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Solution of experimental tasks in the study of physics

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Abstract: The solution of experimental problems has features that reveal wide opportunities for the development of students' creative abilities in the learning process. The task of developing the creative abilities of students is an integral part of the problem of developing their thinking.All problems are solved with the help of an expert. An experiment is a set of sciences about the laws and forms of thinking, about the mathematical-logical laws of calculus, about the most general laws of thinking. Experimental apparatus allows you to build the necessary judgment or inference, to highlight a certain concept with its essential features.

Keywords: Problem solving in physics, methods of composing tasks, methods of problem solving, the development of thinking, the development of logic, problem solving

1. Introduction

In the Message of the President to the people of Kazakhstan, the development and implementation ofinnovative technologies, increasing computer literacy contribute to the qualitative growth of human capital. In the context of globalization, informational opportunities are significantly expanding. The Internet creates access to global information space and Internet resources [1].

Physics is the fundamental basis for the theoretical preparation of students, without which its successful activity is impossible.

At all stages of learning, the practical application of theoretical knowledge is of great importance, one of which is to solve problems when studying a physics course. This is especially important when improving various forms of independent work of students.

Problem solving is one of the important means of repeating the consolidation and examination of students.

2. Methods of experimental problems

Systematic problem solving contributes to the development of students' thinking, their preparation for participation in creative searches, brings up diligence, perseverance, dedication and is a good means of controlling knowledge and skills.

Teaching a student to solve physical problems is one of the most difficult pedagogical problems. Therefore, it is very important what method of teaching the teacher uses.

Material submission methods must meet the following requirements [2]:
- a clear selection of the fundamental concepts of the topic and section;
- a clear formulation of laws explaining the phenomena of nature and the
laws under which they obey;
- highlighting the functional relationship between the quantities using formulas and graphs;
- theoretical generalization of the material.

Problems in physics are very diverse in various ways, reflecting the goals. They can be classified according to various characteristics, reflecting the most typical features for many tasks of different content.

Based on the classification method of solution, we can distinguish the following types of tasks:
- quality tasks or tasks - questions;
- quantitative;
- experimental;
- brain teaser;
- graphic;
- tasks with production and technical content.

3.   Basic elements of experimental problems

Experimental tasks — Experimental tasks are those in which an experiment is used to obtain initial data or to verify the correctness of solutions.

Qualitative experimental problems do not require quantitative data and mathematical calculations for their solution. Let's give an example:

"On the table there is an electrical circuit shown in the picture. How will the ammeter and voltmeter readings change when the rheostat slider moves in one direction or another? Why?"

Quantitative experimental problems in their formulation require obtaining quantitative data and mathematical calculations for their processing.

Qualitative experimental tasks with the production content of students make measurements using technical instruments and tools: calipers, micrometers, technical manometer, etc. For the preparation of tasks the teacher uses the production material of those enterprises, which work students.

Experimental tasks should be planned in advance when approaching a topic, when studying a new material and when it is fixed.

Experimental tasks can be used during the homework of students. The following can be attributed to the number of home experimental tasks: "Calculate the cost of electricity consumed in a flat per week using the readings of an electric meter"; "To determine what will be the image of the flame of a candle, if you look at it through a horizontally positioned and filled with water bottle", etc.

Problems in physics are very diverse in various ways, reflecting the goals. They can be classified according to various characteristics, reflecting the most typical features for many tasks of different content.

Taking the solution method as the basis for the classification, the following types of tasks can be shown (Fig-1) [4].
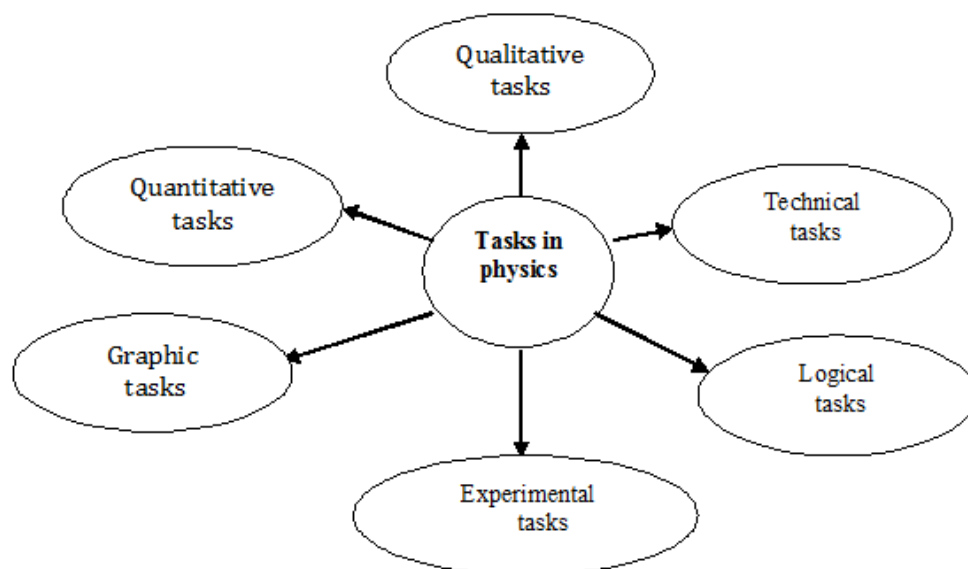

