

Problems for the 11th IYPT

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1. Invent yourself

Take a sheet of paper (A4, 80 g/m²) and construct an aeroplane. Make it fly as far and/or as long as possible. Explain why it was impossible to reach a greater distance or a longer time.

2. Jump out of water

A body is submerged in water. After release it will jump out of the water. How does the height of the jump above the water surface depend on the initial conditions (depth and other parameters)?

3. Spinning disks

Investigate and explain the phenomenon of spinning annular disks as they progress down a straight, cylindrical rod. If the rod is moved upwards with a suitable velocity, the disk will spin in the same height. Investigate the mechanism.

4. Water streams

A can with three holes in the casing at the same small distance from the bottom is filled with water. The water will escape in three separate streams. By gently touching the streams with a finger they may unite. Investigate the conditions for this to happen.

5. Water jet

If you direct a vertical water jet towards a horizontal plate, standing waves will develop on the surface of the jet. Investigate the dependence of this phenomenon on different parameters.

6. Mount Everest

Can you see Mount Everest from Darjeeling?

7. Air bubble

An air bubble rises in a water-filled, vertical tube with inner-diameter 3-5 mm. How does the velocity of the rising bubble depend on its size?

8. Trick

It is known that a glass filled with water and covered with a sheet of paper may be turned upside down without losing any water. Find the minimum amount of water for a successful trick.

9. Woven textiles

Look at a point-like light source through different woven textiles. Describe what you see. What is the explanation of the phenomenon?

10. Oscillating freezing

While cooling a vessel filled with an aqueous solution of a volatile fluid (e.g., ammonia, ethanol or acetone) a repeated freezing and melting can be observed near the surface. Describe and explain the phenomenon.

11. Current system

In a Petri dish, small metal balls, e.g., 2 mm diameter, are immersed in a layer of castor oil. The inner rim of the dish contains an earthed metal ring. Above the centre of the dish there is a metal needle which does not touch the oil surface. Investigate what happens when the voltage between needle and earth is about 20 kV.

Warning: The voltage should be obtained by means of a safe generator, e.g., electrostatic generator!

12. Powder conductivity

Measure and explain the conductivity of a mixture of metallic and dielectric powders with various proportions of the two components.

13. Rope

How is it possible that a very long and strong rope can be produced from short fibers? Prepare a rope from fibers and investigate its rupture.

14. Water rise

Immerse the end of a textile strip in water. How fast does the water rise in the strip and what height does it reach? In which way do these results depend on the properties of the textile?

15. Shining sugar

Investigate and explain the light produced when sugar crystals are pulverized. Are there other substances with the same property?

16. Strange motion

Make a mixture of ammonium nitrate and water in the proportion 5 to 1. Heating to about 100 °C melts the mixture. When cooling, it crystallizes and you may observe a strange motion below the surface. Investigate and explain the phenomenon.

Safety rules: Do not heat without water, preferably use a water bath! Use protection glasses during the experiment!

17. Icicles

Investigate and explain the formation of icicles.