МРНТИ 78.15;78.21.37
https://doi.org/10.56132/2791-3368-2025-3-63-109-122

G.H. Gullarli, E.V. Nasirov
Military Institute named after Heydar Aliyev, Baku, Azerbaijan
E-mail: axundzadegullu@rambler.ru

THE IMPORTANCE OF USING BINARY LESSON ON CHEMISTRY AND PHYSICS IN MILITARY UNIVERSITIES

Abstract. Binary lessons require a lot of preparation, both from the teacher and from the students, so they cannot be conducted often. But such a lesson, conducted not for the sake of external effect, but for systematization of knowledge, formation of conviction in the coherence of objects and the integrity of the world, is an important stage in the formation of the students' worldview, development of their thinking.

This article examines the importance of binary classes in the system of higher military education. In this articles are given examples of binary lesson topics in chemistry and physics.

Keywords: chemistry, physics, teaching methods, integration, binary lesson, meta-subject connections.

Introduction.

The system of modern higher military education is focused on training specialists capable of abstract thinking and analysis. Interactive methods are currently used to increase the interest of the new generation in education [1, 2]. The use and development of these methods pose important tasks for teachers.

One of the modern methods of conducting classes in military universities is an integrated lesson, when several teachers [3] conduct a class, in which a designated topic is considered from different points of view.

A binary lesson is one of the forms of integrating subjects and implementing interdisciplinary connections. Its features are that the presentation and study of a problem in one subject is continued in another; interdisciplinary connections are implemented in the process of teaching disciplines in one educational area.

Establishing interdisciplinary connections promotes deeper acquisition of knowledge, formation of scientific concepts and laws, improvement of the educational process. One of the ways of implementing interdisciplinary connections is integrated lessons. Such lessons eliminate duplication in studying the material, create favorable conditions for the formation of general educational skills and abilities of students. Integration through lessons of subjects of the natural science cycle contributes to the formation of a scientific worldview of students, the unity of the material world, the interrelation of phenomena in nature. Integrated lessons also contribute to raising the scientific level of teaching, systematizing knowledge, developing logical thinking and creative skills of cadets.

The main methodological requirements for this lesson can be reduced of 5 parts:

1) The lesson must have a distinctly formulated main educational and cognitive purpose.

2) The lesson must guarantee high activity of cadets in engaging knowledge from other subjects.

3) The lesson should expand and deepen the students' scientific worldview.

4) The lesson should arouse students' interest in establishing connections between related sciences.

5) The lesson should promote the development of general educational skills in studying popular science literature and in independently applying new knowledge.

The structure of an integrated lesson depends on the content of the material and the form of organization of the lesson. Information obtained in lessons on other subjects is most often either used as background knowledge, or to raise a problem, or to deepen and consolidate knowledge.

An important factor for the correct planning of integrated lessons is mutual contacts between subject teachers, exchange of experience and collective solution of common issues. The success and effectiveness of an integrated lesson is ensured by careful, preliminary preparation of teachers and students for it.

The most significant areas of implementation of interdisciplinary connections are the following:

- formation and development of a system of concepts about a substance in the study of its physical properties and structure;
- study of theories and laws common to physics and chemistry; consideration of the essence of physical and chemical processes;
- familiarization with the structure and operating principles of technological equipment;
-use of chemical concepts, quantities and units of measurement in physics lessons;
- review of the possibilities of using fundamental laws and theories of natural science to explain phenomena;
- formation of ideas about the cycle of elements, substances and energy.

The system of integrated lessons in chemistry and physics is the basis for forming a holistic picture of the surrounding world.

The system of integrated lessons in chemistry and physics is the basis for forming a holistic picture of the surrounding world.

Binary lessons in chemistry and physics are one of the clear examples of the implementation of meta-subject connections of two natural sciences that are fundamentally connected to each other, but not so obvious for many students. Conducting binary lessons in physics and chemistry is used as a foundation for reinforcing related topics in these natural sciences.

Materials and Methods.

Meta-subject connections between chemistry and physics are very strong, to consolidate sections of molecular physics, thermodynamics, atomic and nuclear physics – it is relevant to conduct binary lessons [4].

