

Problems for the 27th IYPT 2014

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*When throwing pebbles into water, watch the ripples;
Otherwise throwing the pebbles becomes a futile pastime.*
Kozma Prutkov

1. Invent yourself

It is known that some electrical circuits exhibit chaotic behaviour. Build a simple circuit with such a property, and investigate its behaviour.

2. Hologram

It is argued that a hologram can be hand made by scratching a piece of plastic. Produce such a 'hologram' with the letters 'IYPT' and investigate how it works.

3. Twisted rope

Hold a rope and twist one end of it. At some point the rope will form a helix or a loop. Investigate and explain the phenomenon.

4. Ball sound

When two hard steel balls, or similar, are brought gently into contact with each other, an unusual 'chirping' sound may be produced. Investigate and explain the nature of the sound.

5. Loaded hoop

Fasten a small weight to the inside of a hoop and set the hoop in motion by giving it an initial push. Investigate the hoop's motion.

6. Bubble crystal

A large number of very small, similar air bubbles float on the surface of a soapy liquid. The bubbles will arrange themselves into a regular pattern similar to a crystalline lattice. Propose a method to obtain bubbles of a consistent size, and investigate the formation of such a bubble crystal.

7. Pot-in-pot refrigerator

The 'pot-in-pot refrigerator' is a device that keeps food cool using the principle of evaporative cooling. It consists of a pot placed inside a bigger pot with the space between them filled with a wet porous material, e.g. sand. How might one achieve the best cooling effect?

8. Freezing droplets

Place a water droplet on a plate cooled down to around -20 °C. As it freezes, the shape of the droplet may become cone-like with a sharp top. Investigate this effect.

9. Water bombs

Some students are ineffective in water balloon fights as the balloons they throw rebound without bursting. Investigate the motion, deformation, and rebound of a balloon filled with fluid. Under what circumstances does the balloon burst?

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10. Coefficient of diffusion

Using a microscope, observe the Brownian motion of a particle of the order of micrometre in size. Investigate how the coefficient of diffusion depends on the size and shape of the particle.

11. Candle Power Plant

Design a device that converts the heat of a candle flame into electrical energy. Investigate how different aspects of the device affect its efficiency.

12. Cold balloon

As air escapes from an inflated rubber balloon, its surface becomes cooler to the touch. Investigate the parameters that affect this cooling. What is the temperature of various parts of the balloon as a function of relevant parameters?

13. Rotating saddle

A ball is placed in the middle of a rotating saddle. Investigate its dynamics and explain the conditions under which the ball does not fall off the saddle.

14. Rubber motor

A twisted rubber band stores energy and can be used to power a model aircraft for example. Investigate the properties of such an energy source and how its power output changes with time.

15. Oil stars

If a thick layer of a viscous fluid (e.g. silicone oil) is vibrated vertically in a circular reservoir, symmetrical standing waves can be observed. How many lines of symmetry are there in such wave patterns? Investigate and explain the shape and behaviour of the patterns.

16. Magnetic brakes

When a strong magnet falls down a non-ferromagnetic metal tube, it will experience a retarding force. Investigate the phenomenon.

17. Chocolate hysteresis

Chocolate appears to be a solid material at room temperature but melts when heated to around body temperature. When cooled down again, it often stays melted even at room temperature. Investigate the temperature range over which chocolate can exist in both melted and 'solid' states and its dependence on relevant parameters.