PRIVATE INSTITUTION OF HIGHER EDUCATION
"DNIPRO INSTITUTE OF MEDICINE AND PUBLIC HEALTH"

APPROVED
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PROGRAM
ENTRANCE EXAM (WRITTEN TEST) IN THE DISCIPLINE "CHEMISTRY" FOR FOREIGN CITIZENS AND STATELESS PERSONS

Dnipro – 2025

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The program was discussed and approved at the meeting of the Department of Social, Humanitarian, and Biomedical Disciplines.

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The program was reviewed and approved at the meeting of the Methodological Commission, protocol dated March 19, 2025, No. 1.

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The entrance examination in chemistry allows for the assessment of the educational achievements of foreign citizens who have completed general secondary education and expressed their desire to enroll in the Private Institution of Higher Education "Dnipro Institute of Medicine and Public Health" (hereinafter referred to as PIHE "DIMPH").

The purpose of the examination is to assess the level of proficiency in fundamental chemical concepts and skills necessary for further studies in the field of medicine.

The entrance examination in chemistry for foreign citizens is conducted in a test format.

The evaluation of test tasks in chemistry serves as a method to assess:

- students' knowledge of the most important laws and theories of chemistry;
- proficiency in chemical language, including the ability to use the names and symbols of chemical elements, as well as the names of simple and complex substances;
- the ability to compose chemical formulas and equations of chemical reactions, and to solve calculation-based and experimental problems;
- understanding the relationship between the composition, structure, physical and chemical properties of substances, their methods of production, and areas of application;
- knowledge of the most important natural and artificial substances, their structure, methods of production, and areas of application;
- understanding the scientific foundations of certain chemical industries;
- awareness of some environmental issues related to chemistry.

The entrance examination program is developed in accordance with current requirements for applicants' knowledge and facilitates the systematization of educational material for effective test preparation.

The chemistry program uses the nomenclature of chemical elements and substances, as well as relevant terminology.

The program also includes the abbreviation "n.u." to denote normal conditions (temperature 0 °C, pressure 101.3 kPa or 760 mmHg).

In accordance with international standards, the quantity of a substance can be denoted by the letters n or ν. The heat effect of a reaction should be denoted as "ΔH".

ENTRANCE EXAMINATION PROGRAM IN CHEMISTRY

№	Section/Topic Title	Content of Educational Material
1. GENERAL CHEMISTRY		
1.1	Fundamental Chemical Concepts. Substance	Concepts: simple substance (metal, nonmetal), complex substance, chemical element; structural units: atom, molecule, ion (cation, anion). Valency. Relative atomic mass (A_r) and molecular mass (M_r), molar mass M(x), amount of substance (ν), and their units. Molar volume (V_m). Avogadro's law. Mass fraction of an element in a compound W(x). Volume fraction of a gas in a mixture φ(x).
1.2	Chemical Reaction	Laws of conservation of mass of substances and volumetric relationships of gases. Concepts: oxidizing agent (ox), reducing agent (red). Types of chemical reactions. Reaction rate. Catalyst.
1.3	The Periodic Law and the Periodic Table of Chemical Elements by D. I. Mendeleev	The Periodic Law (modern formulation) and the Periodic Table (PT): periods, groups, subgroups (main and secondary). Atomic (ordinal) number of an element (Z), the arrangement of metallic and nonmetallic elements in the PT, periods, and groups; alkali metals, alkaline earth metals, noble gases, and halogens.
1.4	Atomic Structure	Composition of an atom (nucleus, electron shell). Concepts: nucleon, nuclide, isotopes, proton number, nucleon number, orbital, energy level and sublevel, paired and unpaired electrons, atomic radius (of a simple ion); ground and excited states of an atom. Sequence of filling energy levels and sublevels with electrons in the atoms of elements No. 1–20, electronic and graphical formulas of atoms and simple ions of elements No. 1–20.
1.5	Chemical Bond	Types of chemical bonds (ionic, covalent, hydrogen, metallic). Types of crystal lattices (atomic, molecular, ionic, metallic). Electronic formula of a molecule. Electronegativity of an element.
1.6	Mixtures of Substances. Solutions	Homogeneous mixtures (solutions) and heterogeneous mixtures (suspension, emulsion, foam, aerosol). Methods of separating mixtures (settling, filtration, centrifugation, evaporation, distillation). Electrolytic dissociation, electrolyte, non-electrolyte, degree of electrolytic dissociation, ionic-molecular equation. Structure of the water molecule (H_2O); hydrogen bonding in water. Color changes of indicators (universal, litmus, phenolphthalein, methyl orange) in acidic, alkaline, and neutral environments.
2. INORGANIC CHEMISTRY		
2.1. Main Classes of Inorganic Compounds		
2.1.1	Oxides	Definition, nomenclature, classification, chemical properties (E_2O_n), and methods of preparation.
2.1.2	Bases (Hydroxides)	Definition (general and from the perspective of electrolytic dissociation), nomenclature, classification, chemical properties, and methods of preparation of bases ($E(OH)_n$).
2.1.3	Acids	Definition (general and from the perspective of electrolytic dissociation), nomenclature, classification (H_nE, $H_nE_mO_p$),