Under the influence of interest, the perception of educational material is more active, observation becomes sharper, emotional and logical memory is activated, imagination works more intensively. The binary lesson develops in students the ability to use theoretical knowledge in various options, in non-standard situations.

An important stage in preparing a binary lesson in physics and chemistry is joint, careful planning.

The lesson is divided [4] into parts that complement each other, while avoiding duplication. A research problem is put forward, the group is divided into creative interest groups that search for information, facts and arguments necessary to conduct the research and to formalize the results [5].

When conducting a binary lesson on physics and chemistry, an important stage is to focus the attention of students on the implicit meta-subject connections [5] of sciences. When explaining the topics of nuclear physics, it is important to focus attention on chemical components and elements.

Physics and chemistry often supplement each other, since the same processes are considered from other inclination in lessons on these subjects. The most necessary concepts common to physics and chemistry cover the abstractions of matter, weight, mass, energy, as well as the law of transformation of energy, electric charges, electric field and so on.

The most major theoretical interdisciplinary relationship between physics and chemistry are set on by the study of the same theories: molecular-kinetic and electronic, the theory of atomic structure and so on. The connection between the teaching of physics and chemistry is mainly important when studying the atomic-molecular structure of matter.

Of great principal for the increasing of concepts of atoms and molecules is the foundation of chemical formulas, the study of chemical properties of materials and chemical reactions. Main features of communication between the teaching of physics and chemistry are working out physical-chemical or chemical-physical problems, managing complex excursions, answer experimental problems and so on.

Results and **Discussion**

We present you the following examples of a binary lesson in chemistry and physics. Lesson plan for a binary lesson in chemistry and physics on the topic "Alkalis as electrolytes"

1. Facilitators announce the objective of the lesson Objective: to form knowledge about electrolytes and non-electrolytes, about alkalis in light of the theory of electrolytic dissociation, to expand and deepen knowledge about electrolytic dissociation, about the properties, production, and use of alkalis as electrolytes.

2. Study of a new topic:

The chemistry facilitator announces the plan:

1) Definition of alkalis.
2) Formulas.
3) Physical properties of alkalis.
4) Electrolytes and non-electrolytes.
5) Electrolytic dissociation.
6) Provisions of TED.
7) Degree of dissociation.
8) Chemical sources of current.
9) Alkalis from the point of view of TED.
10) Chemical properties of alkalis.
11) Application of alkalis.

Chemistry fasilitator: here they are, alkalis: soap, powders, cleaning and washing agents.

"Alkalis are substances consisting of an alkali metal and a hydroxyl group (OH)."

Composition of alkalis and their formulas:

NaOH– sodium hydroxide
KOH– potassium hydroxide
LiOH– lithium hydroxide
$Ca(OH)_2$– calcium hydroxide
$Ba(OH)_2$ – barium hydroxide

Physics facilitator: Base and alkali are solids. They conduct electric current! Therefore, they are electrolytes.

Physics facilitator: what are electrolytes and non-electrolytes?

The concept of electrolytes and non-electrolytes was first introduced by M. Faraday in the first half of the 19th century.

Electrolytes - substances whose solutions or melts conduct electric current. Electrolytes are substances with a highly polar covalent or ionic bond. These include salts, alkalis, acids.

Non-electrolytes-substances whose solutions or melts do not conduct electric current.

Non-electrolytes are substances with non-polar or weakly polar covalent bonds. These include most organic compounds (glucose, fructose, sucrose, ethanol, glycerin, etc.), simple non-metallic substances (sulfur, diamond, nitrogen, oxygen, etc.).

Ions-positively or negatively charged particles.

Cations-are positively charged ions.

Anions carry a negative charge.

Electrolytic Dissociation.

In 1887, Swedish scientist Svante Arrhenius proposed that in aqueous solutions, certain compounds spontaneously split into ions that move towards electrodes. This process, known as *electrolytic dissociation,* explains the electrical conductivity of such solutions. Contrary to the literal meaning of the term, dissociation is not caused by electricity itself but by the solvent, while current simply flows due to the presence of ions.

Further research showed that this is not the case: *ions are only charge carriers in the solution and exist in it regardless of whether a current passes through the solution or not.* With the active participation of Svante Arrhenius, the theory of electrolytic dissociation was formulated, which is often named after this scientist. The main idea of this theory is that electrolytes spontaneously disintegrate into ions under the influence of a solvent. And it is these ions that are charge carriers and are responsible for the electrical conductivity of the solution.

