

Problems for the 35th IYPT 2022

Released by the IOC on July 14th, 2021

1. Invent Yourself

Create a non-invasive device that determines the direction of fluid flow inside an opaque pipe. Optimise your device so that you can measure the smallest flow possible.

2. Rayleigh Disk

A disk suspended vertically by a thin thread is placed in an acoustic field. This device can be used to measure the intensity of sound by turning about the axis of the thread. Investigate the accuracy of such a device.

3. Ring on the Rod

A washer on a vertical steel rod may start spinning instead of simply sliding down. Study the motion of the washer and investigate what determines the terminal velocity.

4. Unsinkable Disk

A metal disk with a hole at its centre sinks in a container filled with water. When a vertical water jet hits the centre of the disc, it may float on the water surface. Explain this phenomenon and investigate the relevant parameters.

5. Bimetallic Oscillator

A simple electric oscillator can be made using a bimetallic contact-breaker. Investigate the relevant parameters that affect the frequency of such an oscillator.

6. Tennis Ball Tower

Build a tower by stacking tennis balls using three balls per layer and a single ball on top. Investigate the structural limits and the stability of such a tower. How does the situation change when more than three balls per each layer and a suitable number of balls on the top layer are used?

7. Three-Sided Dice

To land a coin on its side is often associated with the idea of a rare occurrence. What should be the physical and geometrical characteristics of a cylindrical dice so that it has the same probability to land on its side and one of its faces?

8. Equipotential Lines

Place two electrodes into water, supply a safe voltage and use a voltmeter to determine electric potential at various locations. Investigate how the measured equipotential lines deviate from your expectations for different conditions and liquids.

9. Water Spiral

If a stream of liquid is launched through a small hole, then under certain conditions it twists into a spiral. Explain this phenomenon and investigate the conditions under which the spiral will twist.

Authors: Maria Anghel, John Balcombe, Marya Buda, Jim Chen, Nikita Chernikov, Carlos Márcio de Oliveira e Silva Filho, Teimuraz Gachechiladze, Kent Hogan, Juasher Jejelava, Gerard Jennings, Teck Seng Koh, Frantisek Kundracik, Daniel Lizotte, Ilya Martchenko, Oksana Pshenichko, Andria Rogava, Artem Sukhov

Problem selection committee: John Balcombe, Samuel Byland, Ilya Martchenko

10. Droplet Explosion

When a drop of a water mixture (e.g. water-alcohol) is deposited on the surface of a hydrophobic liquid (e.g. vegetable oil), the resulting drop may sometimes fragment into smaller droplets. Investigate the parameters that affect the fragmentation and the size of the final droplets.

11. Balls on an Elastic Band

Connect two metal balls with an elastic band, then twist the elastic band and put the balls on a table. The balls will begin to spin in one direction, then in the other. Explain this phenomenon and investigate how the behaviour of such a "pendulum" depends on the relevant parameters.

12. Strange Motion

Sprinkle small floating particles on the surface of water in a bowl. Bring a strong magnet above and near to the water surface. Explain any observed motion of the particles.

13. Candle Powered Turbine

A paper spiral suspended above a candle starts to rotate. Optimise the setup for maximum torque.

14. Ball on Membrane

When dropping a metal ball on a rubber membrane stretched over a plastic cup, a sound can be heard. Explain the origin of this sound and explore how its characteristics depend on relevant parameters.

15. Boycott Effect

If particles are suspended in a liquid that has a lower density than the particles, the particles will settle to the bottom of the container. The rate of settling can be affected by tilting the container that holds the liquid. Explain this phenomenon and investigate the effect of relevant parameters.

16. Saving Honey

When rotating a rod coated with a viscous liquid (e.g. honey), under certain conditions the liquid will stop draining. Investigate this phenomenon.

17. Invisibility

Lenticular lenses can be used to distort light and make objects disappear. Investigate how changing the properties of the lens and the geometry of the object affect the extent to which the object can be detected.