



**Problems of V International Natural Sciences Tournament
12-17 November, Saint-Petersburg, Russia.**

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Unit A (November 13)

«The city and the stars»

The novel "The City and the Stars" written by Arthur Clarke tells about residents of Diaspar city: "Outside the city there were such things as day and night, but within it there was only eternal day. As the sun descended the sky above Diaspar would fill with light and no one would notice when the natural illumination vanished. Even before men had lost the need for sleep, they had driven darkness from their cities". Propose a method of decreasing the time people need to sleep up to the total lack of it. The method must not harm intellectual and physical abilities of people in the long term.

«Tastes differ»

Coffeehouse chains (for example, Starbucks) buy raw materials from the same suppliers around the world to keep up quality of drinks. The taste of coffee should be the same in every coffee house of one chain worldwide. But it is not. What are possible reasons of the coffee taste difference in different countries and regions? How can these differences be minimized?

«The tooth fairy»

To fix results of active medical treatment of his bite a patient has to wear a polymer retainer (bite splint). It is uncomfortable and many people do not wear them as long as it was prescribed. This leads a decrease in efficiency and prolongation of the treatment. Propose a method of defining the real time of retainer wearing with a necessary precision

«Laboratory 2020» (Biocad)**

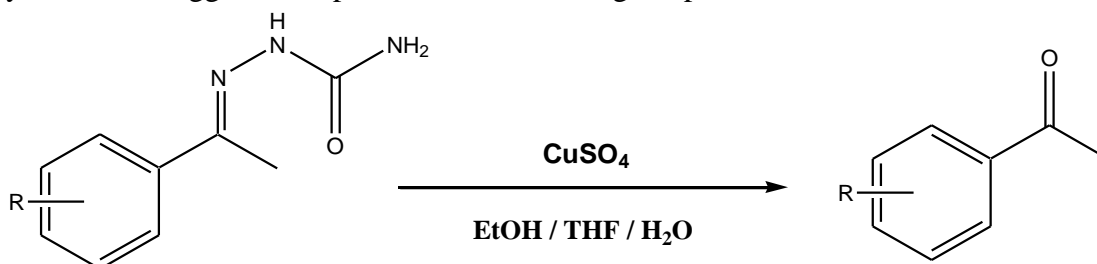
The key to great success in the world of synthetic chemistry is a modern laboratory of organic synthesis. Imagine yourself a designer of a fine organic synthesis laboratory in 2020. The lab obtains and produces up to 1 kg/year of pharmaceutical substances. Suggest new approaches to organize the laboratory with the use of modern science and technology. Note that you must design a storage room for reagents, solvents, glassware and comply with all current regulations and safety requirements.

«A defenseless reaction» ** (Biocad)

Aromatic ketones play a significant role in the modern pharmaceutical industry as precursors for the production of important pharmaceutical substances. Such ketones can be synthesized by means of the Friedel-Crafts acylation of aromatic hydrocarbons. This method mostly results in a mixture of isomers and to be separated they need to be transformed into

corresponding semicarbazones. The desired ketone is obtained by isolation from the mixture of its semicarbazones followed by its deprotection.

One method of removing the protection group is treatment of the semicarbazone with copper sulfate (II) in a solvent system containing tetrahydrofuran, ethanol and water. Suggest and justify the mechanism of this reaction. What reaction conditions can help reach maximum yield? Also suggest a simple method of isolating the product from the reaction mixture.



Unit B (November 15)

«A time to cast away stones»

Sometimes it is necessary to demolish old brick buildings. Because of compact city building often one needs to take a building apart floor by floor. Propose a technology to selectively destroy the material of mortar joints holding bricks together. The method should not act on the bricks and keep them usable. Evaluate economic efficiency of the proposed method.

«Star Trek»

In science fiction movies for example “Star Trek” one can see, how spaceships raise a “force field” to protect from enemy missiles and attacks of laser weapon. Until nowadays there are no methods of protecting from laser radiation of a high power, however systems of anti-missile defense do exist. Propose a method of protecting spaceships from laser weapons. What other applications your concept may have?

«Young chemist»** (MEL Science)

Probably, many of you had a chemical science kit when you were a kid. These kits help children study the basics of chemistry at home. They contain a set of reagents, some simple equipment and an instruction describing a number of experiments. These experiments have not changed for the last hundred years, although technologies have stepped forward. Propose essentially new devices and approaches that can be used in chemical science kits for children, which would make it possible to do real (not virtual) chemical experiments that are more interesting, spectacular, but still safe. Experiments in the kit should include a wide range of the most important chemical phenomena. The collection must meet the safety requirements of the European Union countries and USA.