Electric current - *this is the directed movement of free charged particles. You already know that solutions and melts of salts and alkalis are electrically conductive,* because they do not consist of neutral molecules, but of charged particles - ions. When melted or dissolved, ions become free carriers of electric charge.

The theory of electrolytic dissociation can be presented in the form of the following provisions.

1. When dissolved in water, electrolytes dissociate (break apart) into ions.

The properties of ions differ from the properties of the atoms or group of atoms from which they were formed.

2. The reason for the dissociation of an electrolyte in an aqueous solution is its hydration, i.e. the interaction of the electrolyte with water molecules and the rupture of the chemical bond in it.

Degree of dissociation - is the ratio of the number of particles that disintegrate into ions (N_d) to the total number of dissolved particles (N_P):

$$\alpha = N_д / N_{P.}$$

The degree of dissociation of the electrolyte is determined by experiments and is expressed in fractions or percentages. If $\alpha=0$, then there is no dissociation, and if $\alpha=1$, or 100%, then the electrolyte completely disintegrates into ions. Different electrolytes have different degrees of dissociation, that is, the degree of dissociation depends on the nature of the electrolyte. It also depends on the concentration: with dilution of the solution, the degree of dissociation increases.

According to the degree of electrolytic dissociation, electrolytes are divided into strong and weak.

Strong electrolytes-are those electrolytes that dissociate almost completely into ions when dissolved in water. The degree of dissociation of such electrolytes tends to one (in percent, more than 30%). These include all soluble salts, alkalis ($NaOH$, KOH), strong acids (HCl, HNO_3, H_2SO_4).

Weak electrolytes- are those electrolytes that, when dissolved in water, almost do not dissociate into ions. For such electrolytes, the degree of dissociation tends to zero (less than 3% in percentage). These include water and weak acids.

Chemical current sources are a device that directly converts the energy of a chemical reaction occurring between an anode and a cathode into electrical energy.

All chemical sources are divided into two large groups according to their ability to be reused: primary current sources and secondary current sources.

Primary current sources provide only discharge and cannot be charged - they are used once. These include saline and alkaline batteries. Secondary current sources (batteries) can be charged and used repeatedly in a cyclic "charge-discharge" mode.

The first chemical source of current was invented by the Italian scientist Alessandro Volta in 1800.

It was the Volta element - a vessel with salt water with zinc and copper plates lowered into it, connected by wire. The scientist then assembled a battery from these elements, which was called the Voltaic pile.

Chemical current sources consist of electrodes and an electrolyte, which is located in a container. The electrode on which the reducing agent is oxidized (gives up its electrons) is called the anode. The electrode on which the oxidizing agent is reduced (receives electrons) is called the cathode. The result is an electrochemical system.

The result of the electrochemical reaction occurring in the system is the generation of current. The reducing agent transfers electrons to the oxidizing agent, which is reduced. The electrolyte located between the electrodes is needed for the reaction to occur.

The anode is usually made of zinc powder (Zn) with a brass core, brought to the bottom of the battery, that is, to the minus. The cathode is made of manganese dioxide powder (MnO_2), with the addition of carbon powder (C). Carbon powder promotes better conductivity.

What are alkaline batteries? The first alkaline battery was invented by two American scientists: Waldemar Junger and Thomas Edison. This happened at the very beginning of the 20th century. But they became popular only years later.

Alkaline - in English means "alkali". Therefore, the second name of alkaline batteries is alkaline.

Due to their large charge capacity, alkaline batteries are widely used in various devices: powerful flashlights, cameras, various remote controls, audio players and others.

Students discover new knowledge:

Chemistry facilitator: Tell me the "3 don'ts" when working with alkalis (don't taste, don't spill, don't smell!). We'll look at the following question: Chemical properties of alkalis, what chemical properties do you think alkalis will have?

- How do alkalis color the colors of indicators?
- Let's remember what substances exist in nature?
- What do you think, with which of them alkalis can interact?
- Suggest the properties of alkalis.

3. Questions to check how well the students have understood the topic:

1) Is slaked lime resistant to acids?

2) Why is it not recommended to use laundry soap for everyday body washing?

