**PROGRAMMES FOR**

ADMISSION TESTS HELD AT UNIVERSITY

**Programme for Chemistry**

***The admission test is conducted in the form of a written test and is evaluated on a 100-point scale.***

The present programme is based on the programme of admission exams in Chemistry recommended by the Ministry of Education of the Russian Federation for applicants to universities and consists of three sections.

The first section is devoted to the theoretical foundations of Chemistry. It includes the basic concepts and laws of Chemistry, which are the fundamental foundations necessary for understanding the laws of chemical processes.

The second section is devoted to the study of inorganic chemistry: a general characteristic of the elements of the main subgroups of the periodic system of chemical elements by D.I.Mendeleev, including the features of the electronic structure, the forms of simple substances and the main types of compounds formed by them, the laws of changes in their physical and chemical properties. The section also provides a characteristic of specific elements and the compounds formed by them, as well as methods for their preparation.

The third section contains the basics of organic chemistry: classes of organic compounds and their most important representatives; properties and methods of production, as well as the genetic relationship between the main classes.

The programme includes issues reflecting the chemical production of organic and inorganic substances.

**Programme Contents**

Theoretical Foundations of Chemistry.

The structure of the atom. The structure of the substance.

Atom. The composition of atomic nuclei. Isotopes. Chemical element. Molecule. Simple substance, a Compound substance, Mixture of substances. The concept of allotropy and allotropic modifications. The constancy of the composition of the substance. The law of conservation of mass, its significance in chemistry. Relative atomic and relative molecular weight. Mol. Molar mass. Avogadro number. Physical and chemical phenomena. Valency, oxidation state.

The doctrine of periodicity. The periodic law and the periodic system of elements by D.I. Mendeleev.

The periodic law of chemical elements by D. I. Mendeleev. The distribution of electrons in the atoms of the elements of the first four periods. s-, p-, d-elements. The structure of the periodic system: small and large periods, groups and subgroups. Characterization of individual chemical elements of the main subgroups based on the position in the periodic system and the structure of the atom. The value of the periodic law for understanding the scientific worldview, the development of science and technology.

Chemical bond.

Types of chemical bonds. Covalent (polar and nonpolar) bond and methods of its formation. The length and energy of the bond. The concept of electronegativity of chemical elements. Oxidation state. Ion bond and its formation. Ion charge. Metal bond. Types of crystal lattices. Orbital hybridization model.

Chemical reactions.

Types of chemical reactions: reaction compounds, decomposition, substitution, ion exchange. The thermal effect of chemical reactions. Conservation and conversion of energy in chemical reactions. The rate of chemical reactions. Dependence of speed on the nature of the reacting substances, concentration, temperature. Catalysis and catalysts. Reversibility of chemical reactions. Chemical equilibrium and conditions for its displacement. Redox reactions. The most important oxidizing agents and reducing agents.

Solutions. Electrolytic dissociation.

Solutions. Solubility of substances. The dependence of the solubility of substances on their nature, on temperature, pressure. Thermal effect upon dissolution. The concentration of solutions. The value of solutions in industry, agriculture, everyday life. Methods for expressing solution concentrations. Electrolytic dissociation. The degree of dissociation. Strong and weak electrolytes. Ion exchange reactions. Electrolytic dissociation of inorganic and organic acids, alkalis and salts. Electrolysis of aqueous solutions and molten salts.

Inorganic chemistry.

Oxides, acids, bases, salts. Classification, nomenclature, methods of preparation and properties. The concept of amphotericity. A genetic link between the main classes of inorganic compounds.

Hydrogen.

Physical and chemical properties. Interaction with oxygen, metals, metal oxides and organic compounds.

Halogens.

General characteristics of halogens. Chlorine. Physical, chemical properties. Reactions with inorganic and organic substances. Production of chlorine in industry. Chlorine compounds: hydrogen chloride, chlorides, oxygen-containing compounds. The use of chlorine and its compounds.

Oxygen subgroup.

