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How to Solve the Problem in Physics

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Abstract: This article discusses the recommendations and methods of problem solving in physics and how problem solving affects the student. It is also important to keep the theoretical knowledge in the student's memory for a long time and use the analogy method to easily solve problems.

Keywords: problem solving, problem types, method, recommendation, forward motion, oscillating motion, rotational motion, analogy.

Problem solving is important in teaching physics. Problem solving is an integral part of the process of teaching physics, it contributes greatly to the formation of physical concepts, develops physical thinking, improves the ability to apply knowledge in practice. Solving physical problems is widely used in the following cases:
- providing new information;
- creating a problem situation and putting problems to students;
- in the formation of practical skills and abilities;
- in monitoring the level of knowledge of students;
- consolidation, generalization and repetition of material;
- Introduction to the achievements of modern technology;
- in the development of creative abilities of students.

Problem solving is the application of theoretical knowledge in practice. This is of great importance in the development of students' physical thinking, including the analysis of events, the generalization of information about them, the identification of similarities and differences.

According to the didactic goals and students' mastery, the issues can be divided into the following stages [1]:

Phase I. Simple problems, they serve to reinforce newly learned definitions, concepts, interpret formulas, laws, meaning, use ready-made formulas to find this or that quantity, i.e. exercise problems. Such issues not only require the retrieval of memorized knowledge, but they are also necessary as an initial step in mastering the material studied.

Phase II. More difficult problems include analyzing a particular physical condition, understanding how the physical law describes the phenomenon described in the problem, applying the previously studied material needed to analyze the phenomenon, mathematically expressing the laws used, drawing a diagram or diagram based on the given problem. requires. Such problems are in many ways focused not only on memory but also on thinking - they require students to independently recall the theoretical knowledge they have acquired in finding a solution to a problem condition. Such issues help to deepen the knowledge and know how to apply it in their own experiences.

Phase III. Issues that are less familiar than those described in the context of the issue, the textbook, and the topics covered in the lesson. For example, if a lesson or textbook examines the forward motion of a body to study the laws of motion of a body, then a question related to the oscillating or rotational motion of a similar body may be proposed. The process of solving these problems is characterized by great mental tensions that require students to search, discuss, and prove independently.

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In matters of physics, the special case of a physical law is reflected. It is necessary to compile a list of quantities in memory, which summarizes the theoretical information about the physical law in terms of the problem. In doing so, great care must be taken to determine the quantities given anonymously. In some cases, a single word in the context of an issue will help clarify the list of given sizes.

In the process of independent problem solving, it is advisable to follow the recommendations of the following procedure [5]:

- carefully read the conditions of the problem and determine which event or process is being considered and to which branch of physics it belongs;
- to determine the physical laws of the case;
- Record the quantities given and sought in the context of the problem;
- Representation of given quantities in the system of international units;
- draw a diagram or scheme based on the data;
- Write the basic formulas according to the conditions of the problem and derive from them the working formula.

Describing the event or process in the form of a schematic diagram, showing the characteristic parameters in the drawing, often gives positive results, the given and sought quantities are clearly visible, it becomes clear what additional information is needed to solve the problem.

In solving the problem in general, an algebraic answer to the problem is formed using an equation that represents the quantities sought by the given quantities. The unit of measurement of the quantity sought is examined based on a formula representing the algebraic answer to the problem. To do this, the units to the right of the formula are replaced by their units of measurement, and simplification operations are performed. The result must be the unit of measurement of the quantity sought, otherwise the problem will be solved incorrectly.

The following are solutions to the problems of studying the mechanical motion of bodies and their analogies.

In the mechanics department of physics, the mechanical motion of bodies is studied. The change in the position of an object relative to other objects (or parts of an object relative to each other) is called mechanical motion.

For the purpose of simplification, the motion of bodies is studied in three types: forward, rotational, oscillating motion. When the body of a car moves forward, the wheels rotate and the pistons in its engine vibrate.

