Federal State Budgetary Educational Institution of Higher Education
'Academician I. P. Pavlov First Saint Petersburg State Medical University' of the Ministry of Health of the Russian Federation
(FSBEI HE I. P. Pavlov FSPbSMU of the Ministry of Health of Russia)

APPROVED
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The program and assessment criteria for the entrance examination in chemistry in English for applicants to the FSBEI HE I. P. Pavlov FSPbSMU of the Ministry of Health of Russia in 2026

Basic concepts of chemistry

Atoms and molecules. Chemical element, simple substance, complex substance, mixture of substances. The concept of allotropic modifications. Relative atomic mass, relative molecular mass. Avogadro's law and its consequences. Mendeleev–Clapeyron equation. Valency and oxidation state.

The structure of the atom. Chemical bond. Structure of matter

The structure of the nuclei and electron shells of atoms of chemical elements, s-, p-, d-elements. Periodic law and structure of the periodic system. Isotopes. Types of chemical bonds: covalent (polar and non-polar), ionic, hydrogen, metallic. Structure of complex compounds. Aggregate state of substances, amorphous and crystalline substances. Types of crystal lattices.

Water and aqueous solutions

Water: molecular structure, physical and chemical properties. Solubility of substances, dependence of the solubility of substances on their nature, temperature and pressure. Types of solutions (gaseous, liquid, solid). Expression of solution composition (mass fraction, volume fraction, molar concentration). Concept of colloidal solutions. The importance of solutions in medicine and biology. Electrolytic dissociation. Degree of dissociation. Strong and weak electrolytes. Ionic reaction equations.

Basic principles of chemical reactions

Classification of reactions: connection, decomposition, substitution, exchange. The rate of chemical reactions and its dependence on various factors. Rate constant of a chemical reaction. Catalysis. Thermal effects of chemical reactions. Reversibility of reactions. Chemical equilibrium and conditions for its displacement. Redox reactions.

Classes of inorganic compounds

Oxides, acids, hydroxides, salts (classification, nomenclature, methods of preparation and properties). Amphoteric. Hydrolysis of salts: types of hydrolysis.

Metals

General characteristics of metals: physical and chemical properties. General methods of obtaining metals. Electrochemical voltage series of metals. General characteristics of the IA and IIA groups of the periodic table. Properties of sodium, potassium, calcium and magnesium and their compounds. Water hardness and ways to eliminate it.

Properties of aluminium and its compounds.

Properties of chromium(II) and (III) oxides and hydroxides, chromates and dichromates. Properties of potassium permanganate; reduction of permanganate ion in acidic, neutral and alkaline media.

Properties of iron, oxides and hydroxides of iron(II) and (III). Properties of copper(I) and (II) compounds.

Properties of zinc oxide and hydroxide.

Non-metals

General characteristics of the IVA-, VA-, VIA-, VIIA-groups of the Periodic Table. Hydrogen, its chemical and physical properties.

Chlorine. Properties and methods of producing hydrogen chloride and chlorides, hypochlorites, chlorates.
Oxygen, its production, comparison of the physical and chemical properties of oxygen and ozone, redox reactions involving hydrogen peroxide.
Sulphur, its physical and chemical properties. Properties and methods of producing sulphur compounds: hydrogen sulphide and sulphides, oxides, sulphurous acid and sulphites, sulfuric acid and sulphates.
Nitrogen, its physical and chemical properties, production. Properties of ammonia and ammonium salts, nitrogen oxides (I), (II), (III), (IV) and (V), nitric acid and nitrates, nitrous acid and nitrites. Production of ammonia and nitric acid.
Phosphorus, its physical and chemical properties. Properties of phosphorus compounds: phosphine and phosphides, phosphorus(III) and (V) oxides, orthophosphoric acid and orthophosphates.
Carbon, its physical and chemical properties. Properties and methods of producing carbon oxides and carbonates. Properties of carbonic acid.
Properties of silicon, silicon oxide, silicic acid and silicates.

