

# International Student Tournament of Three Sciences



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## Dear participants!

Here is the list of science problems for the first round of the Tournament of Three Sciences 2015. Please, follow all the safety instructions while conducting your experiments.

*"Don't Panic!"*

*Adams Douglas, The Hitchhiker's Guide to the Galaxy.*

### 1. "Living" antenna

Is it possible to use a plant as an antenna for receiving radio waves? Design a radio set that uses a plant as an antenna, and study the properties of this "living" antenna (operating frequency range, directivity index, attenuation index, radiation height, etc).

### 2. Fountain

It is a well-known fact, that "Mentos" mints when dropped into Coke produce a lot of gas, and the mixture sprays out of the bottle. How can you explain this phenomenon? What other substances (both widely spread and safe) can cause such an effect? What is the maximum height of the fountain at the optimum concentration of the reactants? Study the dependence between the height of the fountain and the concentration of the reactants (we advice to use a standard plastic bottle for the experiment).

### 3. No sides!

Paleontologists have found out that practically all the organisms of Ediacaran period died naturally. Is it possible for Biosphere to exist without predators and parasites? Suggest a model of a food chain consisting of producers and decomposers only, and give an estimate of its energy efficiency.

### 4. Chain reaction in cotton wool

Study the burning velocity and temperature of cotton wool depending on its porosity. Suggest a theoretical model of the cotton wool burning process. What is the dependency between the burning velocity and temperature and the features of the gas in which it is burned (humidity etc.)? Compare the theoretical model with the results of your experiments. Please, follow the safety instructions while conducting experiments.

## **5. Yeast Calculator**

Develop a computer system based on unicellular organisms (for example, yeast). You can use any method of information input - output in the system, but the calculation must be based on changing the state of one or several unicellular organisms. Suggest a theoretical model for your system. Design an experimental physical model of the system.

## **6. Eywa**

Is it possible for plants to communicate using their root system? Identify biological, information, and theoretical parameters of the information transfer for any plant species you choose.

## **7. Truthful Cat**

There are certain tools and techniques that allow us to determine whether a person is lying or not. All of them involve psychophysiological research. Suggest a technique and tools that can be used to study the psychophysiological state of a pet. Optimize the devices used and the proposed technique.

## **8. Communicating with unicellular organisms**

Suggest a chemical way to communicate with unicellular organisms. Chemical method of communication means sending information to unicellular organisms by chemical signals and receiving information from them using the same chemical signals. What information about the state of these organisms and their environment can we get this way? Is it possible to use your chemical method of communication to estimate the air quality or to predict the future of the biogeocenosis?

## **9. Workplace of the Future**

As we all know, office clerks, engineers, programmers and other specialists constantly using computers for their work are subject to various musculoskeletal system illnesses and eye disorders. Suggest a design of a workplace that

- a. will minimise the negative health effect of working at the computer,
- b. will cost (in mass production) no more than an average office desk and a chair in your country, and will be of the same size .

## **10. Acoustics of rhinitis**

When you have rhinitis, your voice changes. How can you explain this phenomenon? Suggest theoretical and experimental models for it. Use your models to study the changes in different characteristics of human voice. Is it

possible to use the results of your studies to diagnose any otorhinolaryngologic diseases by the voice change?

### **11. Stuck waves**

If you make a flat sheet of paper wet, it turns wavy. How can you explain this phenomenon? In which way does the shape of "waves" on the paper depend on the essential parameters?

### **12. Handgum**

A handgum can be made of PVA glue and borax liquor. Why does the resulting mixture have the properties of a non-Newtonian fluid? In which way do the properties of the handgum depend on the concentration of the initial components and the conditions of their mixing?

### **13. Cheap and fresh**

Can you suggest any chemical mixture that will be safe for humans and will be able make sea water fresh and drinkable? The composition must be safe and of minimum cost.

### **14. Mosquito hibernation**

Chironomidae can live practically in any environment, surviving the dehydration even when water constitutes only 3% of their body weight. How can you explain this phenomenon? Can any other organisms manage to do the same? Determine the limiting factors. Suggest ways to use this process for saving rare species.

### **15. Acid radiation**

There are some organic substances (for example, luminol) that, when oxidized, emit light as part of the energy produced by the reaction. Estimate the efficiency coefficient of this process. Define the experimental conditions that allow for the maximum amount of light emission. Which conditions ensure the highest efficiency coefficient? Can we change the emission spectrum by changing the conditions of the experiment?

### **16. The Best Home**

25 tanks were dumped into the Gulf of Thailand recently in order to create artificial coral reefs and increase the population of fish in this region. Suggest your own method for creating artificial shelves. Your method should provide the maximum increase in coral population and be of minimal price. Is your technique environmentally friendly? Provide virtual model results of using your technique.

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***The Organizing Committee is grateful to everyone who suggested the problems  
for the Tournament!***

For more information on the problems contact Alexander Kharin (**phys.vsu@gmail.com**).

***Good luck!***