

Appendix 2: Research Paper Questions

Instructions

Eight Problems for Research have been released for the NSO 2023. In your teams of 6, choose any two of the eight problems to attempt. Make research and make a scientific report / essay of your findings of not more than 3 A4 typed pages. Use of independent diagrams and custom experiments and scientific equations will lead to higher scores, and therefore are highly encouraged. Your work will be subjected to an AI plagiarism test and any unoriginal work will lead to automatic disqualification.

1. Problem 1: The Skakoan

Skakoan is a fictional race in the Star Wars Universe. They are humanoid species from the planet Skako. They breathe methane and have to wear special pressure suits and gear. Describe the chemistry of skakoan breathing.

2. Problem 2: Colourful lines

If a line is drawn on a rough surface with a piece of iron sulfide, the line has a different colour than the mineral piece. Investigate this phenomenon. What other minerals show similar properties?

3. Problem 3: Shower head

A handheld shower head is hanging freely on a long hose. Turn the water on and observe the head deviating at a certain angle. What parameters does this angle depend on?

4. Problem 4: Jumps

A human can jump with straight legs, however so-called squat jumps and countermovement jumps may be higher. Investigate the influence of starting postures and jumping techniques on the maximum height of the jump.

5. Problem 5: No Matter How You Spin It?

In *Harry Potter* book series, an important part of potion preparation is direction of stirring (clockwise or anti-clockwise). Suggest an experiment in which the reaction outcome depends on the way of stirring and explain the underlying mechanism.

6. Problem 6: Grind It

The colour of a chemical sample may change with particle size. For example, while bulk gold is yellow, its colloidal solutions exhibit a wide range of colours. Propose a compound or a mixture of compounds which would change its colour at least twice upon grinding in a mortar if the three colours observed must contrast each other. What are the colours you would expect to see and why?

7. Problem 7: Terraforming Mars

If we want to set foot on Mars, we will have to solve challenging problems never faced before. One of these will be the removal of toxic perchlorate salts from the Martian soil to make growing plants possible. Propose a method that could be viable for an early colony on the red planet.

8. Problem 8: Ferments

Investigate whether oxidizing ferments are present in apples, potatoes, onions and other fruits or vegetables. Which of them has the most active ferments? Analyse the effects of temperature on the action of the ferments.