"APPROVED"

Rector of Danylo Halytsky
Lviv National Medical University
Acad. of NAMS of Ukraine, Prof.
_____ B.S. Zimenkovsky

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PROGRAM
of
Entrance Test in Chemistry
for foreigners and stateless persons

Lviv - 2022

1. GENERAL CHEMISTRY

1.1. Basic chemical concepts. Substance.

The concept of substance physical body, material, simple substance (metal, non-metal), the complex substance, chemical element; the smallest particles of matter - atoms, molecules, ions (cations, anions). The composition of matter (qualitative, quantitative). Valency of chemical element. Chemicals (simple, true) and graphics (structural) formulas. The physical phenomenon. Relative atomic and molecular masses, molar mass, amount of substance. Unit amount of substance, molar mass, molar volume; temperature and pressure that correspond to normal conditions, molar volume of gas. Avogadro's law; Avogadro's number; average relative of molecular mass of the gas mixture and air. Mass part of element in compound.

1.2. The chemical reaction.

Chemical reaction, scheme of reaction, chemical equation. Laws: conservation of mass substances during chemical reactions, volumetric ratios of gases in chemical reactions. External effects that accompany chemical reactions. The concept of an oxidizer, reducer, oxidation, reduction. Types of chemical reactions. The speed of a chemical reaction. The catalyst.

1.3. Periodic law and periodic system of chemical elements D.I. Mendeleev.

Periodic Law (modern formulation). Structure of the short and long versions of the periodic system; periods, groups, subgroups (main, side). Ordinal (atomic) number of elements, placing of metallic and non-metallic elements in the periodic system, periods and groups; alkaline, alkaline earth, inert elements, halogens.

1.4. The structure of the atom.

The composition of atom (nucleus, electron shell). The concept of nucleon, nuclide, isotope, proton number and nucleon number, level and sublevel orbital energy, paired and unpaired electrons, atomic radius (simple ion); ground and excited states of the atom. The essence of the radioactivity phenomenon. Forms of s- and p- orbitals, placement of p-orbitals in space. The sequence of filling electron energy levels in and sublevels for elements № 1-20 atoms, electronic and graphic formulas of atoms and simple ions for № 1-20 elements.

1.5. Chemical bonding.

The main types of chemical bonds (ionic, covalent, hydrogen, metallic). Characteristics of the covalent bond – multiplicity, energy, polarity. Types of crystal lattices (atomic, molecular, ionic, metallic); the dependence of physical properties of matter on the type of crystal lattices. Electronic configuration of the molecule. Electronegativity of element. Oxydation state of element in compound. The degree of elements oxidation in the material.

1.6. Mixtures of substances. Solution.

Homogeneous mixtures (solutions) and heterogeneous (suspension, emulsion, foam, spray). Mass and volume (for gas) parts of matter in the mixture. Methods for separating mixtures (sedimentation, filtration, centrifugation, evaporation, distillation). The concept of solution, solvent, solute, crystalline, electrolytic dissociation, electrolytes, non-electrolytes, degree of electrolytic dissociation, ionmolecular equation. Mass part of solute in solution. The structure of water molecules; hydrogen bonding in water. The colour indicators (universal, litmus, phenolphthalein, methyl

orange) in acidic, alkaline and neutral medium. Exchange reaction between electrolytes in solution.

2. Inorganic Chemistry.

2.1. The main classes of inorganic compounds.

2.1.1. Oxides.

Identification, name, classification of oxides, chemical properties of oxides, oxide preparation methods.

2.1.2. Bases.

Definitions (general terms and electrolytic dissociation), name, classification, chemical properties, methods of bases obtaining.

2.1.3. Acids.

Definitions (general terms and electrolytic dissociation), name, classification, chemical properties, methods of acids obtaining.

2.1.4. Salts.

Definitions (general terms and electrolytic dissociation), name, classification, chemical properties, methods of salts obtaining.

2.1.5. Amphoteric compounds.

Amphoteric phenomenon (for oxides and hydroxides examples), chemical properties, preparation methods of amphoteric hydroxides.

