

federal state budgetary educational institution of higher education  
'FIRST ST. PETERSBURG STATE MEDICAL UNIVERSITY NAMED AFTER  
ACADEMICIAN I. P. PAVLOV'  
OF THE MINISTRY OF HEALTH OF THE RUSSIAN FEDERATION  
(FSBEI HE PSPbSMU named after I. P. Pavlov of the Ministry of Health of Russia)



APPROVED

Rect. of the FSBEI HE PSPbSMU named after  
I. P. Pavlov of the Ministry of Health of Russia

 S. F. Bagnenko

*N256-31 on 31.10.2023*

«31» 10 2023

**The entrance test program in chemistry for applicants to the FSBEI HE PSPbSMU named after. I. P. Pavlova of the Ministry of Health of Russia to the Faculty of Medicine for foreign students**

**Basic concepts of chemistry**

Atoms and molecules. Chemical element, simple substance, complex substance, mixture of substances. The concept of allotropic modifications. Relative atomic mass, relative molecular mass. Avogadro's law and its consequences. Mendeleev–Clapeyron equation. Valency and oxidation state.

**The structure of the atom. Chemical bond. Structure of matter**

The structure of the nuclei and electron shells of atoms of chemical elements, s-, p-, d-elements. Periodic law and structure of the periodic system. Isotopes. Types of chemical bonds: covalent (polar and non-polar), ionic, hydrogen, metallic. Structure of complex compounds. Aggregate state of substances, amorphous and crystalline substances. Types of crystal lattices.

**Water and aqueous solutions**

Water: molecular structure, physical and chemical properties. Solubility of substances, dependence of the solubility of substances on their nature, temperature and pressure. Types of solutions (gaseous, liquid, solid). Expression of solution composition (mass fraction, volume fraction, molar concentration). Concept of colloidal solutions. The importance of solutions in medicine and biology. Electrolytic dissociation. Degree of dissociation. Strong and weak electrolytes. Ionic reaction equations.

**Basic principles of chemical reactions**

Classification of reactions: connection, decomposition, substitution, exchange. The rate of chemical reactions and its dependence on various factors. Rate constant of a chemical reaction. Catalysis. Thermal effects of chemical reactions. Reversibility of reactions. Chemical equilibrium and conditions for its displacement. Redox reactions.

**Classes of inorganic compounds**

Oxides, acids, hydroxides, salts (classification, nomenclature, methods of preparation and properties). Amphoteric. Hydrolysis of salts: types of hydrolysis.

**Metals**

General characteristics of metals: physical and chemical properties. General methods of obtaining metals. Electrochemical voltage series of metals. General characteristics of the IA and IIA groups of the periodic table. Properties of sodium, potassium, calcium and magnesium and their compounds. Water hardness and ways to eliminate it.

Properties of aluminium and its compounds.

Properties of chromium(II) and (III) oxides and hydroxides, chromates and dichromates. Properties of potassium permanganate; reduction of permanganate ion in acidic, neutral and alkaline media.

Properties of iron, oxides and hydroxides of iron(II) and (III). Properties of copper(I) and (II) compounds.

Properties of zinc oxide and hydroxide.

**Non-metals**

General characteristics of the IVA-, VA-, VIA-, VIIA-groups of the Periodic Table. Hydrogen, its chemical and physical properties.

Chlorine. Properties and methods of producing hydrogen chloride and chlorides, hypochlorites, chlorates.

Oxygen, its production, comparison of the physical and chemical properties of oxygen and ozone, redox reactions involving hydrogen peroxide.

Sulphur, its physical and chemical properties. Properties and methods of producing sulphur compounds: hydrogen sulphide and sulphides, oxides, sulphurous acid and sulphites, sulfuric acid and sulphates.

Nitrogen, its physical and chemical properties, production. Properties of ammonia and ammonium salts, nitrogen oxides (I), (II), (III), (IV) and (V), nitric acid and nitrates, nitrous acid and nitrites. Production of ammonia and nitric acid.

Phosphorus, its physical and chemical properties. Properties of phosphorus compounds: phosphine and phosphides, phosphorus(III) and (V) oxides, orthophosphoric acid and orthophosphates.

Carbon, its physical and chemical properties. Properties and methods of producing carbon oxides and carbonates. Properties of carbonic acid.

Properties of silicon, silicon oxide, silicic acid and silicates.

### **Theoretical principles of organic chemistry**

Theory of the chemical structure of organic compounds by A. M. Butlerov. Isomerism. Homologous series. Electronic nature of chemical bonds in molecules of organic compounds. Ways to break bonds, the concept of free radicals. Electronic and spatial structure of molecules using the example of methane, ethylene and benzene. The concept of hybridisation of atomic orbitals. The concept of the mutual influence of atoms using the example of several compounds (toluene, phenol, chloroacetic acid, etc.) General concepts of the chemistry of high molecular weight compounds (monomer, polymer, elementary unit, degree of polymerisation). Polymerisation and polycondensation reactions. Principles of nomenclature of organic compounds.

### **Main classes of organic compounds**

Hydrocarbons: alkanes, alkenes, alkynes, diene hydrocarbons, aromatic hydrocarbons (physical and chemical properties, methods of production). An idea of the structure of cycloalkanes. Oxygen-containing compounds: monohydric and polyhydric alcohols, phenol, aldehydes, carboxylic acids, esters (physical and chemical properties, methods of preparation). Nitrogen-containing compounds, aliphatic and aromatic amines, amino acids (physical and chemical properties, methods of preparation). The most important natural organic compounds (proteins, fats, carbohydrates, nucleic acids).

### **Typical calculation tasks**

1. Calculation of the mass or volume fraction of a component.
2. Calculation of molar concentration.
3. Calculation of the relative densities of substances in the gaseous state.
4. Calculation of the volume of a gaseous substance of a known mass or a known quantity under normal conditions and conditions different from normal.
5. Establishment of the molecular formula of a substance by mass fractions of elements or by masses of combustion products.
6. Calculation of the mass (volume, amount of substance) of one of the reaction participants from the known mass (volume, amount of substance) of the other reaction participant.
7. Tasks involving excess and deficiency of reagents.
8. Tasks taking into account the yield of the reaction product as a percentage of the theoretically possible.

### **Typical qualitative tasks**

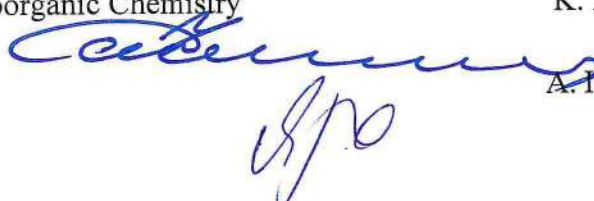
1. Writing reaction equations illustrating a scheme in which all or only individual stages are specified.
2. Multi-stage synthesis of organic or inorganic substances.
3. Identification of the possibility of a reaction occurring between substances in the proposed set of substances.
4. Drawing up equations of redox reactions using the electron balance method.
5. Drawing up formulas of homologues and isomers of organic substances.

Head of the Department of General and Bioorganic Chemistry

K. N. Semenov

APPROVED:

Vice Rector for Academic Affairs



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