

## EXPERIMENTAL COMPETITION

16 January, 2016

### Please read the instructions first:

1. The Experimental competition consists of one problem. This part of the competition lasts 3 hours.
2. Please only use the pen that is provided to you.
3. You can use your own non-programmable calculator for numerical calculations. If you don't have one, please ask for it from Olympiad organizers.
4. You are provided with *Writing sheet and additional papers*. You can use the additional paper for drafts of your solutions but these papers will not be checked. Your final solutions which will be evaluated should be on the *Writing sheets*. Please use as little text as possible. You should mostly use equations, numbers, figures and plots.
5. Use only the front side of *Writing sheets*. Write only inside the bordered area.
6. Fill the boxes at the top of each sheet of paper with your country (*Country*), your student code (*Student Code*), the question number (*Question Number*), the progressive number of each sheet (*Page Number*), and the total number of *Writing sheets* (*Total Number of Pages*). If you use some blank *Writing sheets* for notes that you do not wish to be evaluated, put a large X across the entire sheet and do not include it in your numbering.
7. At the end of the exam, arrange all sheets for each problem in the following order:
  - Used *Writing sheets* in order;
  - The sheets you do not wish to be evaluated
  - Unused sheets and the printed question.

Place the papers inside the envelope and leave everything on your desk. You are not allowed to take any paper or equipment out of the room

## Coal tablet (15.0 points)

In this experiment it is necessary for you to investigate the dependence of the electric resistance of activated coal tablet under mechanical stress.

Devices and the equipment: tablet of activated coal, two wooden rulers with electric contacts, a set of weights with hang-ons (6×100g), multimeter, variable resistor with the maximum resistance of 100 Ohms, constant resistor with the resistance of 1.0 Ohm, source of the constant voltage of 9,0 V, connecting wires.

Teachers of this school have designed for you the mechanical part of the installation: one ruler is fixed, and the other is used to suspend weights. You should design and connect an electric circuit by yourself.

### Part 1. Ohm's law (7.0 points)

1.1 Measure the dependence of the electric current passing through the coal tablet as a function the voltage across it. Measurements should be made for two values of the mechanical load, 200 and 400 g (per tablet). Plot the graphs of the corresponding dependences, specify whether it is possible to treat the resistance of the tablet as independent on the applied voltage. Calculate the resistance of the tablet for the above given mechanical stresses, estimate their errors.

Provide the sketch of the electric circuit that you used to make measurements. In this part of the experiment it is required to use a multimeter in the voltmeter mode only.

### Part 2. Mechanical stress and resistance (5.0 points)

2.1 Make measurements for the dependence of the tablet resistance as a function of the mechanical stress on the tablet measured in grammes. Make measurements «in two directions»: increasing the stress and decreasing it.

2.2. Plot the graphs of the corresponding dependences.

2.3 Propose the simplest linearization of the obtained dependences. Plot the graphs of the linearized dependences.

### Part 3. Designing scales (3.0 points)

In this part of the experiment it is necessary for you to propose an installation for electronic scales in which the central role is played by the tablet investigated in the previous parts.

3.1 Propose an electric circuit in which the voltage on one of the elements is approximately linearly proportional to the total weight used as a load.

3.2 Plot the calibrating graph for your scales, i.e. the dependence of the voltage on the chosen element as a function of the load weight.