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Research Article

SOLVING PROBLEMS IN MOLECULAR PHYSICS THROUGH PROFESSIONAL TRAINING OF PHYSICS FOR CADETS

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ABSTRACT

The article analyzes the specifics of solving problems from molecular physics in the professional orientation of physics in higher military education, as well as selects problematic issues of different levels of difficulty in the military-technical direction. In solving such problems, as a new innovative approach, methods of solving using the interrelationships of physics and specialty sciences are presented.

KEYWORDS

Professional skills and competencies, educational standard, professional knowledge, interdisciplinary links, training material, professional content, military-practical issues, military equipment, weapons, physical principles, physical foundations.

INTRODUCTION

The importance of physics as a basis for the formation of all sciences and the scientific worldview in the training of highly educated military specialists is incomparable. However, one of the main problems in increasing the effectiveness of education is the insufficient attention paid by educators to the connection of physical laws, rules and phenomena with professional knowledge. This has a negative

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impact on the improvement of the content, methods, tools and forms of teaching physics in the training of military personnel with higher education, as well as the development of in-depth knowledge, practical skills and abilities of cadets. In the teaching of sciences, their interdependence is important to increase the effectiveness of learning. Especially in the training of highly educated military specialists in the teaching of physics and professional sciences, it is expedient to pay special attention to their interaction. Because the basis of higher education is vocational education. For this reason, in the training of specialists, especially in the training of military personnel with higher education, ensuring interdisciplinary integration is one of the main issues facing modern pedagogy. The complexity of the goals and objectives of education in the qualification requirements for training requires the need to improve the forms and methods of training students in physics on the basis of interdisciplinary links, strengthening the interaction and consistency of physics education with professional disciplines [1,2].

The main shortcoming of physics education in higher education institutions in all areas is the lack of interaction of physical concepts, methods of their expression and content with professional knowledge. Separate knowledge from physics, which is not interrelated with professional knowledge, does not ensure the deepening of students' knowledge, the formation and development of professional skills and abilities.

To overcome these problems, it would be expedient to make effective use of the didactic requirements for interdisciplinary communication in the teaching of physics. Didactic requirements for the teaching of higher education specialists on the basis of interdisciplinary links include: the transfer of physical knowledge related to the specialty in the process of mastering a new topic; ensuring the effectiveness of students' learning activities through the use of professional teaching materials on the subject; use of links with professional disciplines in explaining the nature of various events, cause-and-effect relationships; learning materials based on interdisciplinary connections should be summarized using lessons of all forms; teaching materials should consist of conclusions related to knowledge in professional disciplines; should help to reflect in the minds of cadets the connections and differences between the knowledge acquired in physics lessons and the knowledge acquired in the professional disciplines; it is necessary to deepen the physical knowledge of cadets by strengthening their professional interests [1].

It is recommended to study the experience of advanced educators, as well as to make interdisciplinary links based on the results of many years of pedagogical activity, following the following educational criteria: To do this, the training material must have a professional content; the effectiveness of educational activities depends on the high level of activity and independence of cadets. The teacher should help them to form these qualities. An important factor in this is the composition of educational motives of educational activities, arousing interest in cadets in physical knowledge. Accordingly, it is necessary to increase the professional content of teaching materials, develop new teaching methods, improve and implement them in practice, provide methodological support for educational activities; make generalizations in the process of training and involve cadets in them; each lesson should have a new element that helps to apply physical knowledge in a practical setting; Professional training materials should be used effectively for the purpose of educating cadets. Through this, the scientific outlook of cadets is formed, spiritual-ethical, socio-political and professional knowledge is given in the form of certain concepts, cadets are formed the right attitude to events, facts and phenomena, are taught to use this knowledge in their professional activities. If these criteria are followed in the process of teaching physics, the effectiveness of education and upbringing will increase [3].

There is a wide range of opportunities for the introduction of vocational-oriented education in the process of teaching physics in higher military education institutions. For example, the study of military-practical issues on each topic. In particular, the department of molecular physics studies the physical basis of the operation of weapons and military equipment, which applies the laws of molecular kinetics - theory, ideal and real gas.

In the selection of materials of military-practical form, it is important to coordinate modern military equipment and weapons and their development prospects in the relevant sections of the physics course. In-depth study of military-practical materials will require a wider use of cadets' knowledge of physics. At the same time, it is necessary to draw the cadets' attention not to the design features of any military-technical device or weapon, but to the physical processes that take place in them. Military - equipment and weapons are continuous as in improvement will be, obviously details will change. On the contrary, they are based lying physical yarns long time does not change. Therefore, for their physical foundations to know military -technical innovations easy understand opportunity creates.

The properties of gases, such as high compression, low density and controllability of pressure, make them unique in use in various technical devices, including explosive devices (mines, shells, bombs, etc.), machinery and military equipment.