3) How can you determine the presence of alkali in detergents?

4) Determine which of the test tubes contains the alkali.

5) Why do people use gloves to protect their hands when washing tiles and plumbing fixtures?

6) Why can't aluminum cookware be cleaned with alkaline products? Containing alkali?

Chemistry facilitator: so, we have found out and confirmed that alkalis interact with metals, bases, salts, and change the colors of indicators. Why does the reaction with these substances occur, what ion enters into the reaction?

Lesson plan for a binary lesson in chemistry and physics on the topic “Electrolysis”.

1. Facilitators announce the objective of the lesson:

1) Checking, adjusting and deepening students' knowledge on the topic of "Electrolysis" through experimentation and problem solving.

2) Formation of skills in the technique of performing an experiment, the ability to solve computational and qualitative problems, to formulate chemical reactions that occur during the electrolysis of solutions and melts of electrolytes.

3) Fostering independence, organization, development of creative abilities, logical thinking, attention, memory.

Equipment: 5V power supply, copper (II) sulfate solution, electrolysis devices (6 pcs), laboratory ammeters (3 pcs), electronic scales, keys, rheostats, connecting wires, clocks, laboratory beakers, clamps, laptops (6 pcs), interactive whiteboard, cards with laboratory problems, texts.

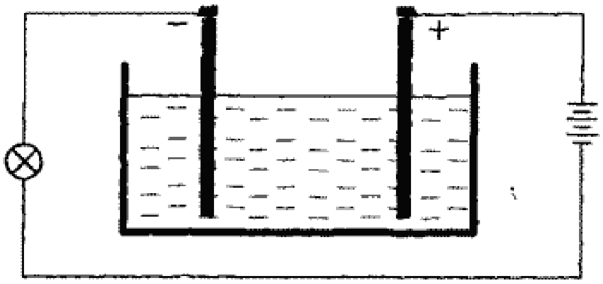
Chemistry facilitator: Today we will consolidate and generalize knowledge and practical skills and conduct an integrated lesson in chemistry and physics.

Physics facilitator: Physics and chemistry are extraordinary sciences. Their laws are universal. They not only explain microscopic properties of crystals and cells but also enable real-world applications, from spacecraft docking to medical technologies. Electrolysis is an excellent example of how physics and chemistry unite to reveal the underlying principles of nature.

Chemistry facilitator: We will work in groups during the lesson. 1st row - group "Physicists-experimentalists", 2nd row - group "Theorists", 3rd row - "Chemists-experimentalists".

Physics facilitator: Demonstration: A circuit is assembled (a power source, a lamp, carbon rods, connecting wires, 2 glasses, one with water, the other with salt, a glass rod).

Let's connect a light bulb and a glass of distilled water with two carbon electrodes dipped into it in series with a current source. After closing the circuit, we see that the lamp does not light, which means there is no current in the circuit. Now take a glass of table salt, add water, stir it slightly, and close the circuit. We find that the lamp connected to the circuit glows.



2. Questions: Students draw conclusions based on their observations:

- dry salt does not conduct current, since there are no free charges;

- distilled water does not either, and solutions of salts, acids, and alkalis do conduct current, since there are free charges.

Quiz:

1) What is called electric current? (directed movement of charged particles).

2) What groups are all substances divided into according to their ability to conduct electric current? (conductors, semiconductors, dielectrics).

3) In what environments can current flow? (in conductors, semiconductors Conductors:

- solid – all metals;

- liquid – solutions of salts, acids, alkalis;

- gaseous – gases under special conditions).

4) What are the charge carriers in these conductors? (positive and negative ions and electrons).

5) What is the name of this process? (Electrolytic dissociation is the breakdown of substances into ions in solutions and melts. The reverse process is called recombination).

Student's conclusion: *When electrolytes dissolve under the influence of the electric field of polar water molecules, the electrolyte molecules disintegrate into ions.*

Chemistry facilitator:

1) What will we observe if a direct electric current is passed through a solution or melt? (electrolysis).

2) Give a definition of electrolysis? (Electrolysis is the process of releasing substances on electrodes associated with oxidation-reduction reactions).

3) Name two types of electrolysis? (in solutions and in melts).

