PROBLEMS FOR THE VII INTERNATIONAL PHYSICS TOURNAMENT

FORMULATE A PROBLEM YOURSELF. The problems 1, 2 and 3 concern subjects for which a question must be formulated and solved by the competitors themselves. According to the new rules of the tournament the points scored for these problems by the opponent are multiplied by a factor of 2.2.

1. OPTICS. Formulate a question connected to the use of a thin lens with a large focal distance.

2. COMPASS. Quotation from a letter by Cherry-Garrar, member of the last expedition of R. Scott: '...During journeys by sledge we use liquid compasses, the most precise of the small formats. But you understand of course that due to the close proximity of the magnetic pole, the needle of the compass generally points downwards. To make it give a horizontal indication a small weight is fitted to its opposite end.' Use the context of this quotation to formulate a problem.

3. MAGNETISM. A cylindrical magnet which falls through a vertical copper tube moves in a virtually uniform manner. The thicker the tube, the slower the velocity of the fall.
Use this information to formulate a problem. The research can connect with that for question 14.

A GRAVITATIONAL FORCE DEVICE. Problems 4, 5 and 6 concern gravitational force. A horizontal flexible plate oscillates harmonically up and down. A steel ball placed onto the plate begins to bounce increasingly higher, and possibly lower again afterwards.

A ferrite core in a coil connected to an audio signal generator is used for the practical application. The butt end of the ferrite core then plays the role of the oscillating plate. Steel balls with a diameter of 1 - 2 mm are the most suitable for the experiment. A glass tube of approx. 1 metre long can also be extremely helpful.

4. UPPER BOUNDARY. Determine experimentally the maximum height that the ball bearing can reach and explain the result.

5. FUNCTION OF DISTRIBUTION. Determine experimentally which part of the time, with a sufficient large interval, the ball bearing is found at a height between H and H + dH and explain the result.

6. ACCELERATION. The mechanical energy (the sum of kinetic and potential energy) of the ball bearing changes every time that it collides with the plate. The mean mechanical energy (averaged over a number of successive collisions) increases at the beginning and subsequently tends toward a constant value.
Determine experimentally how the mean mechanical energy depends on the time.

7. THE ASPEN LEAF. Even in windless weather, an aspen leaf trembles slightly. What causes this?

8. SUPERBALL. An elastic rubber ball (known as a superball) falls onto a horizontal surface from a small height (5 cm or less), and subsequently rebounds several times. How many times does the ball rebound?

9. METEORITE. A meteorite with a mass of 10^6 kg flies directly into the sun. Is it possible to observe this occurrence using modern equipment?

10. WATER DOME. A vertical water jet falls onto the flat end of a cylindrical bar. The water that flows off forms a bell shape, like a dome. Explain this phenomenon and the parameters that play a role, and in what manner.

11. SIPHON. A rubber siphon is used to siphon water from one vessel to another. One vessel is considerably higher than the other, while the level of the water in the vessels also differs. If the tube is withdrawn from one vessel and air is then allowed to enter, siphoning may or may not continue to proceed when the siphon is returned. Investigate this phenomenon.

12. BOILING. Study the phenomenon of intensive evaporation when a metal ball with a temperature of around 150°C - 200°C falls into a vessel of water with a temperature of nearly 100°C. Explain the phenomena observed.

13. ALCOHOL. A closed vessel (or a bottle) contains alcohol, possibly diluted with water. Give a method by which it is possible to determine the percentage of alcohol without opening the vessel (or the bottle).

14. MAGNETIC FRICTION. To investigate that described in problem 3 we suggest a device containing the following elements:

a) A copper plate of a thickness varying between 0.3 mm and 15 mm. The other measurements may be chosen according to your own insight, but should be sufficiently large that peripheral effects do not play a role.
b) A cylindrical magnet with a butted end.
c) A device which ensures that the butted outer end of the magnet can move freely over the horizontal copper plate. It is important that the distance between the magnet and the plate is as small as possible and remains constant.
d) A launching device which provides the magnet with a given uniform velocity over the copper plate.

Suppose that T is the magnetic friction force which the magnet undergoes, v the velocity and h the thickness of the copper plate. Determine experimentally how T depends on h [t = f(h)] at a given velocity. Investigate how this dependence varies with the velocity.

15. TRANSMISSION OF ENERGY. Without using electrical wires, transmit as large a part possible of the energy stored in a capacitor of 10muF which is charged to 100 V. Measure the amount of energy transmitted. The device must not contain energy sources. The charged capacitor must not itself be transported.

16. THE MOON AND THE SUN. 'If you are asked which is more important, the sun or the moon, you should reply: the moon. For the sun shines during daytime even if there is already sufficient light'. Koz'ma Prutkov. When is it possible to see the sun and the moon at the same time? Calculate a schedule for these events for European countries during 1994.

17. STRAW. A Russian saying goes: 'had I known where I was going to fall, I would have laid some straw'.
How much straw should be laid to guarantee a safe fall?