PROGRAM
entrance test in chemistry

St. Petersburg
2022
1. Scope of application and regulatory references

The admissions test program was developed for those entering the SPSPMU of the Ministry of Health of Russia for training in higher education programs: bachelor's programs and specialist programs based on the requirements of the Federal State Educational Standard of Secondary (Complete) General Education (Order of the Ministry of Education and Science of Russia dated May 17, 2012 No. 413).

2. The program of the entrance test in chemistry

I. General chemistry

1. Atom. The structure of the atom.

The concept of an atom, molecules, ions, valence, energy levels, oxidation state, electron slip, possible valences, possible oxidation states. The concept of unpaired electrons, electron pair.

2. Periodic table of chemical elements D.I. Mendeleev.


3. The main classes of inorganic compounds:

- Oxides, acids, hydroxides, salts.


**Hydrolysis.** Hydrolysis concept. Acidity of the medium, pH (pH). Acidic, neutral, alkaline environment. pH value. Indicators as indicators of the acidity of the environment. Hydrolysis by cation, anions, by both ions.

**Electrolysis.** Electrolysis concept. Anode and cathode charges during electrolysis. Peculiarities of electrolysis of salts with oxygen-containing acid residue, anoxic acid residue. Features of electrolysis of salts of active metals, metals of medium activity and inactive metals.

4. Chemical bond
**Covalent bond.** Electronegativity. Polar, non-polar communication. The mechanism of covalent bond formation.


The concept of a radical. Mechanisms for breaking a covalent bond. Homolytic (radical) and heterolytic (ionic) mechanisms of breaking a covalent bond.

Covalent bond parameters.

**Bond length** (length of C–C single bond, C = C double bond, C = C triple bond), bond angle, hybridization of atomic orbitals. L. Pauling’s theory of hybridization. Types of hybridization on the example of atomic orbitals of carbon: sp³, sp², sp-hybridization.

Directivity, polarity of communication.

**Metallic bond.** Definition. Metal crystal lattice.

**Ionic bond.** Ionic crystal bond.

**Hydrogen bond.** Educational conditions. Intra- and intermolecular hydrogen bond.

Crystal lattice: atomic, molecular, ionic, metallic.

**5. Redox reactions.**


**6. Chemical kinetics. The concept of forward and backward reactions.**

a. **The rate of chemical reactions.** Factors affecting the change in the rate of a chemical reaction. Influence of the concentration of starting materials on the rate of direct reaction. Van't Hoff's rule, the effect of temperature change on the rate of a chemical reaction. Van't Hoff coefficient. Influence of pressure on the rate of direct reaction. Changes in the rate of reaction depending on the surface area of the solid. Catalysts, reaction inhibitors. Enzymes as biocatalysts.

b. **Chemical equilibrium.** Factors affecting the shift in chemical equilibrium. Changes in the concentration of starting materials and reaction products. The concept of endothermic and exothermic reactions. The effect of increasing and decreasing temperature during exo- and endothermic reactions. Pressure as a factor affecting the displacement of equilibrium in the presence of gaseous substances.

**II. Inorganic chemistry.**

1. **Subgroup of halogens.**

Halogens as elements. Change in metallic properties, atomic radius, electronegativity for the halogen group. The structure of halogen atoms. Possible oxidation states, halogen valences. The specificity of fluorine as the most electronegative atom.


Hydrohalic acids. Change in acidity in the series of hydrohalic acids depending on the electronegativity of the halogen. Hydrofluoric acid as a weak electrolyte.
2. Oxygen subgroup.
   The structure of oxygen, sulfur, selenium, tellurium atoms. Possible oxidation states, valences. Changes in metallic properties, atomic radius, electronegativity for the chalcogen group.

3. Nitrogen subgroup
   Phosphoric acid. Stepwise dissociation of phosphoric acid. Chemical properties of phosphoric acid.
   Salts of nitric, nitrous and phosphoric acids. Phosphate fertilizers.

