METHODOLOGY FOR SOLVING PROBLEMS IN PHYSICS

Azimov Jumanazar Turgunovich
Associate professor, Department of Natural sciences
Academy of the Armed Forces of the Republic of Uzbekistan

Abstract: In this article, by analyzing the literature on the methodology of solving many problems, we have covered the general aspects of solving problems in physics and the specific aspects of the methodology of solving problems. It is proposed to follow the methodological procedures presented in solving physical problems related to calculations.

Keywords: physical problem, solution methods, types, classification

In the preparation of intellectually capable cadets, many military-related issues have to be solved during practical exercises in physics. This creates a basis for the cadets to acquire the knowledge and skills necessary for their professional activities. The preparation of such issues is a process related to the scientific and methodological activities of the teacher. This activity determines the place of interdisciplinary connections, the use of the basic concepts of military sciences, and their substantiation.

Educational practice, a physical problem is a small problem that is solved by logical thinking and an experiment suitable for the process, drawing a diagram if necessary, using a certain method for the solution, using the laws and rules of physics, and mathematical operations. In essence, any problematic question that arises in the process of studying educational material is also a physical problem for cadets. Active and goal-oriented thinking is half the solution to the problem. In methodological and educational literature, a problem is understood as any example that is selected for a purpose, the main task of which is to study a physical phenomenon, which forms thinking and imagination in cadets, develops their physical thinking, and embodies the ability to apply the acquired knowledge in practice. The solution of the problem is also aimed at other goals: educating cadets, controlling their knowledge, skills, and qualifications, and taking into account. The essence of a physical phenomenon is revealed to cadets through lectures on the topic, demonstration experiments, laboratory work, and problem solving. If a problem situation can be created on this topic, first of all, the activity of cadets increases, and the acquired knowledge becomes deep and solid. In most cases, such non-standard problems are encountered, in the solution of which the cadet, since he does not use ready-made formulas, feels like he has created a new physical law. In some cases, problem solving also becomes a means of studying a physical phenomenon.

Teaching physics. Among practical methods, the importance of solving physics problems is significant. In the process of solving problems, along with

providing knowledge to cadets, important issues such as developing cadets' abilities and educating them are solved. In the process of solving physics problems, cadets' logical thinking expands and creative abilities develop. They understand the fundamental nature of physical phenomena more broadly, and they gain a deeper understanding of the practical application of laws. They become familiar with the function, structure, and operating principles of many physical measuring instruments, and they acquire skills and qualifications to work with them. Also, problems cultivate diligence courage will and character in cadets.

Physics problem sets are classified according to various criteria. For example, according to the level of complexity of the problems, there are simple problems, more difficult problems, problems that are less familiar than those described in the problem statement, in the textbook and in the problems considered in the lesson, and problems that cadets can use to gain new knowledge. Depending on the content of the problems, they can be related to mechanics, the basics of molecular physics and thermodynamics, electricity and magnetism, the basics of optics and quantum physics, and the basics of atomic and nuclear physics. We know that such a division is conditional, since often the conditions of one problem use information from several sections of physics. Also, problems with a polytechnical content, aimed at developing creative abilities, and containing information of a historical nature are classified. Nevertheless, we will briefly dwell on the types of problems and methods for solving them.

Quality issues

That are solved through logical thinking, based on physical laws and physical formulas, are called qualitative problems. Arithmetic calculations are not performed in such problems.

Qualitative problems have some methodological advantages over other types of physical problems. The methods of solving these problems, which are based on physical laws and consist in drawing logical conclusions, serve as an excellent school for developing the framework of thinking. Qualitative problems clearly explain physical phenomena and their laws to cadets, teach them to apply theoretical knowledge in practice, cultivate the correct attitude towards computational problems, teach them to solve any problem, starting with the analysis of its physical content. Qualitative problems are given in order to consolidate the material covered in the lesson. As we know, in the hydrodynamics department of physics, mainly qualitative problems are solved. Quantitative problems are practically not solved in this department. Qualitative problems are diverse in terms of thematic, content and complexity, that is, there are simple and complex qualitative problems.

The main feature of qualitative questions is that in them the attention of the cadets is focused on the qualitative aspects of physical phenomena, the properties of bodies and substances, processes, etc. Qualitative questions should be distinguished from questions that test formal knowledge (for example, what is acceleration? How

is Newton's second law defined?). The purpose of the questions asked to the cadets is to strengthen their formal knowledge, the answers to such questions are given ready-made in the textbook, and the cadet only needs to remember them. In qualitative questions, such a requirement is imposed that the cadet synthesizes the conditions of the given problem and the knowledge gained from physics and prepares the answer himself.

