Problems of the 11th IYPT
(Official version 97/10/15)

2. Popping body

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

4. Water streams

A can with three holes in the side-wall at the same height slightly above 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 a vertical water jet falls down onto 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 to 5 mm. How does the velocity of the rising bubble depend on its shape and 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 any loss of water. Find the minimum amount of water to perform the trick successfully.

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. Repeated freezing

While a vessel filled with an aqueous solution of a volatile fluid, e.g., ammonia, ethanol or acetone, is being cooled, repeated freezing and melting may be observed near the surface. Describe and explain the phenomenon.

11. Current system

In a Petri dish (shallow bowl), small metal balls, e.g., 2 mm in 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 high voltage should be obtained by means of a safe generator, e.g., an 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 tensile strength.

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. Luminescent 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, proportion 5 to 1. When the mixture is heated to about 100 °C it melts. When it cools,it crystallizes and you may observe a strange motion below the surface. Investigate and explain the phenomenon.

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

17. Icicles

Investigate and explain the formation of icicles.

Problems for the International Young Physicists Tournament 1999 in Vienna

---

1. ROTATION
   A long rod, partially and vertically immersed in a liquid, rotates about its axis. For some liquids this causes an upward motion of the liquid on the rod and for others, a downward motion. Explain this phenomenon and determine the essential parameters on which it depends.
   Sketch of experimental setup (16 kByte)

2. IONIC MOTOR
   An electrolyte (an aqueous solution of $CuSO_4$, NaCl, ...) in a shallow tray is made to rotate in the field of a permanent magnet (a small "pill" placed under the tray). An electric field is applied from a 1.5 V battery in such a way that one electrode is in the form of a conducting ring immersed in the electrolyte - the other is a tip of a wire placed vertically in the centre of the ring. Study the phenomenon and find possible relationships between the variables.
   Sketch of experimental setup (14 kByte)

3. MAGIC MOTOR
   Construct a DC motor without a commutator, using a battery, a permanent magnet and a coil. Explain how it functions.
   Sketch of experimental setup (26 kByte)

4. SOAP FILM
   Explain the appearance and development of colours in a soap film, arranged in different geometrical ways.

5. DROPPED PAPER
   If a rectangular piece of paper is dropped from a height of a couple of meters, it will rotate around its long axis whilst sliding down at a certain angle. What parameters does the angle depend on?

6. SINGING GLASS
   When rubbing the rim of a glass containing a liquid a note can be heard. The same happens if the glass is immersed in a liquid. How does the pitch of the note vary depending on different parameters?

7. HEATED NEEDLE
   A needle is hanging on a thin wire. When approached by a magnet, the needle will be attracted. When heated, the needle will return to its original position. After a while the needle is attracted again. Investigate this phenomenon, describe the characteristics and determine the relevant parameters.

8. ENERGY CONVERTER
   A body of mass 1 kg falls from a height of 1 m. Convert as much as possible of the released potential energy into electrical energy and use that to charge a capacitor of 100 μF.

9. AIR DRYER
   During a time span of 4 minutes collect as much water as possible from the air in the room. The mass of the equipment must not exceed 1 kg. Its initial temperature should be equal to ambient (room) temperature. The water should be collected in a glass test tube, provided by the jury.

10. CHARGED BALLOON
    An air-filled balloon rubbed with wool or dry paper may stick to the ceiling and stay there. Investigate this phenomenon and measure the charge distribution on the surface of the balloon.

11. BILLIARD
    Before a pool-billiard game starts, 15 balls form an equilateral triangle on the table. Under what conditions will the impact of the white ball (16^{th} ball) produce the largest disorder of the balls?

12. FLOUR CRATERS
    If you drop a small object in flour, the impact will produce a surface structure which looks like a moon crater. What information about the object can be deduced from the crater?

13. GAS FLOW
    Measure the speed distribution of the gas flow in and around the flame of a candle. What conclusions can be drawn from the measurements?

