

# **PROGRAM of the entrance test in chemistry for the admission of foreign citizens and stateless persons applying for undergraduate and specialty programs at NEFU in 2021**

## **1. Developers**

The program of entrance examinations in chemistry was developed by:

- Fedorova Anna Ivanovna, Candidate of Biological Sciences, Associate Professor of the Chemical Department of the Institute of Natural Sciences, Chairman of the Examination Committee in Chemistry;
- Stepanova Svetlana Innokentievna, Candidate of Chemical Sciences, Associate Professor of the Chemical Department of the Institute of Natural Sciences of the NEFU, Chairman of the Appeal Commission for Chemistry;
- Pavlova Maria Semyonovna, Candidate of Pedagogical Sciences, Associate Professor of the Chemical Department of the Institute of Natural Sciences of the NEFU, a member of the examination committee in chemistry.

## **2. Forms of entrance examinations**

Entrance examinations in chemistry for admission of foreign citizens applying for undergraduate programs at NEFU in 2021 can be conducted in the form of an oral interview on exam tickets in person or remotely using the Skype in real time or in the format online testing.

## **3. Requirements for the applicants' level of training**

The applicant should

### Know / understand:

- the meaning of the most important concepts: substance, chemical element, atom, molecule, relative atomic and molecular masses, ion, isotopes, chemical bond, valence, oxidation state, mol, molar mass.
- electrolytes and non-electrolytes. Electrolytic dissociation. Molecular and ionic forms of the reaction equation. Oxidizing and reducing agent. Solution concentration.
- hydrocarbon skeleton, functional group, isomerism and homology, the main types of reactions in inorganic and organic chemistry.

### Be able to identify:

- oxidation states of chemical elements, ion charges
- types of chemical bonds
- the nature of the environment of aqueous solutions of substances
- oxidizing and reducing agent. Create an electronic balance for redox reactions
- belonging of substances to different classes of inorganic and organic compounds

Be able to characterize:

- chemical elements according to their position in the Periodic Table of D. I. Mendeleev
- chemical properties of the most important classes of inorganic and organic compounds
- types of chemical reactions
- homologous series and isomers of organic substances

Be able to calculate:

- mass fraction of solute,
- a weighed portion for preparing a solution of a given concentration
- amount of substance (mol)

#### 4. Chemistry Entrance Test Program

**Table 1. Program**

<b>1. Modern ideas about the structure of the atom</b>	
1.1. The composition of the nucleus of an atom	1.1.1 Protons, neutrons.
	1.1.2 Isotopes
1.2. Electronic structure of the atom	1.2.1 Electrons
	1.2.2 Energy levels
	1.2.3 Atomic orbitals
	1.2.4 Electronic configuration of chemical elements
1.3. Structure of the Periodic Table of Chemical Elements of D.I. Mendeleev	1.3.1 Characteristics of groups, periods, subgroups
	1.3.2 Periodic law of D. I. Mendeleev
	1.3.3 Periodic properties of chemical elements and their compounds
1.4. Chemical bond	1.4.1 Covalent polar and non-polar
	1.4.2 Ionic
	1.4.3 Metallic
<b>2. Classification of inorganic compounds</b>	
2.1. Oxides	2.1.1 Classification of oxides
	2.1.2 Chemical properties
2.2. Acids	2.2.1 Classification of acids
	2.2.2 Chemical properties
2.3. Bases	2.3.1 Chemical properties of hydroxides
2.4. Salts	2.4.1. Classification
	2.4.2 Chemical properties
<b>3. Solutions</b>	

3.1. Electrolytes	3.1.1 Theory of electrolytic dissociation
	3.1.2 Dissociation of acids, bases and salts
	3.1.3 Ionic reaction equations
	3.1.4 Hydrolysis of salts. Medium of aqueous solutions
3.2. Ways of expressing the composition of solutions	3.2.1 Mass fraction of a solute
	3.2.2 Density of the solution, volume and mass of the solution
	3.2.3 Molar concentration
<b>4. Types of chemical reactions</b>	
4.1. Ion exchange reactions	4.1.1 Reaction equations in molecular, full ionic and reduced ionic forms
	4.1.2 Neutralization reactions
4.2. Substitution reactions	4.2.1 Examples of substitution reaction equations
4.3. Decomposition reactions	4.3.1 Thermal decomposition of hydroxides
	4.3.2 Thermal decomposition of nitrates
4.4. Compound reactions	4.4.1 Formation of complex substances from simple
	4.4.2 Examples of reactions with pi-bond cleavages
4.5. Redox reactions	4.5.1 Determination of the oxidation state of elements
	4.5.2 The main provisions of the theory of OVR
	4.5.3 Major oxidizing and reducing agents
	4.5.4 Drawing up an electronic balance sheet. Selection of coefficients
<b>5. Hydrocarbons</b>	
5.1. Alkanes	5.1.1 Structure. Homological series
	5.1.2 Nomenclature and isomerism
	5.1.3 Chemical properties
	5.1.4 Methods of obtaining
5.2. Alkenes and alkadienes	5.2.1 Structure. Homological series
	5.2.2 Nomenclature and isomerism
	5.2.3 Chemical properties
	5.2.4 Methods of obtaining
5.3. Alkines	5.3.1 Structure. Homological series
	5.3.2 Nomenclature and isomerism
	5.3.3 Chemical properties
	5.3.4 Methods of obtaining
5.4. Arenas	5.4.1 Benzene structure
	5.4.2 Chemical properties
<b>6. Oxygen-containing organic compounds</b>	