General characteristics of the elements of the main subgroup of group VI. Oxygen. Chemical, physical properties. Getting oxygen. Allotropy. The use of oxygen. Sulfur, its physical and chemical properties. Sulfur compounds: hydrogen sulfide, sulfides, sulfur oxides, production and properties. Sulfuric acid, its properties, chemical basis of production. Sulfuric acid salts.

Water. Physical, chemical properties. Crystal hydrates. The value of water in industry, agriculture, everyday life, nature. Protection of water bodies from pollution.

Subgroup of nitrogen.

General characteristics of the elements of the main subgroup of group V. Nitrogen. Nitrogen compounds. Physical and chemical properties. Nitrogen compounds: ammonia, ammonium salts, nitrogen oxides, nitric acid, nitric acid salts, physical and chemical properties. Ammonia production. The use of ammonia, nitric acid and its salts. Nitrogen fertilizers.

Phosphorus, its allotropic forms, physical and chemical properties. Phosphorus oxide (V), phosphoric acid and its salts.

Carbon subgroup.

Phosphoric fertilizers.

General characteristics of the elements of the main subgroup of group IV. Physical and chemical properties. Carbon, its allotropic forms. Carbon compounds: oxides, carbonic acid and its salts.

Silicium. Physical and chemical properties. Chemical properties of silicon compounds; finding in nature and use in technology.

Metals.

Position in the periodic system. Structural features of metal atoms. Metal bond. Characteristic physical and chemical properties. Corrosion of metals.

Alkali metals. General characteristics based on the situation in the periodic system by D.I. Mendeleev. Compounds of sodium, potassium in nature, their use. Potassium fertilizers.

General characteristics of the elements of the main subgroups of groups II and III of the periodic system by D. I. Mendeleev. Calcium, its chemical properties. Properties of calcium compounds and their presence in nature. Water hardness and methods for its elimination.

Aluminum. Characterization of aluminum and its compounds. Amphotericity of aluminum oxide and hydroxide. The use of aluminum and its alloys.

Iron. Characterization of iron, oxides, hydroxides, iron salts (II, III). Natural compounds of iron. Iron alloys – cast iron and steel. The use of alloys and iron compounds.

Metallurgy. Metals in modern technology. Blast furnace production of cast iron. Methods of steel production. Chemical reactions underlying the production of cast iron and steel. Problems of low-waste production in metallurgy and environmental protection. The development of Russia’s metallurgy and its importance for the development of other industries.

Organic chemistry.

The structure of organic compounds.

The main provisions of the theory of the chemical structure by A. M. Butlerov. The dependence of the properties of substances on the chemical structure. Isomerism. The electronic nature of chemical bonds in molecules, organic compounds, methods of breaking bonds, the concept of free radicals.

Saturated hydrocarbons

Homological series of saturated hydrocarbons, their electronic and spatial structure (sp3 hybridization). Methane. Nomenclature, physical and chemical properties of saturated hydrocarbons. Isomerism. Cycloparaffins. Saturated hydrocarbons in nature.

Unsaturated hydrocarbons

Homological series of ethylene hydrocarbons. Double bond, y- and p-bonds, sp2-hybridization. Physical properties Isomerism of the carbon skeleton and the position of the double bond. Nomenclature of ethylene hydrocarbons. Chemical properties. Hydrocarbon production by dehydrogenation reaction. The use of ethylene hydrocarbons. Natural rubber, its structure and properties.

Acetylene. Triple bond, sp-hybridization. Homological series of acetylene. Nomenclature. Isomerism. Physical and chemical properties, the use of acetylene. Getting Acetylene by means of carbide method and from methane.

Aromatic hydrocarbons.

Benzene, its electronic structure, chemical properties. Industrial production and use of benzene. Homologists of benzene. The concept of pesticides, the conditions for their use in agriculture based on environmental protection requirements.

The relationship of saturated, unsaturated and aromatic hydrocarbons.

Natural sources of hydrocarbons.

