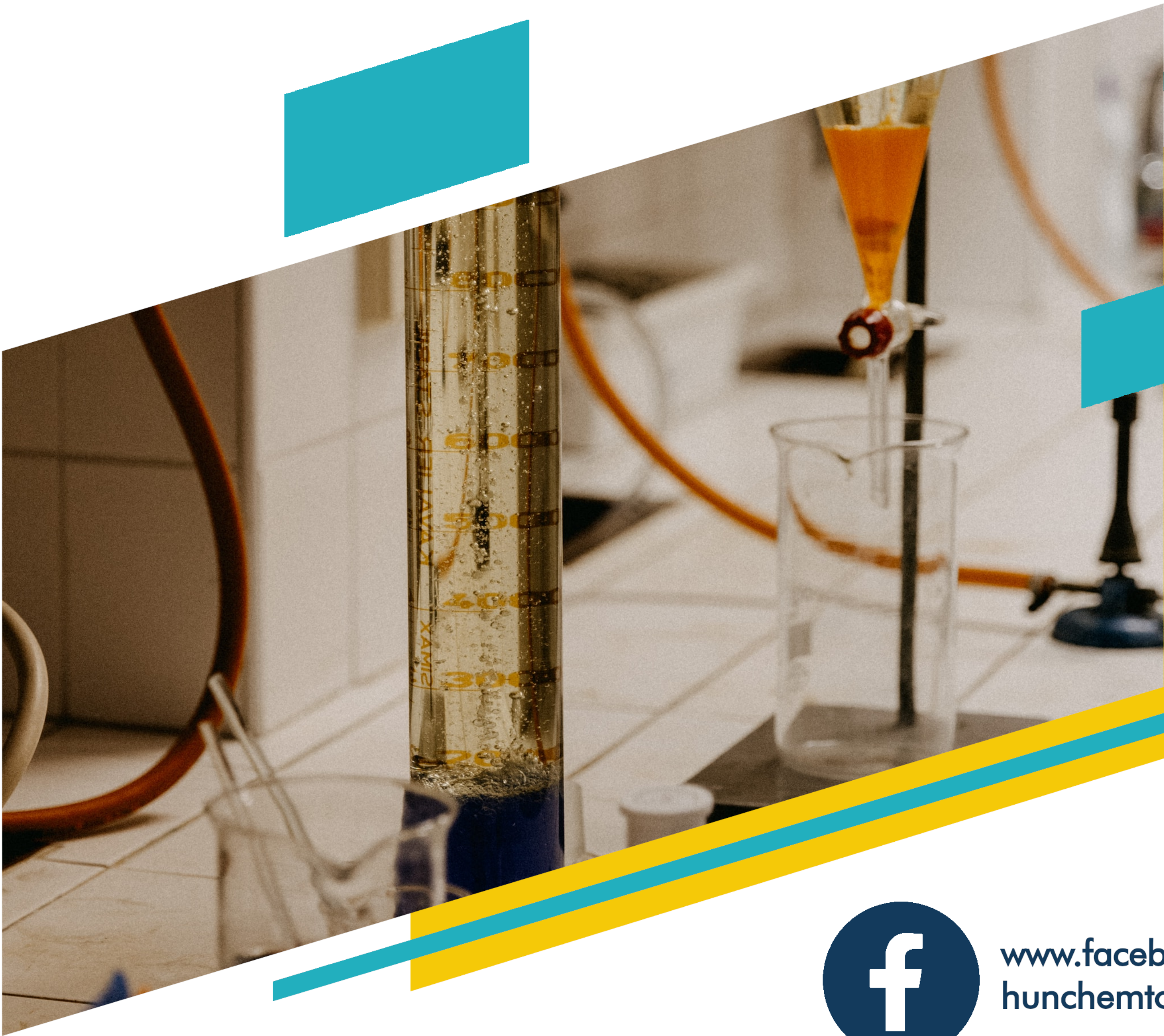
International Chemistry Tournament

# HUNGARIAN SELECTION ROUND



## 2024

## Problem Set

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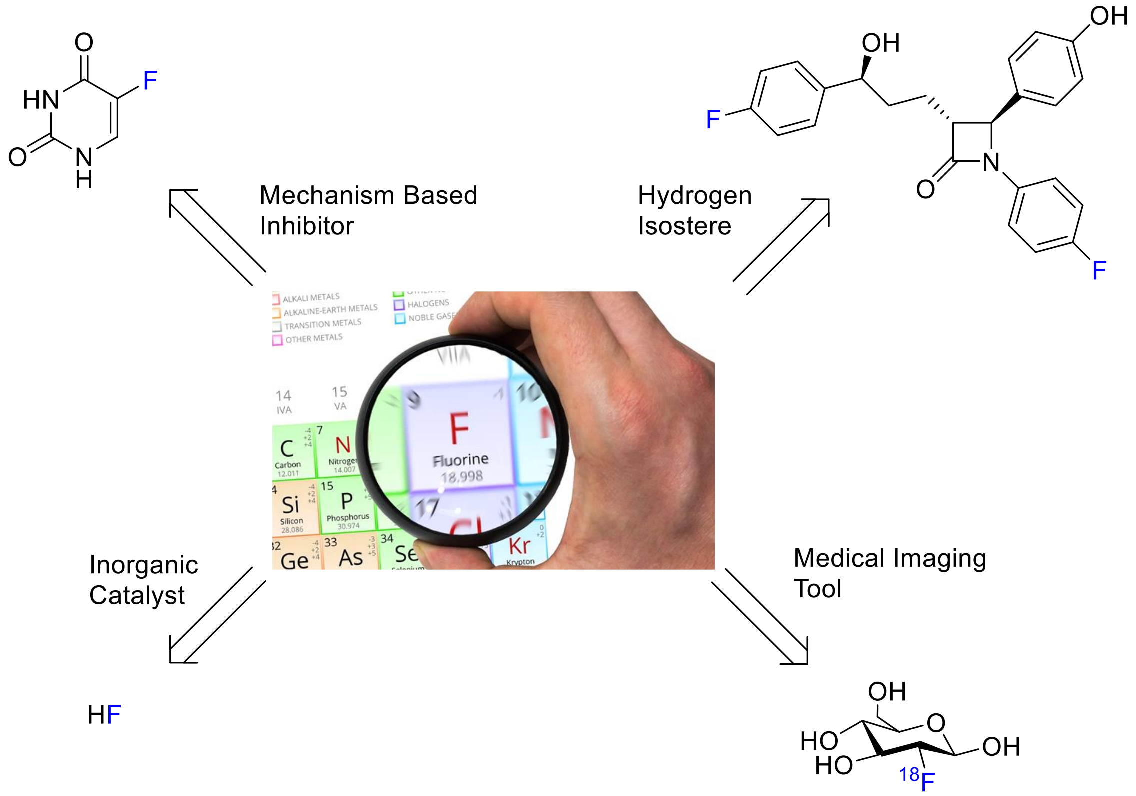
# Chemical cocktail

