Federal State Budgetary Educational Institution of Higher Education
«Pavlov First Saint Petersburg State Medical University»
of the Ministry of Health of the Russian Federation
(FSBEI of HI PFSPbSMU)

Approved
Rector of FSBEI of HI PFSPbSMU
of the Ministry of Health of Russia
_____ S. F. Bagnenko
«25» 10 2022

№241-12 от 25.10.2022

The Program of Entrance Examinations in Chemistry for Applicants to the FSBEI of HI PFSPbSMU

Basic concepts of chemistry

Atoms and molecules. A chemical element, a simple substance, a complex substance, a mixture of substances. The concept of allotropic modifications. Relative atomic mass, relative molecular weight. The law of Avogadro and its consequence. The Mendeleev-Clapeyron equation. Valence and oxidation state.

The structure of the atom. Chemical bond. Substance structure

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

Water and aqueous solutions

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

The main laws of chemical reactions

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

Classes of inorganic com pounds

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

Metals

General characteristics of metals: physical and chemical properties. General methods for producing metals. Reactivity series. General characteristics of the IA- and IIA-groups of the periodic system. 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 oxides and hydroxides (+2), (+3), chromates and dichromates. Properties of potassium permanganate; reduction of permanganate ion in acidic, neutral and alkaline environments. Properties of iron, iron oxides and hydroxides (+2) and (+3). Properties of copper compounds (+1) and (+2).

Properties of zinc oxide and hydroxide.

Medical and biological significance of the compounds of these metals.

Non-metals

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

Chlorine. Properties and methods for 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 for producing sulphur compounds: hydrogen sulphide and sulphides, oxides, sulphurous acid and sulphites, sulphuric acid and sulphates.

Nitrogen, its physical and chemical properties, production. Properties of ammonia and ammonium salts, nitrogen oxides (+1), (+2) and (+4), nitric acid and nitrates, nitrous acid and nitrites. Synthesis of ammonia and nitric acid.

Phosphorus, its physical and chemical properties. Properties of phosphorus compounds: hydrogen phosphorus and phosphides, phosphorus oxides (+3) and (+5), phosphoric acid and phosphates.

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

Properties of silicon, silicon oxide, silicic acid and silicates. Medical and biological significance of these non-metals.

Theory of organic chemistry

The theory of the chemical structure of organic compounds named after A. M. Butlerov. Isomerism. Homologous series. The electronic nature of chemical bonds in the molecules of organic compounds. Ways to break bonds, the concept of free radicals. Electronic and spatial structure of molecules on the example of methane, ethylene and benzene. The concept of hybridisation of atomic orbitals. The concept of the mutual influence of atoms on 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. The principles of the nomenclature of organic compounds.

The main classes of organic compounds

Hydrocarbons: alkanes, alkenes, alkynes, diene hydrocarbons, aromatic hydrocarbons (physical and chemical properties, production methods). The idea of the structure of cycloalkanes. Oxygen-containing compounds: monohydric and polyhydric alcohols, phenol, aldehydes, carboxylic acids, esters (physical and chemical properties, production methods, biomedical value). Nitrogen-containing compounds, aliphatic and aromatic amines, amino acids (physical and chemical properties, production methods, biomedical value). The structure of individual representatives of amino acids: glycine, alanine, cysteine, serine, glutamic acid, lysine, phenylalanine and tyrosine. The structure and chemical properties of heterocyclic compounds (pyridine, pyrrole, pyrimidine, purine). The structure of pyrimidine and purine bases: cytosine, uracil, thymine, adenine, guanine.

Essential natural organic compounds

The structure and properties of fats. Carbohydrates: mono-, di-, polysaccharides. The structure and properties of glucose, ribose, 2-deoxyribose, sucrose, starch, cellulose. The structure of fructose, maltose and lactose. The structure and properties of proteins. The structure of nucleotides and polynucleotides. Differences in the structure of DNA and RNA, their biological role.

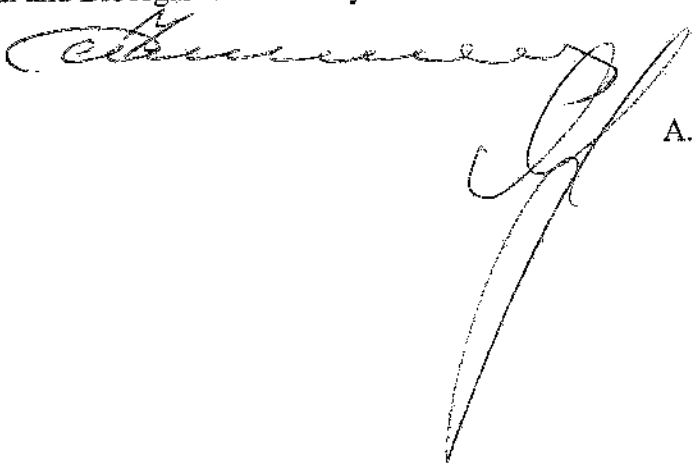
Typical quantitative exercises

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

Typical qualitative exercises

1. Writing reaction equations illustrating a scheme in which all or only individual steps are specified.
2. Multistage synthesis of organic or inorganic compounds.
3. Identification of the possibility of a reaction between substances in the proposed combination of substances.
4. Balancing redox equations using the electronic balance method.
5. Formulation 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 A. I. Yaremenko