STUDENT'S DEVELOPMENT FOR PRACTICAL AND LABORATORY SKILLS DURING EXPERIMENTATION

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Abstract: During the teaching process of physics, the teaching materials serve as a theoretical foundation for the students so they gain practical theoretical skills while learning. On the other hand, while teaching physics, one should put to good use the skills and the knowledge that the students gain from various sources of information. Solving each problem in physics, whether in theory or in practice, is a scientific research process in miniature, a modest act of creation. Knowledge on physics should be treated on the basis of observation and concrete analyses of phenomena both in nature and in classrooms being supported by the study and the reproduction of physical phenomena via physical experimentation. The experiment should be broadly used, and should be considered as an important source of new teaching information to experimentally prove the raised hypothesis and/or ideas and theoretical conclusions drawn earlier, during control and estimation of the knowledge of students, during repetition, as well as during systemization and completion of the students' knowledge, etc. Through experimentation, it is possible to observe and study the physical phenomena. Also, it is possible to understand the measurements equipment and the measuring physical units, as well as how they're built and their working principles. Adding to that, understanding technical mechanisms, discovery and physical control of the laws, as well as the specification of the physical constants and the physical characteristics of each material, are all part of this experimentation. It is important that during each experiment's development, the teacher should assure the active participation of all students. This is achieved through allowing each student to present its own hypothesis for verification. Afterwards, the students need to run specific steps of the experiment, in order to observe and identify the core elements of the phenomena under study. Finally, a full report should be completed by each of the students regarding the conclusions and results, derived from each experiment. There are different forms of experimentation in physics. The most relevant ones are: "The demonstration" form, "The frontal" form, practical laboratory work. Through these main three forms, it is possible to achieve a broad knowledge regarding the phenomena, the units, and the laws of physics. This way, each student improves its independent laboratory working skills using the scientific methods learned during the process. During experimentation, each student gets to learn work ethics, discipline, time management and proper use of laboratory equipment, in real – time situations. During their development, the students improve in their unit's measurement, as well as establishing the borderlines of the real value of a measured unit (especially in transversal measuring). Also, they get a better handling of identifying and evaluating measurement errors independently, etc.
Keywords: knowledge**,** observation, hypothesis, measurement, experiment.

The subject of Physics in schools, as well as the science of Physics itself, is experimental. All knowledge is treated on the basis of observation and concrete analysis of physical phenomena in nature and in classrooms, especially supported by reproduction and the study of physical phenomena through experimentation. Consequently, the physical experimentation is one of the main and most important methods in conveying and absorbing the subject of Physics.

1. DEMONSTRATIVE EXPERIMENTATION

Among physical experiments, the demonstrative experiment[77] is one of the most important. It is widely used as an important information source for new study material. Also, it helps in theoretical evaluation and hypothesis proof for each experimentation. Finally, this type of experiment improves a student's real time learning, results and evaluation. The environment for this experiment can be either a classroom or outdoor locations, where all the students get involved. For it to be successful, the environment should guarantee healthy working conditions. Also, students must have a clear view of each process for better understanding.
The demonstrative experiment develops in three stages:

Stage number one introduces the students with the equipment necessary for the experiment.
Stage number two it's about process. Through this phase, student's get all the instructions needed for each step of the experiment.
Stage three it's about conclusions. After the experiment, the teacher must focus in deriving logical conclusions from the process.

2. FRONTAL EXPERIMENTATION

This type of experimentation is needed for verifying, acquiring and improving a student's thorough knowledge during his class time. Through this process, studying different physical phenomena is made possible. Also, it provides an important understanding about physical measures and the principles of using proper equipment needed to derive these measures. Finally, the equipment will also help defining physical constants, physical characteristics of each material and quantitative control regarding the laws of physics.

Resistors in series[78]

At the start of class time, the teacher, throughout a system of theoretical and experimental questions, recalls the knowledge and skills achieved by the students about measuring stream intensity, voltage, resistors, etc. In each table, a student is provided with a battery accumulator, 2 ammeters, a voltage meter, one rheostat, one key, two resistors and connection cables. The task in hand for each student consists in demonstrating how many ways the two resistors can be connected in an electric circuit.
After analyzing each result, both teacher and student will draw a map of an electric circuit, composed by a constant power source, a key, a rheostat, two resistors R_1 and R_2 connected in succession.

The teacher asks: Do we have the same intensity of the electric current that passes through the resistance R_1 and R_2?
How about the other parts of the circuit?
Student A: After measuring, it results that the intensity of the electric current is the same in the first resistance, in the second resistance, as well as in all the other parts of the circuit ($I_1 = I_2 = I$).

