

# IPT 2013 Problems

## 1. The Tea Is Ready!

Many tea lovers cool the boiling water by pouring it a thin stream into the teapot. How does the final temperature of the water depend on the height, the water flow and the environmental conditions?

## 2. Laser espionage

It is known that a conversation can be overheard using a laser, pointed on a piece of glass in the room. Suggest design of espionage device that enables to overhear a conversation at the maximal distance. Which factors influence the signal quality at most?

## 3. Hexagonal honey

If a small amount of honey is poured out on a plate and then flooded with a layer of cold water a clear hexagonal pattern can sometimes be seen. Explain this phenomenon. Under what conditions this pattern appears and what are the characteristic dimensions of the cells?

## 4. Lethal jump

It is known, that professional stuntmen and traceurs make a roll when they jump from great heights. How does it help to avoid injuries? What is the maximal height one can safely jump on the asphalt from owing rolling technique to perfection?

<http://www.youtube.com/watch?v=rekmYbFRbK0> – video with David Belle, the founder of Parkour.

## 5. Battery Cry

Fabricate the AA type battery powered sound source (i.e. continuously converting electric energy, stored in the battery, into sound) which is as loud as possible.

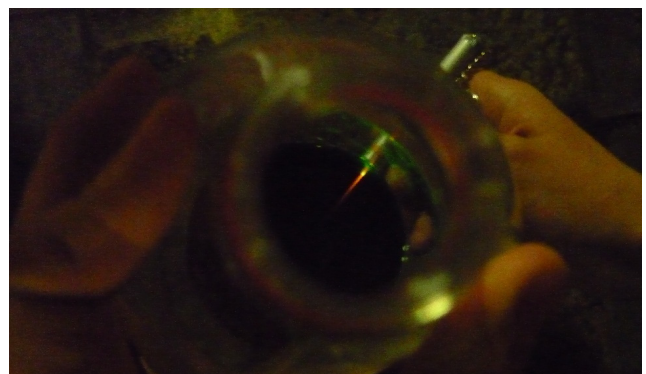
## 6. Vibrocar

Fix an eccentric vibrator on the top of large cleaning brush. When put on a table with bristles down, the brush will start moving ahead. Study and explain this effect. Research in what way this construction can be optimized for obtaining the maximum possible efficiency.



## 7. Spectral Cola

Take a green laser pointer and a half-full Coca-Cola bottle. If you'll point the laser beam horizontally into the cola and look through the bottleneck, you'll see the laser beam propagating on some distance (5-8 cm). The beam will change its color depending on its height: from green near the cola surface to red at a greater depth. What explains this phenomenon? How does the beam spectrum depend on the cola layer thickness?

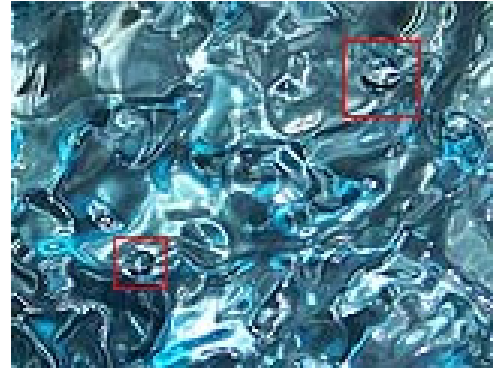


### 8. Frozen waves

Frozen wave crests and splashes can be seen on a solder drop fallen from the soldering iron a smooth surface. What parameters of the solder alloy can be retrieved from the analysis of these structures? Investigate both theoretically and experimentally.

### 9. Drop on water

A container filled with water was set up on a vibrating table so that quasi-stationary waves were formed on the water surface. Under what conditions drops of water that fall on the surface will move in between the waves? Explain this effect qualitatively and evaluate the lifetime of such drops. What does it depend upon?



### 10. Water mercury

A drop of water covered with fine powder, which is obtained by burning the keyboard's rubber, behaves in an interesting way: it doesn't stick to hands and rolls like mercury. Explain this phenomenon. What is the effective surface tension coefficient of the obtained liquid?

<http://www.youtube.com/watch?v=PSiSHhw99Tw&feature=related>

### 11. Anomalous Winter

On the roofs of houses icicles can be formed at a certain angle to the vertical (sometimes significant, see photo). Explain this phenomenon. On what parameters does the icicles' inclination depend?



### 12. Unipolar motor

Unipolar motor can be easily made at home:

[http://www.youtube.com/watch?v=EkU\\_JmtH3PU](http://www.youtube.com/watch?v=EkU_JmtH3PU). What is its maximal speed of rotation? What maximal energy conversion efficiency can be achieved, what factors does it depend upon?

### 13. Free energy from under high-voltage transmission line

A fluorescent (mercury-vapor) lamp is placed under a high-voltage power line. The lamp shines. Explain this phenomenon qualitatively and describe it quantitatively. Estimate light power emitted by the lamp depending on the lamp's parameters, the power line's characteristics and their relative position.



### 14. Fridge-Distiller

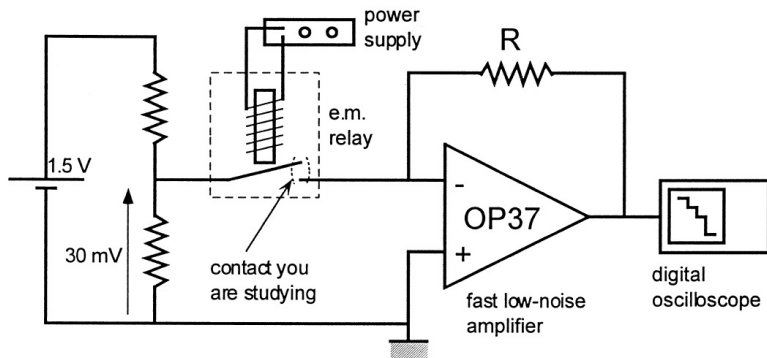
When freezing water the quantity of salt it contains decreases. What is the minimum quantity of salt one may obtain by freezing the water once? May this be a method to desalinate the sea water?

### 15. Sand Castle

Estimate the strength of wet sand. What is the maximum height of a "sand castle" that can be built on a given base area?

### 16. Conductance quantum

Few people know that conductance quantization can be observed in a simple electro-mechanical relay at room temperature. Obtain the experimental value of conductivity quantum. How close can it be to the theoretical value at room temperature? The possible scheme of the experimental assembly is shown in the figure.



### 17. Spirit of Africa

Many native tribes (as well as Japanese ninjas and some others) use blowguns to shoot poisoned needles in war or for hunting. Suggest the optimal construction for achieving maximal shooting range and estimate the shooting range (the air pressure is created by human lungs)?

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