An increase in the mass of the gas at a constant volume, at a constant temperature, leads to an increase in pressure, which is used to inflate the tires. Gases heat worker in machines (engines) body as applied , as a shock absorber used . Real gases (gunpowder and solid fuel combustion product) less densities and high as an ideal gas at temperatures considered and engineering in the books of Mendeleev - Clapeyron from the equation used [4].

isothermal processes in ideal gases are used in various devices of firearms, artillery and missile technology. The isochoric process is characteristic of the period of preparation for the eruption event, during which the powder of the main charge burns and turns into a gaseous product of combustion. The isobaric process occurs during the main operating period of solid fuel rocket engines. To ensure the isobaric process in the rocket engine combustion chamber, it will be necessary to maintain the critical cross-sectional surface of the nozzle and the continuity of the charge combustion surface during fuel combustion.

The state of real gases in military equipment is described by the Van der Vaals equation, which takes into account the size of molecules and their interactions with each other.

$$\left(p+\frac{a}{V_0^{\,2}}\right)\cdot\left(V_0-b\right)=RT,$$

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where p is the pressure, T is the temperature, $\frac{a}{V_0^2}$ – the correction for the interaction of molecules V_0 –, the volume of a mole of gas, b –the correction for the specific volume of the molecule, and R is the universal constant of the gas.

During firing, the gas in the barrel of the weapon barrel is at a very high temperature, so the limit in the Van – der-Vaals equation $\frac{a}{V_0^2}$ –, p - pressure, can be ignored. In this case, the equation of state takes the following form.

$$p = \frac{R \cdot T}{V_0 - b}.$$

Professional naltilgan of education more an important side in cadets' professional skills and competencies development, knowledge in practice free use to know is to provide. This instead increase for from the teacher cadets from the laws of physics independent use to know guide teaching methods to the goal appropriate selection demand are given. Such teaching methods based on military - technical content problem solving important is Cadets military - technical content issues ni military equipment and weapon - wound structure and physical basis of performance learn point of view in terms of examine output big importance profession reaches.

Therefore, it belongs to molecular physics we will look at examples from issues of a military nature and propose solutions to problems for independent resolution.

Issue 1. When an atomic bomb explodes, a temperature of 10 ^{7} K is formed. Determine the quadratic average velocity of a hydrogen ion, assuming that under such temperature conditions all molecules dissociate completely and the atoms split into ions. $\mu_H = 1 \cdot 10^{-3}\, кг/_{моль}$ [5].

Solution: The average kinetic energy of the chaotic forward motion performed by gas molecules makes it possible to find the average quadratic velocity of ideal gas molecules.

$$\overline{E} = \frac{3}{2} k \cdot T$$

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(1)

Instead $\overline{E} = \dfrac{m_0 \cdot \overline{\upsilon}^2}{2}$ of this equation $\overline{E}$ Putting the formula, we find the average square of the velocity :

$$\overline{\upsilon}^2 = \frac{3kT}{m_0}$$

(2)

$$\overline{\upsilon} = \sqrt{\frac{3kT}{m_0}}$$

(3)

Given that it is $\overline{\upsilon}$ the mass of a single molecule $m_0 = \dfrac{\mu}{N_A}$, we determine what.

$$\overline{\upsilon} = \sqrt{\frac{3kN_A T}{\mu}}$$

(4)

The product of the Boltzmann constant and the Avagadro constant is called the universal gas constant.

$$R = k \cdot N_A = 1{,}38 \cdot 10^{-23} \cdot 6{,}023 \cdot 10^{23} = 8{,}31 \, Ж/_{моль \cdot К}$$

Based on this, we write formula (4) as follows.

$$\overline{\upsilon} = \sqrt{\frac{3RT}{\mu}}$$

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(5)

$$\bar{\upsilon} = \sqrt{\frac{3 \cdot 8{,}31 \frac{Ж}{К \cdot моль} \cdot 10^7 К}{0{,}001 кг / моль}} = 5 \cdot 10^5 м / с.$$

Issue 2. When a nuclear bomb explodes, the temperature at its center reaches T = 10 ^{6} K. Determine the pressure at the center of the bomb at this temperature, assuming that the average density of uranium at the center of the bomb is 20 g / cm ^{3} · Ignore the light radiation pressure.

$\mu_U = 238 \cdot 10^{-3} кг/_{моль}$ [5].

Solution: $\frac{N}{V} = n$ Given that the $\frac{pV}{N} = kT$ formula is the relationship between gas pressure and the concentration of molecules and temperature The expressive expression is:

$$p = nkT$$

(1)

From this formula it follows that under the same pressure and temperature conditions the concentration of the molecules of all the gases will be the same.

The equation of the ideal gas state is called the equation that connects the three macroscopic parameters (p-pressure, V-volume, and T-temperature) that characterize the state of a sparse gas of known mass.

$p = nkT$ we put the expression for the concentration of gas molecules in the equation in the form.

