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47th International Chemistry Olympiad

Baku, Azerbaijan

Three Bronze Medals for Switzerland at the 47th International Chemistry Olympiad in Baku, Azerbaijan

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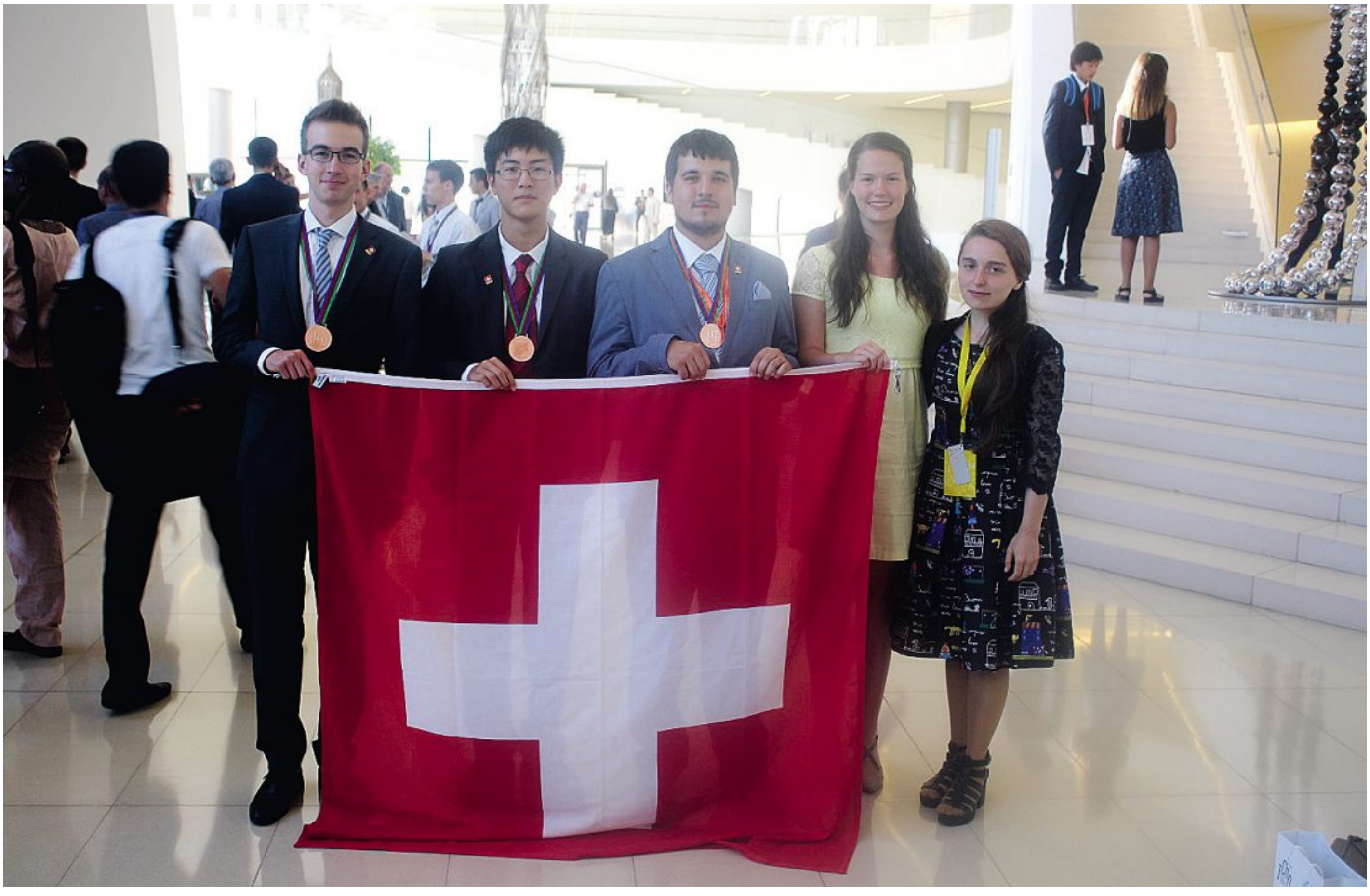
The International Chemistry Olympiad (IChO) is an annual competition in chemistry for students in secondary education from all over the world. Since the first IChO took place in 1968 in the former Czechoslovakia with only three participating countries, the competition was growing steadily to the point where 79 countries participated in the 47th IChO in July 2015 in Baku, Azerbaijan.