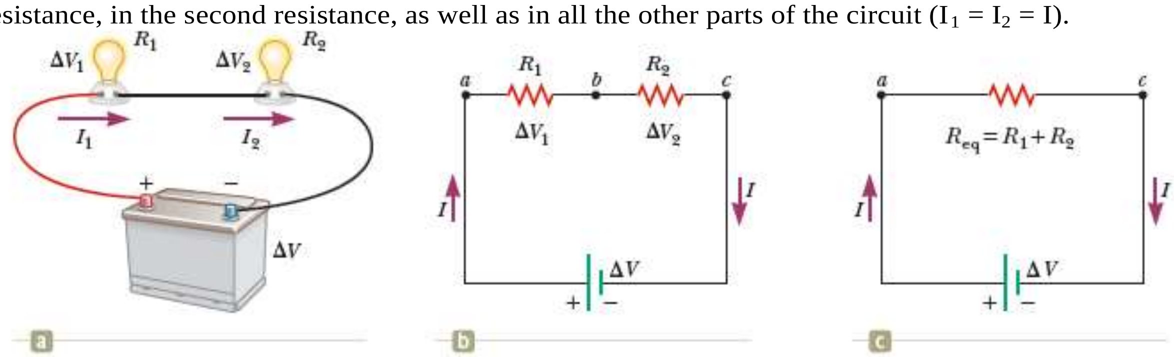


Figure 1 Two lightbulbs with resistances R_1 and R_2 connected in series. All three diagrams are equivalent.

The teacher: Using a rheostat put the current in the circuit 1A and by the help of a voltmeter measure the reduction of the tension: at points A, B (at resistance R_1), at points B, C (at resistance R_2) and at

[77] Metodika e Fizikës, Universiteti i Tiranës, Fakulteti i Shkencave Të Natyrës, Shtypshkronja e Dispencave Tiranë, 1982.
[78] Serway & Jewett – Physics for Scientists and Engineers with Modern Physics, (9th ed) pp. 836-837, 2014.

points A, C (at the ends of both terminals of the resistances that are connected in series). Repeat the measuring for current 2 A in the circuit. Which are the results obtained after measurements?
With the help of the rheostat, the students put the current in the circuit 1 A and with the help of the voltmeter, connected in parallel, they measure the tension $U_{AB} = U_1 = 2V$) $U_{BC} = U_2 = 4v$, $U_{AC} = U = 6v$. Repeat the measuring after putting current in the circuit 2A.
Student B: The measurements show that the reduction of tension in both terminals of both conductors connected in series U_{AC} is equal with the amount of both reductions of tension in the first and the second resistances.
Student C: I think that this result is correct. We can also reach to such conclusion bearing in mind the fact that the tension for a part of the circuit is measured by the work that is done for the displacement of the unit of the charge in this part. The work that is done for the displacement of the unit of charge from point A to C ($A_{AC} = U_{AC} = U$) is equal with the work that is done for the displacement of this charge from point A to B ($A_{AB} = U_{AB} = U_1$), plus the work that is done for the displacement of this charge from point B to C ($A_{BC} = U_{BC} = U_2$). Thus, $U_{AC} = U_{AB} + U_{BC}$ or $U=U_1 + U_2$. After these discussions, the teacher writes on the blackboard the results drawn by the students generalizing it for n resistances connected in series.
The teacher: As students, what do you think? How much is the total resistance that is proportional to the resistance of two resistances connected in series?
Student D: I think that during the current passing through two conductors will face a greater resistance. I think that it will be equal with the amount of two resistances: $R = R_1 + R_2$
The teacher: The correctness of this reason, we can prove by defining the values of resistances R_1 and R_2, as well as the total resistance R of both resistances connected in series. How could we do such a thing?
Student E: Here we are; I think that we can do it by measuring the reduction of the tension in each resistance and the total resistance, as well as the intensity of current in the circuit. Then by applying Ohm‘s Law for a part of the circuit $R = U/I$ we calculate the respective resistances R_1 and R_2.
The teacher: Well done.
Student F: eliminating a repetition of measuring, I think that we can use the measurements of the current in the circuit; we have made previously lA and 2A.
After approving his opinion, the students start making the calculation of resistances.
After analyzing the results of the resistances, the students come to the result that $R = R_1 + R_2$.
One student generalizes all this for a number n of resistances connected in series and writes on the blackboard: $R = R_l + R_2 + ... + R_n$. Then, together with the students, the teacher proves that in this connection the reduction of tension in the conductors is indirectly proportional with their resistances.

3. PRACTICAL LAB WORK

Practical lab work is characterized from a larger scale of independent student work. It helps a student improve its lab skills, using improved scientific calculation methods. Also, it improves studying physical phenomena from different aspects. During their development process, the students improve their ability to: identify the limits of the real value of a phenomenon, process complicated measurements and evaluate independently measurement errors. Compared to the frontal experiments, which are supervised by a teacher, practical lab work consists in a broader independent working time for a student**.**

Projectile motion[79]

This lab work is processed after proper amount of study material is collected by each student, along with necessary information about measuring methods, equipment use and error calculations. All necessary to undergo independently a physical experiment. The equipment used in this experiment will be: ballistic gun, plastic meter or rule divided in centimeters, lab rack, metallic tipped ring, white paper sized 20 by 30 and carbon paper.

[79] Fizika 1, Për shkollën e mesme të përgjithshme, Punë Laboratori, Shtëpia Botuese e Librit Shkollor, fq 59-62, 1986.

