MINISTRY OF SCIENCE AND HIGHER EDUCATION
RUSSIAN FEDERATION
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Kemerovo State University

Approved by
Director of the Institute of
Fundamental Sciences
/ E.G. Gazenaur

ENTRANCE EXAMINATION PROGRAM 2026

for applicants of CHEMISTRY (Specialists, Bachelors)

Kemerovo 2026

ДОКУМЕНТ ПОДПИСАН
ЭЛЕКТРОННОЙ ПОДПИСЬЮ

Сертификат: 00AAEDD5461FD53813B964A5488C8CD20B
Владелец: Просеков Александр Юрьевич
Действителен: с 18.06.2025 до 11.09.2026

Form of entrance examinations: written (testing).

Duration: 3 hours (180 minutes);

The maximum score: 100 points.

The minimum passing score: 40.

The work consists of 3 parts and includes 35 tasks.

Part 1 contains 20 tasks. Each task has 4 answer options, only one of which is correct. Each task is worth 2 points.

Part 2 contains 10 tasks for which it is necessary to provide a short answer (name the substance, type of reaction, oxidizing or reducing agent, indicate the direction of the reaction, etc.). Each task is worth 3 points.

Part 3 contains 5 complex tasks in general, inorganic, and organic chemistry. These tasks require a full (detailed) answer. Each task is worth 6 points.

The programme contains:

sample tests;

summary of topics;

educational literature.

Appeals on entrance tests are held on the next day aher the publication of the results.

CONTENT OF SECTIONS **(TOPICS) INCLUDED IN PROGRAM**

1.1. Theoretical Foundations of Chemistry

Theory ofmatter structure

Atom. Composition of atomic nuclei. Chemical element. Law of definite proportions. Relative atomic and relative molecular masses. The law of conservation of mass and its significance in chemistry. The amount of substance. Mole. Molar mass. Avogadro's number. Isotopes.

The periodicifi theory

The periodic law by D.I. Mendeleev. The electronic configuration of the atom. The ground state and excited state of atoms. Small and large periods, groups and subgroups. The structure of the electron shells of atoms in the elements of the first four periods: s-, p- and d-elements. Patterns of changes in the properties of elements and their compounds by periods and groups. General characteristics of metals of groups IA-IIIA in connection with their position in D.I. Mendeleev's periodic system of chemical elements and peculiarities of their atom structure. Characterization of transitional elements (copper, zinc, chromium, iron) by their position in D.I. Mendeleev's periodic system of chemical elements and structural features of their atoms

General characteristics of non-metals from groups IVA-VIIA by their position in D.I. Mendeleev's periodic system of chemical elements and stmctural features of their atoms.

Chemical bonding

Types of chemical bond. Covalent chemical bond, its varieties and formation mechanisms. Characteristics of a covalent bond Qolarity and bonding energy). Ionic bond. Metallic bond. Hydrogen bond. Electronegativity. The oxidation state and valency of chemical elements.

Chemical reaction

Classification of chemical reactions in inorganic and organic chemistry. Thermal effect of a chemical reaction. Thermochemical equations. The reaction rate, the dependence of the rate on the reactants' nature, concentration, temperature. Catalysis. Reversible and irreversible chemical reactions.

Chemical equilibrium. Shiñ of chemical equilibrium under the inPuence of various factors.

Electrolytic dissociation of electrolytes in aqueous solutions. Strong and weak

electrolytes. Ion exchange reactions. Salt hydrolysis. Medium of aqueous solutions: acidic, neutral, alkaline. Redox (oxidation-reduction) reactions. Corrosion of metals and methods of protection against it. Electrolysis of melts and solutions (salts, alkalis, acids).

Ionic (V.V. Markovnikov's rule) and radical reaction mechanisms in organic chemistry.

1.2. Inorganic chemistry

Classification of inorganic substances. Nomenclature of inorganic substances (trivial and international).