Qualitative problems are solved graphically and experimentally by drawing logical conclusions based on the laws of physics. Mathematical operations are not performed on physical formulas, but are based on them. In some sections of physics textbooks where mathematical formulas are not given, solving qualitative problems is the only type of physics exercises. Analysis and synthesis are inextricably linked in solving physics problems. Therefore, we can talk about a single analytical-synthetic method of solving physics (qualitative) problems. Many years of experience in teaching physics by solving qualitative problems and theoretical research show that solving simple qualitative problems is carried out in the following 5 stages.

1. Familiarize yourself with the terms of the issue.

2. Understanding the conditions of the problem (analyzing the givens, introducing additional conditions, clarifying the question posed in the problem).

3. Develop a plan to solve the problem (select and describe physical laws that correspond to the conditions of the problem, identify cause-and-effect relationships between the logical foundations of the problem).

4. Implement the problem-solving plan (describe and synthesize the laws given in the problem conditions, obtain an answer to the question given in the problem).

5. Check the answer.

Solving complex qualitative problems is carried out in the same 5 stages, but when familiarizing yourself with the problem statement, you should pay attention to its main question, the main goal of the solution. When drawing up a problem-solving plan, an analytical sequence of conclusions is drawn, starting from the question posed in the problem and ending with its given conditions. In the 4th stage, a synthetic sequence of conclusions is drawn, starting from the description of the relevant laws and ending with the answer to the question posed in the problem. The answer can be checked by comparing it with the general *principles of physics*.

Heuristic, graphical, and experimental methods based on the analytical-synthetic method are used to solve quality problems. They can also be used together, in which case they complement each other.

The heuristic method consists of formulating and solving a series of interrelated qualitative problems. Each of them has an independent meaning and solution and is an element of the solution of the whole problem.

The graphical method involves finding the answer to a question posed in a problem by examining a graph, function, drawing, diagram, or picture.

The experimental method is to obtain the answer to a qualitative problem question based on an experiment that is set up and conducted in accordance with the conditions of the problem.

The experiment is done correctly, the answer will come quickly, it will be convincing and demonstrable. Since the experiment itself does not explain why the phenomenon happens the same way and not differently, it is proved verbally.

In a number of cases, cadets, lacking the ability to think logically , use hypotheses. It is not worth rejecting such a way of solving a problem, but rather, it is necessary to examine in detail various proposals, various physical ideas for solving a problem, and prove whether it is possible or impossible to apply it. This, of course, will lead to a discussion, which will help the cadets develop their physical and logical thinking.

Let's look at a few quality issues:

Problem 1. The walls of the barrel of an artillery gun are of different thicknesses. The part where the projectile is fired is thicker. Why?

Solution: The breech of the barrel is thickened to make it stronger, because when gunpowder explodes, a lot of pressure is created in a small space.

Problem 2. How does the motion of a bullet change when it pierces a board encountered in its path? Does the kinetic energy of the bullet remain unchanged? Doesn't the change in kinetic energy of the bullet when it pierces a board violate the law of conservation of energy?

Solution. The bullet pierces the board, doing work against the frictional force due to the change in its kinetic energy. The bullet's speed decreases. This does not violate the law of conservation of energy, because the bullet and the board heat up.

Experimental problems in physics

Connect theory with practice is to solve experimental problems. A characteristic feature of experimental problems is that laboratory or demonstration experiments are used to solve them. In the process of solving experimental problems, the activity and independence of cadets increase. Because they do not receive the necessary information to solve the problem ready-made from a textbook or a set of problems, but from physical measurements that they perform themselves. Another advantage of experimental problems is that these problems cannot be solved without sufficient thinking, that is, the events occurring in the experiment must be widely discussed by cadets. Because in experimental problems, as in laboratory work, the theory is not given, the procedure for performing the work is not shown. It is enough to provide the necessary equipment, materials and ask for the information that needs to be found. As we said above, the cadets learn from a series of thoughts and reasoning what physical phenomenon is involved in the experiment, what physical law is being expressed, and then they derive the final expression for the physical quantity that needs to be found in the experimental problem. By analyzing the final expression, they obtain the quantities needed to solve the problem by directly measuring them. Let's see what has been said in the following simple experimental problem:

Problem 1. Determine the initial velocity, rise, and fall times of a projectile fired from a ballistic pistol. Ignore air resistance.