Fig. 1: Types of physical tasks.

4.   The following types of logical problems exist:

Experimental tasks that do not require complex equipment and a lot of time to perform them are included in the content of tests and tests, for example, to measure the temperature with a thermometer, read out the atmospheric pressure using an aneroid, etc.

The formulation of experimental tasks can be different:

a) The experimental task is set as a demonstration experiment. In this case, the necessary equipment is put on the demonstration table, and the teacher receives the experimental data for the task. In this case, all requirements for the demonstration experiment should be fulfilled:

- clear target setting,
- providing visibility
- short duration
- convincing experience, etc.

b) The experimental task is set as a frontal laboratory task. In this case, the equipment is provided for each table and students receive experimental data and solve the problem on their own.

c) The experimental task has a research character. In this case, each table is given a different equipment, depending on the tasks that students receive. They independently assemble the installations and carry out the necessary experiment. The solution of these tasks should be distinguished by a great independence of students in the selection of equipment and analysis of physical phenomena.

Experimental research problems can be a type of extracurricular work in physics in the case when their solution requires a long time.

The solution and design of the experimental problem of a calculated nature consists of the following elements:

- formulation of the problem;
- condition analysis;
- measurements;
- calculations;
- experienced response verification.

5.   Examples of experimental tasks.

5.1   Problem 1.

On the table there is a rectangular can, scales, weights, scale ruler, a vessel with water, sand. To ensure the vertical position of the banks when swimming in water, it is slightly loaded with sand. Determine the depth of the cans when it is immersed in water.

In this case, the condition of the problem can be expressed in a picture

with the signature of the question under it. Then proceed to the analysis, find out what measurements need to be performed to solve the problem.

Task analysis:

The can will be submerged in water until the force of gravity acting on it and the sand is balanced by the buoyancy force of water acting on the can from below. In this case:

$$F_{Arch} = F$$

But since the Archimedean force F_{arch} is equal to the weight of the fluid displaced by the body, then:

$$F_{Arch} = 9{,}8\frac{N}{kg} \cdot \rho_B \cdot V_B$$

where V_B — is the volume of the submerged part of the can, ρ_B — is the density of water. The volume of the submerged part is equal to the product of the area of the base S and the depth of immersion in water $h.$ Consequently,

$$F_{Arch} = 9{,}8\frac{H}{\kappa z} \cdot \rho_B \cdot V_B = 9{,}8\frac{N}{kg} \cdot \rho_B h S$$

from where,

$$h = \frac{F}{9{,}8\frac{N}{kg} \cdot \rho_B S}$$

The correctness of the found solution is checked by operations with the names of the quantities included in the formula.
From the formula (1) it is clear that to solve the problem it is necessary to
know the weight of the can of sand, the density of water and the area of the base of the can.

Measurements. Determine the weight of the P banks with sand using a dynamometer.

Measure the length l and width of the base. Determine the area of the base

$$S = l\,a.$$

Density of water $\rho_B = 1 g / sm^3$

Experienced check on empirically. On the vertical wall of the can, a color line indicates the depth of immersion found from experience and subsequent calculations, and put the can in a vessel with water. Experience shows that the depth of immersion coincides with the value found.
In connection with the solution of the problem, the principle of determining the draft of the ship is explained.
In experimental qualitative problems, experience is set at the moment when a need arises in it. For example, to solve the problem of a baroscopic on a demonstration table, an installation is prepared in advance with a glass cap, inside which the baroscopic is placed. The air tray is connected to the Komovsky pump. The teacher explains the device of the baroscopic and, drawing attention to the balance of the lever, puts the question to the class: "What changes will occur with the baroscopic if air is pumped out?" The students offer an explanation. In this case, correct and incorrect explanations may be offered. Doubt in their correctness
is allowed by demonstration of experience (Figure - 2):

Fig.2: Bell air pump

However, there may be another way to find the answer to this problem. After the question is posed, the tasks immediately proceed to the execution of experience Watch the occurrence of the phenomenon. Then he is explained theoretically.
Some experimental tasks in physics in a classroom can be posed frontally. Examples of such tasks: "Measure the water pressure at the bottom of the glass using a ruler"; "Determine the power of the current consumed by the light bulb." In this case, they perform the role of frontal experiments.