6.1. Alcohols	6.1.1 Structure. Classification
	6.1.2 Chemical properties
	6.1.3 Phenol
6.2. Aldehydes	6.2.1 Functional group structure
	6.2.2 Chemical properties
6.3. Carboxylic acids	6.3.1 Structure. Classification
	6.3.2 Chemical properties
6.4. Fats	6.4.1 Obtaining ethers and esters
<b>7. Nitrogen-containing organic compounds</b>	
7.1. Amines	7.1.1 The structure of the amino group
	7.1.2 Chemical properties of amines
	7.1.3 Aniline
7.2. Amino acids	7.2.1 Amphoteric properties of amino acids
	7.2.2 Proteins
<b>8. Carbohydrates</b>	
8.1. Monosaccharides	8.1.1 The structure of the glucose molecule
	8.1.2 Chemical properties of glucose
8.2. Disaccharides	8.2.1 Hydrolysis of disaccharides
8.3. Polysaccharides	8.3.1 Hydrolysis of polysaccharides
	8.3.2 Structure of starch and cellulose

## 5. Evaluation criteria

The procedure for conducting an entrance test is in the form of an oral interview. At the beginning of the exam, the applicants prepare with tickets for 30 minutes, after preparation, they are interviewed for 10 minutes.

Examination tickets for the entrance test in the form of an oral interview consist of 6 tasks that correspond to the program of entrance tests presented in clause 4.

Tasks 1 to 4 are evaluated from 0 to 20 points, tasks 5 and 6 - from 0 to 10 points. Maximum points: 100.

The procedure for conducting admissions tests remotely is given in the “Procedure for conducting admissions tests using distance technologies for admission to study at “M.K. Ammosov North-Eastern Federal University” for the 2021/22 academic year.

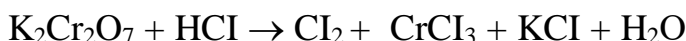
Examination tasks in the format of computerized online testing consist of 21 tasks, the completion of which takes 1.5 hours or 90 minutes. Tasks correspond to the program of entrance examinations presented in clause 4.

Tasks from 1 to 17 with the choice of the correct answer are estimated at 4 points ( $4b * 17 = 68$  points); tasks from 18 to 21 for compliance are estimated at 8 points ( $8b * 4 = 32$  points). Maximum points: 100.

## 7. Samples of chemistry entrance examination tickets

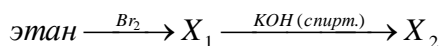
Examination ticket no. \_\_\_

1. The structure of the Mendeleev Periodic Table. Electronic structure on the example of the nitrogen atom.
2. Redox reactions. Oxidation state. Using the electronic balance method, select the coefficients in the reaction equation:



Determine the oxidizing and reducing agent.

3. Write the reaction equations in molecular, ionic and short ionic forms between copper hydroxide and sulfuric acid.
4. Determine the mass of the substance in 200 g of 25% sodium chloride solution.
5. Write the reaction equations with which you can carry out the following transformations:



6. Write the structural formula of para-aminobenzoic acid.

Applicant \_\_\_\_\_

(Full Name)

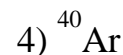
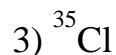
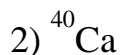
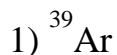
Graduation year \_\_\_\_\_

Citizenship \_\_\_\_\_

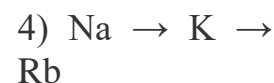
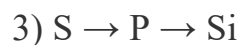
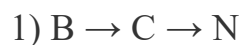
### 7.3. Sample exam ticket in the form of online computer testing

Examination ticket no. \_\_\_

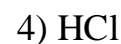
1. The number of neutrons in an atom  $^{39}\text{K}$  is equal to the number of neutrons in an atom



