



Master's program

Entrance examination topics

Chemistry

1. The periodic table of the elements. Properties of nuclei, isotopes, electronic structure, quantum numbers, the Bohr-Sommerfeld model.
2. Properties of atoms, electronegativity, atomic radius, ionization energy, formation of bonds, bonding models, valence, molecular orbital theory, hybridization, VSEPR theory, features of chemical bonds, primary and secondary bonds.
3. Compounds, stoichiometry, classification of compounds, important compounds of the abundant elements, case studies.
4. States of matter, gases, kinetic gas theory, gas laws, fluids, surface tension, cohesive forces. Solid state, crystal structures, changes in states, phase diagrams.
5. Chemical equilibria, acid-base reactions and theories: Arrhenius-Ostwald, Bønsted-Lowry, Lewis, HSAB.
6. Solutions and mixtures. Mixtures of gases, fluids, mixing, phase equilibria in mixtures: fluid-gas, solid-fluid. Colligative properties of dilute solutions.
7. Thermodynamics: main laws, heat, entropy, enthalpy (reaction enthalpy), Gibbs free energy (equilibrium processes), electrochemistry (reactions on a boundary surface).
8. Classification and nomenclature of organic compounds.
9. Aliphatic hydrocarbons: alkanes and derivatives, stereoisomers, the Cahn-Ingold-Prelog convention. Newman- and Fischer-projection, aromatic hydrocarbons, aromaticity.
10. Classification of organic reactions, acidity and basicity of organic compounds, nucleophilicity and electrophilicity, energy profile of reactions, kinetic and thermodynamic control. Factors determining reactivity: inductive, steric and mesomeric effects.
11. Mechanisms of reactions: kinetic overview, first and second-order reactions, parallel reactions, nucleophilic and electrophilic substitutions, radicals. Additions and eliminations.
12. Oxo compounds: aldehydes and ketones, tautomerism, carboxylic acids and their derivatives, carbohydrates and heterocyclic compounds.
13. Amino acids and proteins, protein folding, primary, secondary and tertiary structure, cooperativity.



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14. Nucleosides, nucleotides and nucleic acids, their structure and biological function.
15. Enzymes: fundamentals of enzyme catalysis, basic mechanisms, examples.
16. Bioenergetics: role and production of ATP, completion of energetically unfavorable reactions in the cells.
17. Lipids, biological membranes and transport mechanisms.

Recommended literature:

James E. House: *Inorganic chemistry*. Elsevier, 2008.

Leroy G. Wade, Jan W. Simek: *Organic Chemistry*. Pearson, 2016.

Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Jr., Lubert Stryer: *Biochemistry*. MacMillan, 2015.