Oil, natural gas and associated petroleum gases, coal. Fractional distillation of oil. Cracking. Aromatization of petroleum products. Environmental protection during oil refining.

Alcohols. Phenols.

Alcohols, their structure, chemical properties. Isomerism. The nomenclature of alcohols. Chemical properties of alcohols. The toxicity of alcohols, their destructive effect on the human body. Polyhydric alcohols. Genetic link between hydrocarbons and alcohols.

Phenol, its structure. Physical and chemical properties of phenol, comparison with the properties of aliphatic alcohols. The use of phenol. Environmental protection from industrial waste containing phenol.

Aldehydes.

Aldehydes, their structure, chemical properties. Nomenclature. Features of the carbonyl group. Preparation and use of formic and acetic aldehydes.

Carboxylic acids.

Homological series of limiting monobasic acids, their structure. Carboxyl group, mutual influence of carboxyl group and carbon radical. Nomenclature. Physical and chemical properties of carboxylic acids. Acetic, palmitic, stearic, oleic acids. Production and use of carboxylic acids.

Alcohol esters. Fats

Alcohol esters. Structure, obtaining by the esterification reaction. Chemical properties. Fats in nature, their structure and properties. Synthetic detergents, their meaning. Protecting the environment from pollution with synthetic detergents.

Carbohydrates.

Glucose, its structure, chemical properties, role in nature. Sucrose, its hydrolysis. Starch and cellulose, their structure, chemical properties, role in nature. The use of cellulose and its derivatives. The concept of artificial fibers.

Amines. Amino acids

Amines as organic bases. The structure of amines. Interaction with water and acids. Aniline. Obtaining aniline from nitrobenzene. The practical significance of aniline.

Amino acids. Structure, chemical features, isomerism of amino acids. b-amino acids, their importance in nature. The synthesis of peptides, their structure. The concept of nitrogen-containing heterocyclic compounds on the example of pyridine and pyrrole.

Proteins. Nucleic acids.

The composition, structure and properties of proteins. Success in the study and synthesis of proteins. The value of the microbiological industry. Nucleic acids, nucleotide structure. The principle of complementarity in the construction of the double helix of DNA. The role of nucleic acids in the life of the cell.

High molecular weight compounds.

General concepts of the chemistry of macromolecular compounds: monomer, polymer, structural unit, degree of polymerization, average molecular weight. Polymerization, polycondensation. Linear and branched structure of polymers. Dependence of the properties of polymers on their structure.

**Recommended Reading:**

*Gabrielyan О. S. Chemistry*, 9th grade. – М., 2002.

*Gabrielyan О. S. Chemistry*, 8th grade. – М., 2002.

*Gabrielyan O.S., Lysova G.G. Chemistry*, 11th grade. – М., 2003.

*Gabrielyan O.S., Maskaev F. N., Ponomarev S. Yu., Trenin V. I. Chemistry*, 10th grade – М., 2002.

*Goldfarb Ya. L. Chemistry problem book* 8-11 grades. – М.: Drofa Publishing house, 2000

*Guzei L. S., Surovtseva R. P., Lysova G.G. Chemistry*, 11th grade. – М., 1999.

*Lidin R.A., Molochko V.A., Andreeva L.A. Chemistry for high school students and school graduates*. – М., Drofa Publishing house. – 2000

*Slesarev V.I. et al. Chemistry problem book for high school graduates and university students*. – St.Petersburg, Chimizdat*, 2003*

*Suvorov А.V*. Collection of questions and problems in chemistry 8-11 grades. St.Petersburg.- Specialised literature Специальная литература. -2000

*Tsvetkov L. А. Organic chemistry*, 10-11 grades. – М., 2003.

*Shelinsky G. I. Chemistry*, 8th grade. – St.Petersburg, 2001.

*Shelinsky G.I. Chemistry,* 9th grade. – St.Petersburg, 2001.

*Shelinsky G.I., Shelinskaya V.V. Chemistry*, 10 grade. – St.Petersburg, 1999.