4) The oxidation and reduction processes on the electrodes occur in a certain sequence. Let's remember how metals are reduced from solutions? (there are 3 groups of metals in the series of metal voltages.....).

Physics facilitator: We found out which metals are completely reduced during electrolysis.

Formulate Faraday's law.

(Faraday's first law was discovered experimentally in 1833).

m= k·Q - the mass of the substance released during electrolysis at each of the electrodes is proportional to the amount of electricity passed through the electrolyte.

k - Electrochemical equivalent (kg / C)

Q - amount of electricity (C)

II Faraday's law:

$$k = \frac{1}{F} \cdot \frac{M}{n}.$$

The electrochemical equivalent is directly proportional to the chemical one.

M - Molar mass (G/mol);

n – Valence;

F - Faraday number F = 95500 C/mol.

3. Practical part.

Physics teacher: Problem 1. Film-problem (video):

To protect metal products from corrosion, a very thin layer of another metal is applied to their surface: chromium, silver, gold, nickel, etc. When coating metal using electrolysis, the products are of uniform thickness and durable. Attention question. Calculate the mass of silver that is formed during the electrolysis of an aqueous solution of silver nitrate with graphite electrodes on the anode, if oxygen with a mass of 6 g is released.

Physics facilitator: To solve the problem set before us, we will draw up chemical diagrams of the process and find the mass of silver from the equation or use Faraday's law).

Solution 1. (chemical) *Let's draw up diagrams of electrode processes of electrolysis:* *4 on the cathode:* $Ag^+ + e- Ag^0$ *1 on the anode:* $2H_2O = O_2 + 4H^+ + 4e-$ *Total process:* $4Ag^+ + 2H_2O = 4Ag\ ^+ O_2 + 4H^+$ *From the total equation it is clear that when 1 mole of oxygen is formed, 4 moles of silver are released, i.e.* $m(Ag^0)=4n(O_2)=4\cdot6/32= 0.75(mol).$ $m(Ag^0) = 0.75\cdot 108 = 81(g)$	*Solution 2. (physical)* *From the combined formula of Faraday's laws, the mass of the released substance is:* $m = Q\cdot M / z \cdot F$ *Q is the amount of electricity passed through the electrolyzer;* *M is the molar mass of the released substance; F is the Faraday constant, equal to 96,500 C/mol; z is the number of electrons participating in the electrode process. Having transformed the formula, we obtain:* $Q = m\cdot z\cdot F/M;$ $Q = 6\cdot4\cdot96\ 500/32 = 723.75\ (C).$ *The same amount of electricity was spent on the release of silver.* *Consequently, the mass of the released silver is:* $m = 72,375 \cdot108/1\cdot96\ 500 = 81g$

Problem 2. A solution containing 468 kg of sodium chloride was electrolyzed at a military plant. The resulting gases were used to synthesize hydrogen chloride. The resulting hydrogen chloride was dissolved in 708 liters of water. Calculate the mass fraction of hydrogen chloride in the resulting hydrochloric acid.

Problem 3. To silver-plate spoons, a current of 1.8 A was passed through a silver salt solution for 5 hours. The cathode is 12 spoons, each with a surface area of 50 cm^2. How thick is the silver layer deposited on the spoons?

4. Analysis of the practical part. (5 minutes).

Physics facilitator: So, during electrolysis, a substance is released at the cathodes. You established what the mass of this substance depends on while doing lab work. What did you get?

Chemistry facilitator: Any scientific discovery or conclusion is interesting only when you find a practical application. About where Electrolysis has found its application.

Physics facilitator: You have experimentally confirmed that various substances can be obtained using electrolysis, in particular, copper. In industry, other metals are also obtained by electrolysis, such as aluminum. Showing a fragment of the film *"Obtaining Aluminum"*.

5. Lesson summary.

Physics teacher: Today during learning – teaching process we used different approaches to the process of studying electrolysis, both from the point of view of physics and from the point of view of chemistry. Finally in our creative work, each of us experienced the joy of research, a sense of mutual enrichment of each other. And the exchange of information in the period of the lesson led to understanding and knowledge.

Topics of binary lessons of chemistry and physics in the military field.