Theoretical principles of organic chemistry

Theory of the chemical structure of organic compounds by A. M. Butlerov. Isomerism. Homologous series. Electronic nature of chemical bonds in molecules of organic compounds. Ways to break bonds, the concept of free radicals. Electronic and spatial structure of molecules using the example of methane, ethylene and benzene. The concept of hybridisation of atomic orbitals. The concept of the mutual influence of atoms using the example of several compounds (toluene, phenol, chloroacetic acid, etc.) General concepts of the chemistry of high molecular weight compounds (monomer, polymer, elementary unit, degree of polymerisation). Polymerisation and polycondensation reactions. Principles of nomenclature of organic compounds.

Main classes of organic compounds

Hydrocarbons: alkanes, alkenes, alkynes, diene hydrocarbons, aromatic hydrocarbons (physical and chemical properties, methods of production). An idea of the structure of cycloalkanes. Oxygen-containing compounds: monohydric and polyhydric alcohols, phenol, aldehydes, carboxylic acids, esters (physical and chemical properties, methods of preparation). Nitrogen-containing compounds, aliphatic and aromatic amines, amino acids (physical and chemical properties, methods of preparation). The most important natural organic compounds (proteins, fats, carbohydrates, nucleic acids).

Typical calculation tasks

1. Calculation of the mass or volume fraction of a component.
2. Calculation of molar concentration.
3. Calculation of the relative densities of substances in the gaseous state.
4. Calculation of the volume of a gaseous substance of a known mass or a known quantity under normal conditions and conditions different from normal.
5. Establishment of the molecular formula of a substance by mass fractions of elements or by masses of combustion products.
6. Calculation of the mass (volume, amount of substance) of one of the reaction participants from the known mass (volume, amount of substance) of the other reaction participant.
7. Tasks involving excess and deficiency of reagents.
8. Tasks taking into account the yield of the reaction product as a percentage of the theoretically possible.

Typical qualitative tasks

1. Writing reaction equations illustrating a scheme in which all or only individual stages are specified.
2. Multi-stage synthesis of organic or inorganic substances.
3. Identification of the possibility of a reaction occurring between substances in the proposed set of substances.
4. Drawing up equations of redox reactions using the electron balance method.
5. Drawing up formulas of homologues and isomers of organic substances.

CONTENT AND STRUCTURE OF THE EXAMINATION CARD IN CHEMISTRY

EVALUATION CRITERIA

The content and structure of exam papers in chemistry are developed in accordance with the recommendations of the Unified State Exam (www.fipi.ru) approved by the Ministry of Science and Higher Education.

The examination ticket consists of tasks based on materials from several thematic blocks.

Task number	Task content	Scoring criteria	Maximum score for completing the task	Task completion time (min)
Part 1. Basic level (computer test)				
1	The structure of nuclei and electron shells of atoms of chemical elements.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
2	Periodic law and structure of the Periodic system.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
3	Types of chemical bonds: covalent (polar and non-polar), ionic, hydrogen, metallic.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
4, 5	Classes of inorganic compounds: oxides, acids, hydroxides, salts (classification, nomenclature).	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
6, 7	The rate of chemical reactions and its dependence on various factors. Rate constant of a chemical reaction. Catalysis. Thermal effects of chemical reactions. Reversibility of reactions. Chemical equilibrium and conditions for its shift.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
8	Hydrolysis of salts, types of hydrolysis.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
9	Electrolysis of inorganic salts.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
10	Redox reactions. Main oxidising and reducing agents.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
11–14	Theory of the chemical structure of organic compounds by A. M. Butlerov. Isomerism. Homologous series.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
15	Electronic and spatial structure of molecules. The concept of	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3

