

# Chemistry entrance test program

**General Chemistry.** Basics of the nomenclature of inorganic compounds. Amount of substance. Mole. The Law of mass conservation. The Law of composition constancy. Avogadro's Law. Basic ideas about the nomenclature, structure and properties of crystalline hydrates. Composition of solutions. Mass fraction. Stoichiometric calculations. The structure of the atom. Periodic Law. Valence. Chemical bonding. Crystalline lattices. The main classes of inorganic compounds (oxides, hydroxides, acids, salts). The concept of electrolytic dissociation. Hydrolysis of salts. Oxidation-reduction reactions. Principles of determination of oxidation number. Half-equations. Electrolysis. Practical application of the fundamentals of electrochemistry to biochemical processes.

**Inorganic Chemistry.** Hydrogen, oxygen and their compounds. Halogens and their compounds. Sulfur compounds. The compounds of nitrogen and phosphorus. Features of the interaction of inorganic acids with metals. Compounds of carbon and silicon. General properties of metals. Alkali and alkaline earth metals. The concept of amphotericity. Amphoteric metals. Fundamentals of structure and properties of complex salts.

**Organic Chemistry.** Fundamentals of the structure of organic compounds and the principles of nomenclature. The concept of isomerism. Properties of saturated hydrocarbons (alicyclic and cyclic). Properties of unsaturated hydrocarbons: alkenes, alkadienes, alkynes. Polymerization reactions. Rubbers. Properties of aromatic hydrocarbons. Properties of alcohols and phenols. Properties of aldehydes and ketones. Properties of carboxylic acids and esters. The properties of amines, amino acids and nitrogencontaining heterocyclic compounds. Fundamentals of the structure and properties of fats, carbohydrates and proteins.

**Fundamentals of Thermochemistry.** Types of thermodynamic systems. Homogeneous and heterogeneous systems. Thermodynamic properties. Equilibrium and stationary states. Parameters of state. Types of thermodynamic properties. Internal energy. 1<sup>st</sup> Law of Thermodynamics. Forms of energy transmission (heat and work). Thermodynamic functions and state functions. Properties of enthalpy. Heat effect of a reaction. Standard heat effect of a reaction. Hess's Law applications. Enthalpy change of reaction from enthalpy change of formation and combustion. Enthalpy cycles. Bond energies and enthalpy changes.

**Chemical Equilibrium.** Definition of chemical equilibrium. Equilibrium and stationary states: principal differences. Four particular features of chemical equilibrium. Law of mass action: statement and essence. Definition of thermodynamic equilibrium constant. Thermodynamic equilibrium constant as criteria of reversibility of chemical and biochemical processes. Principle of displacement of equilibrium (Le

Chatelier's Principle): statement and essence. Le Chatelier's Principle for the effects of concentration, temperature, and pressure. Theories of acids and bases. The Brønsted-Lowry classification of acids and bases. Definitions of conjugate acid, conjugate base, conjugate acid-base pair. Reactions of ampholytes. Acidity and basicity constants. The significance of  $pK_a$  and  $pK_b$ . Relation between acidity and basicity constants. The pH of a solution.

**Fundamentals of Chemical Kinetics.** Chemical reaction. Chemical process. Elementary events. Elementary reaction. Molecularity: uni-, bi-, and trimolecular reactions. Complex (multistage) chemical reaction. Mechanism of a reaction. Homogeneous and heterogeneous chemical reactions. Rate of a homogeneous and heterogeneous chemical reaction. Mathematical expression. Factors affecting reaction rate. Kinetic equation. Fundamental Law of chemical kinetics (Rate Law). Kinetic derivation of the equation for the equilibrium constant. Rate-determining step (RDS). Rate constant (physical meaning). Factors affecting rate constant. Overall order of a reaction. Half-life. Kinetic equations and their solutions for zero, first and second order chemical reactions. Methods for determination of chemical reaction order. Van't Hoff equation. Temperature coefficient of the reaction rate. Arrhenius equation. Arrhenius parameters: activation energy and Arrhenius coefficient. Definition of activation energy in collision theory. Energy diagrams for exothermic and endothermic reaction. Examination of energy diagrams. Using Rate Law, Van't Hoff equation and kinetic equations for tasks solution.