ГІДРОТЕХНІЧНЕ БУДІВНИЦТВО, ВОДНА ІНЖЕНЕРІЯ ТА ВОДНІ ТЕХНОЛОГІЇ

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INDEPENDENT WORK DURING PHYSICS LEARNING USING SOLUTION OF PRACTICAL AND THEORETICAL PROBLEMS

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The study of physics by students of the Kherson State Agrarian and Economic University is based on listening to a course of lectures, performing laboratory work, practical classes, as well as independent work on mastering the course. Nowadays, a lot of attention is paid to independent work. Independent work gives an opportunity to deepen the knowledge gained during classroom classes, allows you to more fully and deeply master practical skills and theoretical knowledge. Solving theoretical problems contributes to: consolidation of acquired skills and abilities, acquired by students with the participation of the teacher. Development of the ability to independently solve theoretical problems based on the fundamental laws of physics. Understanding the essence of basic physical laws, the possibility of their application in further professional activity. Solving problems contributes to the analysis along with the systematization of knowledge, helps to find out which laws and regularities of physics can be used to solve this problem; Acquiring skills in the practical application of mathematical apparatus to solve this problem; In the process of solving problems, put forward certain assumptions, find the limits of the application of the laws of physics, put forward certain simplifications when building a physical model; Establish parallels of the application of physical laws to real physical processes that exist in the proposed problem; To acquire skills of independent search, use of intuition when searching for a solution to a problem; Also, solving problems requires clear and logical thinking and explaining one's steps in the process of solving problems; Do not focus on theoretical principles, but also develop practical skills of verification with the help of a physical experiment. Solving theoretical problems in physics gives students the opportunity not only to master physical laws, but also to develop important cognitive and practical skills: mathematical, analytical, logical, as well as the ability to think independently and communicate. This is an important step on the way to a future scientist or engineer, where not only knowledge is important, but also the ability to apply it in practice.

Key words: *physics, problem solving, practical skills, problem solving algorithm, dynamics of a material point.*

Заводянний В. В. Самостійна робота під час навчання фізиці із застосуванням розв'язку практичних та теоретичних задач

Вивчення фізики здобувачами освіти Херсонського державного аграрно-економічного університету базується на слуханні курсу лекцій, виконанні лабораторних робіт, практичних занять а також самостійної роботи над засвоєнням курсу. На сьогоднішній

день самостійній роботі надається велика увага. Самостійна робота дає можливість поглиблювати отримані знання під час аудиторних занять, дозволяє більш повно і глибоко оволодіти практичними навиками та теоретичними знаннями. Розв'язування теоретичних задач сприяє: закріпленню набутих умінь та навичок, отриманих студентами з участю викладача. Розвитку вмінь самостійно розв'язувати теоретичні задачі, спираючись на фундаментальні закони фізики. Розумінню суті основних фізичних законів, можливості їх застосування у подальшій професійній діяльності. Розв'язок задач сприяє аналізу разом з систематизацією знань допомагає з'ясувати, які закони та закономірності фізики можуть бути використанні для розв'язку даної проблеми; Набуття навичок практичного застосування математичного апарату для розв'язку даної проблеми; В процесі розв'язку задач висувати певні припущення, знаходити межі застосування законів фізики, висувати певні спрощення при побудові фізичної моделі; Встановлювати паралелі застосування фізичних законів до реальних фізичних процесів, що існують в запропонованій задачі; Набувати навичок самостійного пошуку, використання інтуїції при пошуку розв'язку задачі; Також розв'язання задач вимагає чіткого та логічного мислення і поясненні своїх кроків, в процесі розв'язку задач; Не зациклюватись на теоретичних засадах, але й розвивати практичні навички перевірки за допомогою фізичного експерименту. Розв'язування теоретичних задач з фізики дає можливість здобувачам не лише опанувати фізичні закони, а й розвивати важливі когнітивні та практичні навички: математичні, аналітичні, логічні, а також здатність до самостійного мислення і комунікації. Це важливий крок на шляху до майбутнього науковця чи інженера, де важливі не лише знання, а й уміння застосувати їх на практиці.

