut**

What maximum travel distance may an astronaut expect [10]

● at the modern level of technical development;
● in far future, when practically all technical problems will be overcame?

**10. Aqueous planet [11]**

What amount of water may form a planet with a constant density

● far from Sun
● in the distance L from Sun?

**11. Mosquito [12]**

At what maximum altitude can a mosquito fly?

**12. Sand in a tube [13]**

A glass tube is installed vertically and its lower end is tightly closed. The tube is filled with some sand. In what time T the sand will flow out of the tube, when it is opened? Study the dependence of the duration $T$ on the following parameters: $d$ is size of sand grains, $L$ is length of the tube. Accept that the sand grains are pressed together at a constant degree - specify and validate this parameter yourself. Don't use an excessively high degree of pressing for being able to compare the results. It is advised to take 10 cm < L < 1 m.

**13. Electrolytic cell [14]**

Prepare some saturated solution of table salt NaCl. Immerse two carbon electrodes into it so that their metal contacts are not immersed into the solution. Investigate

● the current-voltage characteristic of the created electrolytic cell in the interval of currents from 10 mA to 50mA,

● how does the current-voltage characteristic change if the solution is diluted?

## 14. Fence [15]

A picket fence separates you from a distant vast object. It occurs that the object may be seen if you do not stay near the fence, but go along it in a car. Explain this phenomenon. What speed is necessary, if *a* is width of a fence board, *b* is gap between the boards, *L* is distance to the fence (L >> a, b), *g* is angular size of the object, g << [16].

## 15. Electron

An electron with the velocity $v = 3 \cdot 10^5$ m/s flies with an aiming parameter *d* along a metal ball with a radius of a few centimeters. [17] Charge of the ball changes with time by the law $q(t) = q_0 \cos \omega t$, where $q_0 = 10^{-8}$ C [18], $\omega = 10^8$ rad/s. Build a dependence plot of electron scattering angle $\varphi$ on aiming parameter *d*. [19]

## 16. Information

How much information (in bits) you have received after having read the problems of YPT? How much information (in bits) you would receive when looking on a geographic map with the size A4? [20]

## 17. Karlsson

With what rate should Karlsson eat jam not to get thinner during the flight? (Traditionally, problem No. 17 has a humorous tone). [21]

## Notes

[1] The Slovak IYPT Archive* and the participants of the competition** indicate that the list of the problems at the 2nd IYPT differed from the list of the problems for the Correspondence round of 1988-1989, published in Kvant magazine in August 1988.***

However, the temporary 2002 publication of the "Problems for the 2nd IYPT" on the Evgeny Yunosov's Faraday Tournament Web-site****, had reproduced the list of the Problems for the Collective Correspondence round, firstly published in Kvant.*** Most likely, it has been a mistake.

Besides, the Faraday Tournament publication had included the list of physical demonstrations that have been discussed at the 2nd IYPT.

The current list reconstructs the Problems from Russian*** ****, Slovak* and Belarusian** sources with every discrepancy being discussed.

We apologize for any inaccuracies that may remain in this translation and invite everyone who finds them to help improving the text.

[2] Was not quoted in the Slovak IYPT Archive.

[3] In the problems of the Correspondence round***, the laws of sound propagation were mentioned: "Develop and construct a setup for illustrative demonstration of the wave properties of sound propagation in air, and the laws of it."

[4] On December 12, 1988, according to the problems of the Correspondence round***.

[5] In the problems of the Correspondence round***, there was a different problem: "**Puddle and wind.** Measure the parameters of waves that are excited by wind in a shallow basin. Investigate the dependence of wavelength on the speed of wind."

[6] A different problem at the Correspondence round***: "**Chladni patterns.** Research the Chladni patterns for a disk and for a square."

[7] A different problem at the Correspondence round***: "**Soap bubble.** What determines the "lifetime" of a soap bubble? Why does it pop and how does it happen?"

[8] A different problem at the Correspondence round***: "**Leskov.** Explain how has the forger Maroy shortened English bolts. (N.S. Leskov. "The Sealed Angel".)"

[9] The station names were specified***: "Suggest methods and measure the speed of an underground train between the stations "Universitet" and "Prospekt Vernadskogo" (it is for the Muscovites.)"

[10] In the problems of the Correspondence round***, the time of 50 years was specified: "**Astronaut.** What maximum travel distance may an astronaut expect in 50 years of flight?"

[11] A different problem at the Correspondence round***: "**Moon atmosphere.** Imagine you have managed to create an atmosphere on the Moon with the composition as on Earth. Describe its parameters and properties. How fast would it "get thinner" and how to maintain such an atmosphere?"

[12] A different problem at the Correspondence round***: "**Mushroom.** It is surprising but sometimes mushrooms and even grass grow through a layer of asphalt. Explain these phenomena."

[13] A different problem at the Correspondence round***: "**Weather forecast.** "A fall of a barometer means bad weather" - why this statement is most often correct?"

[14] A different problem at the Correspondence round***: "**Photoflash.** Lighten your teeth with a photoflash and observe their glow in the darkness (for that, you have to take off the cover of the camera flash, defend your eyes well, and open them immediately after the flash). Explain and research the phenomenon of afterglow."

[15] A different problem at the Correspondence round***: "**Triboluminescence.** How much sugar would you need to read a message (a few words) from your predecessor in a dark dungeon? You are out of matches and you have already thrown away your lighting."

[16] The value is missing in the Slovak IYPT Archive.

[17] Not "a few centimeters", but "1 cm", according to Kvant magazine.

[18] The value is quoted by the Kvant magazine. It is said $q_0 = 10^{-3}$ C in the Slovak IYPT Archive.

[19] The Kvant version of the problem included the final question "Can this phenomenon be used to explain Compton scattering?"

[20] The Kvant version had minor discrepancies: "How much information (in bits) you have received after having read these tasks of the Correspondence round? How much information (in bits) you would receive when looking on a geographic map with a size of a one page of text?"

[21] The note concerning a humorous tone was not presented in the Slovak IYPT Archive.


**References**

* The Slovak IYPT Archive. http://www.tmfsr.sk/index.php?vyber=archiv&kategoria=archiv-1996&lang=svk

** Private communication with Eugene Zelenko (Belarus).

*** Е.Н. Юносов. XI Турнир юных физиков. Квант, 8, 1988. - стр. 61-63.
http://kvant.mccme.ru/1988/08/index.htm.

**** Evgeny Yunosov's Faraday Tournament official Web-site (www.farad.ru, in Russian, now unavailable).

POISK Centre (Russia), 2007.