

**MINISTRY OF HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY**

APPROVED

**Deputy Chairman of the
Admissions Committee**



Inna VLADIMIROVA
April 2025

**PROGRAM
of chemistry test for admission to study
according to the educational programs
«PHARMACY», «CLINICAL PHARMACY»
«TECHNOLOGIES OF PHARMACEUTICALS»**

**(for admitting foreigners and stateless persons
who have complete total secondary education)**

Specialty I8 «Pharmacy, industrial pharmacy »

Subject area 22 «Public Health»

Level of higher education – second (master's)

Educational degree – master's degree

**Kharkiv,
2025**

EXPLANATORY NOTE

This program is the guide for the persons with complete secondary education who apply for admission to the master course of the educational program «Pharmacy», «Clinical Pharmacy» and «Technologies of pharmaceuticals».

The professional assessment is used to evaluate the basic level of theoretical chemistry knowledge of the applicant. The exam lasts for 1 astronomical hour.

The chemistry program stipulates the level of chemistry knowledge which is sufficient for the further effective study of the foreign students at the university.

CONTENT

1. Subject and problems of chemistry. Chemical elements. Names and symbols of chemical elements

- 1.1. Chemistry as science
- 1.2. problems of chemistry
- 1.3. Names and symbols of chemical elements

2. Atom. Relative atomic mass. Molecule. Relative molecular weight

- 2.1. The concept of atom and molecule
- 2.2. Relative atomic mass and relative molecular weight
- 2.3. Calculation of the relative atomic mass of an element by the mass of an atom
- 2.4. Calculation of the relative molecular weight of a substance

3. The concept of valence. Presentation of formulas according to the valences of the atoms

- 3.1. The concept of valence
- 3.2. Presentation of formulas of complex substances by valence of elements
- 3.3. Calculation of the valence of elements based on the formula of a complex substance

4. Molecular and structural formulas. The mass fraction

- 4.1. Presentation of chemical formulas of simple and complex substances
- 4.2. Writing of the molecular formulas of oxides, bases of different acidity, acids of different basicity, neutral, acidic and basic salts
- 4.3. The concept of mass fraction. calculation tasks

5. Simple and complex substances

- 5.1. Classification of substances depending on their composition (simple, complex)
- 5.2. Classification of substances depending on their physical state (solid, liquid and gaseous)
- 5.3. The difference between the concepts of "simple substance" and "chemical element"

6. Mole. Molar mass

- 6.1. The concept of mole, molar mass
- 6.2. Calculation of the amount of substance
- 6.3. Calculation of molar mass of simple and complex substances

7. Molar volume of gases. Avogadro's law. Relative density of gases

- 7.1. The concept of molar volume of gas
- 7.2. Avogadro's law
- 7.3. Calculation of the molar volume of a gas of simple substances
- 7.4. Calculation of the volume of gas obtained as a result of a chemical reaction
- 7.5. Clapeyron-Mendeleev equation
- 7.6. The formula for calculating the relative density of gases
- 7.7. Calculations of the relative density of gases to hydrogen, oxygen and air

8. The law of conservation of mass. Chemical equation. Calculations using chemical equations

- 8.1. Formulation of the law of conservation of mass
- 8.2. Calculating of the mass of substances in a chemical reaction
- 8.3. The concept of starting and intermediate substances; the products of reactions
- 8.4. Compilation of equations of chemical reactions the role of coefficients
- 8.5. Calculation of the mass of substances
- 8.6. Calculating the volume of gases
- 8.7. Calculation of the amount of substance

9. Types of chemical reactions

- 9.1. Classification of chemical reactions depending on the amount and composition of reactants and reaction products (coupling, decomposition, substitution and exchange reactions)
- 9.2. Redox reactions
- 9.3. Exothermic and endothermic reactions
- 9.4. Reversible and irreversible reactions

10. The structure of an atom. Isotopes

- 10.1. Models of atom
- 10.2. The structure of an atom
- 10.3. Charges of elementary particles
- 10.4. The concept of isotopes

11. The structure of the electron shell. Rules for filling of the electron shells of an atom

- 11.1. Quantum numbers and their physical meaning
- 11.2. Forms of electron orbitals
- 11.3. Principles and rules of filling atomic orbitals

12. Electron formulas of atoms

- 12.1. Electron formulas of atoms
- 12.2. Aufbau diagrams of atoms or orbital filling diagrams
- 12.3. Electron families of atoms

