PROBLEMS FOR THE 16TH IYPT

1ST TO 8TH July, 2003
UPPSALA, SWEDEN

1. Motion of a kite
On windy days one can see kites flying in the wind. Often, one-string kites move on a stable track, which looks like a number 8. Why does a kite move in such a way? Are there other stable tracks?

2. Water drops
Investigate and explain the movement of raindrops on a window pane.

3. Transparent film
If you cover printed text with a piece of transparent polyethylene film you can still easily read it. As you gradually lift up the film, the text becomes increasingly blurred and may even disappear. Study the properties of the film. On what parameters of the film is the phenomenon based?

4. Bright spots
Blow a soap bubble and allow it to rest on a liquid surface or a glass plate. When illuminated by sunlight, bright spots can be observed on the bubble. Investigate and explain the phenomenon.

5. Bubbles at an interface
Certain liquids can be layered one above the other with a sharp interface between them. If the surface tensions of the liquids are different, then an interesting phenomenon can be observed. Blow bubbles of different sizes into the lower liquid and observe their behaviour near the interface. Investigate and explain the phenomenon.

6. Freezing soft drinks
On opening a container of cold soft (carbonated) drink the liquid inside sometimes freezes. Study the relevant parameters and explain the phenomenon.

7. Oscillating box
Take a box and divide it into a number of small cells with low walls. Distribute some small steel balls between the cells. When the box is made to oscillate vertically, the balls occasionally jump from one cell to another. Depending on the frequency and the amplitude of the oscillation, the distribution of the balls can become stable or unstable. Study this effect and use a model to explain it.

8. Heat engine
Construct a heat engine from a U-tube partially filled with water (or another liquid), where one arm of the tube is connected to a heated gas reservoir by a length of tubing, and the other arm is left open. Subsequently bringing the liquid out of equilibrium may cause it to oscillate. On what does the frequency of the oscillation depend? Determine the pV diagram of the working gas.

9. Falling chimney
When a tall chimney falls it sometimes breaks into two parts before it hits the ground. Investigate and explain this.

10. Tungsten lamp
The resistance of the tungsten filament in a light bulb shows a strong temperature dependence. Build and demonstrate a device based on this characteristic.

11. Light scattering
Construct an optical device for measuring the concentration of non-soluble material in aqueous colloid systems. Use your device to measure the fat content of milk.

12. Boiled egg
Construct a torsion viscometer. Use it to investigate and explain the differences in the 'viscous' properties of hens' eggs that have been boiled to different extents.

13. Electro-osmosis
Develop a device that will drain wet sand, with the aid of an electrical voltage but without significant heating.

14. Rotating disk
Find the optimum way of throwing a 'frisbee' as far as possible. Explain your findings.

15. Vortices
Make a box that has a hole in its front wall and a membrane as its back wall. Hitting the membrane creates a vortex that propagates out from the hole. Investigate the phenomenon and explain what happens when two vortices interact.

16. Pot and ice
It is sometimes argued that to cool a pot effectively one should put ice above it. Estimate to what extent this is more effective than if the ice is put under the pot.

17. Prometheus problem
Describe and demonstrate the physical mechanism, based on friction, which allowed our ancestors to make fire. Estimate the time needed to make fire in this way.