1. Move forward. When all points of an object move parallel to each other at the same distance during a motion, such a motion is called a forward motion.

Quantities that generally represent linear (forward) motion:

- speed: $\vartheta = \frac{ds}{dt}$; $\left[\frac{m}{c}\right]$

- if the speed is known, the distance traveled in any time: $ds = \vartheta \cdot dt$; $\left[\frac{m}{s} \cdot c = m\right]$

- acceleration: $a = \frac{d\vartheta}{dt} = \frac{d^2 s}{dt^2}$; $\left[\frac{m}{c^2}\right]$

- When there is a straight line straight motion, $\vartheta = \frac{s}{t} = const$ and $a=0$.

When there is a linear variable motion of a straight line, it is as follows:

- $a = const$; acceleration: $a = \frac{\vartheta - \vartheta_0}{t}$;

- the velocity of a straight-line linear variable motion at an arbitrary time moment can be found using the following expression:

$\vartheta = \vartheta_0 + at$;

here, ϑ_0 – the initial frequency of the material point, a - acceleration of a material point.

- way: $s = \vartheta_0 t + \frac{at^2}{2}$;

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In these equations, an acceleration is "positive" if the motion is flatly accelerating and "negative" if the plane is accelerating smoothly.

- the relationship between speed, acceleration and distance traveled: $\vartheta^2 - \vartheta_0^2 = 2as$. If $\vartheta_0 = 0$ бўлса, $\vartheta^2 = 2as$ or $\vartheta = \sqrt{2as}$ is equal .

- full acceleration in curvilinear motion: $a = \sqrt{a_t^2 + a_n^2}$

In this, a_t– tangential acceleration, a_n – normal (centripetal) accelerations:

$a_t = \frac{d\vartheta}{dt}$ and $a_n = \frac{\vartheta^2}{R}$

In this , ϑ – speed of movement, R – the radius of curvature of the trajectory at a given point.

2. Rotational movement. If a material point passes through arcs of equal length between arbitrary equal times around a circle, such a motion is called a plane rotational motion.

In general, the quantities that represent the rotational motion are:

- turning angle: $d\varphi = \frac{ds}{R}$; $[рад - радиан]$
- angular velocity: $\omega = \frac{d\varphi}{dt}$; or $\omega = \frac{\varphi}{t} = \frac{2\pi}{T} = 2\pi\nu$; $[рад/c]$

In here, T – rotation period: $T = \frac{t}{N}$ $[c]$; $N - t$ the number of cycles in time, ν - rotation frequency: $\nu = \frac{N}{t}$ $[1/c]$;

- angular velocity *(ω)*, the relationship between the linear velocity (ϑ) and the radius of the circle: $\vartheta = \omega \cdot R$
- angular acceleration: $\varepsilon = \frac{d\omega}{dt} = \frac{d^2\varphi}{dt^2}$; $[rad/s^2]$
- tangential acceleration: $a_t = \varepsilon \cdot R$
- normal acceleration: $a_n = \omega^2 \cdot R$

3. Vibration movement. The repetitive motion over its equilibrium position over time is called oscillating motion.

In general, the quantities that represent the oscillating motion are:

- period of oscillation: $T = \frac{t}{N}$ $[s]$; $N - t$ number of oscillations over time,
- vibration frequency: $\nu = \frac{N}{t}$ $[1/s]$;
- the displacement of a periodically oscillating body changes over time according to the law of sines or cosines:

$x = A\sin(\omega_o t + \varphi_0)$ or $x = A\cos(\omega_o t + \varphi_0 - \frac{\pi}{2})$

In here: A – amplitude of maximum displacement, ω_0 – cyclic (circular) frequency depending on the parameters of the oscillating system, φ_0 – initial phase, $(\omega_0 t + \varphi_0)$ – the oscillation phase at time t after the onset of vibration.

