

DOI [https://doi.org/10.58442/2218-7650-2023-25\(54\)-210-222](https://doi.org/10.58442/2218-7650-2023-25(54)-210-222)
UDC 372.853

Afet Mammadzade,

PhD student from the Doctor of Philosophy program,
teacher of Ganja State University.
Ganja, Azerbaijan.

 <https://orcid.org/0009-0007-7672-5787>
fizikaelmi@gmail.com

THE PLACE AND ROLE OF PROBLEM SOLVING IN THE EDUCATIONAL PROCESS

Abstract. Physics studies the general laws of the occurrence of all natural phenomena, the structure and properties of the material world that surrounds us. Physics is an exact science and its laws are expressed by mathematical formulas. The subject of physics taught in secondary school is the basis of scientific physics and is of special importance in understanding the material world and forming people's scientific world views. This subject explores the general properties of matter, its forms of movement and studies how the material world is formed, the processes and events occurring around us and laws which they depend on. Physics is one of the main natural sciences that studies the laws that exist between the objects that make up the entire material world and makes it available to people. Problem solving is an integral part of teaching physics and has both educational and practical importance. Exercises have special importance in the deeper assimilation of physical concepts and topics, in the clear and precise understanding of the meaning and importance of these concepts. The physical nature of various definitions, rules and laws becomes more clear when they are applied to specific and concrete examples. Examining all these facts becomes possible during problem solving in physics. In such a process, many concepts that remain obscure and are mechanically mastered in memory are clarified. When solving a problem, expressions, laws, numerical values of quantities are remembered, and the physical quantities and units by which they are measured are consolidated in the human mind. Problem solving isn't only useful in learning the basic material but it also plays an important role in deepening, expanding and strengthening mental knowledge. Problem solving is an integral part of each lesson. From this point of view problem solving is an integral part of teaching physics in secondary and high

school and has both educational and practical importance in the teaching process. Educational functions of problem solving have a strong influence on the formation of knowledge and intellectual development in the mind.

Keywords: Matter; action; learning; science; cognition; problem solving.

INTRODUCTION / ВСТУП

Formulation of the problem. Physics is one of the natural sciences that studies the objective properties of the material world. Many branches of science study nature. Each of these sciences separately investigates the phenomena occurring in nature, studies the regularity of their occurrence. All living and non-living things in nature are called physical bodies. In physics, mechanical, thermal, electrical, magnetic, light, sound and atomic phenomena are studied.

The material world – matter – is a material entity that exists independently of us. The main property and form of existence of matter is motion. Arbitrary change in the material world is called movement. This movement is caused by matter itself, by the interaction of its various forms. There are also various forms of motion of matter, including physical, chemical, biological and other forms of motion. These forms of movement are interconnected and can move from one to another.

Different sciences study different forms of motion of matter. Physics studies only the mechanical and physical forms of motion of the material world. Forms of matter and field are accepted as forms of material existence in physics. The material form of matter includes elementary particles formed from atoms of a molecule and bodies consisting of atoms and molecules. The main characteristic of matter is that it is corpuscular, discrete and has a finite size. The field is a means that creates a connection between these particles and transfers their influence to each other, it is a form of material existence, unlike matter, the field is continuous and unlimited in the environment. The field exists both inside the medium and in the out-of-body space, for example, in space.

Analysis of major research and publications. In the methodological literature, such researchers as I. Ismailov [6], Sh. Alizade [2], A. Mehrabov [10], Z. Garalov [9], V. Orujov [15], S. Imanov [5] dealt with this problem. Scientists-researchers in their works noted that when solving a problem, expressions, laws, numerical values of quantities are remembered, and physical quantities and units by which they are measured are fixed in the human mind. Problem solving not only helps in the study of basic material, it plays an important role

in deepening, expanding and strengthening mental knowledge.

AIM AND TASKS / МЕТА ТА ЗАВДАННЯ

The **purpose** of this article is to determine the important role of laboratory practical classes, astronomy and chemistry taught in physics in higher education, in deep mastery of physics, in the formation of students' scientific worldviews and polytechnic creativity of students.