13. Periodic law and periodic system D.I. Mendeleev.

- 13.1. Periodic law of D.I. Mendeleev (modern formulation)
- 13.2. The structure of the periodic table
- 13.3. Periodicity of changes in the properties of elements and their compounds based on ideas about the structure of atoms

14. Types of chemical bonds. Covalent bond. Hybridization of atomic orbitals

- 14.1. The concept of chemical bonding
- 14.2. The main characteristics of chemical bonding
- 14.3. Types of chemical bonds
- 14.4. The principle of covalent bond formation
- 14.5. Mechanisms of covalent bond formation
- 14.6. The concept of hybridization of atomic orbitals
- 14.7. Theory of atomic orbitals hybridization

15. Ionic and metallic bonds. Hydrogen bond

- 15.1. The concept of ionic bonding
- 15.2. The difference between ionic and covalent bonds
- 15.3. Influence of hydrogen bonding on physical and chemical properties of substances
- 15.4. Properties of metal bonds

16. The degree of oxidation. Electronegativity

- 16.1. The degree of oxidation of elements in simple and complex compounds
- 16.2. The concept of electronegativity
- 16.3. The value of the electronegativity of the atoms depending on the type of chemical bond in the compounds
- 16.4. Determination of oxidation state and valence of atoms in compounds

17. Classification of inorganic compounds. Oxides

- 17.1. Classification of inorganic compounds (oxides, bases, acids, salts)
- 17.2. The concept of oxides. Salt-forming and non-salt-forming oxides
- 17.3. Properties of basic, amphoteric and acid oxides
- 17.4. Preparation of oxides
- 17.5. Structural formulas of oxides

18. Bases

- 18.1. The definition of bases
- 18.2. Properties of hydroxides of active metals

