Physics

Problem P1

Science battle

Electric motor vehicles are becoming more and more popular in the modern world. Such cars are quite sporty since electric engines provide high torque even from the low rpm (revolutions per minute), unlike internal combustion engines. You need to connect the engine to the drive wheels via gears and investigate how the motion of this system relates to the engine's power, the type of transmission gears, the wheels' friction coefficient, etc.

Experimental race

Materials provided:

- Car frame
- Wheels with different parameters
- Different transmission gears
- Electric motor

Teams will assemble experimental cars, with which they will participate in the race and compete with each other. During the race, the teams will aim to overcome various obstacles with their vehicles (for example carrying loads, climbing hills, crossing barricades, etc.) in the shortest possible time to earn as many rating points as possible.

Problem P2

Science battle

In various cases, it is convenient for the car to have a jet engine. You need to make a pump that moves the vehicle forward by expelling certain gas or liquid. Investigate how the motion of this system relates to the engine's power, the diameter of the exhaust channel, the coefficient of friction of the wheels, etc.

Experimental race

Materials provided:

- Car frame
- Wheels with different parameters
- Propellers with different parameters
- Electric motor

Teams will assemble experimental cars, with which they will participate in the race and compete with each other. During the race, the teams will aim to overcome various obstacles with their vehicles (for example carrying loads, climbing hills, crossing barricades, etc.) in the shortest possible time to earn as many rating points as possible.

Problem P3

Science battle

In certain situations, it might be practical to move the vehicle through a propeller. You need to connect the electric engine to the propeller so that the spinning of the propeller drives the car. Investigate how the motion of this system relates to the engine's power, the type of propeller and positioning, the friction coefficient of the wheels, etc.

Experimental race

Materials provided:

- Car frame
- Wheels with different parameters
- The tank of the liquid with a discharge tube of different diameters
- Electric motor

Teams will assemble experimental cars, with which they will participate in the race and compete with each other. During the race, the teams will aim to overcome various obstacles with their vehicles (for example carrying loads, climbing hills, crossing barricades, etc.) in the shortest possible time to earn as many rating points as possible.

Chemistry

Problem C1

Science battle

Producing nylon-n,m (nylon with specific molecular weights or chain lengths) from respective acyl chloride and alkyl diamine involves the polymerization of these monomers. The length of the polymer chain (or the molecular weight) can depend on various parameters. To produce the longest possible length of the polymer wire, you need to consider factors like the initial concentrations of monomers, reaction conditions, rotational time, reaction time etc.

Experimental race

Materials provided:

- Essential chemical glassware
- Certain alkyl diamine
- Tweezers
- Distilled water
- Cyclohexane

The participants will engage in the competition to determine whose experiment is the most accurate and optimized the best. The teams will be given mentioned materials with specific instructions and they will aim to make the longest possible polymer wire.

Problem C2

Science battle

“Elephant’s toothpaste” is one of the most eye-catching chemical reactions, where a large volume of foam is formed from produced gas and dishwashing liquid. The reaction includes catalyst, hydrogen peroxide and dishwashing liquid. When mixing them with determined amounts, you can obtain an “eruption". Participants have to optimize the reaction and study how the eruption depends on different parameters such as catalyst, chemical glassware, concentrations and so on.

Experimental race

Materials provided:

- Essential chemical glassware
- Hydrogen peroxide 50%
- Potassium Iodide
- Dishwashing liquid
- Distilled water

The participants will engage in the competition to determine whose experiment is the most accurate and optimized the best. The teams will be given mentioned materials with specific instructions and they will aim to make the highest possible eruption of the foam.

Problem C3

Science battle

Some metals reduction from solution occurs pretty easily. If you conduct DC power supply in the solution of Tin (II) chloride from the cathode, it instantly starts producing metallic “webs” which occupy the whole glassware. You have to develop a system of the reaction to make the dendrite and study how this process depends on different parameters such as voltage, concentration of solution, etc.

Experimental race

Materials provided:

- Essential chemical glassware
- Distilled water
- Tin (II) chloride dihydrate
- Concentrated hydrochloric acid
- Different kinds of batteries
- Various pipettes

The participants will engage in the competition to determine whose experiment is the most accurate and optimized the best. The teams will be given mentioned materials with specific instructions and they will aim to make the longest possible metallic web in the solution in the fixed time.