

# Problems for the 1st International Young Physicists' Tournament

Moscow, Soviet Union, 1988

Translated from Russian in October 2007 [1]

## 1. Invent yourself

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

## 2. "Eternal radio"

Develop and construct a portable radio receiver that would not use power cells. 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 ( $n < 10$ ) [2] are connected with each other with batteries of known EMF and  $r$ . Compile a computer program to calculate the potential difference between the first and second knots. Consider the time from the start of data input (tables of EMF and  $r$  values) to the moment of 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 inventive starfarer decided to supply physical laboratories worldwide with vacuum from cosmic space. What are the venture's chances of being successful?

## 7. Sunset

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

## 8. Colour television

You have to construct a four-colour television receiver. What colours would you choose as basic? In this case, is it necessary to modify the image-capturing equipment?

## 9. Ninth wave

"Before me are the waves of the sea.  
There are so many. They are countless."

B. Pasternak [3]

Does the 'Ninth wave' phenomenon exist? Clarify this question. To begin with, use the ideas from the article "Troika, semyorka, tuz..." (Znanie - sila, 1987, No. 1, pp. 97-104).

## 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 [4]

Thus the Roman philosopher has explained the origin of forest fires. Estimate the probability of such an ignition and its role among other factors that cause fires in nature, i.e. which are not consequences of human activities.

## 11. Incandescent lamp

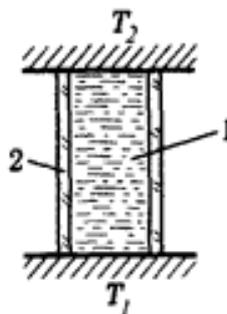
It is said that two 60 W light bulbs shine brighter than three 40 W bulbs. Is it true? Investigate the change of light emission and the change of light bulb's lifetime at a small change of supplied voltage.

## 12. Spring in city

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

## 13. Heat-transfer

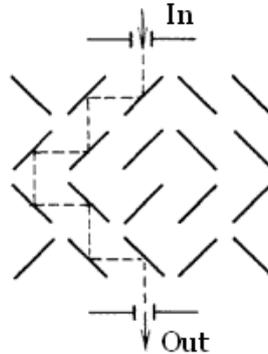
Research the heat-transfer through the vertical water column in two cases:  $T_1 < T_2$  and  $T_1 > T_2$ .



"1" is water column, "2" is heat-insulating tube.

## 14. Mesoscopics

One of the mesoscopic effects is the significant change of the resistance of a two-dimensional metal sample at low temperatures, if just a single atom within crystal lattice is displaced. This effect can be evidently 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  $n \times n$ ,  $n > 10$ . Each mirror can exist in two positions only; it can be rotated  $45^\circ$  clockwise or counter-clockwise.



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

## 15. Copper coin

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. [5]

## 16. Trapped electrons

Several electrons ( $2 \leq n \leq 30$ ) can freely move inside a circle of a radius  $R$ . What relative position of 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, problem No. 17 has a humorous tone).

## Notes

[1] Major source of the Russian version: [Т.П. Корнеева, Е.Н. Юносов, И.В. Яминский. X Турнир юных физиков. Квант, №8, 1987. - стр. 59-60.](#)\* The Slovak IYPT Archive\*\* releases the Slovak translation of this Kvant publication.

However, no known source claims that the problems of the International rounds were identical to the problems of the Correspondence round. E.g., it was not so in 1989. Therefore, there is a minor probability that certain problems at the International rounds had discrepancies from the problems presented in this document.

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

[2] In the temporary 2002 publication of these Problems on the Evgeny Yunosov's Faraday Tournament Web-site<sup>\*\*\*</sup>, it was stated " $n > 10$ ". Seemingly, it must have been a misprint.

[3] Translated from Latin by William Ellery Leonard; the Russian text quotes the translation by F.A. Petrovsky

[4] Translated from Russian by Anesa Miller-Pogacar

[5] In the temporary 2002 publication of these Problems on the Evgeny Yunosov's Faraday Tournament Web-site<sup>\*\*\*</sup>, no interaction with sunlight was mentioned: "1-kopeck coin 'fell out' of a space rocket and became an artificial planet. Estimate its lifetime as a planet of the Solar System."

## References

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

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

\*\*\* Evgeny Yunosov's Faraday Tournament official Web-site ([www.farad.ru](http://www.farad.ru), in Russian, now unavailable).

POISK Centre (Russia), 2007.