5.2   Problem 2.

Question: How with the help of a ruler can you find the height of a tree on a sunny day without climbing into it? [9].
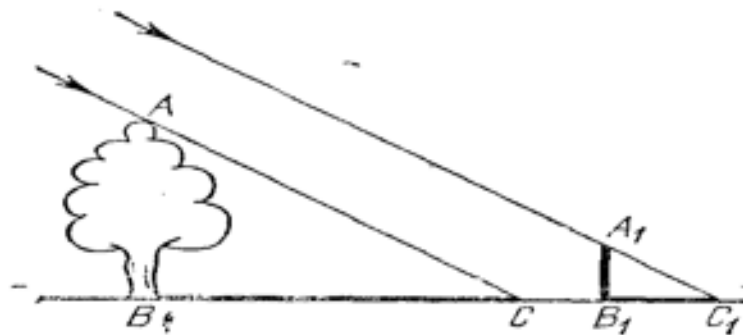
Fig. 3: Drawn tree to determine the height

Answer: Putting the ruler vertically, mark on the ground the length of the shadow B_1C_1, and also the length of the shadow BC from the tree. From the similarity of the triangle ABC and $A_1B_1C_1$ find the tree height equal to,

$$AB = \frac{A_1B_1}{B_1C_1} \cdot BC$$

where - A_1B_1 is the known ruler length.

5.3　　Here Are Examples of Logical Problems. Problem 3.

There is a plank on both banks, but each one is somewhat shorter than the width of the stream. How can an adult and a child run from one bank to another? An adult and a child need to go through speeches: one from the left bank to the right bank, the second in the opposite direction.

Fig.4: There is a plank on both banks, but each one is somewhat shorter than the width of the stream

5.4　　Problem 4.

The Fall of the pressure in pluming is demonstrated on the following model (the rice. 5). Narrow (for increase of friction) pipe A and her (its) branch B, supplied man metric tube, can be closed tap but and b.
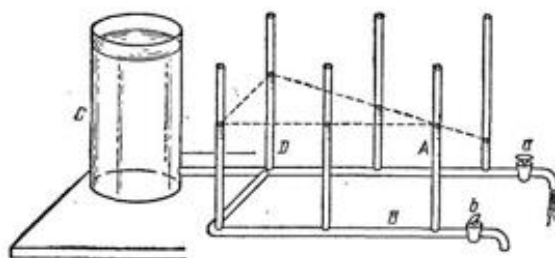

Fig. 5: Water tank and metric tube for demonstrating pressure drop

If fill water in container C and close the taps that we observe what spreads the height to liquids in turban a, b and C and as so much for possible explain?

5.5   Problem 5.

Why should high-speed trains (Fig. 6) slow down at a meeting, otherwise the windows in the cars will break? Which way does the glass fall out: inside the cars or out? Can this happen if trains move in one direction? Will you be attracted to the train or push away from it if you find yourself too close to the fast train?
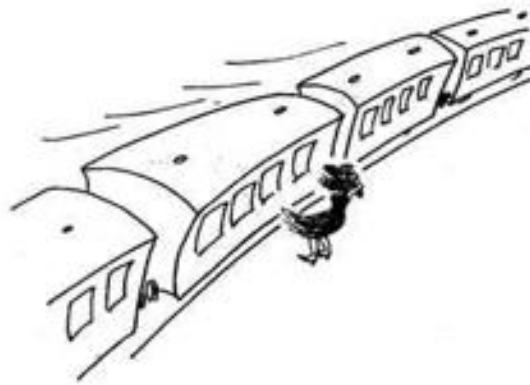

Fig. 6: As an example, consider the movement of a railroad car at the rounding of a horizontal track

5.6   Problem 6.

In rainy windy weather, each of us noticed that the opened umbrellas sometimes "turn inside out" (Fig.7). Why is this happening?
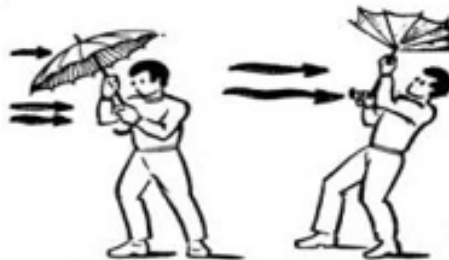

