

METHODOLOGY FOR ORGANIZING AND CONDUCTING THE PHYSICS CLUB "EUREKA"

Qahhorov G'olibjon G'ulomovich

Physics and Astronomy teacher at School No. 56, Parkent District, Tashkent Region

Ramazonov Ozodbek Rahmat o'g'li

Student of Physics and Astronomy with Additional Mathematics at Navoi State University

Abstract: This article presents the methodology of organizing extracurricular physics clubs for upper-grade students in general secondary schools. It describes the importance and role of physics in science and technology, and provides a one-hour lesson plan for the topic "Mechanical Work. The Relationship Between Mechanical Energy and Work" as part of the "Eureka" club. In addition, methodological recommendations for organizing and conducting extracurricular physics sessions are provided.

Keywords: Extracurricular activities, clubs, innovative teaching technologies, mechanical work, mechanical energy, work.

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Today, improving the quality of education, fostering students' independent and creative thinking, effectively and widely using innovative technologies in the educational process, developing teachers' scientific capacity and professional skills, fundamentally reforming the education system of our country, elevating it to the level of modern standards, and raising a well-rounded generation for the future have become the top priorities of state policy. The foundation of the modern educational system lies in a high-quality and technologically enriched environment. The creation and development of such an environment are technically complex, but they serve to improve the educational system, implement innovative information and communication technologies in the teaching process, and contribute to the advancement of science and technology. In particular, organizing the educational process in general secondary schools in accordance with international and national standards, preparing highly qualified and competitive personnel who meet today's requirements, and increasing the quality and efficiency of education underline the invaluable importance of teaching natural and exact sciences.

Organizing students' creative activities, in turn, requires them to acquire deep knowledge of natural and exact sciences. One of the leading branches of modern science and technology is physics, which has now become an integral part of human life and activity. Today, physics is considered a highly advanced field. Many electrical devices and technical tools are used in various enterprises, in space and deep-sea explorations, and in highly technological and industrial processes. Physics evolves in a high-tech and rapidly developing information environment. To make effective use of its potential, it is crucial to organize a high-quality learning process in general secondary education institutions. In this regard, organizing extracurricular physics club activities and preparing students for creative engagement holds

significant importance. Admitting students into clubs should be carried out based on specific criteria. To successfully engage in creative activities, students must possess a certain level of preparation. A student can only achieve great success in creative activities if they have strong knowledge and practical skills. It is advisable to group students based on age and individual characteristics, preferably with a 1–2 year age difference. Moreover, one of the key criteria in forming club groups is the students' interest in a specific type of club. Physics is taught in a systematic and spiral structure from grades 7 through 11, including the topics "Mechanics", "Electrodynamics", "Fundamentals of Molecular Physics and Thermodynamics", "Optics", and "Atomic and Nuclear Physics". Information is delivered in a spiraling approach, and students' practical skills are developed accordingly.

Table 1.

Topic	Mechanical Work. The Relationship Between Mechanical Energy and Work.
Purpose and Objectives	Lesson Purpose:
	Educational: To provide understanding of mechanical work, the formula for calculating mechanical work, and units of measurement;
	Educational: To broaden students' scientific worldview, teach creative thinking, and cultivate respect for labor;
	Developmental: To develop students' ability to think independently, make correct choices, and take appropriate decisions.
Technology for Conducting the Lesson Process	Methods: Lecture, oral presentation, "Blitz-survey" method, test, discussion.
	Form: Theoretical
	Tools: Visual teaching aids, samples, literature, necessary equipment.
	Assessment: Based on a 5-point grading system.
Expected Results	Teacher: Ensures that all students grasp the topic in a short time; increases student engagement during the lesson; stimulates interest in the lesson; assesses all students during the lesson.
	Student: Learns self-monitoring and adherence to safety rules; acquires a large amount of knowledge in a short time and gets assessed.
Homework	Teacher: Assigns answers to control questions on the topic, test tasks related to the topic, and asks students to prepare 5 tests on the topic for the next lesson.
	Student: Gains deeper knowledge on the topic; improves practical skills and competencies.
Future Plans	Teacher: To master innovative pedagogical technologies and apply them in the teaching process; improve personal skills and creativity.
	Student: Learns to use equipment and visual aids used in the lesson; acquires new knowledge on topics; learns to work individually and in

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	groups; develops knowledge, skills, and competencies.

Lesson Stages

Table

2.