The main **task** of physics is to clarify the real picture of the physical world and determine its laws. When teaching physics, the following tasks are set:

- give students knowledge of the basics of physics at the modern level in a certain system: basic concepts, laws, theories;
- to form in students a modern natural-science picture of the world;
- mastering the methods of scientific research by students;
- familiarization with the scientific foundations of modern technologies.

THE THEORETICAL BACKGROUNDS / ТЕОРЕТИЧНІ ОСНОВИ ДОСЛІДЖЕННЯ

Problem solving is an integral part of teaching physics and has both educational and practical significance. Problems in physics are of particular importance in a deeper assimilation of physical concepts and topics, in a clear and precise understanding of the meaning and significance of these concepts. The physical nature of the various definitions, rules and laws becomes clear when these definitions, rules and laws are applied to particular and specific examples. The study of all these facts in teaching physics becomes possible when solving problems. In such a process, many concepts are clarified, which remain unclear and are mechanically assimilated in memory.

A significant part of each lesson is problem solving: explanation of a new lesson, consolidation, knowledge testing and other learning situations are accompanied by problem solving. Homework is almost always about problem solving. The main feature of optional exercises, competitions and olympiads is also problem solving. Problem solving plays an important role in extracurricular activities, circles, excursions.

When solving a problem, expressions, laws, numerical values of quantities are remembered, and the physical quantities and units by which they are measured are fixed in the human mind. Problem solving not only helps in the study of basic material, it plays an important role in deepening, expanding and strengthening mental knowledge. Problem solving is an

important part of every lesson. It is from this point of view that problem solving is an integral part of teaching physics both in secondary and higher schools and has both educational, educational and practical significance in the educational process. The upbringing and educational functions of problem solving have a strong influence on the formation of knowledge and intellectual development in the mind in conditions of strong communication. A problem solution is a means for a clearer understanding of the material covered in the educational process, consolidating the material, practical application of the material studied, and doing homework.

Scientists have distributed the problems in physics according to their various characteristics: content, didactic goal, method of setting the condition, degree of difficulty, main methods of solution, according to their nature, according to their content, and also grouped them in the following order.

Content tasks can be functional, laboratory, polytechnic, historical and others.

A large number of tasks in the course of higher education are associated with functional tasks. In such problems, one physical quantity is functionally dependent on another physical quantity. The solution of these types of problems is of particular importance in the repetition of students' knowledge and in the functional relationship between quantities, in their understanding of patterns. For example, in high school, they studied the application of the law of conservation of momentum to a body with a variable mass, the law of momentum and its conservation, Ohm's law depending on the strength of current, voltage and resistance.

The problems of a laboratory nature include those problems in which the desired value is determined using the quantities associated with it and measured by instruments during the experiment. Laboratory problems prepare students for independent creativity. Consider the following laboratory problem.

Problem. The weight of an ingot of gold and silver in air is 0.309 N. In the mechanics section, you should use the laboratory experience associated with the experimental verification of Archimedes' law and determine the percentage of gold and silver by weight in the alloy. To do this, using student experience, using the law of Archimedes, one should determine the viscosity of the mixture in water, and the problem is solved using the corresponding values obtained.

Questions of polytechnical content include problems related to industry, agricultural production, transport, communications, household appliances, etc. Such questions prepare students for work and have a strong influence on their

professional orientation.

Problem. 20 lamps are connected in parallel in a circuit. The current in the lamp is 0.5 A. The resistance of the connecting wires is 0.2 Ohm. The internal resistance of the generator is 0.05 Ohm. What voltage should the generator produce so that the voltage drop in the lamps is 220 V.

By solving problems of this type, students gain a deeper understanding of Ohm's law.

The problems associated with the discovery and invention of the laws of physics and related technology can be classified as problems of historical content. When solving such problems, the attention of students is directed to issues related to the history of science and technology problems of historical content reveal to students the essence of scientific discoveries, show missing pages, introduce research methods, for example, Newton's law of universal gravitation, the law of radioactive decay, Coulomb's law, the law of conservation of electric charge, the basic laws of geometric optics, etc. For example, the discovery of radioactivity made it possible to determine the age of the Earth, as well as to determine the history of ancient people who lived in the Azykh cave. All these facts allow you to repeat the materials on physics and deeply understand the materials.