Metals as simple substances and their characteristic chemical properties: alkaline metals, alkaline earth metals, aluminum; transition metals (copper, zinc, chromium, iron).

Non-metals as simple substances and their characteristic chemical properties: hydrogen, halogens, oxygen, sulfur, nitrogen, phosphorus, carbon, silicon.

Characteristic chemical properties of oxides: basic, amphoteric, acidic.

Characteristic chemical properties of bases and amphoteric hydroxides. Characteristic chemical properties of acids.

Characteristic chemical properties of salts: medium, acidic, basic; complex (using aluminium and zinc compounds as an example).

The relationship between the different classes of inorganic substances.

1.3. Organic chemistry

Theory of the structure of organic compounds

Theory of the structure of organic compounds. Homology and isomerism (structural and spatial). Mutual influence of atoms in molecules. Types of bonds in molecules of organic substances. Hybridization of the atomic orbitals of carbon. Radical. Functional group.

Classification of organic substances. Nomenclature of organic substances (trivial and international).

Main classes of organic compounds

Characteristic chemical properties of hydrocarbons: alkanes, cycloalkanes, alkenes, dienes, alkynes, aromatic hydrocarbons (benzene and toluene).

Characteristic chemical properties of sa%rated monatomic and polyatomic alcohols, phenol.

Characteristic chemical properties of aldehydes, saturated carboxylic acids, esters and methods for their obtaining.

Characteristic chemical properties of nitrogen-containing organic compounds: amines and amino acids. Methods for their obtaining.

Biologically important substances: fats, proteins, carbohydrates (monosaccharides, disaccharides, polysaccharides).

The relationship between organic compounds.

1.4. Methods of knowledge in chemistry.

Experimental foundations of chemistry

Rules for working in the laboratory. Laboratory glassware and equipment. Safety rules when working with caustic, combustible and toxic substances, household chemicals.

Scientific methods for investigating chemicals and transformations. Methods for separation of mixtures and purification of substances. Determining the nature of the medium of aqueous solutions of substances. Indicators. Qualitative reactions for inorganic substances and ions. Qualitative reactions of organic compounds.

Basic methods for obtaining (in the laboratory) specific substances belonging to the studied classes of inorganic compounds.

Basic methods for obtaining hydrocarbons (in the laboratory).

Basic methods for obtaining oxygen-containing compounds (in the laboratory).

General ideas abofft industrial processes for the manufacture of essential substances

The concept of metallurgy: common methods of metal production.

General scientific principles of chemical production (examples of industrial production of ammonia, sulphuric acid, methanol).

Natural sources of hydrocarbons, their processing.

High molecular weight compounds. Polymerisation and polycondensation reactions. Polymers. Plastics, fibers, rubbers.

1.5. Calculating chemical formulas and reaction equations

Calculations using the concept "mass fraction of a substance in solution".

Calculating volume ratios of gases in chemical reactions.

Calculating the mass of a substance or the volume of a gas from the known amount of a substance or the mass or volume of one of the substances involved in the reaction.

Calculating the thermal effect of the reaction.

Calculating the mass (volume, amount of substance) of the reaction products if one of the substances is given in excess (has impurities).

Calculating the mass (volume, amount of substance) of the reaction products if one of the substances is given as a solution with a certain mass fraction of dissolved substance.

Finding the molecular foimula of a substance.

Calculating the mass or volume fraction of the reaction product yield from the theoretically possible.

Calculating the mass fraction (mass) of a chemical compound in a mixture.

4. SAMPLE TESTS

Part 1

When you complete the tasks in this part, circle the number on the form that corresponds to the answer you have chosen.

