

Problems for the 3rd IYNT 2015

Nach dem Spiel ist vor dem Spiel.
Sepp Herberger

1–3. Invent yourself

Formulate an open ended problem focused on a particular topic, and then solve this problem.

1. Invent yourself: Physics

Topic: precise weighting. Study the physical effects that influence precise weighting of solid objects with a mass of 10 to 100 g.

2. Invent yourself: Biology

Topic: microorganisms. Suggest an investigation of such cases that allow for a quantitative study and reproducible measurements.

3. Invent yourself: Chemistry

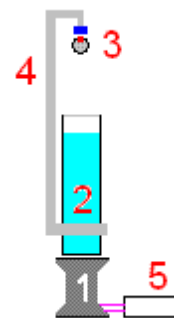
Topic: chemistry of potatoes. The ‘life’ of one potato tuber, from its growth in soil, to storage, and finally to human use such as boiling or production of chips, is a lengthy chain of chemical processes. Select and study one or several links of this chain.

4. Sunset

The visible Sun disk touches the horizon and after a particular time interval disappears behind the horizon. What is the duration of this time interval? Explain the optical phenomena observed during a sunset.

5. Falling ball

An electronic balance (1) is connected to a PC (5) in order to record the time dependence of the measured weight. A light frame (4) is mounted on a tall beaker (2) filled with water. The frame has a holder (3) allowing controlled release of a small ball such that it falls into the water. The beaker is placed on the balance as depicted in the Figure. Investigate how the readings of the balance reflect the different phases of the motion of the ball.



6. Disappearing ink

Suggest a chemical formulation for the ink that would disappear after used to write a text. What parameters determine the time when the text becomes invisible? Is it possible to process the paper in such a manner that the text appears again?

7. Pancakes

It is argued that pancakes can be so good looking that they ignite appetite by their appearance only. Suggest grounded scientific criteria to parameterize how appetizing the pancakes are.

8. Library

One person has decided to download all of the fiction existing in the English language and store it on a single USB stick. He expects to find or generate the respective text files, compress them, and then index them conveniently. Is this ambition realistic? Suggest a plan to approach this goal and solve a partial problem of this plan.

9. Distances in open space

How do astronomers measure distances between the planets of the Solar System, between the stars in our Galaxy, or between the galaxies? Determine the distance between the two space objects of your choice.

10. Ice hole

You have drilled two ice holes in a frozen lake on a frosty winter day. One ice hole is close to the shore, while the other ice hole is far from the shore. Surprisingly, the height difference between the ice surface and the liquid water is different for each hole. How can you explain this? How can one use this height difference to determine the local ice thickness?



11. Puzzle in a beaker

A researcher decided to measure the diffusion rate of ammonia in gelatin. He added some magnesium sulfate to the hot gelatin solution which set to a gel on cooling. He then poured some aqueous solution of ammonia onto the gel and left the beaker for two days. The researcher was surprised to discover white layers of precipitate in the beaker, as depicted in the Figure. Explain this phenomenon and determine what does the number of bands depends upon.

12. Structure of a hair

The hair of various animals may significantly differ in their structure. What are these differences and how can you explain them?

13. Shining orbs

Bright and rather unexpected white disks may appear in a photo taken with a flash in a dark room. Explain why such shining orbs appear in the photos.

14. Galton box

In the Galton box, a regular 2D lattice of obstacles disperses a thin flow of falling particles. When falling on the bottom of the box, the particles show a normal distribution. Use various types of particles and different arrangements of the obstacles to find the conditions when the distribution is no longer normal.

15. Fly

A fly can easily walk on a ceiling. How is this possible? Can one find such a ceiling that the fly would be unable to walk on?

16. Smoke ring cannon

Construct such a vortex ring cannon that would shoot with smoke rings on a distance sufficient to hit the chairperson of your Science Fight.

17. Starch monsters

A water suspension of starch is placed on a loudspeaker. Investigate and describe the resulting starch monsters.

The problems are authored by Svetlana Buldygina, Elena Derevyagina, Tatyana Korneeva, Andrei Malykhin, Ilya Martchenko, Evgeny Yunosov. The problem set, including the epigraph, is compiled, prepared and edited by Evgeny Yunosov and Ilya Martchenko. Translated by Ilya Martchenko in Kyustendil.
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This official set of problems for the IYNT 2015 is approved by General Council of the IYNT and can be used only at the events endorsed by the General Council of the IYNT.