Ключові слова: *фізика, розв'язок задач, практичні навички, алгоритм розв'язку задач, динаміка матеріальної точки.*

Introduction. The study of physics by students of the Kherson State Agrarian and Economic University is based on listening to a course of lectures, performing laboratory work, practical classes, as well as independent work on mastering the course. Candidates learn the basic concepts of regularities and laws of physics at lectures. Also, application of theoretical knowledge in practice is obtained in laboratory classes. Understanding of theoretical laws is achieved in practical classes. Also, independent work on physics plays an important role in mastering the material.

Analysis of recent research and publications. Nowadays, a lot of attention is paid to independent work. Independent work gives an opportunity to deepen the knowledge gained during classroom classes, allows you to more fully and deeply master practical skills and theoretical knowledge. It also plays an educational role: it promotes the development of will, self-discipline, develops the ability to find and learn new material, which in the future leads to the desire of students to improve themselves [1].

Solving practical and theoretical problems is one of the main components of the educational process. When solving problems, students acquire the necessary skills, namely [2]:

– Ability to analyze natural phenomena, processes.

– Compare objects, phenomena and find their interrelationships.

– Independently draw correct conclusions and their justification.

The purpose of the study. The purpose of the article can be the analysis and evaluation of the effectiveness of approaches to the study of physics, as well as the creation and application of algorithms for solving typical physics problems.

Presentation of the main material. Students learn how to solve practical problems in physics during laboratory work. The solution of theoretical problems is included in the independent work of students during the course of physics. Solving theoretical problems contributes to:

– Consolidation of acquired abilities and skills acquired by students with the participation of the teacher.

– Development of the ability to independently solve theoretical problems based on the fundamental laws of physics.

– Understanding the essence of basic physical laws, the possibility of their application in further professional activity.

In the process of solving problems, the winners acquire a number of important skills and abilities that can be applied in further professional activities. Namely:

– Analysis together with the systematization of knowledge helps to find out which laws and regularities of physics can be used to solve this problem;

– Acquiring the skills of practical application of mathematical apparatus to solve this problem;

– In the process of solving problems, put forward certain assumptions, find the limits of the application of the laws of physics, put forward certain simplifications when building a physical model;

– Establish parallels of the application of physical laws to real physical processes that exist in the proposed problem;

– To acquire skills of independent search, use of intuition when searching for a solution to a problem;

– Also, solving problems requires clear and logical thinking and explaining one's steps in the process of solving problems;

– Do not focus on theoretical principles, but also develop practical skills of verification by means of a physical experiment.

Theoretical problems in physics can be conditionally divided into three groups by complexity:

– Reproductive type – requires the student to determine the fundamental law by which the problem is solved and to find an unknown quantity (a problem in almost one step) that corresponds to a low level of knowledge.

– Algorithmic type – requires the student to solve the problem using an appropriate algorithm or sequence of actions that must be performed for the correct solution, corresponding to the average level.

– Creative – searching type – requires a creative approach from the student to solve non-standard problems, which corresponds to a high level of knowledge. Since the largest number of students have an average level of knowledge, in my opinion, great attention should be paid to the creation and familiarization of students with algorithms for solving typical problems during the physics course. We offer the following algorithm for solving problems on the topic "Dynamics of a material point":

1. Carefully read the condition of the problem. Determine to which section of physics the problem should be assigned.

2. To clearly understand which quantities are known from the condition of the problem, which can be taken from reference books, as well as the quantities that must be found.

3. Make a short note of the condition of the problem.

4. Write down all physical quantities and necessary constants in the SI system.

5. Make a schematic drawing.

6. Choose a reference system (coordinate axes, reference point, time) convenient for solving the problem.

7. Show the direction of the body's speed.

8. Show the direction of acceleration of the body:

a) if the acceleration of the body is zero, it should not be shown in the figure;

b) if the movement of the body is uniformly accelerated, the acceleration is directed in the direction of the speed;

c) if the movement of the body is uniformly decelerated, the acceleration is directed in the direction opposite to the direction of the body's speed.