		chemical properties, and methods of preparation of acids.
2.1.4	Salts	Definition (general and from the perspective of electrolytic dissociation), nomenclature, classification, chemical properties, and methods of preparation of salts.
2.1.5	Amphoteric Compounds	The phenomenon of amphoterism (illustrated by examples of oxides E_2O_n and hydroxides $E(OH)_n$); chemical properties and methods of preparation of amphoteric hydroxides.
2.1.6	Genetic Relationships Between Classes of Inorganic Compounds	
2.2. Metallic Elements and Their Compounds. Metals		
2.2.1	General Information About Metallic Elements and Metals	Position of metallic elements in the Periodic Table, electronic structure of their atoms; metallic bonding; physical and chemical properties of metals, methods of obtaining metals; reactivity series of metals; corrosion, methods of protecting metals from corrosion; iron-based alloys (cast iron, steel).
2.2.2	Alkali and Alkaline Earth Elements	Chemical properties, applications, and names of compounds of Sodium (Na), Potassium (K), Magnesium (Mg), and Calcium (Ca); potassium fertilizers; water hardness (H_2O).
2.2.3	Aluminum	Chemical properties and production of Aluminum (Al); names and formulas of the most important aluminum compounds.
2.2.4	Iron	Chemical properties and production of Iron (Fe); names and formulas of the most important iron compounds; applications of iron and its compounds.
2.3. Nonmetallic Elements and Their Compounds. Nonmetals		
2.3.1	Halogens	Formulas, names, and properties of the most important compounds (HCl, $MeCl_n$); methods of laboratory preparation and chemical reactions of HCl gas and HCl acid; key applications of chlorine (Cl_2), HCl gas, and HCl acid; qualitative test for detecting chloride ions (Cl^-).
2.3.2	Oxygen and Sulfur	Properties of O_2, O_3, S, and compounds of Oxygen and Sulfur, including sulfur oxides (SO_2, SO_3), sulfuric acid (H_2SO_4), and sulfates; methods of laboratory preparation of oxygen (O_2); key applications of oxygen (O_2), ozone (O_3), sulfur (S), sulfuric acid (H_2SO_4), and sulfates; qualitative test for detecting sulfate ions (SO_4^{2-}).
2.3.3	Nitrogen and Phosphorus	Properties of nitrogen (N_2), white phosphorus (P_4), red phosphorus (P_8), nitrogen oxides (NO, NO_2), phosphorus pentoxide (P_2O_5), ammonia (NH_3), ammonium salts, nitric acid (HNO_3), nitrates, orthophosphoric acid (H_3PO_4), and orthophosphates; methods of laboratory preparation of NH_3, HNO_3, and H_3PO_4; applications of N_2, NH_3, HNO_3, nitrates, H_3PO_4, and orthophosphates; qualitative tests for detecting ammonium ions (NH_4^+) and orthophosphate ions (PO_4^{3-}).