The application of some topics where chemistry and physics converge in the military field is very important. Modern military technologies are based on the combination of these sciences. Below are specific examples:

1. Energy, Heat and Explosions (Thermodynamics + Chemistry).

Topics:

- Exothermic Reactions
- Energy Conversions
- Laws of Thermodynamics

Military Applications:

- Manufacturing and Use of Explosives (TNT, C4, etc.)
- Fuel Systems – Extracting Energy for Tanks, Missiles, Fighters
- Controlling Ignition and Combustion Reactions (e.g., Gunpowder Combustion)

2. Atomic Structure and Nuclear Reactions.

Topics:

- Atomic Nucleus, Radioactivity
- Nuclear Fission and Fusion
- Energy Levels

Military Applications:

- Nuclear Weapons – Uranium and Plutonium Bombs
- Radiation Technologies – To Detect and Neutralize the Enemy
- Nuclear Reactors – As a Source of Power in Submarines

3. Mechanical and Kinetic Energy.
Topics:
- Laws of Motion
- Conservation of Energy and impulse
- Missile and projectile flight trajectory
Military applications:
- Calculation of weapon and projectile trajectories
- Analysis of kinetic energy and velocity of ballistic missiles
- Flight control systems for drones and missiles
4. Gas laws and explosion dynamics.
Topics:
- Pressure, volume, temperature of gases
- Ideal gas laws
- Compression and expansion reactions of gas
Military applications:
- A bullet is ejected due to the expansion of gases in the barrels of a weapon.
- Manufacturing and distribution of poisonous gases of chemical weapons
- Design of gas masks and protective equipment
5. Electricity, magnetism and electrochemistry.
Topics:
- Electric current
- Electrochemical reactions
- Magnetic fields

Military applications: Radar and sonar systems – detecting enemies using electromagnetic waves***:***
- Electromagnetic weapons (EMW) – disable electronic systems
- Batteries and energy storage systems – energy for military equipment
6. Spectroscopy and wave concepts**.**
Topics:
- Electromagnetic spectrum
- Wavelength and frequency
- Absorption and scattering of light
Military applications:
- Thermal imaging cameras and infrared devices – night vision
- Laser weapons and ranging systems
- Analytical instruments for chemical detection

Lesson plan for a binary lesson in chemistry and physics on the topic "Exothermic reactions in the manufacture and use of explosives"

1. Teachers announce the objective of the lesson:

Chemistry facilitator: What is an exothermic reaction?

An exothermic reaction is a chemical reaction that, when it occurs, releases heat (energy) into the surrounding environment.

In these reactions, the chemical energy inside the substances is released abruptly and quickly.

The energy of the products → is lower than the energy of the reactants.

As a result: The temperature rises. Heat, light, sound and gases are released

2. Study of a new topic:

Explosives and exothermic reactions.

A detonation is a sudden release of a large amount of gas and energy as a result of the rapid exothermic decomposition or combustion of a substance. The resulting pressure wave destroys the surrounding space.

Substances	Application	Type of reaction	Note
TNT (trinitrotoluene)	Military missiles, bombs	Thermal decomposition (exothermic)	It disintegrates on its own, releasing a lot of energy.
Nitroglycerin	Dynamite, explosives	Exothermic decomposition	Can explode with a slight impact
Gunpowder (black or smokeless)	Gun bullets	Combustion (exothermic)	It creates gas and pushes the bullet forward.
Ammonium nitrate + yanakak (ANFO)	Mining industry, military equipment	Oxidation-combustion	Explosion with a strong exothermic reaction

Chemistry teacher: The fission of TNT can be described in simple terms by the following reaction:

$$2\ C_7H_5N_3O_6 \rightarrow 3N_2 + 5H_2O + 7CO + 7C + \text{thermal energy.}$$

In this reaction, gases are formed quickly, resulting in an increase in volume. The heat release is very high, and therefore the explosion creates a shock wave.

Military department teacher: Military applications:

Mines, shells, bombs - directed explosion.

Anti-tank weapons - concentrated explosive energy.

In aviation - thermal and shock wave effects in aerial bombs.

Missile warheads - exothermic substances in the fuel and warhead parts.

Hazard and control:

These substances are very sensitive (can be activated by heating, impact, friction).

It is prepared and stored in closed, strictly controlled conditions in the military industry.

Experts accurately calculate the kinetics and heat release of the reaction.

