

## Eighth Experimental Physics Olympiad (EPO8)

Sofia Branch (SB) of the Union of Physicists in Bulgaria (UPB), together with the Society of Physicists of Republic of North Macedonia (SPRNM) are organizing the eighth Experimental Physics Olympiad (EPO8). The Olympiad will be held in a hybrid mode: both online and in local personal participation, and the ranking will be separate for the two different streams. The Olympiad will be held on May 8, 2021, and the ranking of the best participants will be announced the following day, May 9, 2021, St. Thomas Sunday (in honor of St. Thomas the Unfaithful - the patron saint of experimenters and scientists in general :-).

Students will receive the set-ups with which they will work by email, and the text of the task will be published on the website <http://www.bgphysics.eu/deynosti/epo> on the day of the event at 11:00 Central European Time (CET) (12:00 Sofia time). Students must have 2 multimeters, a calculator, squared paper (graph paper), writing paper, and a pen. Online participants must take photos or scan their work and send it to the email [epo@bgphysics.eu](mailto:epo@bgphysics.eu) by 15:00 CET, i.e. 4 hours from the beginning of the Olympiad.

**Registration** (for participants outside Bulgaria). There is no participation fee for registration in the Olympiad. The Olympiad will consist of two rounds: 1) For the selection round, participants are asked to send the solution to a task to [epo@bgphysics.eu](mailto:epo@bgphysics.eu) by 23:59:59 CET of the 28 of February 2021. The task is given below. Additionally, the participants must fill out the **registration form**, which will be published later. Further information about online participation in the Olympiad will be published no later than May 6, 2021. If participants wish to be present in live gatherings, (which will be organized at a local level should conditions allow) they will have to contact the local organizer; the organizers for each country will be announced additionally later. 2) The final round will be held on the day and hour of the Olympiad; for the task look at the web-page of the Olympiad.

**Task for the selection round.** One of the purposes of this task is to establish contact between the participant and the organizers of EPO8. The solution of the problem has to be sent to the organizers, preferably in PDF (scanned or photographed). The student must have 2 multimeters. To start, measure the voltages of their batteries; it is good to have them replaced this year. For each of the multimeters, prepare a separate table for their internal resistances  $R_V$  when switched to all of their settings when functioning as a voltmeter. Similarly, for all possible settings when the multimeters are switched to an ammeter, measure their internal resistances  $R_A$ . Calculate the ratio  $Z_{V/A} = R_{V,\min} / R_{A,\max}$  between the smallest  $R_V$  value and the largest  $R_A$  value. Also measure the voltages  $U_\Omega$  which the multimeter generates for all ranges when it is switched on as an ohmmeter. Next, take a potentiometer, a battery, a resistor, and cables with crocodile clips, and measure the voltage  $U$  and current  $I$  through the resistor, while applying different voltages to the resistor. Present the results first in a table  $(n, U_n, I_n)$ ,  $n=1,2, \dots, N$ ; and then graphically. For each of those  $N$  measurements, plot the experimental point on squared paper, with the current horizontally (abscissa) and the voltage vertically (ordinate). Draw a line of best fit. At the ends of this line, select two points A and B and measure the differences of their voltage  $\Delta U = U_B - U_A$  and their current  $\Delta I = I_B - I_A$ , and calculate the ratio  $R = \Delta U / \Delta I$ . What is the dimension of this slope of the line? What law did you measure, and what accuracy did you achieve? Older students can compare the graphical solution with the results of the linear regression calculated from the experimental data. This is a good estimate of the error in processing experimental data. If you find can diodes, measure

the relationship between current and voltage  $I(U)$ . The current from the batteries must always pass through a protective resistance of about  $300\ \Omega$ , because the diodes can be burnt easily.

**Age categories.** The categories are as follows: S, M, L, and XL. For different countries the educational system is different, but if physics is to be studied for 6 years on average at school, the S category is for the first 2 years, the M category is for the middle 2 years, and category L is for the last 2 years of high school. The XL category is for university students. A separate ranking will be made for each age group. The task of the Olympiad is actually a sequence of many related tasks, given as different sub-tasks with increasing difficulty – every participant has to do the best to solve these sub-tasks. The Olympiad is in experimental physics, but with these measurements taken, the understanding of what is being done will be necessary. Thus, there will be several entirely theoretical sub-tasks. The authors of the tasks have combined experiments described in various textbooks.

**For sponsors.** Bank account of the Sofia Branch of the Union of Physicists of Bulgaria (SBUPB):

Bank: UniCredit Bulbank, Sveta Nedelya Branch, Sofia

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Reason for the transaction: support for Experimental Physics Olympiad

**Around and after the Olympiads.** The Sofia branch of SFB, the Regional Society of Physicists from Strumica (RSFS) and Society of Physicist of Republic of North Macedonia (SPRNM) have been organizing such Olympiads since 2011 and they are gradually becoming a traditional part of out-of-school physics education. The Experimental Physics Olympiad (EPO) has gradually become a forum for colleagues teaching physics, complementing the social life of the collegium. An analysis of the 7 Olympiads showed that students learn a lot during the Olympiads themselves, and when they return to class they can illustrate the solution to their classmates. Thus, the Olympiad complements the informal out-of-school work indispensable in the crating of future professionals. After the Olympiad, participants are encouraged to repeat the experiment looking at the published solution and the work of the champion, arriving to an even better solution. That is why the set-up hast to be considered as a gift from the organizers. If they wish, at the end of the school year, the participants may donate the set-up to the physics laboratory of their school. In such a way, the Olympiad directly affects the level of teaching in each school that has EPO participants. Next year, the edited EPO task will be published in a methodological journal and will become a basis for further work by colleagues developing experimental work in physics education.

Updated information can be found on the website of the SB of UPB <https://sites.google.com/a/bgphysics.eu/bgphysics/deynosti/epo> .

Please spread this message among students and teachers.

With best regards,

EPO, February 13, 2021