PROBLEMS FOR THE 8th INTERNATIONAL YOUNG PHYSICISTS' TOURNAMENT

1. Think up a problem yourself (paradox)

Try to puzzle your rivals by a paradoxical physical experiment.
(The coefficient of the opponent challenging for this problem is 2.5).

2. Boiling water

Some people say it is important to put a lid on the pot when you want to boil water for tea to save energy and time. Investigate this phenomenon and determine the energy and time saving.

3. Drop

A drop of salted water drying on a smooth surface creates a system of rings. Investigate and explain this phenomenon.

4. Gravitational spacecraft

A spacecraft (having a shape of a dumb-bell of variable length) can shift from the Earth orbit (300 km above the Earth surface) to the Moon orbit without the use of jets. Calculate the time taken by such a manoeuver.

5. Sound

Transfer the electric energy stored in a capacitor of 100 μF charged to the voltage of 30 V into the energy of the sound, with the highest efficiency possible. No external energy sources are allowed. Determine the fraction of energy converted into sound in the discharge.

6. Curtain

A light curtain (light scatters on dust particles) is used in some theaters. Suggest the design of a light curtain, which allows its effective action with the minimum power supplied for one meter of stage width?

7. Three discs

Investigate collisions of three homogeneous, rigid discs which can move in a plane. At first two discs are at rest. The third disc:
(a) collides at exactly the same time with two other discs,
(b) collides at first with one of the discs.

8. Carpet

When a carpet is rolled into a cylinder it sometimes unrolls by itself or with the help of a gentle push. Determine the factors on which the speed of the rolling carpet depends.

9. Ice cream

Obtain supercooled water in an experimental setup. By how many degrees below 0^0C did you manage to supercool it? What can be the record in this experiment? Determine the freezing point of water.

10. Cathode–ray tube

While a well-known physicist A. First watched a football match by TV, another well-known physicist B. Second made a hole of diameter 1 μm in the cathode-ray tube. Did A. First manage to see the football match up to the end?

11. Moon light

It is possible to set paper on fire using a lens and solar radiation. Could it be possible using lunar instead of solar light? If yes - invent an optimal optical system for such a purpose. If not - what should the Moon be like, for being this possible?

12. Tinder box

When someone strikes two pieces of flint, sparks are created. Investigate and explain this phenomenon.

13. Air lens

Lenses are usually made of solids and sometimes made of liquids. Construct an optical lens made of air in such a way that light can travel through the lens without crossing any material but air. Determine on which factors the focal length of an air lens depends.

14. Frozen lake

The water surface of a lake is in winter exposed to cold air at a fixed temperature below zero. There is no wind. Determine the thickness of the ice layer as a function of time.

15. Bottle

A plastic bottle of a capacity between 1 and 2 litres completely filled with water is "accidentally" dropped on the floor from the height $H = 1$m. What maximum height can the spray reach and why? Determine the minimal height from which the bottle should be dropped to burst?

16. Oscillations of plates

Water has been poured on a horizontal glass plate and a second glass plate placed on it. If the lower plate is oscillating in a horizontal plane, at certain amplitudes and frequencies, the upper plate begins to oscillate in vertical direction. Investigate and describe this phenomenon. Is there any difference when you use another liquid ?

17. Epic hero

An epic Russian hero Ilya Muromets had once thrown his mace weighing forty poods (1 pood = 16 kg) and in forty days this mace fell at the same place. Estimate the parameters of the throw of the hero.