The chemical element corresponds to the highest oxide of the composition RO_3. The electron configuration of the outer energy level of the atom of this element is

1) ns^2np^3 2) ns^2np^4 1) ^{2} 1) ns^2np^6

#2
In the series of chemical elements,

MG G Ca O Sr G Ba

the metallic properties
1) decrease
2) do not change
3) change periodically
4) increase

#3
The oxidation state of carbon in CH_3Cl

1) + 1 2) - 2 3) + 2 4) - 1

#4
The properties of a substance **<u>are not affected</u>** by

1) the number of intermediate production stages
2) spatial structure of the molecule
3) order of connection of atoms in a molecule
4) mutual influence of atoms in the molecule

#5
Of the metals listed below, the most active is
1) beryllium 2) magnesium 3) barium 4) calcium

#6
Iron reacts with each of two substances:

1) sodium chloride and water
2) aluminum oxide and potassium carbonate
3) oxygen and chlorine
4) water and sodium hydroxide

#7
In the transformation diagram

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the letters X and Y represent substances

1) X — CaO; Y — HCl
2) X — CaCl2i Y — CO2 H HzO
3) X — CaF2; Y — CO2 H CO
4) X — Ca(OH)z; Y — NaCl

#8
The compound ... has a molecular crystal lattice
1) HBr 2) L12O 3) BaO 4) KC1

The number of isomeric carboxylic acids with the general formula $C_5H_{10}O_t$ is
1) 5 2) 2 3) 3 4) 4

#10
In the 2-methy1butene-2 molecule, hybridization of the orbitals of the carbon atoms is
1) sp^3 and sp^2
2) only sp^2
3) only sp
4) sp^3 and sp

#11
Reaction with ammonia solution of silver oxide is characteristic of
1) propanal
2) 1-propanol
3) propanoic acid
4) dimethyl ether

#12
Fats are esters of
1) ethylene glycol and lower carboxylic acids
2) ethylene glycol and higher carboxylic acids
3) glycerol and higher carboxylic acids
4) glycerol and lower carboxylic acids

#14
When aniline reacts with bromine water, it produces
1) 2,4,6-tribromani1ine
2) ortho-bromaniline
3) 3,5-dibromani1ine
4) meta-bromaniline

#15
Zinc (II) hydroxide
1) exhibits amphoteric properties
2) exhibits only acidic properties
3) exhibits only basic properties
4) does not exhibit acid-base properties

#16
The reaction with chemical equation

$$CaCO_{3\,(к)} \longrightarrow CaO_{\,(к)} + CO_{2\,(г)} - Q,$$

is identified as a reaction of
1) combination, exothermic
2) decomposition, exothermic
3) combination, endothermic
4) decomposition, endothermic

#17
As the pressure increases, the chemical equilibrium **<u>does not shift</u>** in the system
1) CO (r) + Cl2 (r) COC12 (r)
2) CO2 (r) + C ' 2 O (r)
3) C + 02 (r) CO2 (r)
4) 2CO (r) + 02 (r)' 2C 2 (r)

#18
The volume of hydrogen sulphide (n.c.) produced by the action of an excess of sulphuric acid on 35.2 g of iron (II) sulphide is

1) 2.24 1 2) 8.96 1 3) 6.72 1 4) 4.48 1

#19
Basic oxides include

1) ZnO 2) SiO2 3) BaO 4) CO2

#20
... has no geometrical isomers.

1) 2-methy1hexene-3 2) butene-2 3) pentene-2 4) 2-methylhexene-2

Part 2

Put the number of the correct answer in the box in the table below the task or write it down below the task.

#21

Match the name of a substance with the number of n-bonds in its molecule

COMPOUND NAME	NUMBER OF n - LINKS IN A MOLECULE
1) acetylene	A) zero
2) butadiene-1,3	B) one
3) methanal	C) two
4) ethan	D) three
	E) four

COMPOUND NAME	1	2	3	4
NUMBER OF *n* - LINKS IN A **MOLECULE**				

#22

Match the reagents to the ion-molecular reaction equation

REACTIVE CHEMICALS	**IONIC-MOLECULAR EQUATION**
1) CaCO3+ HCl	A) CaCO3 + 2H“ Ca^{2}++HzO + COz
2) NH2 3 + CO2 +	B) 3^{2} + H2O = HCO3* + OH”
3) NazCO3+ HCl	C) OH + H = HCO
4) NaOH + HNO3	D) CO3 + 2H+ = CO2 + H2
	E) CO3 ” + CO2 + TO — 2HCO3‘

REACTIVE CHEMICALS	1	2	3	4
IONIC-MOLECULAR EQUATION				

#23

Match the name of the compound with the general formula of the homologous series to which it belongs.

