

International Natural Sciences Tournament

February 1-6, 2019

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participants@scitourn.com

Problems of the Intramural round of IX International Natural Sciences Tournament

Unit X

1. T-1000

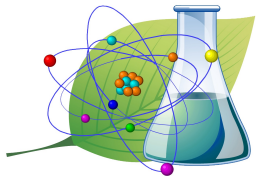
In nature, there are insects, the color of which is not based on pigments, but on the surface morphology. Recently, scientists were able to apply a similar approach to metals, as a result of which the surface acquired superhydrophobic properties and became almost completely black. Suggest your own methods for creating different solid colors of metals only by modifying the surface structure of the metal or alloy itself. Assess the thermal, chemical and mechanical stability of such a surface, depending on what color is created. Suggest applications for the metal products with such a surface.

2. Char Ecosystem

The StarCraft series of computer games features the planet Char – a volcanic world with a high temperature, due to which the lava does not freeze even on the surface, and a complete lack of vegetation. However, it is inhabited by a huge number of alien creatures – zergs. Judging by their appearance, all zergs, even the weakest and most numerous of them, are predators. How could the Char ecosystem be arranged then? What serves as food for so many predators if there are no traces of autotrophs on the surface of the planet? Your solution should not contradict to the known laws of biology and ecology. You can find more information about this fictional planet [here](#).

3. The Chinese study

In the summer of 2018, some batches of the drug valsartan, for which the active substance was produced by the Chinese company Zhejiang Huahai Pharmaceuticals, were recalled from the pharmaceutical market. The reason of the recall was the presence of a dangerous impurity N-nitrosodimethylamine (NDMA) in the active pharmaceutical substance. NDMA is highly hepatotoxic and is classified as a proven carcinogen. Its presence in valsartan is believed to be caused by the changes in the production method of the active substance. What do you suppose was the source of N-nitrosodimethylamine in the active pharmaceutical substance? How should the way it is produced be modified to avoid the appearance of this



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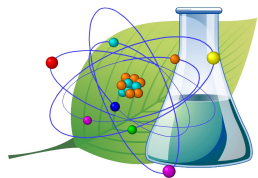
impurity? Is it possible to effectively purify the supplied substance from NDMA? If this is possible, suggest an alternative production scheme, which excludes the appearance of N-nitrosodimethylamine in the substance.

4. Shake, but do not mix

Check out this [video](#). If you look at the tape in polarized light through a polarizing filter, it will become colored. Furthermore, the observed color will depend on the number of layers of scotch tape and the rotation angle of the polarizing filter. Investigate this phenomenon, create a theoretical prediction model of the spectral line shape of such 'colored' light, and check experimentally whether the model you propose is consistent with the taken spectrum.

5. Breakthrough Starshot

„Breakthrough Starshot“, announced in 2016, is a program that aims to send micro probes to the Alpha-Centauri star system. This will be the first interstellar flight of an object developed by man. The probe used in the program is a set of measuring instruments weighing 1 gram equipped with a solar sail. An array of lasers is supposed to be used to accelerate the entire structure to 20% of the speed of light. One of the unsolved problems of the project is the material of the solar sail: since it is accelerated to high speed, the sail can suffer from star dust or overheat by reflected light. Suggest a physical model of the solar sail and your material options, which would have a high light reflection factor, be heat-resistant, lightweight, and durable.



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Unit Y

6. The Olive

According to various estimates, more than half of all sold olive oil is more or less counterfeit. One of the main methods of adulteration is adding cheaper low-quality oil. This threatens to cause great economic damage to stores and large oil producers, and also cases of serious health problems and even the death of consumers have been recorded. To date, the control of quality and authenticity of olive oil requires a series of analyzes, which is too labor consuming, since each batch of oil must be analyzed. Suggest a method, or the minimum possible number of analyzes that could be easily applied to numerous samples, and allowed one to detect the addition of other oils to olive oil in an amount of more than 1% by weight.

7. Smartdryer

When traveling, a person may need various heating devices – a hair dryer, a kettle, a shoe dryer, a heater, etc. All of them have a similar operating principle, however, they differ greatly in power and efficiency. Offer the concept of a compact universal heating device that performs the functions of the above devices in reasonable time for each case.

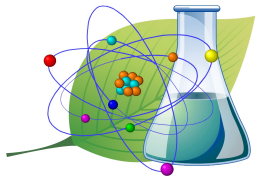
8. Vitamin sea

With the development of aviation, moving around the world has become very simple and affordable, and within a day you can get to anywhere in the world for work or vacation. Evolutionarily, the human body is not adapted to such a drastic change in external conditions, which leads to significant discomfort and possible health problems. Explain the mechanisms that occur in the body during the adaptation to new environmental conditions when traveling to different climatic zones, and suggest a way to accelerate acclimatization based on the described mechanisms.

9. WALL-E 2.0

In 2009, the commercial communication satellite Iridium 33 came into collision with the decommissioned communication satellite "Kosmos-2251". This collision created a large amount of debris, and yet again increased the mass of industrial waste on the orbit of the Earth.

Space debris is a severe problem for launching and operating spacecrafts, yet still there are no reliable ways of cleaning up our planet's orbit. Propose your own technology for removing space debris, as well as assess and justify its recyclability.



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10. Green worms

There is a belief among fishers that fish bite at green worms that glow underwater better. Is there any physiological prove of this assumption? Propose your own way of increasing the appeal of worms to the fish, taking into account the fish's physiological and behavioral characteristics. Your alteration should be available to the ordinary fisher.

Please, be careful to work through every problem. Remember that you may refuse to solve any one problem in each unit.

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 via:

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