International Natural Sciences Tournament
February 6-12, 2020
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Problems of the Grand final of X International Natural Sciences Tournament

Part 1

1. Glitter (Krastsvetmet)

Rhodium plating, i.e. coating with a thin layer of rhodium, is one of the ways to give silver alloys used for jewelry a better resistance to darkening during usage. The most common alloy composition is silver and copper in weight ratio of 37 to 3. However, even though rhodium plating is widely used, this method is insufficient – over time, rhodium-plated silver darkens when worn or used. Suggest an alternative way to make silver products that will not darken when used. Economic efficiency must be taken into account.

2. Forever together (Krastsvetmet)

Iridium, rhodium, ruthenium, and osmium are called satellite metals due to their presence in small quantities in platinum and palladium ores. These metals have found their use in many industrial fields if being properly separated from each other. Suggest an industry-efficient refining scheme for these metals from platinum-palladium concentrates and explain each step of the scheme. In order to estimate the conditions, take into account the following facts: average volume of concentrate in a tank is *ca.* 500 kg, the fraction of all four elements does not exceed 0.5%, and their concentrations can be considered roughly equal. Average value of platinum and palladium (in total) in concentrate can be considered as 95% by weight.

3. Atlas shrugged

Nowadays almost everyone has experienced muscle cramp at least once in their life. Long-term tension of the shoulder girdle and collar zone may lead to cramps of neck muscles. Muscle cramps block blood circulation that results in stagnant and degenerative processes, as well as chronic illnesses. The list of instrumental methods for diagnosing this condition is short and consists of very expensive investigations. Propose a concept for a device capable of diagnosing muscle cramps at home in a timely manner.

4. Rhinella marina

Cane toad, or *Rhinella marina*, was artificially introduced to Australia 80 years ago and since then its population has reached 200 million specimens and keeps growing. All body parts of cane toad are poisonous, causing not only economical, but also ecological damage. Nowadays the most effective but time-consuming method against *Rhinella marina* is simply trapping it manually. Offer cost-effective technology for controlled reduction of the species population in Australia with its further maintenance at a safe or low level. Minimize the possible impact of your proposed method on the Australian eco-system.

5. Vostok

Lake Vostok is the largest and deepest subglacial lake in Antarctica. Obtaining samples from this lake could shed a light on the evolution of life on the Earth and be a model system for getting subglacial samples from other celestial bodies. However, there is a high chance of contaminating the lake while taking up samples. Scientists managed to investigate only periglacial layer, but such samples cannot be considered as representative due to possible living activity in the lake since the conditions on the bottom and on the periglacial layer can differ quite drastically. How to carry out sampling from the bottom of the lake Vostok without contaminating it? Is it possible to use the method you suggested for experiments in space?

6. Biology - 21st-century science (MelScience)

MEL Science produces and distributes educational physics and chemistry sets so users can conduct experiments at home. Propose a prototype of an experiment set for biology and medicine that visually demonstrates a central achievement of molecular biology, biochemistry, or physiology. The proposed set must be completely safe and comply with international shipping regulations.

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 Teams' coordinator Polina Lavrik via:
e-mail: participants@scitourn.com.