



THE MINISTRY OF SCIENCE AND HIGHER EDUCATION
OF THE RUSSIAN FEDERATION

Federal State Budgetary Educational Institution of Higher Education
«Penza State University»
(PENZA STATE UNIVERSITY)

Approved by
Chairperson of the Admission Committee,
Rector of PSU A.D. Gulyakov
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Programme
of the entrance examination in the discipline

CHEMISTRY

Compiled by
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The program of the general educational entrance test is formed on the basis of the federal state educational standard of secondary general education and the federal state educational standard of the basic general education. The program of general entrance tests is formed taking into account the need to match the level of complexity of such entrance tests to the level of complexity of the USE in the relevant general educational subjects.

1. Form of the entrance exam

The entrance examination in chemistry takes place in the form of testing. 2.5 hours are required for the examination.

2. Program's contents

The subject of chemistry. Chemical elements. Atoms and molecules. Atomic and molecular masses. Elementary composition of substances. Simple and complex substances. Allotropy. Valence of elements. Graphical formulas of substances. Mole. Molar mass. Avogadro's law. Molar volume. Mendeleev-Clapeyron equation. The law of conservation of mass. Chemical equations. Derivation of chemical formulas. Calculations by chemical formulas and equations. The most important classes of inorganic substances. Nomenclature, classification and graphical formulas of oxides, bases, acids, salts. The concept of amphoteric hydroxides. Periodic law and Mendeleev's periodic system of chemical elements. The structure of the atom: the physical meaning of the atomic number of the element, the mass numbers of atoms, isotopes. The structure of the electron shell of an atom, quantum numbers. Pauli exclusion principle. Filling the orbitals with electrons. Electronic configurations of atoms the I-IV periods. Dependence of the properties of elements on the structure of their atoms. The value of the periodic law and the periodic system elements. Chemical bond and the structure of substances. Covalent bond. Hybridization of electronic orbitals. Directivity of covalent bond. Spatial structure of molecules. Donor-acceptor mechanism of chemical bond formation. Ionic, metallic, hydrogen bond. Intermolecular interactions. Types of crystal lattices. Oxidation number of elements. Oxidation-reduction reactions. The most important oxidizing agents and reducing agents. Thermal effects of chemical reactions. Hess's Law. Consequences from the Hess's Law. The rate of chemical reactions. Dependence of the rate of chemical reactions on environmental factors. Catalysis. Chemical equilibrium. Reversible and irreversible chemical reactions. General classification of chemical reactions. The concept of solutions. Quantitative characteristic of the composition of matter. Electrolytic dissociation. Dissociation of acids, bases, salts of amphoteric hydroxides in aqueous solutions. Dissociation of water. pH. Exchange reactions in aqueous solutions of electrolytes. Ionic reaction equations. Hydrolysis of salts.

Electrode potential. Galvanic cell. Chemical sources of current. Electrolysis. Metals. General characteristics of metals: physical and chemical properties. Position of metals in the periodic system and features of the structure of the atom. General methods of metals.

General characteristics of IA and IIA groups of the Periodic Table. Properties of sodium, potassium, calcium, magnesium and their compounds. Water hardness and ways to eliminate it. Properties of aluminum and its compounds. Amphotericity of aluminum oxide and hydroxide. Properties of chromium (+2), (+3) oxides and hydroxides, chromates and dichromates. Properties of manganese oxides and hydroxides, potassium permanganate. Properties of iron, oxides and hydroxides of iron (+2), (+3.).

Properties of copper compounds (+1), (+2). Properties of zinc oxide and hydroxide.

Non-metals. General characteristics of IVA, VA, VIA, VIIA - groups of the periodic system. Hydrogen, its chemical and physical properties, interaction with metals and nonmetals, oxides and organic compounds.

Water. Halogens and their general characteristics. Hydrogen halides. Halides. Oxygen-containing compounds of chlorine.

Nitrogen, its production, chemical and physical properties. Properties of ammonia and ammonium salts, nitrogen oxides (+1), (+2), (+4), nitrous acid and nitrites, nitric acid and nitrates. Production of ammonia and nitric acid. Phosphorus, its physical and chemical properties.