   Baking and technical soda. Glass.

5. Boron subgroup.
   The structure of boron and aluminum atoms. Change in metallic properties, atomic radius, electronegativity in the third group of the main boron subgroup.

6. Elements 1 and 2 of groups of main subgroups

7. d - elements.

### III. Organic chemistry.

1. **Theory of the structure of organic compounds A.M. Butlerov.**

   **Basic concepts of organic chemistry.**


   Classification of organic compounds. Functional groups.


   IUPAC nomenclature of organic compounds.

2. **Alkanes**


3. **Alkenes.**


   Halogenation reactions (with bromine water). Interaction with aqueous and acidic solutions of potassium permanganate, ozone.


3. **Alkyne**


4. Alkadienes.

5. Cycloalkanes.

7. Alcohols

Nomenclature of carbonyl compounds. The structure of the carbonyl group. Addition reactions at the carbonyl group. Redox reactions of aldehydes. Cannizzaro’s reaction. The qualitative reaction to the aldehyde group is the silver mirror reaction. Obtaining aldehydes and ketones. Hydration reactions of alkynes, oxidation of alkenes, alkynes, alcohols.


b. Toluene (methylbenzene)


15. Aniline

Aniline structure. Chemical properties of amines due to the amino group, due to the benzene ring. Gelogenation with bromine water. Halogenation, alkylation, nitration of aniline in the presence of a catalyst. Getting aniline. Zinin's reaction.


17. Carbohydrates.


18. Lipids.


3. The form of the entrance test
The exam is in interview format.

4. The structure of the entrance test

The entrance test consists of questions in accordance with the above program of the entrance exam.

5. Indicators and criteria of the result of the entrance test, grading scale and procedure

When completing the tasks of the entrance test in chemistry, the applicant must show knowledge in writing electronic configurations of various elements, determine the possibility of the formation and existence of various types of chemical bonds between atoms, molecules, be able to apply knowledge about the properties of the general class of compounds on specific molecules, based on knowledge about general changes in the periodic table to be able to predict the expected properties of substances, atoms, to make the necessary calculations.

When performing assignment requires knowledge of common patterns in a number of classes, the group of compounds forming a single presentation and logic in the development of chemical properties inherent in certain groups of compounds.

The ionic ticket exam includes 5 questions.

20 points for tasks # 1 and # 2, the final score is reduced by 5 in case of an incorrect answer;

10 points for task number 3, the final score is reduced by 2 points in case of an incorrect answer;

25 points for assignments №№ 4.5, the final score is reduced by 5 in case of an incorrect answer.

Thus, in general, an applicant who has correctly completed tasks 1-35 of the entrance test receives 100 points. The result of the entrance test is considered positive if the sum of the points scored corresponds to the minimum number of points established by the Rules for admission to study in higher education programs - bachelor's programs, specialty programs in 2023 at the FSBEI HE SPbSPMU MOH Russia in the relevant field of study (specialty), or exceeds it.

Sample exam ticket

1. Describe the structural configuration of the element ..., the possible oxidation states and electronic configurations in these oxidation states; what chemical bonds a given atom can form; provide examples with explanations.

2. Describe the hydrolysis process for the following salt ... (write in ionic form, including all the necessary steps, give the names of the intermediate ions formed); determine the acidity of the environment.

3. Make the next transition ....

4. Solve the problem: during the decomposition of nitrate (carbonate ...) ... g of solid residue was formed, ... l of solution ... with concentration ... and density ... as a result of the reaction released ... l of gas.

Calculate the mass of the starting nitrate ... and the volume of the gas mixture evolved during decomposition.
5. During combustion ... g of organic matter released ... l of carbon dioxide and ... g of water. Determine the gross formula of an organic substance if it is known that it contains a tertiary carbon atom and reacts with an ammoniacal solution of silver oxide.

**Recommended reading:**