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DETERMINING KINETIC AND POTENTIAL ENERGIES OF A MOVING BODY VIRTUAL LABORATORY

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ABOUT ARTICLE

Key words: Kinetic energy, potential energy, mechanical energy, law of conservation of energy, Effect of friction on energy, Energy Skate Park Simulation (PhET Simulation), virtual laboratory.

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Abstract: This article studies the relationship between kinetic energy, potential energy and total mechanical energy. Also, the study of the law of conservation of energy. The processes of studying the effect of friction on energy are demonstrated using the Energy Skate Park Simulation (PhET Simulation) virtual laboratory work on a computer or smartphone via the Internet system.

Introduction. A State Program has been developed based on the principle of "From Action Strategy to Development Strategy" in seven priority areas of development of our country for 2022–2026. It also focuses on improving the quality of education in schools, bringing the knowledge and skills of teaching staff to the international level. In the Resolution of the President of the Republic of Uzbekistan No. PQ5032 dated March 19, 2021, on measures to improve the quality of education in the field of physics and develop scientific research: Today, great attention is paid to improving the quality of teaching physics in educational institutions, introducing modern teaching methods into the educational process, selecting talented students, preparing competitive specialists for the labor market, developing innovations, and focusing on practical effectiveness [1].

At the same time, a number of unresolved issues in the field indicate the need to implement measures aimed at improving the quality of education and the effectiveness of scientific research in the field of physics.

In the resolution of the President of the Republic of Uzbekistan dated December 29, 2020, it was decided to radically improve the quality of education in physics, train highly qualified teachers and researchers, provide educational institutions with modern laboratories, textbooks and other educational equipment, develop the potential of scientific organizations, effectively organize their activities, establish close dialogue and cooperation between the spheres of science and production, and ensure the timely implementation of the tasks set forth in the Address of the President of the Republic of Uzbekistan to the Oliy Majlis [1]:

The study focused on the widespread introduction of modern teaching methods in physics, including information and communication technologies, and the use of modern methods and techniques in classes, as well as on current problems and their modern solutions.

Since physics is not only a fundamental but also an experimental science, it is necessary for a future physics teacher to have extensive theoretical and practical knowledge and skills in this field. [2] It is clear from this that every physics teacher is required to have a deep and solid knowledge of modern achievements and discoveries in physics, while theoretical knowledge alone is insufficient. The role of laboratory training in applying theoretical knowledge in practice and becoming a fully qualified and competent person in the field of physics is invaluable.

Currently, students studying physics in higher pedagogical educational institutions face various problems in organizing laboratory classes in physics. Conducted pedagogical research, studies and observations have shown that the level of preparation of students in physics and mathematics and the formation of initial experimental skills in laboratory classes varies [3]. In physics classes, the presence of students with a very high desire to perform laboratory work and, conversely, very low competence in laboratory classes makes it very necessary to train them to perform laboratory work and acquire skills and abilities in the work they have done. Taking into account the above problems, it is necessary to improve the conduct of laboratory classes and develop modern innovative methods.

When students do laboratory work in physics classes, they first pay attention to which section of the physics course they are in. In the mechanics department, laboratory work is somewhat simpler and requires more work from the student. In the molecular physics department, the work is relatively interesting. In the current laboratories in higher education

institutions, students try to do the work more as a team, which means that all students do the same work and each student receives the results individually. The use of a team when calculating the results also reduces the interest of some students in this work. The work in the electrical department is somewhat interesting for these students, and if we look more closely at the programs at the pedagogical institute, it is considered to be laboratories related to everyday life. The student is interested in doing these works with his own hands, the results obtained from them, the fact that most of the equipment in the work is related to electricity, the fact that the numbers are visible in modern laboratory devices, and the errors in the results obtained in the work are small, cause students to be interested. The laboratory work in the optics department also increases the interest and enthusiasm of the students to some extent.

When students perform laboratory work, it cannot be assumed that all students in the group will perform the same tasks and achieve the same results, and this leads to duplication. Taking this into account, it is necessary to recommend modern methods of organizing laboratory exercises .

Methodology. According to A. Akhmedov, before allowing a student to do laboratory work, he must pass tests on the theoretical subject. After the teacher checks the student's level of preparation for the subject during the test, he is allowed to do laboratory work. In order for students not to take laboratory work lightly and to take care of the necessary equipment as if it were the apple of their eye, and if permission is granted after the teacher has recorded the level of theoretical preparation, we will increase the responsibility for laboratory work, which will serve to increase the quality of education [2].

Considering the rapidly increasing demand for laboratory equipment in physics and the need for students to properly allocate and use their time effectively, it is advisable to use information technologies in laboratory work [4]. In physics, a number of works are being carried out to improve the efficiency of education by using the development of 21st century technology in conducting laboratory work in a modern way. One of the important effects of digital technologies in science and education today is virtual laboratories.

What is a “virtual laboratory”? According to V.V. Trukhin, a virtual laboratory is a set of software and hardware that allows experiments to be carried out without direct contact with the real installation or in its absence [4,5]. In the first case, we are dealing with a laboratory setup with remote access, which includes a real laboratory, software and hardware for controlling the setup and digitizing the obtained data, as well as communication facilities. In the second case, all processes are modeled using a computer” [4, 8].

The virtual learning laboratory is in line with the idea of open and distance learning and helps to reduce the relevance of material and technical problems in the educational process, although they are minor.

The results of I. Troitsky's research on the impact of the use of virtual laboratories on the quality of education are noteworthy. He notes that the use of virtual laboratory work has led to an increase in the level of students' mastery by 17.7% and a reduction in the time required to complete laboratory work by 10–50% [4,5,6].