2.3.4	Carbon and Silicon	Simple substances of carbon (diamond, graphite, carbyne); adsorption properties of activated carbon; properties of carbon (C), silicon (Si), carbon oxides (CO, CO_2), and silicon dioxide (SiO_2); acids: carbonic acid (H_2CO_3) and silicic acid (H_2SiO_3); salts: carbonates and silicates; methods of laboratory preparation of carbon oxides; applications of diamond, graphite, activated carbon, carbon oxides, silicon, carbonates, bicarbonates, silicon dioxide (SiO_2), and silicates; qualitative tests for detecting carbonate and silicate ions.
3. ORGANIC CHEMISTRY		
3.1	Theoretical Foundations of Organic Chemistry	The most important organogenic elements, organic compounds; natural and synthetic organic compounds.
		Molecular structure of organic compounds. Chemical bond in organic molecules: energy, length, spatial orientation, polarity. σ-bond and π-bond. Single, multiple (double, triple), and aromatic bonds.
		Hybridization of the electron orbitals of the carbon atom; sp^3-, sp^2-, sp-hybridizations.
		Classification of organic compounds based on the structure of the carbon chain and the presence of characteristic (functional) groups.
		The phenomenon of homology; homologs, homologous series, homologous difference. Classes of organic compounds. General formulas of homologous series and classes of organic compounds.
		The concept of primary, secondary, tertiary, and quaternary carbon atoms.
		Nomenclature of organic compounds.
		The phenomenon of isomerism, isomers, structural and spatial (geometric or cis-trans) isomerism.
		Mutual influence of atoms or groups of atoms in organic molecules.
		Classification of chemical reactions in organic chemistry (addition, substitution, isomerization reactions).
3.2. Hydrocarbons		
3.2.1	Alkanes	General formula of alkanes, their nomenclature, isomerism, molecular structure, physical and chemical properties, methods of preparation, and applications.
3.2.2	Alkenes	General formula of alkenes, their nomenclature, isomerism, molecular structure, properties, methods of preparation, and applications; qualitative reactions for the double bond.
3.2.3	Alkynes	General formula of alkynes, their nomenclature, isomerism, molecular structure; properties, methods of preparation of ethyne, applications; qualitative reactions for the triple bond.
3.2.4	Aromatic Hydrocarbons. Benzene	General formula of the homologous series of arenes based on benzene. Structure, properties, methods of preparation of benzene; the concept of aromatic bonds and the 6π-electron system.
3.2.5	Natural Sources of Hydrocarbo	Petroleum, natural and associated petroleum gases, coal, their composition; cracking and aromatization of petroleum and petroleum products, detonation resistance of gasoline,