Newton gave the first idea of light. This theory is the corpuscular theory of light. But since Newton's theory could not explain the law of refraction of light, Huygens created a new wave theory. Both theories dominated in parallel for about 150 years. At present, the modern quantum theory of light has emerged.

Problems can be abstract or specific. In abstract problems, one should not consider secondary, unimportant facts. But abstract problems provide good visibility. Usually, the solution of abstract problems is of a general and template nature.

Problems in physics vary greatly in their content, nature and level of complexity. Therefore, the methods for solving them are also different. The choice of one or another method for solving a problem is determined not only by the content and nature of the problem, but also by the degree of difficulty of the problem, its position in the course of physics, the mathematical preparation of students, their knowledge, skills and abilities. When discussing the problem, the teacher determines which method is more effective and convenient in solving the problem. In the process of teaching physics, the following methods are used to solve problems in physics:

1. Oral method.

2. Computational method.
3. Algebraic method.
4. Graphical method.
5. Geometric method.

Oral method. Students are not required to make a written report when solving a problem by the oral method. Such questions are very important for the development of memory and thinking of students. This technique enlivens the course of the lesson, increases the interest and attention of students. For example, in the electromagnetism section, the teacher suggests solving the following problem in order to deepen knowledge about measuring instruments.

Problem 1. How can I measure a current of 10 A with an ammeter with a measurement limit of 5 A?

The computational method means solving the given problem step by step without applying any formula. A computational method based on four arithmetic operations is commonly used in the first grade of secondary general education. In this case, these issues are resolved by gradually studying them and solving them on the basis of free reasoning without applying any formula. The computational method also prepares for solving more complex problems with other formulas in the future.

Algebraic method. In the educational process, a broader algebraic method is used to solve problems in physics. Algebraic problem solving includes: problem solving using a ready-made formula, analytical method, synthetic method.

The solution of problems according to a ready-made formula is applied after studying certain patterns. With this method, a formula is used that expresses one or another law when solving a problem. When applying this method to solve a given problem, it establishes physical patterns, repeats the formula expressing this pattern, performs calculations, writing information corresponding to the condition of the problem into the formula.

Problem. An ideal gas occupies a volume of 855 liters at a temperature of 285 K and a pressure of 810 kPa. At a temperature of 320 K, this gas occupies a volume of 800 liters. Determine the gas pressure.

The problems of the graphical method is solved for two purposes.

1. To establish graphical dependencies of functions.
2. In cases where high mathematical knowledge is not required.

The value of the graphical method in solving problems is as follows.

1. The graphical method simplifies the solution of the problem.

2. The graphical method visualizes the physical phenomena associated with the solution of the problem.

3. No special mathematical background is required.

4. This method prepares students to use the ruler and other mathematical tools in solving problems and be able to choose the appropriate scale.

5. This method helps to determine the functional relationships between quantities and to understand them.

A detailed discussion of the process of solving problems is important for a better understanding of the problems of physics and a deep understanding of their solution. When discussing each issue of physics, first of all, it is necessary to distinguish between two aspects of the issue: the physical aspect of solving the problem and its mathematical aspect. The physical aspect of solving the problem is as follows.

Geometric method. Applying the geometric method of solving problems, the value of the quantity sought in the problem is found on the basis of geometric or trigonometric rules. In this case, an important part of solving the problem is the construction of an appropriate graph or drawing. Unlike the graphic method, in the geometric method, graphs and drawings are used to determine the existing geometric relationships between known quantities and sought quantities. Certain geometric relationships make it possible to find the quantities sought in the problem to solve the problem. Let's solve the following problem geometrically.

A detailed discussion of the process of solving problems is important for a better understanding of the problems of physics and a deep understanding of their solution. When discussing each problem in physics, first of all, it is necessary to distinguish between two aspects of the question: the physical aspect of solving the problem and its mathematical aspect. The physical aspect of solving the problem is as follows.

Finds a quantitative relationship between the known values and the desired values as follows.