Most of the virtual laboratory work currently used in physics teaching is in the form of video, which does not take into account many aspects related to direct student participation, independent decision-making, and research [6]:

-independent selection of equipment necessary for the work from the equipment warehouse;

-formation of the laboratory work device; -proportional arrangement of the device components (design);

-change the parameters of the object under study in the widest possible range;

-make changes to the device if necessary.

-access to modern measuring and control equipment.

The use of information and communication technologies in the teaching of physics allows for the demonstration of physical phenomena and processes that are technically very difficult or impossible to fully demonstrate in a laboratory setting, expanding the possibilities of conducting high-quality laboratory exercises, and simulating various processes and phenomena [6,7].

Results and Duscussion. Investigating the transfer of energy from one type to another without taking into account the friction force

Figure 1. https://phet.colorado.edu/sims/html/energy-skate-park/latest/energy-skate-park_all.html

Figure 1. Ignoring the friction force

Steps to complete the task:

1. Run the simulation:

•Run the simulation from the link below: Energy Skate Park

•Select the "Intro" option and observe the skateboarder.

2. Skateboarder motion:

•Drop the skateboarder from different heights and observe his motion (observe the changes in velocity).

•Pay attention to the kinetic energy, potential energy and total energy diagrams during the motion.

3. Set the skateboarder's mass to 60 kg.

4. Measure the velocity for different heights and enter it in Table 1 below:

Table 1.

№	Height (m)	Speed (m/s)	Potential energy (J)	Kinetic energy (J)	Full of energy (J)
1					
2					
3					
4					
5					

5. Calculate the skateboarder's potential energy using the formula and enter it in the table.

6. Calculate the kinetic energy of a skateboarder using the formula.W_k=(mv^2)/2

7. Calculate the total energy using the formula. W_t=W_p+W_k

8. Answer the questions (write answers in the blanks):

•When is the skateboarder's potential energy the highest?

•When is the skateboarder's potential energy the lowest?

•When is the kinetic energy the highest?

•When is the kinetic energy the lowest?

•When (where) are the kinetic and gravitational potential energy levels the same?

Investigating the transfer of energy from one type to another, taking into account the friction force.

Figure 2. https://phet.colorado.edu/sims/html/energy-skate-park/latest/energy-skate-park_all.html

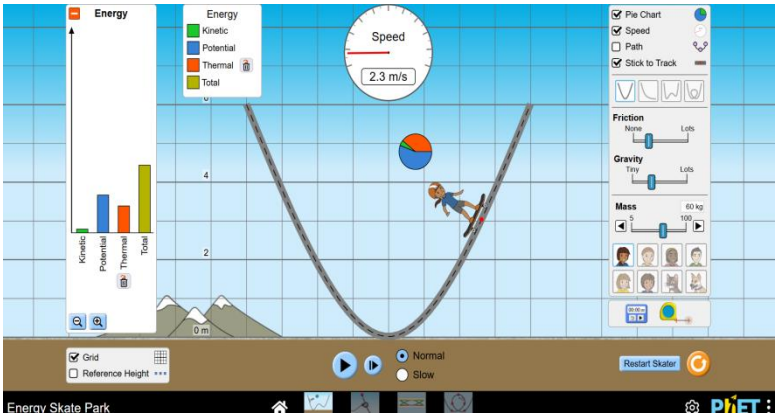

Figure 2. Taking into account the friction force

Steps to complete the task:

1. Run the simulation:

•Run the simulation via the link below: Energy Skate Park

•Select the "Measure" option and observe the skateboarder.

2. Skateboarder's movement:

•Drop the skateboarder from different heights and observe his movement (observe the changes in velocity).

•Pay attention to the kinetic energy, potential energy and total energy diagrams during the movement.

•Observe his movement taking into account the friction force.

Take into account the friction force, to do this, slide the button to the right

Figure 3.

Figure 3. Friction force control

4. Let the mass of the skateboarder be 70 kg. m=70 kg

5. Place the skateboarder at a height of h=6 m. Calculate his total energy at this height. W_t=W_k+W_p+Q=0+W_p+0

6. Determine h=0 m the skateboarder's velocity as he reaches the height and enter it into the table.

7. Calculating the kinetic energy of a skateboarder using the formula

W_k=(mv^2)/2

8. Calculate h=0 m the skateboarder's thermal energy at altitude: and enter it in the table: Q=W_t-W_p-W_k.

9. Comparison with the thermal energy presented in the simulation is Table 2.

Table 2.

№	Height (m)	Speed (m/s)	Potential energy (J), W_p	Kinetic energy (J), W_k	Heat energy (J), Q	Full energy (J), W
1						
2						
3						
4						
5						

10.Answer the questions (write your answer in the blanks):

How does thermal energy change during motion?

Does the law of conservation of energy hold when taking into account the friction force?

How does the total energy change over time?

Conclusion. Taking into account the above considerations, our research conducted at a pedagogical university shows that before performing laboratory work, it is advisable to provide the student with complete instructions on the topic of laboratory work in the science program and for each student to read this instruction independently and first ask the teacher about the

knowledge or equipment that he does not understand, their operation, thoroughly familiarize himself with the instructions for performing the work, and then consolidate the information provided in the instructions in the form of a short question and answer session between the student and the teacher regarding the work. Organizing laboratory work in real and virtual form leads to an increase in the student's knowledge level and an increase in the quality and efficiency of the educational process.

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