- cyclic frequency 2π the number of oscillations per second: $\omega = \frac{2\pi}{T}$; $\left[\frac{рад}{c}\right]$
- velocity in harmonic oscillation: $\vartheta_x = \vartheta = \frac{dx}{dt} = x'(t)$ or $\vartheta = A\omega\cos(\omega_0 t + \varphi_0)$
- the amplitude value of the velocity: $\vartheta_{\max} = A\omega = A \cdot 2\pi\nu = A \cdot \frac{2\pi}{T}$
- acceleration at harmonic accelerations:

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$$a = \frac{d\vartheta}{dt} = \vartheta'(t) = -A\omega^2 \cdot \sin(\omega_0 t + \varphi_0) = A\omega^2 \cos\left[(\omega^2 t + \varphi_0) + \pi\right]$$

- amplitude value of acceleration: $a_{\max} = A\omega^2 = A \cdot 4\pi^2 v^2 = A \cdot \frac{4\pi^2}{T^2}$

Examples of solving problems related to the types of motion of objects [2]:

1 - masala. The plane is flying from point *A* to point *B*, *300 km* east. Find the time for the aircraft to fly this distance in the following cases: 1) when there is no wind, 2) when the wind blows from south to north, and 3) when the wind blows from west to east. Wind speed υ_1*=20 m/s*, aircraft speed υ_2*=600 km/hour*.

Given:
s = 300 km = $3 \cdot 10^5$ *м*
u – speed of wind:
u = 20 м/с
ϑ – speed of plane:
ϑ = 600 km/ҳ = 2160 м/с

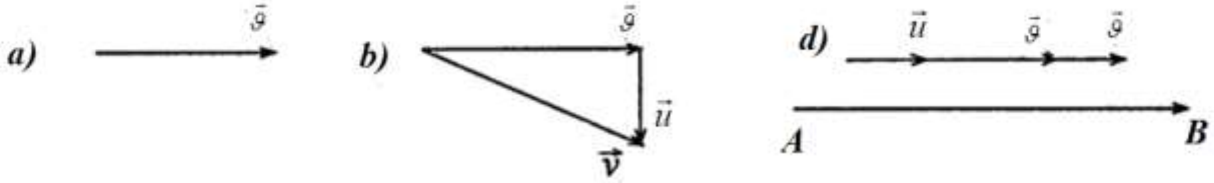
t_1 – ?, t_2 - ?, t_3 - ?

Formula:
From the basic formulas we can derive working formulas:
1. Main formulas:

$$\upsilon = \frac{s}{t_1}; \quad \upsilon^2 = \left(\frac{s}{t_2}\right)^2 + u^2 = \frac{s_2}{t_2^2} + u^2; \quad s = (\vartheta + u) \cdot t_3;$$

2.Working formulas:

$$t_1 = \frac{s}{\vartheta}; \qquad t_2 = \sqrt{\frac{s^2}{\vartheta^2 - u^2}}; \qquad t_3 = \frac{s}{\vartheta + u};$$

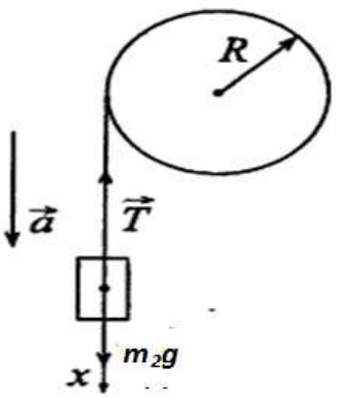


Solution: Mathematical calculations

2 - example. A rope with a mass of *9 kg* is wrapped with string and a load of *2 kg* is hung on its end. Find the acceleration of the load. Let the drum be considered a homogeneous cylinder. Friction should not be taken into account.

Given:
m_1 - drum mass:
m1 = *9 kg*
m_2 - suspended load mass:
m_2 *= 2 kg*

a - ?