COMPOUND NAME	**GENERAL FORMULA**
1) butyne	A) C_nH_{2n+2}
2) cyclohexane	B) C_nH_{2n}
3) propane	C) C_nH_{2n-2}
4) butadiene	D) C_nH_{2n-4}
	E) C_nH_{2n-6}

COMPOUND NAME	1	2	3	4
GENERAL FORMULA				

#24

Match the equation of the reaction with the property of the element nitrogen which it exhibits in this reaction.

REACTION EQUATION	**PROPERTY OF NITROGEN**
1) NH HCO, — NH,+HCO + COC	A) is an oxidizing agent
2) 3CuO + 2NH =N +3Cu + 3H,O	B) is a reducing agent
3) 4NH,+iO —4NO+ 61f2O	C) is both an oxidizing agent and a reducing agent
4) 6Li + N2'2Li N	D) does not exhibit redox properties

REACTION EQUATION	1	2	3	4
PROPERTY OF NITROGEN				

#25

Match the name of the salt with its relation to hydrolysis.

NAME of SALT	**HYDROLYSIS BEHAVIOUR**
1) ammonium chloride	A) is hydrolysed by the cation
2) potassium sulfate	B) is hydrolysed by the anion
3) sodium carbonate	C) does not undergo hydrolysis
4) aluminum sulfide	D) is hydrolyzed by both the cation and the anion

NAME of SALT	1	2	3	4
HYDROLYSIS BEHAVIOUR				

#26

Match the two substances nd the reagent that can be used to distinguish between these substances.

SUBSTANCES	**REAGENT**
l) propanone and propano1-2	A) HC (solution)
2) aniline and triethylamine	B) Afi2 (NH3 SOlutiOrl)
3) pentyne-2 and ethyl acetate	C) Bra (water)
4) benzene and hexene-2	D) K

SUBSTANCES	1	2	3	4
REAGENT				

#27

Match the name of the organic compound with the class to which it belongs:

COMPOUND	CLASS
1) toluene	A) hydrocarbons
2) divinyl	B) esters
3) methyl formate	C) cetones
4) acetone	D) aldehydes
	E) carboxylic acids

COMPOUND	1	2	3	4
CLASS				

#28
Match the formula of the substance with the oxidation state of chlorine:

SUBSTANCE FORMULA
1) A1 3
2) KC1O2
3) HCIO3
4) Ca(OC1)2

OXIDATION STATE OF CHLORINE
A) +7
B) +3
C) +5
D) +1
E) 0

SUBSTANCE FORMULA	1	2	3	4
OXIDATION STATE OF CHLORINE				

#29
Match the name of the organic compound with the class to which it belongs:

COMPOUND
1) toluene
2) divinyl
3) methyl formate
4) acetone

CLASS
A) hydrocarbons
B) esters
C) cetones
D) aldehydes
E) carboxylic acids

COMPOUND	1	2	3	4
CLASS				

#30
Match the formula of a substance with the electrolysis products of its aqueous solution:

SUBSTANCE FORMULA:
1) NaOH
2) NaNO3
3) ZnSO4
4) AgNO3

ELECTROLYSIS PRODUCTS:
A) Na, 02
B) Hz, 2
C) Zn, H2, Oz
D) ZilO, O2
E) Ag, NO2
F) Ag, 02

SUBSTANCE FORMULA	1	2	3	4
ELECTROLYSIS PRODUCTS				

Part 3

Write the solution on a separate paper sheet.