The competition with 292 participating students and 237 mentors, observers and guests was held at the Baku Branch of Lomonosov Moscow State University. The team representing Switzerland consisted of ***Lukas Lüthy*** (Alte Kantonsschule Aarau, AG), ***Gary Shang*** (International School of Geneva, GE), ***Ramon Kuster*** (Kantonsschule Wattwil, SG) and ***Fanny Tschopp*** (Gymnasium Münchenstein, BL). They were accompanied by ***Yannick Suter*** (ETH Zürich) and ***Matthieu Mottet*** (IBM Research Zürich). ***Mario de Capitani*** (Universität Bern) completed the team as observer for Liechtenstein.

We are happy to announce that the Swiss team received three bronze medals, awarded to Lukas Lüthy, Gary Shang and Ramon Kuster for their performances in both the theoretical and the practical tasks. The 47th IChO was won by Yifu Ouyang from China who led an impressive Chinese team effort as they were placed 1st to 4th in the overall ranking.

Not only is the IChO a competition, it is also a chance for the students to meet and connect with fellow students from many different countries. The cultural exchange did not only happen between the students but also with the Azerbaijani culture and history. The opening and closing ceremonies featuring many traditional music and dance performances and also a tour through Baku where we were introduced to the rich history of the city are just some of the very positive memories of Baku and Azerbaijan. Chemistry is also very important and has a rich history in Azerbaijan due to the use of petroleum since ancient times, which is also reflected in the national flag of Azerbaijan.

The theme of this year's IChO was 'Life is a huge laboratory'. The organizers used the theme on one side to highlight the importance of chemistry in modern science, the utilities of industrial applications as well as the combination with biology, summarized by the statement "we are all bioreactors". This also showed in the exam tasks reflecting many aspects of modern chemistry as well as referencing to either the history of Azerbaijan or the



From left to right: Lukas Lüthy, Gary Shang, Ramon Kuster, Fanny Tschopp and our guide Medina Alizade.

IChO's theme. As an example, we give here the second part of the 5th theoretical task.

Example Task 5.2: Diagnosis of Disease

The derivative of glucose, 2-deoxy-2-(18F)fluoro-D-glucose (FDG), is the most common radiopharmaceutical for diagnosis of cancer using positron emission tomography. The first step of FDG preparation is to produce a radionuclide fluorine-18 by nuclear reaction in a cyclotron. The next step is the radiochemical synthesis. Fluorine-18 is introduced into a D-glucose molecule by nucleophilic substitution. FDG, once injected into the patient, actively accumulates in cells of malignant tumors; this process is accompanied by decomposition of fluorine-18. This radionuclide is a β^+ emitter, meaning the nucleus emits a positron (anti-electron). This positron interacts with an electron, annihilating both particles, which can be detected. This allows the tumor sizes and type to be determined precisely.

1. Complete the nuclear reactions leading to various fluorine isotopes.

a) $^{18}O + p \rightarrow \ldots + ^{18}F$
b) $\ldots + ^{2}_{1}D \rightarrow ^{18}F + \alpha$
c) $^{19}F + ^{2}_{1}D \rightarrow ^{20}F + \ldots$
d) $^{16}O + \ldots \rightarrow ^{18}F + p + n$

2. The decay mode of unstable light nuclei depends on the ratio between the number of neutrons and protons in them. If this ratio is greater than that for a stable isotope then the nucleus decays in a β^--mode, if it is smaller – in a β^+-mode. Determine the type of decay for the following nuclei: ^{11}C, ^{20}F, ^{17}F, ^{14}C.

3. It is known that within five minutes after completion of irradiation of the target the ratio of radioactivities of ^{18}F and ^{17}F is 10^5. Assume the radioactivity of each isotope is proportional to the nuclear reaction yield, irradiation time is short, and the mole fraction of a component in the irradiated target. Calculate the mass fraction of $H_2{}^{18}O$ in the target. $t_{1/2}(^{18}F) = 109.7$ minutes, $t_{1/2}(^{17}F) = 65$ seconds. The ratio between nuclear reaction yields is $\eta_{^{18}O-^{18}F} / \eta_{^{16}O-^{17}F} = 144.7$.

4. Calculate the yield of labeling D-glucose with fluorine-18, if the initial radioactivity of the fluorine-18 sample was 600.0 MBq and radioactivity of the obtained FDG is 528.2 MBq. Synthesis time is 3.5 minutes.

5. Biological half-life (through the excretory organs) of FDG is 120.0 minutes. How much radioactivity (in MBq) will remain in the patient ten hours after injection of FDG with the initial radioactivity of 450.0 MBq?

All tasks together with more information about IChO can be found at *http://icho2015.msu.az/*.