Formula:
Here are the working formulas from the basic formulas:
1. Basic formulas:
At rest of the drum, its potential energy is equal to the sum of the forward kinetic energy of the body and the rotational motion energy of the drum:

$$m_2 gh = \frac{m_2\vartheta^2}{2} + \frac{I\omega^2}{2}; \qquad \omega = \frac{\vartheta}{R};$$

Moment of inertia of the drum:: $I = \frac{m_1 R^2}{2}$;

from the above: $m_2 gh = \frac{m_2\vartheta^2}{2} + \frac{m_1 R^2}{2 \cdot 2} \cdot \frac{\vartheta^2}{R^2} = \frac{\vartheta^2}{2}\left(m_2 + \frac{m_1}{2}\right)$;

From a smooth accelerating motion: $h = \frac{at^2}{2}$; $\vartheta = at$;

so, $m_2 g \frac{at^2}{2} = \frac{a^2 t^2}{2}\left(m_2 + \frac{m_1}{2}\right)$; $\quad a = \frac{m_2 g}{m_2 + \frac{m_0}{2}}$;

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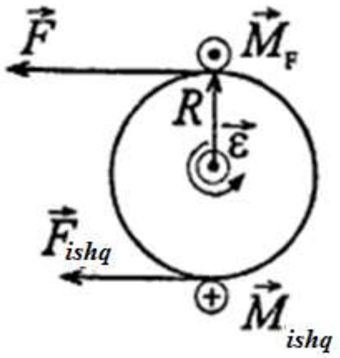
2.Working formula: $a = \frac{2m_2 g}{2m_2 + m_0}$;

Solution: Mathematical calculations.

3 - example. The flange of a homogeneous disk with a radius of *0.2* m is subjected to a constant force of *98.1* N. A torque of *98.1* Nm acts on a rotating disk. If the disk is rotating with a constant angular acceleration of *100 rad / s2*, find the mass of the disk.

Given:
$R = 0.2$ *м*
$F = 98.1$ *Н*
$M_{ишқ} = 98.1$ *Нм*
$\varepsilon = 100$ *рад/с*^{2}

$M_{диск}$ - ?



Formula:
Here are the working formulas from the basic formulas:
1. Basic formulas: from the law of rotational motion

$$I\varepsilon = \vec{M}_F + \vec{M}_{ишк};$$

M_F – power moment, $M_{ишқ}$ – frictional moment.
Projection of movements on the *x*-axis:

$$I\varepsilon = M_F - M_{ишк};$$

In the figure, the angular acceleration and the friction force moment are opposite.

Moment of inertia of the disk: $I = \frac{mR^2}{2}$; $M_F = F \cdot R$;

from the above: $\frac{mR_2}{2}\varepsilon = F \cdot R - M_{ишк}$;

2.Working formula $m = \frac{2(F \cdot M_{ишк})}{\varepsilon \cdot R^2}$;

Solution: Mathematical calculations

4 - example. The amplitude of the harmonic oscillation is 5 cm and the oscillation period is 4 seconds. Find the maximum velocity and acceleration of the oscillating point.

Given:
$A = 5$ *см*
$T = 4$ *с*

ϑ_{max} - ?,
a_{max} -?

Formula:
Here are the working formulas from the basic formulas:
1. Basic formulas: from the law of rotational motion,

$$x = A\cos(\omega t + \varphi_0); \qquad \omega = \frac{2\pi}{T};$$

$$\vartheta = x'(t) = A\omega \cdot \cos\left(\omega t + \frac{\pi}{2}\right); \qquad \vartheta_{\max} = A\omega = A \cdot \frac{2\pi}{T};$$

$$a = \vartheta'(t) = -A\omega^2 \cdot \cos\omega t; \qquad a_{\max} = A\omega^2 = A \cdot \frac{4\pi^2}{T^2};$$

2. Working formula: $\vartheta_{\max} = A \cdot \frac{2\pi}{T}$; $a_{\max} = A \cdot \frac{4\pi^2}{T^2}$;

Solution: Mathematical calculations

In many cases, analogy has been used successfully in problem solving. The word analogy comes from Latin (*analogue*) which means similarity. At the same time, in solving problems related to one branch of physics, it is possible to use the method of solving the problems of another branch [6].