Properties of phosphorus compounds: phosphine and phosphides, phosphorus oxides (+3), (+5). Ortho-, meta-, and diphosphoric acids and their salts.

Carbon, its physical and chemical properties. Properties and methods of obtaining carbon oxides and carbonates. Properties of carbonic acid. Properties of silicon, silicon oxide, magnesium silicide, silicic acid and silicates.

Hydrocarbons. Nomenclature. Isomerism. Saturated hydrocarbons. Alkanes and cycloalkanes.

Unsaturated hydrocarbons. Alkenes. Alkadiens. Alkines Polymerization of butadiene and isoprene. Arenes. Benzene and toluene. Obtaining. Physical and chemical properties.

Alcohols and phenols. Structure and Properties of methanol, ethanol, ethylene glycol and glycerol. Ethers. Aldehydes and ketones.

Carboxylic acids. Saturated and unsaturated. Esters.

Nitrogen-containing organic compounds. Amines. Aniline. Heterocyclic compounds. Amino acids. Fats. Carbohydrates. Proteins. The structure of nucleotides.

3. Criteria for evaluating

When applying for undergraduate and undergraduate programs the results of each entrance test are carried out on a 100-point scale. When applying for undergraduate and undergraduate programs. The results of each entrance test are carried out on a 100-point scale. The minimum number of points scored during the exam cannot be less than 36.

4. Educational and methodological support

1. Kuz'menko N.E., Yeremin V.V., Popkov V.A., *Nachalakhimii* [Beginning chemistry]. Moscow: Laboratoriya znaniy Publ., 2016. 707p. Available at: [http://e.lanbook.com/book/84084./](http://e.lanbook.com/book/84084/)
2. Kuz'menko N.Ye., Yeremin V.V., Popkov V.A., *Khimiya Dlyashkol'nikov starshikh klassov ipostupayushchikh v VUZy*. [Chemistry. For high school students and entering universities]. Moscow: MGU im. Lomonosova Publ., 2015. 472p. Available at: [http://e.lanbook.com/book/99332./](http://e.lanbook.com/book/99332/)
3. Yegorov A. S. *Khimiya. Spravochnik dlyapodgotovki k YEGE* [Chemistry. Guide to prepare for the exam] Rostov-on-Don: Feniks Publ., 2016. 174p. Available at: [http://e.lanbook.com/book/102304./](http://e.lanbook.com/book/102304/)
4. Blinov L. N., Perfilova I. L., Sokolova T. V., Yumasheva L. V. *Khimiya* [Chemistry.] Edited by Perfilova I. L., Sokolova T. V. St. Petersburg: Lan' Publ., 2016. 272p. Available at: [http://e.lanbook.com/book/73179./](http://e.lanbook.com/book/73179/)
5. Borzova L.D., Chernikova N.YU., Yakushev V.V. *Osnovy obshchey khimii* [The foundations of general chemistry] St. Petersburg: Lan' Publ., 2014. 480p. Available at: [http://e.lanbook.com/book/51933./](http://e.lanbook.com/book/51933/)
6. Lewis R., Evans W. Chemistry. 4th-Edition, IL: PALGRAVE MACMILLAN New York, 2006. — 470p. <https://he.palgrave.com/companion/Lewis-And-Evans-Chemistry-4th-Edition/>
7. Derry L., Connor M., Jordan C. Chemistry: For use with IB Diploma Programme Standard Level. — Melbourne: Pearson Edition Australa, 2008. — 540p. https://www.pearsonplaces.com.au/places/secondary_places/science_place/science_companion_websites/chemistry_standard_level.aspx
8. Karen C. Timberlake. Chemistry: an introduction to general, organic, and biological chemistry. 11th ed. IL: Pearson Education, Inc. U.S., 2012. — 1075 p.
9. Burdge, Julia R. Chemistry. 2nd ed. IL: The McGraw-Hill Companies, Inc., New York, 2009. — 1121p.

The developer of the program:
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