2.1.6. Genetic relationships between classes of inorganic compounds.

Equations of reactions between inorganic compounds of different classes. Compare chemical properties of oxides, bases, acids, amphoteric hydroxides, salts. Establish relations between the structure and chemical properties of oxides, acids,

bases, amphoteric hydroxides, salts; genetic relationships between simple substances, oxides, bases, acids, amphoteric hydroxides, salts.

2.2. Metallic elements and their compounds. Metals.

2.2.1. General information about metal components and metals.

The position of the metallic elements in the periodic system; features of the electronic structure of metallic elements atoms; features of metallic bonding; general physical and chemical properties of metals, general methods for their obtaining; number of active metals; corrosion phenomenon, ways to protect metals from corrosion; alloys based on iron (iron, steel).

2.2.2. Alkali and alkaline earth elements.

Names of all alkali and alkaline earth elements, their chemical properties. Chemical properties of sodium, potassium, magnesium and calcium; names and formulas of the most important compounds of these elements; the use of compounds of sodium, potassium, magnesium, calcium; chemical formulas and names of the major potash; water hardness.

2.2.3. Aluminium.

Chemical properties, obtaining and application of aluminum; names and formulas major aluminum compounds.

2.2.4. Iron.

Chemical properties and obtaining of iron; names and formula of the most important compounds of iron; use of iron and iron compounds.

2.3. Non-metallic elements and their compounds. Non-metals.

2.3.1.Halogens.

Chemical formulas of fluorine, chlorine, bromine, iodine; chemical formulas, names and physical properties of the most important compounds of halogens (hydrogen chloride, halides); preparation methods in the laboratory and chemical properties of hydrogen chloride and hydrochloric acid; the most important fields of application of chlorine, hydrogen chloride, hydrochloric acid; qualitative reaction for detection of chloride ions. Oxygen-containing chlorine acids: perchloric acid, hypochlorous acid, chloric acid.

2.3.2. Oxygen and Sulfur.

Chemical formulas of oxygen, ozone, sulfur and the most important compounds of oxygen and sulfur; physical and chemical properties of oxygen, ozone, sulphur and of sulfur oxides, sulfuric acid, sulfates, sulfurous acid, sulfites; methods of obtaining of oxygen in the laboratory; the most important fields of application of oxygen, ozone, sulfur, sulfuric acid and sulfates; qualitative reaction for detection of sulfate ions.

2.3.3. Nitrogen and Phosphorus.

Chemical formulas of nitrogen, white and red phosphorus, essential compounds of nitrogen and phosphorus; physical and chemical properties of nitrogen, white and red phosphorus, nitrogen (I) oxide, nitrogen (II) oxide, nitrogen (IV) oxide, nitrogen (V) oxide, nitrogen (III) oxide, phosphorus (V) oxide, ammonia, ammonium salts, nitric acid, nitrates, nitrous acid, nitrites, phosphoric acid and phosphates; preparation methods of ammonia, nitric acid and phosphate acid in the laboratory; the most important fields of nitrogen, ammonia, nitric acid, nitrates, phosphate acid and phosphates application; qualitative reaction for detection of ammonium ions and phosphate ions.

2.3.4. Carbon and Silicon.

A simple carbon substance; adsorption, adsorption properties of activated carbon; chemical formulas of the most important carbon and silicon compounds; physical and chemical properties of carbon, silicon, carbon oxides, carbonates, silicon (IV) oxide, silicate acid, silicates; methods of carbon oxides obtaining in the laboratory; the most important application areas of diamond, graphite, activated carbon, carbon oxides, carbonates, hydrocarbonates, silicon (IV) oxide, silicates; qualitative reactions to detect carbonate and silicate ions.

3. Organic chemistry

3.1. Theoretical basis of organic chemistry.

The major organic compounds; natural and synthetic organic compounds.

The molecular structure of organic compounds. Chemical bonding in molecules of organic compounds: energy, length, spatial directivity, polarity. 6-bond and π-bond. Single, multiple (double, triple), aromatic bonds.

Hybridization of carbon atoms electronic orbitals; sp^3-, sp^2-, sp-hybridization.

Classification of organic compounds in structure carbon skeleton and the presence of characteristic (functional) groups.

The phenomenon of homology; homologues, homologous series, homologous difference. Classes of organic compounds. The general formula of homologous series and classes of organic compounds.

The concept of primary (secondary, tertiary, quaternary) carbon atoms.