1. Drawing up the corresponding formulas and equations based on experimental and theoretical data.

2. Refinement of each written equation and the result of its solution, as well as the final result obtained.

The mathematical side of solving problems consists in solving equations drawn up according to mathematical rules, and carrying out the necessary calculations to find the desired values. When solving a problem, the teacher

conducts a detailed study in order to more clearly convey to the students the physical essence of the problem. All this allows a deeper understanding of physics.

The process of solving problems in physics consists of the following steps.

1. Reading the conditions of the problem.
2. Explanation of incomprehensible words and terms in the conditions of the problem and the definition of relevant concepts.
3. Analysis of the content of the problem in order to clarify the physical meaning of the problem.
4. A summary of the conditions of the problem on the left side of the notebook.
5. Determination of the system of units for solving the problem. After that, these values should be brought to the same system of units.
6. Determination of all physical laws associated with the solution of the problem, and the construction of the corresponding equations.
7. Obtaining the general formula of the desired value, the construction of the corresponding drawings and diagrams.
8. Finding the numerical value of the desired value.
9. Analysis of the answer received when solving the problem with students.

In order for students to clearly and clearly understand the condition of the problem, it is necessary to repeat the condition of the problem frontally. A brief statement of the condition of the problem has both pedagogical and methodological significance. In order to write the condition succinctly, students must study it carefully and have a clear idea of what quantities are given and what quantities are required. After solving the problem, you should analyze the result in detail with the students.

Graphic method. The graphical method consists in constructing appropriate graphs or vector drawings with a certain scale according to the problem statement. In this case, the answer to the problem, i.e., the numerical value of the sought value, is determined using line segments, in some cases, angles or areas taken as scales. Graphical problem solving is more often used in the section of physics, mechanics and optics. The solution of the problem graphically consists in the construction of appropriate graphs or vector drawings with a certain scale according to the condition of the problem. In this case, the answer to the problem, i.e., the numerical value of the desired quantity, is found by direct measurement of line segments, sometimes angles or

areas based on the accepted scale. The graphical method is used to solve many problems in physics, especially mechanics and optics.

RESEARCH METHODS / МЕТОДИ ДОСЛІДЖЕННЯ

Natural phenomena are studied by scientists using certain methods. These methods are called scientific methods. As in all natural sciences, methods for studying phenomena in physics are built according to the following scheme:

Phenomenon – Observation – Problem – Hypothesis – Experiment – Theory.

Observation is the collection of information about events through the senses without interfering with the course of their actions.

RESULTS OF THE RESEARCH / РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ

Solving problems in higher educational institutions and secondary educational institutions further develops the mathematical thinking of students and leads to the expansion and deepening of their knowledge. Problem solving instills in students the ability to work independently and develops many skills in them. Problem solving helps to establish functional dependencies between physical quantities. Problem solving is a great way to put theory into practice and create an interface between physics and technology. Solving problems helps to combat formalism in students' knowledge and instills in them the ability to work independently. Problem solving develops the volitional qualities of students and is an excellent tool for repeating and summarizing the material they have studied.

Solving problems, being an integral part of the lesson, is a means for deepening and consolidating knowledge, performing practical applications and homework.

Problem solving has educational value. It forms in students such important volitional qualities as: perseverance, diligence, desire for research, a conscious attitude to work.

Solving problems forms independent thinking among schoolchildren and students, contributes to the development of their knowledge.

Problem solving increases students' interest in an in-depth study of the physical foundations of technology.

Problem solving contributes to the development of mental education of students and the formation of their special abilities.

Solving problems helps students develop logical thinking, contributes to the emergence of new ideas and thinking styles in them.

Since the problems have different content, they introduce students to classical and modern methods of physics, establishes a connection between theory and practice.

CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH / ВИСНОВКИ ТА ПЕРСПЕКТИВИ ПОДАЛЬШИХ ДОСЛІДЖЕНЬ

Thus, based on the foregoing, we come to the following conclusions that the practical significance of solving problems is as follows:

Problem solving is a means of demonstrating the application of acquired knowledge.

Problem solving is a means of testing the knowledge of pupils and students, as well as a means for assessment.

Problem solving is a means of understanding natural phenomena and explaining them on a scientific basis.

Problem solving is a powerful tool for determining functional dependencies between certain quantities.