9. Consider all the forces acting on the body.

10. Show the direction and points of application of forces acting on the body (forces are shown in the figure by vectors): a) take into account that the force of the earth's gravity is directed perpendicularly down to the horizon line, and its magnitude is equal to the product of the mass of the body by the acceleration of free fall $P = m \cdot g$ (g=9,81м/с^2);

b) take into account that the friction force is directed in the opposite direction to the direction of the body's speed, and its value is determined as for the sliding friction force, the product of the friction coefficient by the support reaction force $F = k \cdot N$;

c) take into account that in the case of an inextensible thread (cable), the force of tension of the cable on both sides is the same in magnitude and is directed along the thread (cable).

11. Show the projections of the forces applied to the body on the coordinate axis of the selected coordinate system.

12. Write the force equation in vector form.

13. Write down the force equations in projections on the selected coordinate axes.

14. Determine the number of unknown forces or quantities included in the force projection equations.

15. If the number of unknown values in the force projection equations is greater than two:

a) pay attention to paragraph 10 of part a) and b) and write down the relevant forces as indicated in these paragraphs;

b) to pay attention to the fact that the acceleration of a body during constant motion is related to kinematic quantities (path, time, initial and final velocities of bodies) by the formulas given below:

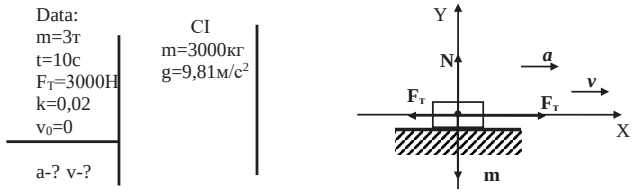
$$S = v_0 \cdot t \pm \frac{a \cdot t^2}{2}, S = \frac{v^2 - v_0^2}{2 \cdot a}, \quad a = \frac{v - v_0}{t}.$$

16. Solve the system of equations in projections and find the unknown quantity.

17. Record the answer in the SI system.

18. If in the problem it is necessary to consider the interconnected movement of a system of bodies, then, as a rule, it is necessary to consider the movement of each body separately, obtaining a system of interconnected equations, which must be solved and the desired quantity found. Let's consider an example of the application of the given algorithm for solving the problem of the dynamics of a material point:

Example: A car with a mass of 3t moves from rest along a horizontal path for 10s under the action of a traction force of 3000N. Determine with what acceleration the car moves during acceleration and what speed it reaches during this time? The coefficient of movement resistance is 0.02. Solution:



Consider the forces acting on the car. Gravity and road reaction force act vertically. During acceleration, the force of traction and the force of friction directed against the direction of movement act. The acceleration vector is directed in the same direction as

the velocity and thrust vector, because the motion is uniformly accelerated. Newton's second law in vector form looks like this:

$$\vec{N} + \vec{F}_T + m\vec{g} + \vec{F}_{тр} = m\vec{a} \quad (1)$$

In the projections on the X and Y axes, equation (1) takes the form:

OX: $F_T - F_{тр} = ma$

OY: $N - mg = 0 \quad N = mg$

Using the definition for the force of friction, we write:

$$F_{тр} = k \cdot N = k \cdot mg$$

Therefore:

$$F_T - k \cdot mg = ma$$

Where do we get:

$$a = \frac{F_T - k \cdot mg}{m}$$

The speed of the car at the end of the movement can be found using the speed formula for uniformly accelerated motion:

$$v = v_0 + at$$

Since the initial speed is zero, the expression for the speed at the end of the movement takes the form:

$$v = at$$

By substituting numerical values in the SI system from the condition of the problem, we get:

$$a = \frac{3 \cdot 10^3 - 0{,}02 \cdot 10 \cdot 3 \cdot 10^3}{3 \cdot 10^3} = 0{,}8 \text{ м/с}^2$$

$$v = 0{,}8 \cdot 10 = 8 \text{ м/с}$$

Respond: a=0,8м/с^2; v=8м/с.

Conclusions and prospects for further research. Therefore, the study of physics using a complex approach, namely lectures, laboratory and practical classes, and independent work on mastering the material allows you to gain theoretical knowledge and the ability to apply it in practice. Allows to develop practical and critical thinking. It is also possible to suggest further research into interactive learning methods, optimization of independent work on mastering the physics course, and the use of digital technologies.

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