Experiences in teaching physics show that the study of theoretical topics is effective if they are analyzed using problem solving and analogies between them, in order to explain them and keep them in the student's memory for a long time. This greatly simplifies the identification of commonalities and problem solving between actions of a different nature. Table 1 below shows the similarity between the quantities required to solve

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problems based on the analogy between forward, oscillating, and rotational motions, and a partial analogy of the mathematical expressions of these processes.

Table 1.

Sizes	move forward	Vibration movement:	Rotational movement:
Speed	$\vartheta = s/t$	$\vartheta = x'(t)$	$\omega = \varphi/t$
Acceleration	$a = (\vartheta - \vartheta_0)/t$	$a = \vartheta'(t)$	$\varepsilon = (\omega - \omega_0)/t$
Printed path (period)	$s = \vartheta t$	$T = t/N$	$T = 2\pi/\omega$

The importance of analogy in solving problems in physics and in studying the properties of physical phenomena and processes and learning more about them is immeasurable. The analogy method also simplifies the problem-solving process and allows the reader to easily remember physical processes and laws in memory. Problem-solving develops students' critical thinking, independent thinking, interest in reading, determination to achieve goals, and creative abilities.

References:

1. Razumovskiy V.G va boshqalar. O’rta maktabda fizika o’qitish asoslari.
2. Toshkent. “O’qituvchi”, 1990. -414 б.
3. Волькенштейн В.С. Сборник задач по обьему курсу физики. - Москва. Наука, 1985. -366 с.
4. Глазунов А.Т ва бошқалар. Ўрта мактабда физика ўқитиш методикаси.
5. Тошкент. Ўқитувчи, 1996. -340 б.
6. Srajiddinov N va boshqalar. Fizika o’qitish uslubi asoslari. O’quv qo’llanma. - Toshkent. “O’zbekiston”, 2006. -182 b.
7. Sheraliev S.S. Factors of organizing physical experiments based on non-traditional technologies. Academicia An International Multidisciplinary Research Journal, (Double Blind Refereed & Peer Reviewed Journal) ISSN: 2249-7137 Vol. 11, Issue 3, March 2021 Impact Factor: SJIF 2021 = 7.492
8. Quvandiqov O.Q., Sheraliyev S.S va boshqalar. Mexanik va elektromagnit tebranishlar o’rtasidagi anologiya asosida masalalar yechish. Fizika, matematika va informatika. - Toshkent, 2016. -№3. –B. 63–70
9. Suyunboevich S. S., Usmanovich I. D., Tashpulatovich Y. L. Significance and Application of Pedagogical Innovations in Physics Teaching //Eurasian Journal of Physics, Chemistry and Mathematics. – 2022. – T. 5. – С. 33-36.
10. Suyunboevich S. S. Factors of organizing physical experiments based on non-traditional technologies //ACADEMICIA: An International Multidisciplinary Research Journal. – 2021. – Т. 11. – №. 3. – С. 2610-2614.
11. 9.Шералиев С. С., Турматов Ф. А., Бобожонов Ф. Э. ФИЗИКАНИ ЎҚИТИШДА ЭЛЕКТРОН ЎҚУВ-МЕТОДИК ТАЪМИНОТЛАРНИНГ АҲАМИЯТИ //Интернаука. – 2020. – №. 14-2. – С. 85-87.
12. 10.Sa’dullo S. S. Integrated Technique for Solving Problems in Physics Using MathCad Programs and Crocodile Technology 3D //Eastern European Scientific Journal. – 2017. – №. 4.
13. 11.Sheraliev S. S. Integrated Technique for Solving Problems in Physics Using MathCad Programs and Crocodile Technology 3D //Eastern European Scientific Journal. – 2016. – №. 4. – С. 105-109.