INTERNATIONAL PHYSICISTS' TOURNAMENT

IPT 2012 Problems

MOSCOW INSTITUTE OF PHYSICS AND TECHNOLOGY

1. Mean Trick in the Shower

It is known that in conditions of collective water supply the temperature of the water flowing on the man in the shower can change, if in the next booth, the valve is being opened or closed. Why does it happen? For how many degrees can one change the temperature of the neighbor's water with such actions?

2. Water Shield

When washing dishes one can easily see that if one puts the spoon under the stream, the water will scatter not in the form of droplets but in the form of a thin film of pretty large radius (the faster and the thicker water jet is, the greater is the radius). Describe this phenomenon both qualitatively and quantitatively.

3. The Less People the Better

As you know, when people are sitting in a small closed room for several hours the air in the room becomes hot and stuffy. Assuming that people just are sitting and talking explore the dependence of the temperature in the room on its size, the temperature on the street, and the number of people in it. How will the situation change if we open the window? How will the humidity outside affect the situation.

4. Incandescent Data Transfer

Achieve a maximum data transfer rate using an incandescent bulb as a transmitter to modulate the optical signal, and a photo sensor as a receiver.

5. Aerial Man

One can find a radio with a missing antenna. When one brings a finger close to the aerial plug of such a radio, the reception is often dramatically improved. Aerial of what quality can a man represent without touching the radio antenna? What is the length of a metal spoke that a man can match with in the quality of signal reception?

6. Rope Phone

In the childhood we played with a rope phone. Two cups connected by a rope gave us the opportunity to talk on the distance. What determines the distance and the quality of communication of such a phone? How does the frequency transmission of the sound at the other end of the rope depend on its tension and diameter?

7. Cheating Dice

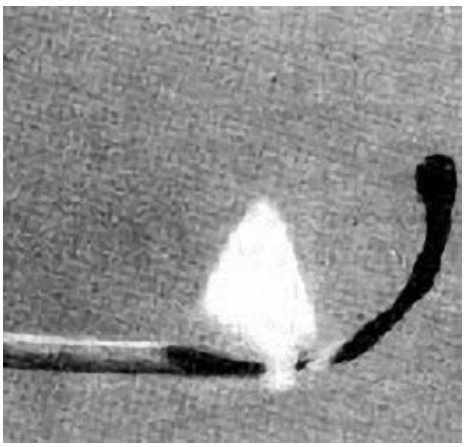
Consider the possibility of fraud in a casino with the help of the dice with a displaced center of mass or with ferromagnetic marking of faces. Estimate the displacement for center of mass or the magnitude of the magnetic field of the magnet embedded in the table needed to provide double probability of getting the required face in each of the methods.

8. Dolphin Rings

Dolphins can create stable vortex rings from air bubbles and play with them under water afterwards. Investigate the stability of this ring, estimate its lifetime. How dolphins manage to disconnect smaller rings from the larger ones?
http://www.youtube.com/watch?v=UkmfmosZONc

9. Curve Match

Why a horizontal lighted match will be curled up after burning down? However vertical match remains flat. Try to obtain the form of a match burnt at a certain angle.



10. Soap Cruiser

Construct a toy ship, working on the engine of soap or other surfactant. Estimate the maximum speed that can be achieved in a ship of this type.

11. Airplane

You have a sheet of A4 paper. At what maximum distance can fly an airplane, made from the sheet? How does the distance depend on the density of the paper and the type of airplane?
Rules for airplanes making can be found at: http://www.augq07.dsl.pipex.com/paamain/distance.html

12. Leaping Halfball

Take a tennis ball and cut it into two parts. Turn inside out one of the halves and put it on the table. It will bounce not immediately, but after a few seconds. How one should cut the ball in order to observe this effect? How the altitude and the delay of bouncing depends on the thickness and properties of rubber?

13. Hot Shots

Find the speed of the fire wave running along a row of matches with their heads in contact. How will it change when the distance between the heads is increased?

14. Candle Overclocking

When a burning tea candle (low candle in a metal bowl) is boiling one can drip a drop of water in it. This will produce a high fire pillar. How does the height of the pillar depend on the parameters of the problem? Due to which reasons is it restricted?

15. Winnie-the-Pooh

Why does the rubber balloon burst produce a lot of scraps? Estimate their amount and examine their size distribution.

16. Tearing in the Thinnest Points?

Experienced anglers say that any knot on the fishing line reduces its strength by several times. Is this true? If so, which knots are the most "dangerous" ones? Explore how does the strength of fishing line with a knot depend on the line's diameter with respect to original strength. Explore this phenomenon experimentally and theoretically.

17. Icy Hedgehog

When freezing water in a glass you might see some unusual structure consisting of a set of long channels (see my photo). Explain this phenomenon. What does the average distance between channels depend on?

Bonus problem. Precious Cold

The Snow Queen gave Kai the last task, after which she promised to release him. She often traveled to various countries, some of them were very hot. The only thing that saved the Snow Queen was a thermos of liquid nitrogen.

In order to save Kai you should make the best thermos of 0.5 liters volume, that is one in which the nitrogen evaporates as slow as possible. Justify theoretically the choice of your thermos and estimate the time of evaporation.

Note: The Snow Queen gave Kai only 20 Euros for supplies. He also has only 3 hours for its manufacture. Ambient temperature is 20°C, as well as the initial temperature of the thermos (before filling it with nitrogen).

The best solution of the bonus problem will be awarded by a special prize from Organizing Committee. Moreover this problem will be the subject of the final captain competition.

The Organizing Committee is grateful to all people who took part in proposition and selection of the problems.