Principle of work. The shell launched at a certain angle with the horizon at an initial speed of v_0 moves in a curved trajectory, which is called parabola. Studying this movement, we know that distance l of launching the shell in horizontal direction and the highest altitude h_m of ascension, is given by the formulae

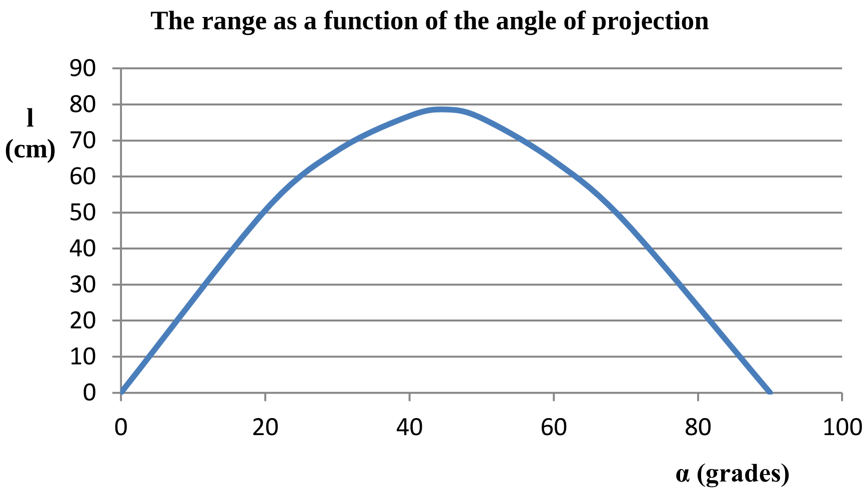
$$l = -2\frac{v_{0x} \cdot v_{0y}}{g} \quad \text{and} \quad h_m = -\frac{v_{0y}^2}{2g} \quad \text{where } g < 0.$$

Process of work.

We study the dependence of the distance of launching a shell from the angle of projection. The pistol is fixed on one edge of the desk, directing the launching of the shell at an angle of 45^0 with the horizon. We make several shoots, to adjust the right squeezing of the pistol spring, so that the shell lands on the other end of the desk. In other experiments we do not have to adjust the squeezing or the pistol spring. We make sure that on one edge of the desk we adjust the pistol so that the shell is launched at an angle of 20^0, 30^0, 40^0, 50^0, 60^0, and 70^0, measuring two or three times for each angle. At the place where the shell lands, we put a white sheet of paper fixed on the desk. Beside the points of landing we write down the angle of launching, using a pencil. For every angle we measure the average distance of launching and we write down the results on a table.
Table 1

Angle of projection (in grades)	20^0	30^0	40^0	45^0	50^0	60^0	70^0
Distance, Average range (in cm)	50.6	67.2	76.8	78.6	76.2	64.4	47.2

Graph[80]



[80] Jerry D. Wilson Cecilia A. Hernández-Hall, Physics Laboratory Experiments, (8th ed) pp. 129-142, 2014.

Define the initial speed v_o of launching the shell. Using the formulae $l = -2\frac{v_{0x} \cdot v_{0y}}{g}$ and the fact that the angle of launching $\theta=45^0$, $v_{0x} = v_{0y} = v_0 \frac{\sqrt{2}}{2}$, we express the distance of launching *lm* for the angle of 45^0. To calculate the initial speed v_0, l_m we take from the above table and $g = -9.8 m/s^2$.

Table 2

$v_0 = \sqrt{-gl_m}$ (m/s)	$\frac{\Delta v_0}{v_0} = \frac{1}{2} \cdot \frac{\Delta l}{l_m}$	$\Delta v_0 = v_0 \frac{1}{2}\frac{\Delta l}{l_m}$ (m/s)	$v_0 \pm \Delta v_0$
2.743	0.0006	0.001	2.743 ± 0.001

To define the highest altitude of ascension for the angle 45^0. Using the formulae $h_m = -\frac{v_{0y}^2}{2g}$, we express the h_m for the angle of 45^0. In this case $v_{0y} = v_0 \frac{\sqrt{2}}{2}$.

The maximal altitude of the ascension of the shell for the angle of 45^0 is $h_m = -\frac{v_{0y}^2}{2g} = 0.1919m$

Questions/Answers
Which throwing angle results in the farthest flying distance of a sphere?
From the results, it is clear that the farthest flying distance of a sphere is achieved in a 45^0 angle.
Which throwing angle results in equal flying distances of a sphere?
The flying distance lengths of a sphere are approximately equal for angle pairs of
20^0-70^0, 30^0-60^0 and 40^0-50^0 degrees.
The above results are achieved under air pressure.
Find the cumulative value of these angle pairs. What's the total?
The total amounts to 90 degrees.

For the total amount of disputed work, a special report will be submitted.
A short theoretical intro will be presented by each student, alongside a short description about the phenomena and its related calculation formulas. The next step will constitute in detailed description of each experiment, along with the results achieved and the calculated errors during the process. In the end, conclusions will be provided along with proper argumentation.

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