Problems of the International Young Naturalists' Tournament 2014

Yes, "know"! Men call it so, but then
Who dares to call the child by its right name?

Faust, Goethe

1. Invent yourself
Formulate an open problem on your own and solve it. Topic: experiments using a microscope. Allowed magnification: from 10X to 60X.

2. Potatoes
A classic board, as understood by carpenters, is a rectangular parallelepiped with significantly varied linear dimensions (length>width>thickness.) They call such a parallelepiped a bar if width and thickness are comparable. If all three dimensions are comparable, they call it a cube. When a homogenous board floats on the water surface, its biggest face is horizontal. A board "knows" perfectly this rule and always "abides" to it. But for a bar the rule becomes ambiguous and its behavior is determined by ratio of its density to water density. For a cube, it is even more "ambiguous" in this regard. Use potatoes for an experimental investigation of floating bodies of different shape. Regulate the density ratio through adding salt to water. Investigate the different ways of how bodies of various shapes can float.

3. Discovery of chemical elements
Name ten most common chemical elements in the Earth crust. For one of them describe and, if possible, reproduce as many as possible of the experiments through which this element has been discovered.

4. Pulse
Investigate how human pulse depends on the speed of running and fitness of the human. Come up with a parameter characterizing the fitness. Estimate how much energy the human spends on running in addition to normal body functions.

5. Last droplet
A beaker is filled to the brim with water that dips into the middle of the beaker from a low height. Can you estimate what droplet will be "the last straw", i.e. the drop that will make the water to spill over the edge of the beaker?

6. Water on the Earth
The modern astrophysics states that the World Ocean emerged on the Earth due to a lengthy and intensive comet bombarding at a certain stage of the Solar System formation. Find out as many parameters of this grandiose phenomenon as you can.

7. Tourist route
You are a manager at a travel agency developing sport and sightseeing trips. In a summer, a family with children wishes to make a week-long trip from Paris to Düsseldorf. They wish to cover part of the route on a bicycle (no more than 50 km per day) and part of the route on regional trains (no more than 2 hours per day.) Since the children have to sleep during the night, the travel should not start before 10 a.m. and finish after 8 p.m. on any day. The overnight stays should be possible at camping sites where pitching a tent is allowed. The trip should pass through interesting places.
Suggest a journey plan to the family and specify the following for each day: mileage on the bicycle, duration of train connections, highlights of the sightseeing. List the online resources required for a detailed planning of the travel. Take into account the usability of the services given the fact that the tourists speak only English.

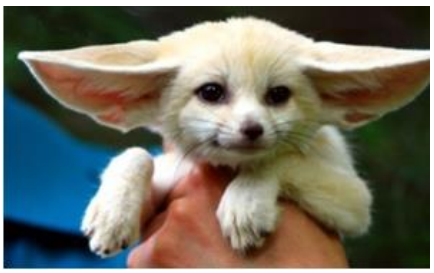
8. Droplet
Place a droplet of salt water on a glass plate and study the process of drying. How does the deposit of dried droplets depend on the salinity of water? Perform the same with a droplet of black tea.

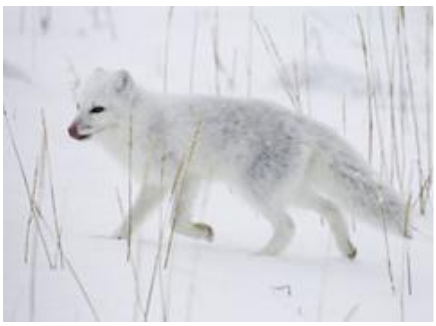
9. Traffic lights in a test tube
Volodya the fifth grader decided to collect as many liquids of various colors as possible in one tube. He succeeded to produce the "chemical traffic lights" as shown. Try to beat Volodya's record.

10. Straw
What is the maximum length for a vertical straw such that you still can drink non-carbonated water through it? Still can drink cola through it?

11. Colorful bouquet
It is known that the color of a carnation flower can be changed if the plant is watered with an ink solution. Can the color of the flowers be changed by other methods? Explain the principle of your method. To what flowers is it applicable?

12. Foxes and penguins
There are certain regularities in the distribution of closely related species of warm-blooded animals. For example:
1. North Africa is home for the smallest and long-eared Fennec Fox, and tundra is home for the bigger Arctic Fox, which has shorter ears and legs. The regular fox is something intermediate between them.





2. The biggest of the penguins, the Emperor Penguin (height over 120 cm), lives on the Antarctic coast; while the smallest, the Galapagos Penguin (height about 50 cm), lives in the tropical belt near the coast of South America.

Identify and explain the regularities in the distribution of warm-blooded animals across the Earth. Show your own examples evidencing these regularities.

13. Format of photos
You have a photograph in the BMP file format (a natural scenery or a portrait.) Convert it to the JPG file format. The differences are nearly invisible though they exist. Propose a visual method to demonstrate these differences.

14. Weight loss
Weigh yourself on a "good" balance immediately before the going to the bed in the night and then immediately after waking up. Did you detect a difference? Explain the results. Besides, what balance would you consider a "good" balance?

15. Four points
Do the following experiment: put points at arbitrary positions on several sheets of paper, four points per each sheet. Suggest other participants of the experiment (e.g., members of your team) to do the same. Now connect sequentially these points with straight line segments so that they form a quadrilateral (cases in which a triangle or just a straight line are formed, should be discarded.) Now count the total number of the quadrilaterals (N) and the number of convex quadrilaterals (n), and calculate the ratio $k=n/N$. Likely to be that $k>0.5$.
Question: What is k for a very large N and why, if :

a) the experiment is performed by a computer and visualized on the display?

b) the experiment is performed by a computer, but is not visualized, and is carried out in a mathematical program?

c) the experiment is performed a large number of people?

d) a real experiment is not performed, but you find the ratio theoretically if N tends to infinity?

16. Potatoes again
If a freshly dug potato tuber, or a tuber stored in a dark room, is left in the sunlight, its surface becomes green. Why does this happen? And what would happen to the color of the tuber if it is put again into a dark room for a long time?

17. Measurement of color sensitivity
Some people (called color blind persons) have difficulties comparing the colors of two objects. But most people perceive the color difference at the first glimpse. The difficulties arise when the colors are hardly distinguishable, e.g. if colors of two leaves from the same tree need to be compared. How is it generally possible to quantitatively estimate the ability of a person to distinguish the color shades? Is a single numerical parameter sufficient, or a more complicated evaluation system is required?

Selected and approved in Moscow
Problems authored by Tatyana Gratsianova, Yury Kaminsky, Tatyana Korneeva, Andrei Kravtsov, Ilya Martchenko, Ekaterina Mendeleeva , Viktor Nechayev, Elena Snigireva, Elena Trufanova, Evgeny Yunosov.
Compiled, edited and prepared by Evgeny Yunosov.

Epigraph translated from the German by George Madison Priest
Problems translated from the Russian by Ilya Martchenko in Lund and Andrei Klishin in Cambridge
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