Problems for the 40th IYPT 2027

Approved by the IOC on 14 July 2026

1. Invent yourself: Pinhole sunglasses

Investigate the optimal arrangement of pinholes in an opaque film to produce sunglasses that reduce light intensity and help correct short-sightedness.

2. Disc spectrometer

Data tracks on optical media (e.g. CDs / Blu-ray discs) behave as high-quality reflection-diffraction gratings. When illuminated, these discs can disperse light into its spectral components. Construct a spectrometer using a digital optical disc. Optimise the design to maximise the resolving power and minimise optical aberrations.

3. Snail ball

A hollow sphere contains a heavy ball and some viscous fluid. The rolling motion of such a sphere down an inclined plane is uneven and surprisingly slow. Explain and investigate this effect.

4. Singing capacitor

Certain types of ceramic capacitors emit an audible sound when an alternating voltage is applied across them. Investigate the characteristics of the sound produced and how they depend on relevant parameters, such as voltage, frequency, and capacitor properties.

5. Y-shaped pendulum

Construct a Bowditch pendulum (a pendulum whose strings form a "Y" shape). Investigate how the Lissajous patterns generated by the bob depend on the relevant parameters.

6. Seeing sound

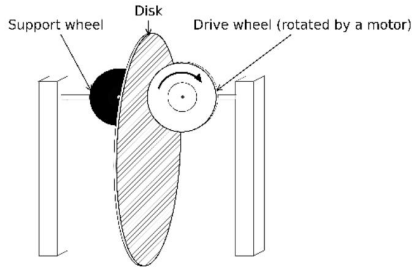
A thin rubber membrane is stretched over a circular frame and driven into vibration by a loudspeaker. A small mirror is attached to the membrane, and a laser beam is reflected off it onto a distant screen. Under certain conditions, the laser spot traces out complex, steady, or evolving geometric patterns. Investigate the relationship between the driving parameters, the membrane's properties, and the resulting light patterns.

7. Sinking funnel

When a long-stemmed and sufficiently heavy funnel is released vertically into water with the stem pointing downward, it undergoes a series of damped vertical oscillations while gradually sinking. Investigate the motion and stability of the sinking funnel and the conditions under which the funnel tips over.

8. Upward-driven disc

A circular disc is suspended from the point where it is sandwiched between two wheels, making it free to oscillate as a pendulum. One of the wheels is driven by a motor and thus exerts an upward driving force on the disc. Investigate the motion of the disc.



9. Photographic bokeh

Bokeh is an effect observed in photographs that show objects at different distances from the camera and have both sharp and out-of-focus areas. If a slit is placed in front of the lens of the camera, the image may have unusual anisotropic distortions in out-of-focus areas, while in-focus areas remain undistorted and sharp. Investigate how the properties and sharpness of resulting images depend on relevant parameters.

10. Air vortex

Place a small rod-shaped magnet on the bottom of a vessel filled with liquid and set it into rotation using a magnetic stirrer. Above a certain rotation speed, a thin air channel forms, extending from the liquid surface down to the rotating magnet itself. Investigate and explain this phenomenon.

11. Sound isolation

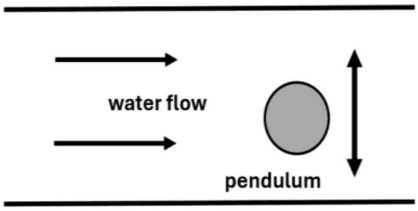
The sound isolation of a room may become breached if the door is not shut properly, even if the gap is negligibly small. Investigate how the shape and size of a small opening affect the transmission of sound.

12. Dotted line trick

Under certain conditions, when a piece of chalk is dragged across a blackboard, the resulting trace is not a continuous line but a periodic sequence of dots, even though the motion is uninterrupted. This can happen with other writing materials and surfaces. Investigate the physical parameters that govern this phenomenon.

13. Vortex pendulum

A pendulum with a vertically oriented cylindrical bob is suspended above a channel of flowing water. When the bob is partially submerged, the flow may cause the pendulum to oscillate in a direction perpendicular to the flow. Explain this phenomenon and determine how it depends on relevant parameters.



14. Non-Newtonian worms

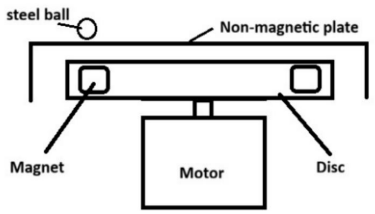
A dilatant non-Newtonian fluid (e.g. a suspension of water and cornflour) is vibrated vertically in a reservoir. When certain conditions are met, wormlike structures that rise from the surface may form. Explain and investigate this phenomenon.

15. Cold drink

A can or bottle of drink at room temperature can be cooled in a cooler containing ice. Adding salt and alcohol to the ice can increase the rate of cooling and affect the drink's final temperature. Investigate how the relevant parameters affect the lowest achievable temperature and the maximum cooling rate.

16. Magnetic carousel

Several neodymium magnets are attached to a horizontal disc, with adjacent magnets oriented in opposite directions. A fixed non-magnetic plate is placed horizontally above the disc. When the disc rotates about its vertical axis and a steel ball is placed on the plate, the ball may move either in the same direction as, or opposite to, the rotation of the disc. Investigate this phenomenon and determine how the motion depends on relevant parameters.



17. Falling book cover

A book is placed horizontally, and the partially open cover is allowed to fall. Investigate the motion of the falling book cover.

Problems submitted by: Artsiom Bury, Samuel Byland, Wang Duanyu, Sam Edgecombe, Artem Golomolzin, Lucas Heck, Gavin Jennings, Nikita Karpenko-Chernikov, Qingtong Liu, Fabricio Marques, Ilya Martchenko, Oksana Pshenichko, Kyo Tovchigrechko, Aleksandr Zinkevich.
Special thanks to: Gavin Jennings, Fabricio Marques, Samuel Byland, Falk Ebert, Andrei Schetnikov, Giorgi Khomeriki, Ilya Martchenko, Łukasz Gładczuk.