Problem solving is a means for understanding and investigating certain patterns that occur in nature.

Problem solving is the main means of applying the acquired knowledge in practice.

Solving problems at the university forms the skills and abilities of students to use tables associated with physical constants.

Problem solving is important for mastering and memorizing the units of measurement of physical quantities, helping them to establish relationships between units of measurement of quantities.

Problem solving develops students' ability to formulate problems, identify problems and look for convenient ways to solve them.

Problem solving forms a system of physical concepts, creates a functional relationship between the quantities included in the laws of physics, helps in an in-depth study of physics.

Prospects for further research in this direction. When teaching physics both in secondary and higher schools, the cognitive activity of students increases in the process. At the next stage of cognition, this activity is further developed and strengthened due to the free creativity of students. Problem solving is based on reproductive and productive methods. Solving problems increases the effectiveness of students' knowledge, helps them apply knowledge in practice, consciously assimilate theoretical material, repeat it, skillfully apply the laws of physics in many areas of technology and nature,

prevent mechanical memorization, create and develop deep and solid knowledge, realize the essence of physical phenomena and for a long time to remember the studied material.

REFERENCES (TRANSLATED AND TRANSLITERATED) / СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

- [1] Ş. H. Əlizadə, *Fizikadan nümayiş eksperimenti (9-cu sinif üçün)*. Bakı, Azərbaycan: “Vətən”, 2011.
- [2] Ş. H. Əlizadə, *Fizikadan nümayiş eksperimenti (8-ci sinif üçün)*. Bakı, Azərbaycan: “Vətən”, 2011.
- [3] T. X. Əzizov, A. S. Xalıqov, *Fizikanın tədrisində fəal və interaktiv təlim metodlarının tətbiqi*. Bakı, Azərbaycan, 2007.
- [4] S. A. Xəlilov, *Elm haqqında elm*. Bakı, Azərbaycan: “Çaşıoğlu” mətbəəsi, 2011.
- [5] S. Ş. İmanov, *Orta məktəbdə fizika tədrisi metodikası*. Bakı, Azərbaycan: ADPU nəşriyyatı, 2007.
- [6] İ. N. İsmayılov, *Fizikanın tədrisində yeni informasiya texnologiya larından istifadə üzrə işin sistemi*. Bakı, Azərbaycan: “Mütərcim”, 2009.
- [7] A. Abbasov, *Pedaqogika*. Bakı, Azərbaycan: “Mütərcim”, 2010.
- [8] Ə. Ağayev, *Təlim prosesi: ənənə və müasirlik*. Bakı, Azərbaycan: “Adiloğlu” nəşriyyatı, 2006.
- [9] Z. İ. Qaralov, *Fizika qanunlarının tədrisi*. Bakı, Azərbaycan: Elm, 1997.
- [10] A. O. Mehrabov, *Müasir təhsilin konseptual problemləri*. Bakı, Azərbaycan: “Mütərcim”, 2010.
- [11] S. Ş. İmanov, *Fizika tədrisi metodikası, I hissə*. Bakı, Azərbaycan, 1982.
- [12] S. Ş. İmanov, *Orta məktəbdə fizika tədrisi metodlarının seçilmə prinsipi və təsnifi*. Bakı, Azərbaycan: API, 1987.
- [13] Ə. X. Paşayev, F. A. Rüstəmov, *Pedaqogika; Yeni kurs*. Bakı, Azərbaycan: “Elm və təhsil”, 2010.
- [14] V. Ö. Orucov, *Fizikanın tədrisi metodikasının aktual problemləri*. Bakı, Azərbaycan: “Nurlan”, 2007.
- [15] V. Ö. Orucov, *Azərbaycanda fizikanın tədrisi metodikasının inkişafı*. Bakı, Azərbaycan: “Bakı Universiteti”, 2011.

МІСЦЕ І РОЛЬ РОЗВ'ЯЗАННЯ ПРОБЛЕМ В ОСВІТНЬОМУ ПРОЦЕСІ

Мамедзаде Афет Джалал,

аспірант з програми доктора філософії,
викладач Гянджинського державного університету.
Гянджа, Азербайджан.