«A fight with Hogweed »

In the middle of the XX century in USSR it was planned to use Sosnowsky's Hogweed (lat. *Heracléum sosnóvskyi*) as a forage fodder. But it turned to run wild soon and to seize territories displacing other plants. The sap of Hogweed causes painful chemical burns. Propose an inexpensive and effective method of fighting Sosnowsky's Hogweed, which laymen could use without risking their health. Take into account, that soil must be safe and suitable for agriculture in no more than a year after Sosnowsky's Hogweed is rid of.

«Hypochlorite» (Neohim)**

Sodium hypochlorite is one of the strongest oxidizing agents widely used in industry. It is used for many purposes, e.g. for bleaching wood pulp, mold removal, etc. However, aqueous solutions of this compound are unstable. Suggest the most economically efficient way to store a 15% sodium hypochlorite solution in the summer herewith preserving an active chlorine level of at least 14% in conditions of a production warehouse. Sodium hypochlorite is supplied in tanks, poured into 1m³ containers and consumed within two weeks. The maximum possible temperature inside the stock is +32°C. There is water and electricity in the stock; however modifying or dismantling the concrete warehouse floor is not possible.

Unit C (November 16)

«Anti-pepper»

In many countries of Asia and South America it is a tradition to cook using a lot of hot pepper. This fact often turns to be very uncomfortable for tourists and can lead to serious health problems. Propose a safe method of alleviating or neutralizing the irritation of the mucous membranes caused by pepper. It is desirable that the method doesn't change the taste of other ingredients.

«Dunno on the Moon» †

People's energy duty is doubled every 10-15 years. Scientists suggested to construct solar power stations on the Moon in search of new energy supplies. In lunar soil there is a mineral regolith which includes up to 30% of silicon. Please, suggest a technology for automated production silicon from regolith and for creation a solar power stations on the Moon. How could one deliver the energy from Moon to the Earth? How much energy can be obtained using the technology?

«A dusty story»

There are diseases that require a patient to be shielded from contact with even a little quantity of domestic dust. Eliminating the contact with allergens from the atmosphere still remains one of the most important medical tasks. However in some serious cases it is not enough to clean surfaces from dust only once, because one cannot be sure that all dust has been removed. Propose a practical way to detect domestic dust on surfaces (for example, walls, household things, toys, etc.) which could help solve this problem.



«The basis» (ELTECH)**

Currently, petrochemical synthesis is bound to a particular raw material. However, there is an alternative approach, which involves the transformation of primary raw materials into a basis chemical compound which is then used to construct the full cycle of the synthesis of important chemicals, fuels and lubricants. Evaluate the advantages and disadvantages, as well as the economic feasibility of the use of dimethyl ether as a basis compound

«Wastewaters» (Pharmsynthez)**

Industrial wastewaters require additional processing before they undergo biological transformation at wastewater treatment plants. Most industrial wastes are highly diluted aqueous solutions (90-95% of water). Moreover, they contain water-soluble organic compounds (i. a. 5-30% DMF, 83% IPA), volatile organic amines, hydrazines, alkalis and acids, fluorescent compounds, metal complexes, lipids, inorganic salts (chlorides more than 16 g/L). It is asked to develop the most general approach to the pre-treatment of wastewater, so that water after cleaning meets the following requirements:

- pH-interval = 6.5 - 9.0
- temperature < 40 °C
- COD/BOD_{full} < 1-5 or COD/BOD₅ < 2.5

- When put in a column 10 cm high and diluted no more than 1 to 16, the solution should be colorless.

Moreover, your technology shouldn't be cost-intensive (it should demand an investment of no more than \$100000 and maintenance costs no more than \$2500 per month). The amount of waste is 60 m³/year.

****Problems proposed by sponsoring companies are marked with two asterisks (**). For intermural-round problems extended solutions are not required. However, you can receive a special prize and diploma from a sponsor for the best solution by laying out your decision in the form of a .doc MS Word document and passing it to the organizing committee for participation in the contest along with presentations on the day the problem is played. Even those who are not participating in the tournament can send their solutions to sponsor's problems by email tournament@chem.spbu.ru till November 11, 2014**