	hybridisation of atomic orbitals. The concept of the mutual influence of atoms in molecules.			
16	Hydrocarbons: alkanes, cycloalkanes, alkenes, alkynes, dienes, aromatic hydrocarbons (physical and chemical properties, methods of production).	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
17	Oxygen-containing compounds: monohydric and polyhydric alcohols, phenol, aldehydes, ketones, carboxylic acids, ethers and esters (physical and chemical properties, methods of preparation).	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
18	Qualitative reactions to various classes of organic compounds.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
19, 20	Acid-base properties of organic compounds.	1 point is awarded for the correct answer; 0 points are given for an incorrect answer or no answer.	1	2–3
Part 2. Advanced level (computer test)				
21	Reactions confirming the relationship between different classes of inorganic substances (chain of chemical transformations).	For each correctly established match, 2 points are awarded (up to 6 points); 0 points are given for an incorrect answer or no answer.	6	4–5
22	Reactions confirming the relationship between different classes of organic substances (chain of chemical transformations).	For each correctly established match, 2 points are awarded (up to 6 points); 0 points are given for an incorrect answer or no answer.	6	4–5
23	Inorganic chemistry calculation task.	A correct answer is awarded 9 points; 0 points are given for an incorrect answer or no answer.	9	15
24	Organic chemistry calculation task.	A correct answer is awarded 9 points; 0 points are given for an incorrect answer or no answer.	9	15
Part 3. Theoretical questions (situational tasks)				
25	Question on inorganic or organic chemistry to establish compliance.	For each correct answer, 2 points are awarded (up to 6 points); for each correct explanation of the selected answer, 3 points are awarded (up to 9 points); if the applicant is unable to give the correct answer or explain his choice, 0 points are given.	15	5 minutes to answer
26	Question on the Periodic Table of Chemical	For a competent description of each chemical element in terms of electronic structure and	35	10 minutes to answer

	Elements named after D. I. Mendeleev.	physicochemical properties, 5 points are awarded (up to 15 points for three chemical elements); for each correct answer to an additional question from the examiner, 5 points are awarded (up to 20 points for four questions); if the applicant is unable to give the correct answer or explain it, 0 points are given.		

SAMPLE EXAMINATION CARD

Test part

1. An atom of which element in its ground state has one unpaired valence electron in its outer level?
a) Ca b) Be c) Mg d) Li
2. Which element exhibits the greatest non-metallic properties?
a) N b) P c) As d) Sb
3. A covalent non-polar bond is present in the following compound
a) MgO b) Br_2 c) NH_3 d) H_2O
4. The basic oxides are
a) Li_2O and MgO b) SO_2 and Na_2O c) Al_2O_3 and CO_2 d) BeO and Cl_2O
5. Select hydroxides that exhibit only basic properties
a) $Al(OH)_3$ and $Ba(OH)_2$
b) $Ba(OH)_2$ and KOH
c) $Sn(OH)_2$ and $Sr(OH)_2$
d) NaOH and $Zn(OH)_2$
6. How can you increase the rate of a forward reaction H_2 (g) + I_2 (g) ⇄ 2HI (g)?
a) reduce the pressure
b) increase the temperature
c) increase the concentration of HI
d) reduce the temperature
7. With increasing pressure, the equilibrium in the system C_2H_2 (g) + $2H_2$ (g) ⇄ C_2H_6 (g) shifts
a) left b) right c) does not shift
8. What salt can be detected in a solution using an indicator?
a) $SrCl_2$ b) Na_2SO_4 c) $Cu(NO_3)_2$ d) KCl?
9. During the electrolysis of a solution of which salt, only hydrogen is released at the cathode?
a) RbCl b) $CuCl_2$ c) $FeCl_2$ d) $ZnCl_2$
10. What coefficient should be for the acid in the reaction equation?