14. WHEAT WAVES
    The wind blowing through a wheat field creates waves. Describe the mechanism of the wave formation and discuss the parameters which determine the wavelength.

15. BRIGHT SPOTS
    Bright spots can be seen on dew drops if you look at them from different angles. Discuss this phenomenon in terms of the number of spots, their location and angle of observation.

16. LIQUID DIODE
    Make an electrochemical diode and investigate its properties, in particular the frequency dependence.

17. SOUND FROM WATER
    When you heat water in a kettle you hear a sound from the kettle before the water starts to boil. Investigate and explain this phenomenon.

Problems for the
13th International Young Physicists'
Tournament 2000
8-15 July 2000, Budapest, Hungary

1. Invent for yourself

Suggest a contact-free method for the measurement of the surface tension coefficient of water. Make an estimate of the accuracy of the method.

2. Tuning fork

A tuning fork with resonant frequency of about 100 Hz is struck and held horizontally, so that its prongs oscillate up and down. A drop of water is placed on the surface of the upper prong. During the oscillation of the tuning fork standing waves appear on the surface of the drop and change with time. Explain the observed phenomena.

3. Plasma

Investigate the electrical conductivity of the flame of a candle. Examine the influence of relevant parameters, in particular, the shape and polarity of the electrodes. The experiments should be carried out with a voltage not exceeding 150V.

4. Splash of water

Measure the height reached by splashes of water when a spherical body is dropped into water. Find a relationship between the height of the splashes, the height from which the body is dropped, and other relevant parameters.

5. Sparkling water

Bubbles in a glass of sparkling water adhere to the walls of the glass at different heights. Find a relationship between the average size of the bubbles and their height on the side of the glass.

6. Transmission of signals

Using a bulb, construct the optimum transmitter of signals without any modulation of the light beam between transmitter and receiver. Investigate the parameters of your device. The quality of the device is defined by the product of the information rate (bits/sec) and the distance between transmitter and receiver.

7. Merry-go-round

A small, light, ball is kept at the bottom of a glass filled with an aqueous solution and then set free. Select the properties of the solution, so that a moving up time of several seconds is achieved. How will this time change if you put your glass on the surface of a rotating disk?

8. Freezing drop

Drops of melted lead or tin fall from some height into a deep vessel filled with water. Describe and explain the shape of the frozen drops as a function of height of fall.

9. Radioactivity

Use efficient methods to collect as much radioactive material as you can in a room. Measure the half-life of the material you have collected.

10. Liquid fingers

When a layer of hot salt solution lies above a layer of cold water, the interface between the two layers becomes unstable and a structure resembling fingers develops in the fluid. Investigate and explain this phenomenon.

11. Throwing stone

A student wants to throw a stone so that it reaches the greatest distance possible. Find the optimum mass of the stone that should be used.

12. Tearing paper

Tear a sheet of paper and investigate the path along which the paper tears.

13. Rolling can

A can partially filled with water rolls down an inclined plane. Investigate its motion.

14. Illumination

Two bulbs, 100 and 40 watts, respectively, illuminate a table tennis ball placed between them. Find the position of the ball, when both sides of the ball appear to be equally lit. Explain the result.

15. Cooling water

Two identical open glasses, filled with hot and warm water, respectively, begin to cool under normal room conditions. Is it possible that the glass filled with hot water will ever reach a lower temperature than the glass filled with warm water? Make an experiment to investigate this and explain the result.

16. Coloured sand

Allow a mixture of differently coloured, granular materials to trickle into a transparent, narrow container. The materials build up in distinct bands. Investigate and explain this phenomenon.

17. A strange sound

Pour hot water into a cup containing some cappuccino or chocolate powder. Stir slightly. If you then knock the bottom of the cup with a teaspoon you will hear a sound of low pitch. Study how the pitch changes when you continue knocking. Explain the phenomenon.