18.3. Properties of hydroxides of amphoteric elements

18.4. Preparation of bases

18.5. Structural formulas of bases

19. Acids

19.1. The definition of acids

19.2. Basicity of acids

19.3. Properties of acids

19.4. Preparation of acids

19.5. Structural formulas of acids

20. Salts

20.1. The definition of salt

20.2. Nomenclature of salts

20.3. Properties of salts

20.4. Preparation of salts

20.5. Structural formulas of salts

21. Relations between classes of inorganic compounds

21.1. Scheme of relations between the main classes of inorganic compounds

21.2. Chemical transformations of different classes of inorganic compounds

21.3. Problems dealing with interconversions of different classes of inorganic compounds

22. Chemical kinetics. The rate of chemical reactions

22.1. The concept of chemical kinetics

22.2. The concept of the rate of a chemical reaction

22.3. Factors affecting the rate of a chemical reaction

22.4. Chemical kinetics problems

23. Solutions. Ways to express concentration

23.1. The definition of solutions

23.2. Types of solutions depending on the size of solutes' molecules

23.3. Properties of solutions

23.4. Methods of expressing the concentration of the solution (mass fraction, molar concentration)

24. Electrolytic dissociation. Strong and weak electrolytes. Ionic reaction equations. Hydrogen index (pH)

24.1. The concept of electrolytic dissociation

24.2. Acids, bases and salts in terms of the theory of electrolytic dissociation

24.3. The definition of the degree of dissociation. Strong and weak electrolytes

24.4. Ionic equations of reactions

24.5. Hydrogen index (pH)

25. Hydrolysis of salts

25.1. Types of salts

25.2. Hydrolysis of salts formed by cations of strong bases and anions of weak acids

25.3. Hydrolysis of salts formed by cations of weak bases and anions of strong acids

25.4. Hydrolysis of salts formed by cations of weak bases and anions of weak acids

25.5. Hydrolysis of salts formed by multicharged cations and anions

26. Redox reactions

26.1. The concept of oxidation and reduction processes

26.2. Balancing of redox reactions' equations

26.3. Defining of coefficients for redox reactions' equations by electronic balance method

26.4. Influence of pH of the media on redox processes

27. Electrolysis of solutions of salts and molten salts

27.1. The concept of electrolysis

27.2. Conditions for electrolysis of aqueous solutions (cathode and anode reactions)

27.3. Electrolysis of molten salts

28. Alkali and alkaline earth metals. Aluminum. Zinc. Iron. Copper

28.1. Classification of metals

28.2. Physical and chemical properties of metals

28.3. Extraction of metals

28.4. Corrosion of metals

28.5. General characteristics of alkali and alkaline earth metals (Sodium, Potassium, Calcium)

28.6. General characteristics of the Bohr subgroup. Aluminum

28.7. Iron family (Iron, Cobalt, Nickel).

29. Non-metals. Hydrogen. Chlorine. Oxygen. Sulfur. Nitrogen. Phosphorus. Carbon. Silicon.

29.1. Classification of nonmetals

29.2. Hydrogen

29.3. General characteristics of halogens. Chlorine. Oxygen-containing chlorine compounds

29.4. Properties of elements of the Oxygen subgroup (Oxygen, Sulfur, Selenium)

29.5. Nitrogen and Phosphorus

29.6. Carbon and Silicon

30. Organic chemistry. O.M. Butlerov's Structural theory of organic chemistry. Isomerism

30.1. The subject of organic chemistry

30.2. O.M. Butlerov's structural theory of organic chemistry

30.3. The concept of isomerism. The main ways of organic molecule formula drawing

31. Classification and nomenclature of organic compounds

- 31.1. Classification of organic compounds by the structure of the carbon chain and by of the functional group
- 31.2. The main functional groups and the corresponding classes of organic compounds.
- 31.3. Nomenclature systems: trivial, rational and international (IUPAC)
- 31.4. Basic principles of construction of names of organic compounds according to the international nomenclature (substitutive, radicofunctional nomenclature)

32. Alkanes. Alkenes

- 32.1. Homologous series of alkanes and alkenes
- 32.2. Nomenclature of alkanes and alkenes
- 32.3. Preparation of alkanes and alkenes
- 32.4. Physical and chemical properties of alkanes and alkenes

33. Alkadienes. Alkynes

- 33.1. Homologous series of alkadienes and alkynes
- 33.2. Nomenclature of alkadienes and alkynes
- 33.3. Preparation of alkadienes and alkynes
- 33.4. Physical and chemical properties of alkadienes and alkynes

34. Aromatic hydrocarbons. Benzene

- 34.1. The definition of aromatic hydrocarbons
- 34.2. Classification. Nomenclature of aromatic hydrocarbons
- 34.3. Benzene. Molecule structure. Criteria of aromaticity
- 34.4. Preparation of aromatic hydrocarbons
- 34.5. Chemical properties of aromatic hydrocarbons

35. Hydroxyl derivatives of hydrocarbons. Alcohols. Phenols

- 35.1. Classification and nomenclature of alcohols and phenols
- 35.2. Preparation of alcohols and phenols
- 35.3. Chemical properties of alcohols and phenols

36. Carbonyl compounds. Aldehydes. Ketones

- 36.1. Classification and nomenclature of aldehydes and ketones
- 36.2. Preparation of aldehydes and ketones
- 36.3. Chemical properties of aldehydes and ketones

37. Carboxylic acids. Esters. Fats. Soaps

- 37.1. Classification and nomenclature of carboxylic acids
- 37.2. Preparation of carboxylic acids
- 37.3. Chemical properties of carboxylic acids
- 37.4. Esters. Fats. Soaps

38. Amines. Amino acids. Proteins. Relationship between classes of organic compounds

38.1. Amines: structure, chemical properties

38.2. Amino acids: structure, chemical properties. Essential amino acids

38.3. Proteins. Protein structure. Protein test reactions

38.1. Relationship between classes of organic compounds

38.2. Chemical transformations based on hydrocarbons and their functional derivatives

Literature

1. General and Inorganic Chemistry (textbook) V.O. Kalibabchuk, V.V. Ohurtsov, V.I. Halynska et al. , 2019
2. J. Mc Murry Ballantine, Hoeger Peterson. Fundamentals of General, Organic and Biological Chemistry in SI Units. — Longman (Pearson Education), 2017. — 763 p.
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5. Huheey J. E., Keiter E. A., Keiter R. L. Inorganic Chemistry: Principles of Structure and Reactivity, 4 th ed. Harper Collins College Publishers: New York, 1993, Chapter 11.
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16. Neuman, R. Organic Chemistry Textbook [Електронний ресурс] / Robert Neuman. — Режим доступу: <https://chem.ucr.edu/curricular-materials/textbook>

MEASURES OF PROGRESS

Each exam card contains 20 closed-ended test tasks. The correct answer is estimated as 10 points, incorrect - 0 points. The maximum number of points is 200.

Entrants who received 150 points or more according to the results of written testing are allowed to participate in the competition.

The program is considered and approved at the meeting of the Admissions Committee
Protocol № 8 of April, 25, 2025.

**Chair of the Subject Commission,
Associate professor**

Tetiana KOSTINA

**Executive secretary
of Admissions Committee,
Associate professor**

Oleg KRYSKIV