	ns and Their Processing	octane number; coal processing; challenges in producing liquid fuel from coal and alternative sources.
3.3. Oxygen-Containing Organic Compounds		
3.3.1	Alcohols	Characteristic (functional) group of alcohols. Classification of alcohols. General formula of monohydric saturated alcohols. Structure, nomenclature, isomerism, properties, methods of preparation, and applications. Concept of hydrogen bonding. Ethylene glycol and glycerol as representatives of polyhydric alcohols; qualitative reaction for polyhydric alcohols.
3.3.2	Phenol	Formula and structure of the phenol molecule, characteristic (functional) group in it; properties, preparation, applications; qualitative reactions for phenol.
3.3.3	Aldehydes	General formula of aldehydes. Structure of aldehyde molecules, characteristic (functional) group, nomenclature, isomerism, properties, preparation, applications; qualitative reactions for the aldehyde group.
3.3.4	Carboxylic Acids	Characteristic (functional) group of carboxylic acids. Classification of carboxylic acids. General formula of saturated monobasic carboxylic acids. Structure, nomenclature, isomerism of monobasic carboxylic acids, properties, preparation, applications.
3.3.5	Esters, Fats, Soaps	General formula of esters of carboxylic acids. Structure, nomenclature, isomerism, properties, preparation, applications. Fats – esters of glycerol and higher carboxylic acids. Classification of fats, properties, preparation, applications. Soaps and synthetic detergents.
3.3.6	Carbohydrates	Classification of carbohydrates; composition, molecular formulas of glucose, fructose, sucrose, starch, and cellulose; structural formula of the open form of the glucose molecule; properties of glucose, sucrose, starch, and cellulose; preparation of glucose, production of sucrose and starch; qualitative reactions for the identification of glucose and starch; applications of glucose, starch, and cellulose.
3.4. Nitrogen-Containing Organic Compounds		
3.4.1	Amines	Characteristic (functional) group of amines. Classification of amines. Nomenclature, isomerism, structure, properties, methods of preparation, and applications.
3.4.2	Amino Acids	Composition and structure of molecules, nomenclature, properties, preparation, and applications of amino acids. Concept of amphoterism of amino acids, zwitterion; di-, tri-, polypeptides, and peptide bond.
3.4.3	Proteins	Structure of proteins, their properties, applications, and color reactions for proteins.
3.5. Synthetic High-Molecular Compounds and Polymer Materials Based on Them		
3.5	Synthetic High-Molecular Compounds and Polymer	Concept of polymer, monomer, repeating unit, and degree of polymerization. Classification of high-molecular compounds; methods of synthesis of high-molecular compounds; structure and properties of polymers; thermoplastic polymers and plastics based on them; concept

	Materials Based on Them	of natural and synthetic rubbers, synthetic fibers; significance of polymers in the economy and everyday life.
3.6. Generalization of knowledge about organic compounds		
Establishing genetic relationships between different classes of organic compounds and between organic and inorganic compounds.		
4. CALCULATIONS IN CHEMISTRY		
4.1	Solving problems using chemical formulas and determining the formula of a compound.	Formulas for calculating the amount of substance, the number of particles in a given amount of substance, the mass fraction of an element in a compound, the relative density of a gas, the mass (volume) fraction of a component in a mixture, and determining the formula of a compound based on the mass fractions of elements.
4.2	Expression of the Quantitative Composition of a Solution (Mixture)	Mass fraction of the dissolved substance.
4.3	Solving Problems Using Reaction Equations	Algorithms for solving problems based on reaction equations; relative yield of the reaction product.

Appendix 1
to the Chemistry Entrance
Examination Program for Foreign
Citizens

STRUCTURE AND CRITERIA FOR ASSESSING KNOWLEDGE of Foreign Applicants in Chemistry

Structure of Knowledge Assessment

□ The chemistry entrance examination for foreign citizens is conducted in a test format.

□ The time allocated for completing the test is 60 minutes.

□ The total number of tasks is 40.

□ The tasks cover all sections of the Chemistry Entrance Examination Program for Foreign Citizens of the current year.

□ Each task consists of a question and four answer options, only one of which is correct.

□ A task is considered completed if the exam participant selects and marks the answer on the answer sheet.

□ The maximum score is 200 points.

□ The minimum passing score ("pass/fail") is 100 points.

Appendix 1
to the Chemistry Entrance Examination Program for Foreign Citizens

Criteria for Knowledge Assessment

The maximum score a test participant can achieve by correctly completing all test tasks is 200 points.

After determining the test score, the result of each applicant who passed the test is converted into a rating score on a scale from 100 to 200 points.

The test tasks are considered successfully completed if the applicant scores **100 points or more.**

Table for Converting Test Scores into the 100–200 Point Rating Scale

Number of Correct Answers	Score
20	100
21	105
22	110
23	115
24	120
25	125
26	130
27	135
28	140
29	145
30	150
31	155
32	160
33	165
34	170
35	175
36	180
37	185
38	190
39	195
40	200

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