The iodine clock reaction is the basis of a popular magic trick presented as turning lemonade into coke, without even touching the bottle. Had you tasted it (which you really should not), you would be up for a disappointment and potentially a trip to the hospital, as the liquid will not taste anything like Coke. But the concept of a drink (that is drinkable) that changes both taste and colour is quite intriguing, and one might try to create one.

Your task is to design such a drink, that suddenly changes both its colour and taste, preferentially at the same time, a couple of minutes after it has been served up. The drink must not be toxic and should have a pleasant or at least bearable taste. No good party starts with a salad, and that is also true for interesting chemistry competition tasks, thus the cocktail must have a substantial ethanol content.




# Oxidised fluorine

Situated in the top right corner of the periodic table, fluorine is one of the more exotic elements for both inorganic and organic chemists. It is sometimes affectionately called the T-rex of the elements. It is heavily used in medicinal chemistry as an isostere of hydrogen. Its binary compound with hydrogen is widely used as a catalyst and solvent for industrial-level alkylation processes in petrochemistry and pharmaceuticals. Fluorine is conventionally thought to have the highest Pauling electronegativity of all elements, missing solely one electron to complete its valence shell. This thirst for electrons is also the driving force for its whacky chemical properties. However, all great chemical discoveries started from breaking down the models and pushing the boundaries.

Suggest a way to make a stable compound where the oxidation state of fluorine according to the Pauling electronegativity scale is higher than zero. We also invite you to predict its chemical properties if you can.

# Keep the blue

When the topic of acid-base indicators is introduced to students as part of their high school curriculum, one of the most commonly used demonstrative experiments relies on the indicator properties of red cabbage juice. The molecule responsible for the colour change belongs to the class of anthocyanins, a large group of red-violet-blue pigments found in many plants. The beauty of the experiment lies in its simplicity, so much so that it is quite common to recreate this effect unintentionally when working in the kitchen. One such example is jam production, during which the requirement for an acidic environment results in some fruits changing their colour during the process.

Your task is to envision a production process of edible blueberry jam, in which, despite the acidic environment, the fruit retains its characteristic blue colour. You may use any food-safe additives, or modify the pigment molecules, but in the end, the colour of your final product must be based on the anthocyanins from the blueberry fruits added at the beginning.


# Re(many)scents

There is a joke that says “If it is science and stinks, then it must be chemistry.” Although most compounds have an arguably unpleasant smell, some do smell good, such as limonene, vanillin or cinnamaldehyde. They are usually organic compounds, with a rather lengthy synthesis and conversions, thus demonstrating these organic procedures are usually omitted from high school classrooms.

Your task is to propose a synthesis pathway that has 3 different fragrance compounds in it, all of which have distinctly recognisable and pleasant aromas (eg.  reminiscent of mint, chocolate or vanilla etc. and not just "floral"). It must be possible to safely carry out the entire synthesis under 4 hours. The synthesis pathway must be linear, so one has to make the third compound from the second which was made from the first scent molecule. There is no need to isolate the compounds, but the aromas must be distinguishable.

# The serpent’s tongue

Humanity has long been obsessed with gemstones and other precious materials, with cultures often attributing supernatural powers to them. Of these magical effects, the detection and possible elimination of poisons gained significant attention in medieval times, with monarchs and other influential people trying to defend against poisoning with jewels. The following section from Umberto Eco’s famous historical novel, „The Name of the Rose”, describes one such instrument:

*„And I know for certain that not long ago, in Avignon itself, with necromancies of this sort philters and ointments were prepared to make attempts on the life of our lord Pope himself, poisoning his foods. The Pope was able to defend himself and identify the toxin only because he was supplied with prodigious jewels in the form of serpents’ tongues, fortified by wondrous emeralds and rubies that through divine power were able to reveal the presence of poison in the foods.”*

While these magnificent collections were likely ineffectual for the detection of poison, one might imagine that with the power of modern chemical knowledge, we could recreate at least some of the effects described. Propose a system of three diagnostic tests, each representing one „serpent’s tongue”, capable of detecting a certain poisonous compound with reasonable specificity. The tests should utilise minerals (i.e. the jewel, strictly inorganic) for the detection of toxic compounds, and detection should be based on cues recognisable without a specialised instrument (e.g. colour change, heat, smell etc.). The tests do not need to be reusable.