

7th IYPT (1994)

Sources: [Rozhledi mat.-fyz. 71, 1993/4, 5, 243—249](#), [Dev. Tal. in Phys., 28—30, 1995](#)

Problems selected at an unknown time in 1993, possibly in Russian

[Exemplary solutions for 1994 →](#)

Think up a problem yourself (problems 1, 2, 3). Invent yourself and solve a problem on the given theme.

1. Optics

Think up and solve a problem connected with employing a thin lens of a large focal length.

2. Compass

“In sledge trips we use liquid compasses, the most exact of the small ones. But you understand of course that due to proximity to the magnetic pole the arrow usually points downwards. To make it horizontal, its opposite end is balanced with a weight.” (From the letter of Cherry-Garrad, member of the last expedition of R. Scott). Use the context of this quotation to formulate a problem.

3. Magnetism

A cylindrical permanent magnet falling inside a copper tube is found to move at an almost constant velocity, the slower the thicker and the walls of the tube. Use this fact to formulate a problem (See also 14).

Gravitation machine (problems 4, 5, 6). A horizontal plate (a vibrator) oscillates harmonically up and down. A steel ball put on the surface of the plate starts jumping higher or lower. For the experimental device one may successfully use a ferrite core in a coil connected to an alternating current generator (a sound generator). The butt-end of the ferrite core will play the part of the vibrating horizontal plane. Steel balls of diameter 1 or 2 mm are suitable for the experiment. The glass tube approximately 1 m long can also be very helpful.

4. Upper boundary

Measure experimentally the maximum height to which the ball rises to and explain the result.

5. Distribution function

Determine experimentally what part of a sufficiently large time interval the ball is in the range of heights H , $H+dH$ and explain the result.

6. Acceleration

The mechanical energy of the ball changes after every impact. The mean mechanical energy (averaged over all successive impacts) increases at the beginning of the process and then tends to a constant value. Try to obtain experimentally the time dependence of the mean mechanical energy of the ball.

7. Aspen leaf

Even in windless weather aspen leaves tremble slightly. Why does an aspen leaf tremble?

8. Superball

A highly elastic ball (a superball) falls on a horizontal surface from a small height (5 cm or less) and recoils several times. What is the number of impacts of the superball against a table?

9. Meteorite

A meteorite of mass 1000 tons flies directly into the Sun. Can modern instruments register the fact of its fall on the Sun?

10. Water dome

A vertical water jet falls on the butt-end of a cylindrical bar and creates a bell-like water dome. Explain this phenomenon and evaluate the parameters of the dome.

11. Siphon

A rubber tube is used as a siphon to flow water from one vessel into another. The vessels are separated by a high partition and the levels of water in them are different. If one withdraws the tube from one vessel, lets the pole of air enter it and then puts the tube into the water again, the action of the siphon may be resumed or not. Investigate this phenomenon.

12. Boiling

Put a metallic ball heated to the temperature $150\text{ }^{\circ}\text{C}$ — $200\text{ }^{\circ}\text{C}$ into hot water at the temperature close to $100\text{ }^{\circ}\text{C}$ and observe the process of intensive evaporation of the water. Explain the observed phenomenon.

13. Spirits

A closed vessel (a bottle) contains spirits — pure or substantially diluted by water. Suggest a method of estimation of the concentration of spirits without opening the vessel.

14. Magnetic friction

To investigate the phenomenon described in the problem 3 we suggest to create the device containing the following elements:

- a. a copper plate (or a set of plates) 0.3 to 15 mm thick. The length and the width of the plate may be chosen according to one's convenience, but they should be large enough to avoid the effect of the boundaries;
- b. a cylindrical electromagnet with a flat butt-end;
- c. a device providing free motion of the flat butt-end of the electric magnet over the horizontal surface of the copper plate. It is very important that the gap between the magnet and the plate is small as possible and constant everywhere;
- d. the push providing the uniform motion of the magnet at a given velocity over the plate surface.

Introduce the following notation: T — the push (and the force of magnetic friction), v — the velocity of the magnet, h — the thickness of the plate. Investigate and determine experimentally the dependence of T on h at $v=\text{const}$ for several values of v .

15. Transmission of energy

Transmit without wires to a distance of 3 meters the largest possible part of the energy stored in a capacitor having capacity of $C=10 \mu\text{F}$ charged to voltage $U=100\text{ V}$. Measure this energy. Your device should not contain energy sources. Naturally the capacitor itself must not be transported.

16. The Moon and the Sun

“If you are asked what is more important, The Sun or the Moon, you should answer the Moon. For the Sun shines in daytime when there is enough light without it,” says a joke. When is it possible to see the Sun and the Moon at the same time? Calculate the schedule of the events for the European countries during 1994.

17. Straw

The Russian proverb says: “Had I known the place where I fell, I would have laid some straw there.” How much straw should be laid to guarantee a safe fall?