 <https://orcid.org/0009-0007-7672-5787>
fizikaelmi@gmail.com

Анотація. Фізика вивчає загальні закономірності виникнення всіх природних явищ, будову і властивості матеріального світу, що нас оточує. Фізика – це точна наука, і її закони відзначаються математичними формулами. Предмет фізики, що викладається в середній школі, є основою наукової фізики і має особливе значення в пізнанні матеріального світу і формуванні наукового світогляду людини. Цей предмет досліджує загальні властивості матерії, форми її руху та вивчає, як утворюється матеріальний світ, процеси та події, що відбуваються навколо нас, і закони, від яких вони залежать. Фізика – одна з основних природничих наук, яка вивчає закони, що існують між об'єктами, з яких складається весь матеріальний світ, і робить його доступним для людей. Розв'язування задач є невід'ємною частиною навчання фізики і має як навчальне, так і практичне значення. Вправи мають особливе значення для глибшого засвоєння фізичних понять і тем, для ясного і точного розуміння змісту і значення цих понять. Фізична природа різних визначень, правил і законів стає більш зрозумілою, якщо застосувати їх до конкретних прикладів. Перевірити всі ці факти стає можливим під час розв'язування задач з фізики. У такому процесі з'ясовується багато понять, які залишаються незрозумілими і механічно засвоюються в пам'яті. Під час розв'язування задачі запам'ятовуються вирази, закони, числові значення величин, у свідомості людини закріплюються фізичні величини та одиниці, якими вони вимірюються. Розв'язування задач корисно не лише для вивчення основного матеріалу, а й відіграє важливу роль у поглибленні, розширенні та зміцненні розумових знань. Розв'язування задач є невід'ємною частиною кожного уроку. З цього погляду розв'язування задач є невід'ємною частиною навчання фізики в середній та старшій школі і має як навчальне, так і практичне значення в освітньому процесі. Виховні функції розв'язання завдань мають сильний вплив на формування знань і

інтелектуальний розвиток у свідомості.

Ключові слова: матерія; дія; навчання; наука; пізнання; вирішення проблем.

REFERENCES (TRANSLATED AND TRANSLITERATED)

- [1] Sh. H. Alizadeh, Physics demonstration experiment (for 9th grade). Baku, Azerbaijan: "Vatan", 2011.
- [2] Sh. H. Alizadeh, Physics demonstration experiment (for 8th grade). Baku, Azerbaijan: "Vatan", 2011.
- [3] T. Kh. Azizov, A. S. Khalikov, Application of active and interactive learning methods in physics teaching. Baku, Azerbaijan, 2007.
- [4] S. A. Khalilov, Science about science. Baku, Azerbaijan: "Chashioglu" printing house, 2011.
- [5] S. Sh. Imanov, Middle school physics teaching methodology. Baku, Azerbaijan: ADPU publishing house, 2007.
- [6] I. N. Ismayilov, The system of work on the use of new information technologies in the teaching of physics. Baku, Azerbaijan: "Mutercim", 2009.
- [7] A. Abbasov, Pedagogy. Baku, Azerbaijan: "Mutercim", 2010.
- [8] A. Agayev, Training process: tradition and modernity. Baku, Azerbaijan: "Adiloglu" publishing house, 2006.
- [9] Z. I. Garalov, Teaching the laws of physics. Baku, Azerbaijan: Elm, 1997.
- [10] A. O. Mehrabov, Conceptual problems of modern education. Baku, Azerbaijan: "Mutercim", 2010.
- [11] S. Sh. Imanov, Physics teaching methodology, Part I. Baku, Azerbaijan, 1982.
- [12] S. Sh. Imanov, The principle of selection and classification of physics teaching methods in secondary school. Baku, Azerbaijan: API, 1987.
- [13] A. Kh. Pashayev, F. A. Rustamov, Pedagogy; New course. Baku, Azerbaijan: "Science and Education", 2010.
- [14] V. O. Orucov, Actual problems of physics teaching methodology. Baku, Azerbaijan: "Nurlan", 2007.
- [15] V. O. Orujov, Development of physics teaching methodology in Azerbaijan. Baku, Azerbaijan: "Baku University", 2011.

*Стаття надійшла до редакції
6 липня 2023 року*