$$MnO_2 + HCl \rightarrow MnCl_2 + Cl_2 + H_2O$$

a) 4 b) 2 c) 8 d) 16
11. Select a pair of homologues
a) butane and but-1-ene
b) butan-1-ol and butan-2-ol
c) nonane and decane
d) but-2-ene and but-1-yne
12. Select a pair of isomers
a) hexane and heptane
b) pentene and pentane
c) hept-1-ene and hept-2-ene
d) ethane and ethene
13. In which compound are all carbon atoms in the state of sp3 hybridisation?
a) but-1-ene b) but-1-yne c) hexane d) hex-1-ene
14. Choose the formula of the homologous series of diatomic saturated alcohols
a) $C_nH_{2n}O$ b) $C_nH_{2n+2}O$ c) $C_nH_{2n}O_2$ d) $C_nH_{2n}(OH)_2$
15. Choose a substance whose molecule contains a π bond

a) ethene b) butan-1-ol c) isobutane d) butane

16. Reduction of butanal with hydrogen leads to the formation

a) butan-2-ol b) butan-1-ol c) but-1-ene d) but-2-ene

17. Acetic acid does not react with

a) Na_2SO_4 b) CuO c) $Cu(OH)_2$ d) Na_2CO_3

18. Determine the sign of the reaction between phenol and bromine water

a) the disappearance of the colour of the solution and the formation of a white precipitate

b) the disappearance of the colour of the solution and the formation of a brown precipitate

c) discoloration of the solution without precipitation

d) formation of a solution with an intense blue colour

19. Select a compound that has acidic properties

a) methane b) cyclopropane c) propadiene d) propan-1-ol

20. Select an organic compound that has basic properties

a) butylamine b) nitroethane c) ammonia d) ethanol

21. Indicate intermediate substances in the reaction scheme

$$Al \xrightarrow{I_2} A \xrightarrow{NaOH} B \xrightarrow{HCl} C$$

A	1) HI	2) HIO	3) AlI_3
B	1) Al_2O_3	2) Al	3) $Al(OH)_3$
C	1) Al_2O_3	2) $Al(OH)_3$	3) $AlCl_3$

22. Indicate intermediate substances in the reaction scheme

$$C_2H_5OH \xrightarrow{CuO,\ t^\circ} A \xrightarrow{Cu(OH)_2,\ t^\circ} B \xrightarrow{Ca(OH)_2} C$$

A	1) CH_3CHO	2) CH_3COOH	3) $(CH_3COO)_2Cu$
B	1) C_2H_5COOH	2) CH_3COOH	3) $(CH_3COO)_2Cu$
C	1) $(C_2H_5COO)_2Ca$	2) $(C_2H_5O)_2Ca$	3) $(CH_3COO)_2Ca$

23. When calcium carbonate was heated, part of the substance decomposed and 3.36 litres of gas were released. The mass of the solid residue was 18.4 g. This residue was added to 200 g of hydrochloric acid, taken in excess. Determine the mass fraction of salt in the solution.

a) 13 % b) 26 % c) 49 %

d) 57 % e) 62 % f) 73 %

24. The combustion of 2 g of saturated monohydric alcohol produced 4.4 g of carbon dioxide and 2.4 g of water. The vapour density of the substance for hydrogen is 30. Determine the molecular formula of the substance.

a) $C_6H_{13}OH$ b) $C_5H_{11}OH$ c) CH_3OH

d) C_2H_5OH e) C_3H_7OH f) C_4H_9OH

Oral part

25. Match the reactants with the products. Explain your answer based on the properties of inorganic compounds.

A) $MgO + SO_2 \rightarrow$	1) $MgSO_3$	4) $MgSO_4$
B) $MgO + SO_3 \rightarrow$	2) $MgSO_3 + H_2$	5) $MgSO_4 + H_2$
C) $MgO + H_2SO_3 \rightarrow$	3) $MgSO_3 + H_2O$	6) $MgSO_4 + H_2O$

26. Describe elements Nos. 13, 14 and 15 based on their atomic structure.

Example of additional questions from the examiner:

a) how do metallic and non-metallic properties change when moving through a period from left to right?

b) how do the properties of the oxides of these elements change?

c) compare the acid-base properties of the hydroxides of these elements;

d) in what parts of the salts of these elements (cation or anion) can these elements be found?

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APPROVED:

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