Fig. 7: Open umbrellas "turned inside out"

5.7   Problem 7.

For the experience, we will manufacture a cylinder of thick, but not thick paper with a diameter of 5 cm, 25-30 cm long. A sharp movement along the horizontal surface of the table will inform the cylinder of a complex movement
(translational and rotational (Fig. 8). At high speed, the cylinder rises and describes a small vertical loop. Explain why this is happening.
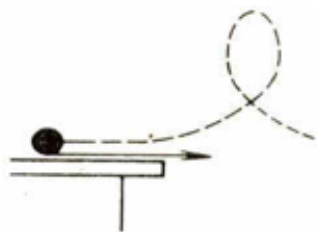
Fig. 8: Describes a small vertical loop

5.8   *Problem 8.*

That occurs if blow on sheet of paper along his(its) surfaces that occurs and as this possible explain (Fig - 9)?

Fig. 9: Blow on a sheet of paper along its surface

6.   Conclusion

The solution of experimental problems begins with the formulation of the problem, then a brief record of the conditions and requirements is carried out, a hypothesis is formulated, the test of which is planned. Then, the implementation of the planned plan is carried out by various means: experimental, logical and mathematical. Then the result is checked.

The results of solving experimental problems are refined model ideas about the didactic material of the educational process and the creation of experimental tasks of a new generation. The tasks set the level of complexity and the scope of the task, due to the fact that the activity of the teacher is aimed at building a model of the educational process with predetermined quality objectives.

The solution of experimental problems with students in the professional competence of the teacher, who mediates between theory and practice.

With the mastery of this skill, a new technological thinking of the teacher begins: clarity, structure, clarity of the methodological language, the emergence of a reasonable standard in learning.

So, only through the pedagogical technology, the practice of its implementation and implementation, the volume and level of complexity of the teaching content are derived. The object of the activity of the methodologist is the design of the educational process on technology. The activity of the teacher - becomes the reorientation of the project - a sample of the educational process to the characteristics of the teacher, and his methodological enrichment.

References
[1]   http //www.bnews.kz/
[2]   Nurkasymova S N 2004 Methods of teaching physics - Semey, p.110-114
[3]   Apatova N V 1994 Information technology in school education. M. p.165
[4]   Nurkasymova S.N. The use of information technology in educational the process - Astana, 2010 p.109 - 112
[5]   2002 Journal "Informatics and Education",p.128

[6]   Usova AV and Tulkibaeva N N 2001 Workshop on the solution of physical problems "Education" Moscow

[7]   Tarasov L V 1990 Modern physics in high school. - M .: Enlightenment

[8]   Bugaev A I 1990 Methods of teaching physics in high school. - M .: Enlightenment.

[9]   Lange V N 1986 Experimental physical tasks for ingenuity. - M .: Enlightenment.

[10] Theory and methods of teaching physics in school. Private issues. Ed. S.E. Kamenetsky. // M .: Academy, 2000.

[11] Yastrebtseva E N 1998 Project "Harmony" // Computer at school. **3**

[12] LabVIEW computer modeling tools, 8. Measurement Studio, etc. Internet address: http://labview.nm.ru

[13] Khutorskoy A V 1998 The development of schoolchildren endowment: Methods of productive learning. - M., x. p. 66. http://www.corbina.net/~snark/

[14] Sevchenko N E 2000 Problems in physics with the analysis of their solutions. M .: Enlightenment -

[15] Saveliev I V 2003 Collection of questions and problems in general physics. M .: Science

[16] 2002 Journal "Informatics and Education".p.128

[17] Kotkin G L and Cherkassky V S 2001 Computer simulation of physical processes using MATLAB. Novosibirsk,169 b.

[18] Porshnev S V 2003Computer simulation of physical processes in the MATLAB package. –M,. p. 592

[19] Martynov N N and Ivanov A P 2000 MATLAB 5.X. Calculations, visualization, programming. M, KUDITS-IMAGE, p.332

[20] Evans, J.ST.B.T., 1972. On the problems of interpreting reasoning data: Logical and psychological approaches. Cognition, 1(4): 373-384.

[21] Hutorskoj A V 2000. The development of gifted students : Methods of Productive Teaching. pp: 66.

[22] Marco De Boni 2007 Using logical relevance for question answering. Journal of Applied Logic,5(1): 92-103.

[23] Physics at school - 2003

[24] Quant - 2004

[25] Physics at school - 2005

[26] http: //l-micro.ru/

[27] http://school56.spb.ru/lego/lego.index.html