$N = N_A \frac{m}{\mu}$ Given the formula, the gas concentration can be written as follows:

$$n = \frac{N}{V} = \frac{1}{V} \cdot \frac{m}{\mu} \cdot N_A$$

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(2)

Substituting expression (2) into equation (1) gives the equation of an ideal gas state of arbitrary mass:

$$pV = \frac{m}{\mu} RT$$

(3)

$$p = \frac{\rho VRT}{V\mu} = \frac{\rho RT}{\mu}$$

(4)

$$p = \frac{20 \cdot 10^3 \cdot 8{,}31 \cdot 10^6}{238 \cdot 10^{-3}} = 700 \cdot 10^9\, Па = 700 ГПа$$

Issue 3. Ambient air temperature 0 $^\circ$C (273K) when it occupies a volume of 7.4 l in the nakatnik and is under a pressure of 6 MPa, determine the mass of air in the nakatnik. Molar mass of air $\mu = 29 \cdot 10^{-3}\, кг/моль$ [6].

Solution: From the equation of ideal gas state (Mendeleev-Clapeyron equation) we derive the formula for calculating the mass.

$$pV = \frac{m}{\mu} RT$$

(1)

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$$m = \frac{pV\mu}{RT}$$

(2)

$$m = \frac{6 \cdot 10^6 \cdot 7{,}4 \cdot 10^{-3} \cdot 29 \cdot 10^{-3}}{8{,}31 \cdot 273} = 0{,}57кг$$

Issue 4. What is the internal energy of this gas if 0.8 kg of carbon monoxide (SO) is heated to 3000 K as a result of the combustion of gunpowder in the gun chamber? $\mu_{CO} = 28 \cdot 10^{-3}\, кг/_{моль}$ [6].

Solution: To calculate the internal energy of an ideal gas with one atom of mass m, the average kinetic energy of one atom $\overline{E} = \frac{3}{2} k \cdot T$ must be multiplied by the $R = k \cdot N_A$ number of atoms . $N = N_A \frac{m}{\mu}$ Given that, we find the value of the internal energy of the ideal gas:

$$U = \frac{3}{2} \cdot \frac{m}{\mu} RT$$

(1)

Internal energy does not depend on the volume of the gas and other macroscopic parameters. If the mass of a gas increases, its internal energy also increases. Internal energy depends on the type of gas, i.e. the molar mass of the gas. This is because the larger the molar mass, the fewer atoms in a gas of a given mass.

$$U = \frac{3}{2} \cdot \frac{0{,}8}{28 \cdot 10^{-3}} \cdot 8{,}31 \cdot 3000 = 1{,}07 \cdot 10^6\, Ж = 1{,}07 МЖ$$

Issue 5. A lead bullet with velocity pierces the board . $\upsilon_1 = 400\frac{м}{c}$ As a result, the speed of the arrow is $\upsilon_2 = 50\frac{м}{c}$ reduced to. If the initial temperature of the arrow $t_1 = -25^0 C$ is equal to, how many parts of the arrow are melted. Suppose that when an arrow hits a board, 60 percent of its energy is spent on heating the arrow. Specific heat capacity for lead $c = 0{,}13 \cdot 10^3 \frac{Ж}{кг \cdot K}$, specific melting heat $\lambda = 25 \cdot 10^3 \frac{Ж}{кг}$. Do not take into account the heat exchange with the board.

Solution: The initial kinetic energy of the axis is written as follows.

$$E_{k_1} = \frac{m\upsilon_1^2}{2}$$

(1)

The kinetic energy of the lead axis after it leaves the board and the kinetic energy expended are represented in the following figure.

$$E_{k_2} = \frac{m\upsilon_2^2}{2}$$

(2)

$$\Delta E_k = \frac{m}{2}\left(\upsilon_1^2 - \upsilon_2^2\right)$$

(3)

About 60% of this energy (initially) is used to raise the $-25^0 C$ temperature of the lead axis from melting point to melting $327^0 C$ some Δm of it. Taking into account the above considerations, we write an equation that represents the law of conservation and circulation of energy for the process under consideration.

$$\eta A = \Delta U \tag{5}$$

$$\eta \frac{m}{2}\left(\upsilon_1^2 - \upsilon_2^2\right) = cm(t_2 - t_1) + \lambda \Delta m \tag{6}$$

Multiplying both sides of this equation by 2, we get m and $\frac{\Delta m}{m}$ find n.

$$\frac{\Delta m}{m} = \frac{\eta\left(\upsilon_1^2 - \upsilon_2^2\right) - c(t_2 - t_1)}{2\lambda} = 0{,}06.$$

In doing so, trainees: make sure that physical theories are correct; will have the skills to work by hand. All this will be very important for the future military specialist with higher special education, and later in his career in the military.

Many years of experience, scientific research and studies have led to the following conclusions:

1. The effective use of professional facts and evidence in the teaching process further increases the interest of students in learning.

2. Professional orientation of physics teaching provides a link between general professional and special (specialty) disciplines. This allows trainees to gain deep and solid professional knowledge.

3. Increasing the professional content in teaching physics will help to expand the scientific outlook of future military professionals.

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