Stages	Content of the Stage	Methods	Allocated Time (min)
Stage 1	Organizational part: Greeting students, checking attendance, checking students' readiness for the lesson, preparing visual aids, technical tools, and teaching materials.	Discussion	5
Stage 2	Review of previous topic: 1. The teacher introduces the new topic and its objectives. 2. A short test is conducted to activate students.	Q&A, Test, Discussion	10
Stage 3	Explanation of new topic: The purpose, main content, and applied methods of the new topic are explained to students.	Lecture, Discussion	20
Stage 4	Reinforcement of new topic: Students' knowledge is reinforced through Q&A, Blitz-survey, and discussion.	Q&A, Blitz-survey, Discussion	5
Stage 5	Assigning homework and concluding the lesson: Students are assigned to answer control questions and create 5 test questions on the topic. The classroom is tidied, and the lesson is concluded.	Independent work, Q&A	5

II. Reinforcement of the Previous Topic:

1. What is defined as work?
 - a) The product of the force and the distance traveled under the action of that force.
 - b) The gravitational force of the Earth.
 - c) The ability of a body to do work.
2. What is the symbol for work?
 - a) F b) A c) N

3. Choose the correct formula for calculating work:
a) $p = F/S$ b) $F = gm$ c) $A = FS$
4. What is the unit of measurement for work?
a) N b) m c) J
5. In which of the following situations is work being done?
a) A car is stuck in the mud.
b) A tractor is pulling a car.
c) A student is doing physical exercises.

The test is displayed on the screen, and students complete it in their notebooks. After completing the test, students exchange their notebooks with their desk mates. The correct answers are then shown on the screen, and students check each other's tests and assign the appropriate scores.

Correct Answers:

1. What is defined as work?
a) The product of the force and the distance moved under the action of that force.
2. How is work denoted?
b) A
3. Show the formula for calculating work:
c) $A = FS$
4. What is the unit of work?
c) J
5. In which case is work being done?
b) A tractor is pulling a car.

This method allows the teacher to determine the knowledge level of all students and assign scores to the entire class at once.

After activating the students, the teacher asks the following questions:

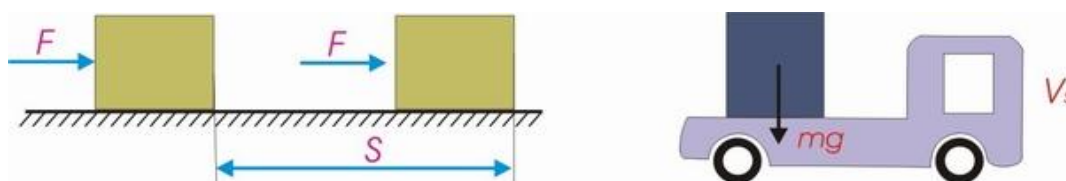
1. Is mechanical work the same as the meaning of "work" in our daily life?
2. Provide examples of mechanical work.
3. What is the ability of a body to perform work called?

Once the questions are discussed, the teacher summarizes the students' responses.

III. Explanation of the New Topic

In the morning, you leave for school, and your parents go to “work.” When you return home, you help them with household “work.” So, what do we really mean by “work”? In everyday life, “doing work” usually means doing labor or effort. However, in physics, the concept of “work” does not always correspond to what we mean in daily life.

In physics, **work is defined as the product of a force and the distance traveled by an object in the direction of that force.**



We denote mechanical work by the letter **A**. In that case, the formula for calculating work is:
 $A = F \cdot s$ Work = Force $\times$ Distance

Where **A** – work, **F** – force, and **s** – displacement.

According to the formula for mechanical work, if a force is applied to a body but there is no displacement, no work is done. For example, if you hold a heavy backpack full of books in your hand and wait for your friend for a long time, you are not doing **mechanical work**.

Since **s = 0**, then **$A = F \cdot 0 = 0$** .

As mentioned above, it is necessary to distinguish between labor and mechanical work.

Teaching a lesson by a teacher, treating a patient by a doctor, or managing school affairs by a principal are all considered labor in everyday terms, but not mechanical work in physics.

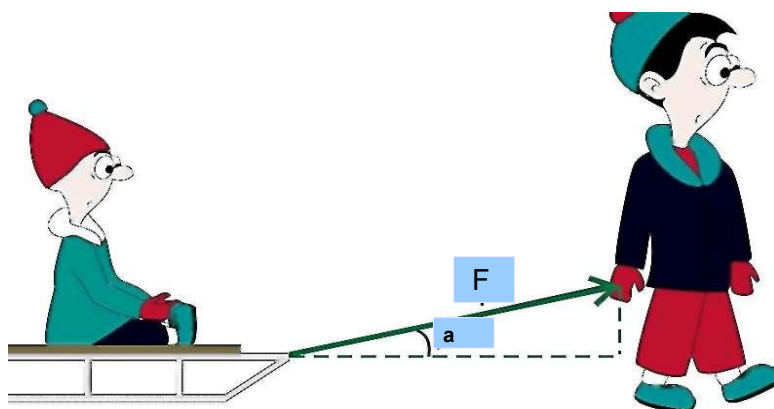
The unit of mechanical work is: **$A = 1 \text{ N} \cdot 1 \text{ m} = 1 \text{ joule}$** , abbreviated as **1 J**. This unit is named after the English scientist **James Prescott Joule** (1818–1889).