Physics facilitator: Gas laws and explosion dynamics

Gas laws describe the behavior of an ideal gas under changing pressure, volume and temperature:

Boyle's Law	Formula	Description
Charles	$P \cdot V = const$ when $T = const$	Provide regression
Gay-Lussac	$V/T = const$ at P	Volume is directly proportional to temperature
Gas Equation of State	$P/T = const$	Pressure is proportional

		to temperature
Boyle's Law	PV=nRT	Universal ideal gas equation

Detonation dynamics: physics of the process.

A detonation is a very fast exothermic reaction, in which: a large amount of hot gases are formed, the gases expand sharply and a shock wave (shock) occurs.

Application of laws:

During an explosion, the gas temperature increases rapidly → according to Charles: $T\uparrow \Rightarrow V\uparrow$.

At constant volume, the pressure increases sharply → according to Gay-Lussac: $T\uparrow \Rightarrow P\uparrow$.

If the volume is limited (for example, in a shell), according to the equation of state of the gas: $PV=nRT \Rightarrow P\uparrow, T\uparrow$.

This leads to the destruction of the shell and the formation of influence - the main damaging effect of the explosion.

Chemistry facilitator: The division and decomposition of nitroglycerin can be simplified by the following reaction:

$$4C_3H_5N_3O_9 \rightarrow 12CO_2+10H_2O+6N_2+O_2+\text{thermal energy}.$$

The reaction occurs instantly, heat is released, according to the laws of physics: pressure and volume grow exponentially.

In this reaction, gases are formed quickly, as a result, the volume increases.

Heat release is very high and therefore the explosion creates a shock wave.

Military department teacher: Application in military equipment.

Region	Application
Artillery	Gaseous products of gunpowder push the projectile out of the barrel
Explosives	Rasho
Rocket engines	React
Brontekh	React

Mathematical modeling.

Explosion propagation speed:

$v_{\text{shock wave}} \gg \text{sound speed}$

$$P = \frac{nRT}{V},$$

where n is the number of moles of gas, P—; T—; V is the volume.

Summary:

1) Gas laws help to model and predict the behavior.

2) Understanding these laws is critical when designing ammunition, engines, and defense systems.

3) The connection between physics and chemistry is the key to the controlled use of energy.

Conclusion.

Integrated lessons allow students to develop a holistic understanding of the world around them and find common platforms for bringing knowledge closer together.

Integrated teaching has a great future, because thanks to it, students develop a more objective and comprehensive picture of the world, students apply their knowledge in practice, and teachers can reveal their subject in a new way, showing its relationship with other sciences.

REFERENCES

1. Mammadova M.F., Gullarli G.H., Nasirov E.V. “Hərbi təhsil müəssisələrində interaktiv və immersiv təlim metodlarının tətbiqinin effektivliyi” (“Effectiveness of the application of interactive and immersive training methods in military educational institutions”)/Journal of Scientific News of AUL / N4 / 2023. p.102-110

2. Gyullarly G.G., Nasibova L.E. The case method in teaching chemistry in military universities. (Case method in teaching chemistry in military universities) / Sciences of Europe/N120 / 2023. p.32-34

3. Adiyeva A.Q., Mammadova M., Aghayeva J. “Empowering Future social workers: The role of technology in 21st century education”/International scientific research and innovation congress –III/June 09-11, 2025/Nakhchivan – Azerbaijan. Congress Program, p. 187-191.

4. Donenko A.V., Donenko L.N., Donenko I.L. Meta-subject relations of physics and mathematics. (Meta-subject connections of physics and mathematics). - Moscow: TSTU, 2017. - p. 1

5. Khmelnitskaya V.V. Modern meta-subject connections: "Binary lesson" (Modern meta-subject connections: "Binary lesson") Saki, NUBIP At KATU, 2016.- 45 p.

Gullu Gullarli, candidate of chemical sciences, associate professor, Military Institute named after Heydar Aliyev, Baku, Azerbaijan, axundzadegullu@rambler.ru

Emin Nasirov, PhD, associate professor, Military Institute named after Heydar Aliyev, Baku, Azerbaijan

Поступила: 14 июля 2025 года
Рецензирована: 24 августа 2025 года
Принята: 25 августа 2025 года