Solution. We set up the ballistic pistol so that it can be fired upwards parallel to a one-meter ruler. We fire a projectile from the pistol and measure its launch

height of 110 centimeters. Then, using the following formulas, we calculate the initial velocity of the projectile, its rise and fall times.

$$\upsilon_0 = \sqrt{2gh}, \quad h = \frac{gt^2}{2}, \; t = \sqrt{\frac{2h}{g}}$$

$$\upsilon_0 = \sqrt{2gh} = \sqrt{2 \cdot 9{,}8m/s^2 \cdot 1{,}1m} \approx 4{,}5m/s.$$

$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \cdot 1{,}1m}{9{,}8m/s^2}} \approx 0{,}47s$$

Problem 2. Using a ruler, calipers, and stopwatch, determine the period of oscillation of a mathematical pendulum attached to a tripod.

Solution. The cadets write the formula for the period of oscillation of the pendulum using their thinking (g = 9.8 $T = 2\pi\sqrt{\frac{l}{g}}$ m/s^2 - acceleration of free fall). Here $l = l_m + \frac{D}{2}$ they recall that the length of the pendulum is l_m. The length of the pendulum is measured using a ruler with a scale, and the diameter of the sphere *D* using a caliper. Using the experiment, the time taken for the pendulum to oscillate *n* times is measured several times, their average value is taken, and the period of $T = \frac{t}{n}$ oscillation of the pendulum is determined according to the formula. Then, the period of oscillation determined as a result of the measurements is compared with the theoretically calculated period, and the appropriate conclusions are drawn. In general, the cadets' interest in solving experimental problems is great. It is appropriate for the teacher to solve experimental problems together with the cadets, starting from the conditions of the physics classroom. Teachers can turn some laboratory work and problems in problem sets into experimental problems, or creative teachers can create experimental problems themselves and recommend them to cadets for solving.

The solution of experimental problems should provide an understanding of natural phenomena, which involve the measurement of physical quantities and the mathematical study of functional relationships between them. Such problems develop skills in research work.

How can one determine the acceleration of free fall using a mathematical (physical) pendulum?

We can examine the functional dependences of the acceleration of free fall on height g=f(h) and latitude g=f(φ) by drawing graphs.

In physics graphic issues

Importance in general education and polytechnics. In the process of solving graphic problems, cadets deeply master the basics of physics. In the process of solving graphic problems in class and in the process of independently completing homework, cadets see in practice the interrelationships of physics and mathematics.

Graphical problems also develop the thinking skills of students. All sections of the physics course contain graphical problems of practical importance. In the

simplest case, problems that consist of graphs of the relationship between two physical quantities are called graphical problems.

Cases, the graph is given in the conditions of the problem, in other cases, the graphs need to be constructed based on the results obtained based on the conditions of the problem. The algorithm for solving graphical problems is as follows: if a graph of the relationship between physical quantities is given, it is necessary to carefully read and understand the graph, and study the nature of the relationship in a separate section.

It is necessary to find the values of the desired quantities on the abscissa and ordinate axes from the graph. In cases where a correlation graph is not given, a graph is constructed according to the conditions of the problem or the result obtained from the problem. To do this, coordinate axes are drawn, on which certain scales corresponding to each physical quantity are selected, tables are compiled if necessary, after which points corresponding to the abscissa and ordinate axes of the plane on which the coordinate axes are located are plotted. By connecting these points, a correlation graph between physical quantities is constructed and analyzed, conclusions are drawn.

Creative problems in physics

It is agreed that problems for which the solution algorithm is unknown are called “creative problems”. The conditions for such problems are: the given ones are not enough, the given ones are too much, or the physical data from the field necessary for solving the problem are not given at all. In solving creative problems in physics, the first step is to explain the phenomenon, that is, to answer the question “why”. In the second step, the implementation of real phenomena that meet the requirements is required, that is, to answer the question “How to do it”. Thus, according to the method of the task, creative problems are divided into search (why?) and constructive (How to do it ?).

Construction-type problems in physics

a) questions formulated on the basis of explaining certain technical phenomena or obtaining certain technical effects;

b) issues that require the use of certain natural phenomena;

Issues that require explaining the working principle of a particular device or designing a new device;

Require an explanation of a laboratory phenomenon, a model of a phenomenon that satisfies the given conditions, or the discovery of a new phenomenon.

In the process of solving creative problems, the creative abilities of cadets are developed. One of the factors determining the strength of our independent state is the cultivation and training of educated, highly skilled, creatively active personnel. Therefore, it is appropriate to allocate special time for solving creative problems in physics problem-solving classes in various educational institutions of our republic.

In conclusion, it is worth noting that problems are divided into qualitative, experimental, graphic and creative problems according to the methods of solution. This division is also conditional, because in solving experimental problems we use both verbal reasoning, graphics and computational work. However, each of these

problems is different in terms of content and complexity. The solutions of each problem are aimed at a specific goal and have different solution methods. There is separate literature for each type of physical problem.

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