Nomenclature of organic compounds.

The phenomenon of isomerism, isomers, structural and spatial (geometric, or cis-trans-) isomers.

Influence of atoms or groups of atoms in molecules of organic compounds.

Classification of chemical reactions in organic chemistry (reactions, substitution, isomerization).

3.2. Hydrocarbons.

3.2.1. Alkanes.

The general formula of alkanes, their nomenclature, isomerism, structure of molecules, physical and chemical properties, preparation methods, application.

3.2.2. Alkenes.

The general formula of alkenes, general formula of dienes (as compounds containing two carbon-carbon double bonds), their nomenclature, isomerism, structure of molecules, chemical properties, preparation methods, application; qualitative reactions to double bond.

3.2.3.Alkynes.

The general formula of alkynes, their nomenclature, isomerism, structure of molecules; chemical properties and preparation methods, application; qualitative reactions to triple bond.

3.2.4. Aromatic hydrocarbons. Benzene.

The general formula of the benzene homologous. The structure, chemical properties, preparation methods of aromatic hydrocarbons; formula of benzene; chemical properties of benzene; the concept of the aromatic bonds, 6π-electron system.

3.2.5. Natural sources of hydrocarbons and their processing.

Oil, natural and associated petroleum gas, coal, their composition; cracking and aromatization of oil and oil products, detonation resistance gasoline octane number; processing of coal; problems of obtaining liquid fuel from coal and alternative sources.

3.3. Organic compounds with oxygen atoms.

3.3.1. Alcohols.

Characteristic (functional) group of alcohols. Classification of alcohols. The general formula of monohydric saturated alcohols. Structure, nomenclature, isomerism, chemical properties, preparation methods and application. Ethers as possible products of dehydration reaction of alcohols, their nomenclature. Ketones as products of oxidation of secondary alcohols, their nomenclature. The concept of the hydrogen bond.

Ethylene glycol and glycerol as representatives polyhydric alcohols; qualitative reaction on polyhydric alcohols.

3.3.2. Phenol.

Phormula of phenol. The structure of phenol molecule, characteristic (functional) group in it; properties, production, application; qualitative reaction to phenol.

3.3.3. Aldehydes.

The general formula of aldehydes. The structure of the aldehydes molecules, characteristic (functional) group, nomenclature, isomerism, properties, production, application; qualitative reactions for aldehyde group.

3.3.4. Carboxylic acids.

Characteristic (functional) group of carboxylic acids. Classification of carboxylic acids. The general formula of saturated monobasic carboxylic acids.

Structure, nomenclature, isomerism of monobasic carboxylic acids, properties, production, application.

3.3.5. Esther. Fats.

The general formula of carboxylic acid esters. Structure, nomenclature, isomerism, properties, production, application. Fats - esters of glycerol and long-chain fatty acids. Classification fats, properties, production, application. Soaps and synthetic detergents.

3.3.6. Carbohydrates.

Classification of carbohydrates; composition, molecular formula of glucose, fructose, sucrose, starch and cellulose; structural formula of glucose in opening form of molecule; properties of glucose, sucrose, starch and cellulose; obtaining of glucose; sucrose and starch production; qualitative reactions for glucose and starch; the use of glucose, starch, cellulose.

3.4. Organic compounds with nitrogen atoms.

3.4.1. Amine.

Characteristic (functional) group of amines. Classification of amines. Nomenclature, isomerism, structure, properties, preparation methods and application.

3.4.2. Aminoacids.

The composition and structure of molecules, nomenclature, properties, production, application of aminoacids. The amphotery concept of aminoacids, bipolar ion; di-, tri-, polypeptides, peptide bond (peptide group of atoms).

3.4.3. Protein.

The structure of proteins, their properties, application, color qualitative reactions on proteins.

3.5. Synthetic macromolecular substances and polymer materials based on them.

The concept of polymer, monomer, elementary link, the degree of polymerization. Classification of macromolecular substances; means synthesis of macromolecular substances; structure and properties of polymers; thermoplastic polymers and plastics based on them; the concept of natural and synthetic rubbers, synthetic fiber; their significance in the public sector and life.

3.6. Generalization of knowledge about organic compounds.

Installing the genetic relationships between different classes of organic compounds, between organic and inorganic compounds.

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