THIRD INTERNATIONAL YOUNG THE PHYSICISTS' TOURNAMENT
YPT-problems for collective competition by mail.

1. "Your invention" (Physics photographic competition). Produce photographs of high speed physical processes. Explain the value of these photographs for understanding the nature of the processes you have recorded.

2-4. “The ball and piston” A piston oscillates along a vertical axis. The position, x, of the upper surface of the piston is given by the equation $x = x_0\cos(\omega t)$. At an arbitrary moment a small ball falls from a height H onto the piston.

2. How high will the ball rise after the first collision with the piston? In this case consider the collision as absolutely elastic and take $H > x_0$.

3. After many collisions, the system “forgets” the initial conditions. Determine the maximum height to which the ball may rise after a large number of collisions and also the average value of the height attained. Disregard any irreversible changes in the ball and piston, arising from the collisions.

4. Now consider placing a ceiling above the piston at a height H’. In this situation, it is possible to obtain stationary solutions. Find some of these and investigate their stability. For the purpose of making numerical estimates consider the situation in which H’ = 1 m, H ‘>> x_0 , g = 10 m/s2. Take the coefficient of restitution, k, for the ball and the piston (the ratio of relative velocity after collision to the relative velocity before collision) as 0.8.

5. "The planet". What is the maximum volume for which a planet may exist in the form of a cube.

6. "Evaporation - Condensation". The Π-shaped glass tube contains water, with a difference, H, in the levels of liquid in the two limbs of the system. After some time has passed, the two levels become equal. Estimate the rate of restoration of equilibrium for a given value of H at a fixed temperature, T, in the following two cases:
a). The tube is evacuated.
b). The tube contains air at standard pressure.

7. "Cylinder in a tube". A solid cylinder of diameter, d, moves with constant velocity within a long water-filled tube of diameter, D, and length, L. How does the force of resistance to movement depend on the velocity of the cylinder? Take h = D-d « d and L>d. Compare your theoretical predictions with experimental results.

8. "Segner'8 wheel". In Segner's wheel rotation is caused by the reactive forces of water running out of jets in the wheel. When water is 2 sucked into the wheel in a reversal regime, will the wheel rotate or not?

9. "Franklin’s wheel". Rotation of a metal wheel with points mounted on it (Franklin's wheel) when suitably charged is explained by the existence of so called "electric wind". Explain why this wheel will rotate if it is placed between the plates of a parallel-plate capacitor charged by a high voltage generator (Wimshurst machine or

Van de Graaff generator). If Franklin's wheel is replaced by a dielectric disc between the capacitor plates, wi11 th1s system rotate or not?

10. "Electret". 150 years ago, Michael Faraday suggested the electret as an electrostatic analogue of a permanent magnet. Produce an electret and investigate it’s properties.

11. "Colour's of clouds" Explain the observable colours of clouds.

12. "Clouds' boundary". The observable boundary of clouds is often rather sharp and may best be observed from an airplane. Determine the width of clouds' boundary.

13. "Cloud of astronauts" (A fantasy with physical significance). A cloud of astronauts is formed from a large number of astronauts in space. Initially, each has a football. At a given moment, the astronauts begin to exchange these footballs whithout loosing any in the process. Describe the evolution of the "cloud of astronauts". (We dont want to ‘limit your fantasy, so you may choose your own initial conditions, rules of exchange and other characteristics of the "cloud". The selection of all such condit1ons must be properly justified and the conclusions should be supported by numerical estimates. The number of variants described should not exceed two.)

14. "Fractal ?". An old woman reels up woollen yavn into a ball. How does the mass of the ball depend on its diameter?

15. "Light in the tube". Look at a light source through a piece of glass tube about 25 cm, long and 5 mm in diameter. Explain the origin of the rings observed in the tube.

16. "Interference". If two transparent glass plates are put tightly together, one can observe interference fringes. If they are put on a table and a finger pressed in the middle of the upper plate the fringes transform into concentric rings. When the finger is removed, the rings move from the middle to the edges of the plate. Try this experiment and explain the observed phenomena. Estimate theoretically the velocity with which the rings move after the load has been removed.

17. “Scientific labour organization”. Suppose you intend to drive 1990 identical nails, 50 mm long and 2.5 mm in diameter, into a wooden beam. Which hammer will you select to do this fastest and with high quality finish (what is the mass of the hammer head and the length of the handle) for:
a) a pine beam
b) an oak beam