

Problems of VII International Natural Sciences Tournament October 10-16 2016, Novosibirsk, Russia

Version 1, 30.08.2016. Contains 8 from 15 problems divided into 3 units

Unit X*

1. Hibernation

In 1961 Yuri Gagarin made the first human spaceflight. Fifty five years later, in spite of all the difficulties and failures of space programs, humankind still has not lost the hope of interstellar flight. Lots of science fiction books and movies describe the risks of launching so-called “generation starship”, which could reach the destination only after several generation changes among the passengers. Therefore, in future necessary will be the technologies, which could let a group of trained individuals to fly towards new discoveries and set up a colony in another planetary system before the end of their lives.

Propose a method of human hibernating for a long-term space flight. Consider the details of entering hibernation state and getting out of it. Providing that the spacecraft can achieve 0.5% speed of light, explore if the radiation, relativistic effects or astronomical objects will affect the proposed method.

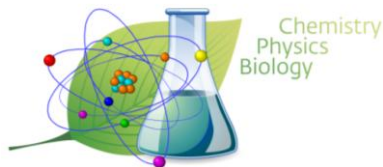
2. Back to the future

To make the time machine from the movie “Back to the Future” work, 1 GW of electric power is required. This power in the movie can be generated with the help of nuclear reactor. As soon as the main heroes get to the past, the nuclear fuel becomes unavailable, so the only way to get back to the future is using a lightning spark as an energy source. Keeping lightning under control is not an easy task. Most of the energy, produced by the electric discharge and captured by lightning rod, is known to be spent on heating the atmosphere. Only a tiny part of this energy can be preserved. Estimate, how much energy can be obtained with the help of a lightning rod. Propose other methods of extracting atmospheric electricity. Point possible application area. Estimate practicability of the proposed methods for different regions of the Earth.

3. Will be published until September 12.

4. Will be published until September 12.

5. Will be published until September 12.



Unit Y*

6. The 5th sense

In the last few years, there has been a large development in the area of limb prostheses engineering. Mind-controlled bionic limbs or parts of exoskeletons are not just a science fiction, but real working devices. However, in spite of the fact that the ways of motor functions recovery have already been found, sensory perception is still unavailable for all types of prostheses. From physiological point of view, explain the importance of the interaction between motor and sensory parts of nervous system for making static and dynamic movements by an individual limb. Propose various modules, which could provide prostheses with sensory function. Clarify their working mechanism and principle of their interaction with the nervous system.

7. Emperor's ring

Long ago gemstones were believed to possess mysterious and magical properties. For example, rich people, who were afraid of being poisoned, often wore rings with rubies. A ruby was thought to change its color if put into poisoned drink, warning about the danger. Do the gemstones, applicable for the detection of widespread poisons, poured into beer or wine, really exist in nature? If so, describe their composition and working mechanism. Relying on contemporary scientific knowledge, propose a method of creating gemstone indicators, applicable for jewelry. The created gemstone should be an indicator to several poisons.

8. Will be published until September 12.

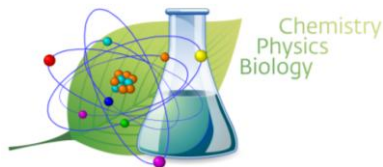
9. Will be published until September 12.

10. Will be published until September 12.

Unit Z*

11. Colorful distillation

One of the most important educational aspects is visualization of processes and phenomena. The key specialty of demonstrative experiments is their clarity and spectacularity. However, such an important process as separating liquids by distillation often looks like obtaining colorless fractions out of colorless liquid. Color differences would make this experiment more impressive, understandable and memorable. Propose a method of performing an experiment on separation of at least three liquids by distillation. The experiment must include color changes, which will make clear the process of separation in dephlegmator or fractional column. Resulting fractions must be different in color too.



12. A Song of Water and Fire

One of Russian Academy of Science libraries burned down in 2015. About 5 million books were destroyed; most of them had not been digitized. All the knowledge contained in those books was lost forever. Current fire detectors either have low sensitivity or are very expensive. A possible solution of the problem might be book impregnation, with a special compound featuring release of a specific gas upon smoldering. In that case, the gas could be easily detected with an inexpensive gas detection system. The compound should not compromise quality of books, and such books should be safe to handle, even after a long-term storage. Propose such a compound.

13. Osmotic eel

In the Star Trek: Enterprise series (2000, season 1, ep.1-2), a so-called “osmotic eel” – a small aquatic lifeform — was used to heal a starship captain leg wound he got from a laser rifle fire-fight. Propose a concept of a device or biological object that would autonomously promote healing of burns, deep cuts, and stab or gunshot wounds. The device/object should stop bleeding and promote healing in a timely manner. Would it be possible to use your device/object for internal organs healing as well?

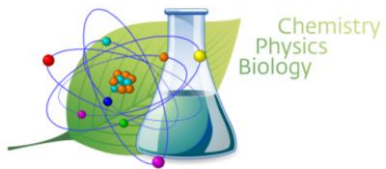
14. Hot water

Solar energy use is one of innovative areas in renewable energy industry, where thermal or electrical energy is produced from sun irradiation. Solar collector systems are a promising technology, widely used for water heating and space heating. However, these systems are usually bulky and heavy; require a sophisticated manufacturing technology and laborious transportation; need an additional energy source as a backup. These features, together with a high cost, render a solar collector system unattractive for outdoorsmen, campers, and other consumers who prefer outdoor activities. Propose an alternative design of an affordable solar collector system (or its components) for water heating with the following features: lightweight, portability, ease of installation, independent operation mode, and high thermal efficiency.

15. Will be published until September 12.

* The problems are divided into units X, Y and Z. Each unit corresponds to a certain tournament day (including final round). The order of units will be announced in three days before the tournament starts. Please, be careful to work through each problem. Remember, that you may refuse to solve any one problem in each block.

No extended solution (*.doc) is needed.



If you have any questions in regard to the presented information, please, do not hesitate to contact us again by:

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