In practice, we also use derived units of work:

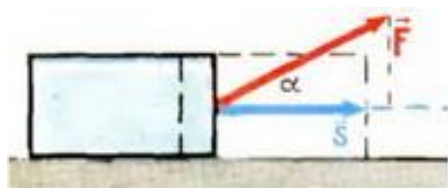
- **Megajoule (MJ)** – $1 \text{ MJ} = 10^6 \text{ J}$
- **Kilojoule (kJ)** – $1 \text{ kJ} = 10^3 \text{ J}$
- **Millijoule (mJ)** – $1 \text{ mJ} = 10^{-3} \text{ J}$
- **Microjoule (μJ)** – $1 \mu\text{J} = 10^{-6} \text{ J}$

Since mechanical work is performed under the influence of different forces, it is often referred to as the **work of a force**. Mechanical work is a **scalar quantity**.

The formula above for mechanical work applies when the direction of the force acting on a body coincides with the direction of the displacement. But what happens if the force is applied at an **angle** to the direction of motion?



In this case, the **projection of the applied force onto the direction of displacement** is taken.



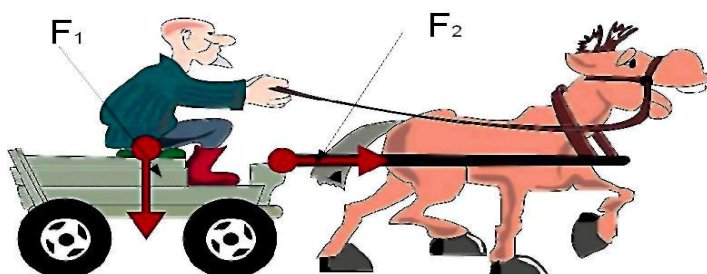
As can be seen from the illustration, the work done is reduced. As the angle between the direction of the applied force and the displacement increases, the projection $F \cos \alpha$ of the force onto the direction of displacement decreases. This results in a decrease in the amount of work done by the force. If the angle between the direction of the force and the displacement is 90° , i.e., the force is perpendicular to the displacement, **no work is done**.

IV. Reinforcement of students' knowledge on the new topic:

Using the "Blitz-questioning" method, students' knowledge of the new topic is reinforced.

1. The product of the force and the displacement of a body in the direction of that force is called ...
2. Work done is denoted by the letter ...
3. The formula for calculating work is ...
4. The unit of measurement for work is ...
5. The unit of work is named in honor of which scientist?
6. What derived units of work do you know?
7. What type of quantity is mechanical work?
8. What happens if the force acting on a body is directed at an angle to the direction of displacement?
9. As the angle between the direction of the applied force and displacement increases, the work done becomes equal to what?
10. If the angle between the direction of force and displacement is 90° , what is the value of the work done?

11. In this diagram, which force performs work?



12. Does the same work get done?



When this method is used, key concepts are reinforced and better remembered. It helps students to stay focused, become more responsive, feel a sense of responsibility, and enables the teacher to assess how well students have understood the material.

Then students are offered a problem to solve:

Problem:

Find the work done by the gravitational force when a raindrop with a mass of 20 mg falls from a height of 2 km.

Solution to be done independently:

Given:

$$m = 20 \text{ mg} = 2 \cdot 10^{-5} \text{ kg}$$

$$H = 2 \text{ km} = 2 \cdot 10^3 \text{ m}$$

$$A = ?$$

Formula

$$A = F \cdot s$$

$$F = mg, s = H$$

$$A = mgH$$

Solution:

$$A = 2 \cdot 10^{-5} \text{ kg} \cdot 9.8 \text{ m/s}^2 \cdot 2 \cdot 10^3 \text{ m}$$

$$A \approx 0.02 \text{ J}$$

$$\text{Answer: } A = 0.02 \text{ J}$$

V. Assigning Homework and Conclusion of the Lesson:

At the end of the lesson, the teacher summarizes the main points and provides feedback on students' participation. Based on the test results, Q&A, and problem-solving activity, the teacher announces the scores of the most active students and assigns homework.

Homework:

- Write answers to the review questions related to the topic.

- Prepare 5 test questions based on the topic.

The classroom is tidied up, and the lesson concludes. Summary:

In preparing this article, the organization of extracurricular club activities in general secondary education schools, the maintenance of school regulatory documents, and the experience of leading teachers were studied. The necessity of organizing extracurricular physics club activities under the name "Eureka" was examined, a club program and schedule were developed, a sample of the club's technological map and lesson plan was created. The possibilities of developing students' physics knowledge through these club activities were analyzed, and methodological recommendations were provided. It was noted that using group work techniques and interactive methods is effective in developing students' creative abilities.

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