

CHEMISTRY EXAM TOPICS

1. Structure of the atoms

Basic concepts: atom, atomic nucleus, electron shells. Quantum numbers. Rules for filling electron shells and subshells. Schematic representation of the electron configuration of atoms from the first three periods of the Periodic table of chemical elements.

2. Periodic table of the chemical elements

Structure of the Periodic table: groups and periods. Type and general properties of chemical elements as a function of their place in the Periodic table. Periodicity of the properties. Chemical elements, elemental forms, and compounds. Valence and oxidation state of the elements. Mole and Avogadro's number.

3. Chemical bonds and molecular structure

The chemical bond: shared electron pair, electronegativity, σ - and π -type overlap of atomic orbitals, sp -, sp^2 -, and sp^3 -hybrid orbitals, bond order. Types of chemical bonds: non-polar and polar covalent, ionic, metal, donor-acceptor. Lewis structure. The hydrogen bond. Geometry of molecules. Solids.

4. Chemical kinetics and chemical equilibrium

Reactants and products, rate of a chemical reaction, rate constant, activation energy. Dependence of the reaction rate on the nature of the reactants and on temperature. Catalysts, enzymes. Reversible chemical reactions, chemical equilibrium, equilibrium constant. Le Chatelier's principle. Influence of temperature, pressure, and concentration on chemical equilibria.

5. Acids, bases, and salts

Definitions of an acid and a base. Acid-base theories. Strong and weak acids and bases, examples. Neutralization. pH definition and scale. Salts, hydrolysis.

6. Solutions

Solution: definition, solute and solvent, degree of saturation. Concentration, molar concentration, weight and volume parts. Osmotic pressure. Freezing and boiling points of solutions, comparison to pure solvent. Solutions of electrolytes, strong and weak electrolytes, degree of dissociation. Ion-exchange reactions, types.

7. Redox reactions

Redox reactions: oxidants and reductants, redox chemical equations, balancing. Relative redox activity series, strength of oxidants and reductants. Electrolysis, applications.

8. Physical and chemical properties of metals

Metals: structure and physical properties. Alkaline and alkaline earth metals: representatives, characteristic chemical reactions, properties and application of compounds.

9. Physical and chemical properties of nonmetals

Nonmetals: structure and physical properties. Nitrogen, phosphorus, sulphur, and chlorine: oxidation states, characteristic chemical reactions, properties and application of compounds.

10. Carbon and its inorganic compounds

Carbon: electron configuration, valence, oxidation states. Elemental forms and their physical properties. Characteristic chemical reactions of carbon. Inorganic compounds of carbon - properties and application.

11. Structure of organic compounds

Straight and branched acyclic carbon chains, cyclic compounds. Structural formulae of organic compounds: types, examples. Types of chemical bonds in organic compounds, delocalization, relation of the type of chemical bonding to the geometry of organic molecules. Homologues. Isomers: structural, positional, geometric (*cis*- and *trans*-), stereoisomers. Naming of organic compounds: IUPAC rules and common names. Functional groups: types, examples.

12. Alkanes

Alkanes: chemical structure, nomenclature, preparation, and physical properties. Characteristic chemical reactions - combustion; interaction with halogens, radical substitution reactions. Priority of primary, secondary, and tertiary carbon atoms. Applications.

13. Alkenes and alkynes

Alkenes and alkynes: chemical structure, nomenclature, preparation, and physical properties. Characteristic chemical reactions - combustion; addition of hydrogen (partial and full for alkynes), halogens, hydrogen halides, water; moderate and vigorous oxidation. Applications.

14. Aromatic hydrocarbons

Aromatic hydrocarbons: chemical structure, nomenclature, preparation, and physical properties. The aromatic chemical bond in benzene. Characteristic chemical reactions - electrophilic substitution in the aromatic ring; side chain reactions (substitution and oxidation). Applications.

15. Alcohols

Alcohols: chemical structure, nomenclature, preparation, and physical properties. Characteristic chemical reactions - with metals; with hydrogen halides; with inorganic and organic acids; dehydration, oxidation. Identification reactions of alcohols. Applications.

16. Aldehydes, ketones, and carboxylic acids

Chemical structure, nomenclature, preparation, and physical properties. Strength of carboxylic acids. Characteristic chemical reactions - addition of hydrogen, water, hydrogen cyanide; oxidation of aldehydes; reduction; esterification of carboxylic acids. Esters and amides. Identification reactions of aldehydes, ketones, and carboxylic acids. Applications.

17. Amines, amino acids, and proteins

Amines: chemical structure, nomenclature, preparation, and physical properties. Basicity of amines. Characteristic chemical reactions - with halogens, hydrogen halides, carboxylic acids. Amino acids: chemical structure, nomenclature, stereoisomers, acid-base properties. α -amino acids, formation of the peptide bond. Peptides and proteins. Primary, secondary, and tertiary structure of proteins. Coagulation and denaturation. Identification reactions of proteins.

18. Saccharides and carbohydrates

Mono- and disaccharides, polysaccharides, examples. Classification of aldoses and ketoses. Acyclic and cyclic chemical formulae. Characteristic chemical reactions of monosaccharides - oxidation; reduction; acylation. Hydrolysis of di- and polysaccharides. Identification reactions of aldoses, ketoses, and carbohydrates.

19. Nucleic acids

Components of nucleic acids: bases, saccharides, phosphate backbone. Types of nucleic acids in living organisms. Primary and secondary structure of nucleic acids.

20. Fats, soaps, and surfactants

Fats: composition, structure, and physical properties. Characteristic chemical reactions of fatty acids – esterification (saponification) and hydrogenation. Structure and physical properties of soaps and surfactants.

Recommended reading: high school textbooks in Chemistry