2. The non-metallic properties of elements are enhanced in a row



3. The formula of a substance molecule, in which only the covalent polar type of bond is realized, has the form



4. Are the following statements about magnesium and calcium compounds true?

A. The hydroxides of these metals are gaps.

B. In the connection, these metals show the degree of oxidation +2.

1) only A is true

2) only B is true

3) both statements are true

4) both statements are wrong

**5.** Carbon monoxide (IV) reacts with each substance of the pair

- 1) water and calcium oxide
- 2) oxygen and sulfur oxide
- 3) potassium sulfate and sodium hydroxide
- 4) phosphoric acid and hydrogen

**6.** The degree of oxidation of phosphorus is (+ 5) in the compound

- 1)  $P_2O_3$
- 2)  $Mg_3(PO_4)_2$
- 3)  $H_3PO_3$
- 4)  $PH_4Cl$

**7.** The reduced ionic equation  $H^+ + OH^- = H_2O$  corresponds to the interaction

- 1)  $H_2SO_4$  и  $NaOH$
- 2)  $Cu(OH)_2$  и  $HCl$
- 3)  $NH_4Cl$  и  $KOH$
- 4)  $HCl$  и  $HNO_3$

**8.** ... reacts with water with the greatest speed at the room temperature

- 1) potassium
- 2) calcium
- 3) magnesium
- 4) aluminum

**9.** In which reaction is sulfur oxide (IV) is a reducing agent?

- 1)  $SO_2 + 2NaOH = Na_2SO_3 + H_2O$
- 2)  $SO_2 + 2H_2S = 3S + 2H_2O$
- 3)  $SO_2 + H_2O = H_2SO_3$
- 4)  $2SO_2 + O_2 = 2SO_3$

**10.** Isomers of the position of the multiple bond are:

- 1) 2-methylbutane and 2,2-dimethyl-propan
- 2) pentin-1 and pentin-2
- 3) pentadiene-1,2 and pentadiene-1,3
- 4) butanol-1 and butanol-2

**11.** Unlike propane, cyclopropane reacts with:

- 1) dehydrogenation
- 2) hydrogenation
- 3) combustion
- 4) esterification

**12.** Acetic acid reacts with each of the two substances:

- 1) copper and ethyl acetate
- 2) copper sulphate (II) and acetaldehyde
- 3) iron hydroxide (III) and ethanol
- 4) iodine and diethyl ether

**13.** Aniline reacts with:

- 1) alkaline
- 2) hydrochloric acid

- 3) carbon dioxide
- 4) aluminum hydroxide

**14.** Are the following statements about the rules for handling substances true?

- A. In the laboratory, you can get acquainted with the smell and taste of substances.
- B. Gas-like chlorine is very toxic.

- 1) only A is true
- 2) only B is true
- 3) both statements are true
- 4) both judgments are wrong

**15.** When heating a mixture of iron and sulfur, a ... reaction occurs

- 1) connections 2) exchange 3) replacement 4) decomposition

**16.** The mass of a substance in a 5% 450 g sodium chloride solution is

- 1) 10%
- 2) 28.6%
- 3) 22.5%
- 4) 11.5%

**17.** The amount of substance (mol) of silver nitrate weighing 17 g is

- 1) 0.5
- 2) 0.1
- 3) 0.6
- 4) 0.3

**18.** Set a correspondence between a substance and its belonging to a certain class (group) of inorganic compounds

NAME OF SUBSTANCE	CLASS (GROUP) OF COMPOUNDS
A) Ba(OH) <sub>2</sub>	1) acid oxide
B) HClO <sub>4</sub>	2) anoxic acid
C) NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>	3) acidic salt
D) Mn <sub>2</sub> O <sub>7</sub>	4) basic oxide
	5) oxygenated acid
	6) base

**19.** Set a correspondence between the name of the substance and the class (group) of organic compounds to which it belongs.

NAME OF SUBSTANCE	CLASS (GROUP) OF ORGANIC COMPOUNDS
A) methyl acetate	1) amino acids
B) ethylene glycol	2) aldehydes
C) ethanol	3) alcohols
D) pentane	4) esters
	5) carbohydrates
	6) carbohydrate

**20.** Set a correspondence between the name of the salt and its ability to hydrolyze.

NAME OF SALT	ABILITY TO HYDROLYZE
A) sodium acetate	1) hydrolysis is not subject to
B) calcium iodide	2) hydrolysis in cation
B) aluminum sulphide	3) hydrolysis by anion
D) potassium carbonate	4) hydrolysis in cation and anion

**21.** Set the correspondence between the formula of organic matter and its relative molar mass

NAME OF SUBSTANCE	RELATIVE MOLAR MASS
A) butane	1) 28
B) ethylene	2) 46
C) ethanol	3) 58
D) benzene	4) 78

Applicant \_\_\_\_\_

(Full Name)

Graduation year \_\_\_\_\_

Citizenship \_\_\_\_\_