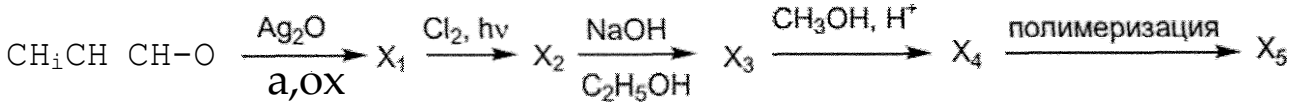
2g of a hydrocarbon can react with either 2.24 litres of hydrogen or 16g of bromine or 1.15g of metallic sodium. Write the formula, the name of this compound and the equations of all reactions.

#32
When 25.5 g of saturated monobasic carboxylic acid reacted with an excess of sodium bicarbonate solution, 5.6 1 (n.c.) of gas was released. Write down the reaction equation in general terms. Identify the molecular formula of the acid.

#33
Find the volume of air required to burn 100 litres (n.c.) of a propane-butane mixture consisting of 40% propane and 60% butane by volume.

#34
Calculate how much 10% hydrogen chloride solution with a density of 1.05 g/ml will be used to completely neutralize the calcium hydroxide produced during the hydrolysis of calcium carbide if the gas released during the hydrolysis took up a volume of 8.96 1.

#35
Write the reaction equations that can be used to carry out the following transformations:



*rioniiMepu3aI}iie = polymerization

List of recommended literature:

1. Goco6He no xHziilH ,f{Jis nocvynaioujilx B Byoi.I. / F.G.XOMVOHKO - M.: HoB£tlf BOJiHa, 2013. (A manual on chemistry for university students. / G.P. Khomchenko - M.: Novaya volna, 2013.)
2. EF3. XHMHlf. OJIHi.Iñ xypc. / P.A. H,f{HH- M.: GxsaMeH, 2014. (USE. Chemistry. Complete course. / R.A. Lidin - M.: Examen, 2014.)
3. XHMHIi. 3apaHHfl BbIGoxoro ypoBHs CJIOWHOGTH (vaGTa C) q:is noproToBKH K EFG. / A.F.fiepeziHaIf, T.B.CaziHeBa, B.A.&eBpaneBa, B.H.@O]3OHhKHH - M.: XerHoH, 2014. (Chemistry. Tasks of a high level of complexity (part C) to prepare for the exam. / A.G. Berezhnaya, T.V. Sazhneva, V.A. Fevraleva, V.N. Doronkin - M.: Legion, 2014.)
4. EFG - 2014. XHMHlf. CaMoe nonHoe H3paHHe THnOBhIX BapiiaHrOB 3apaHHiJ / & £tBTO]3bI- cocvaBHvenH: A.A. KaBepHHa, @.O. O6j3OTHH, M.F.CHacTHHa - M.: HHTennexT-IJ,eHTp, 2014. (USE - 2014. Chemistry. The most complete edition of standardised test papers / FIPI (FIPM) authors- compilers: A.A. Kaverina, D.Yu.Dobrotin, M.G.Snastina - M.: IntellectCenter, 2014.)
5. OTJIHUHHE EFG. XHMHs. PeiueHHe GJIOWHbIX 3aQav / &IDOI aBTO)3bI- GOcTaBH-TenH: KaBepHHa A.A., KopoiiieHKo A.C., QO6pOTilH Q.O., MepBepeB O.H., H£tGTHHa M.F. - M.' HHvennexT-IJ,eHzp, 2010. (A top student at the unified state exam. Chemistry. Solving complex problems / FIPI (FIPM) authors- compilers: Kaverina A.A., Koroshchenko A.S., Dobrotin D.Yu., Medvedev Yu.N., Snastina M.G. - M.: Intellect-Centre, 2010.)
6. EFG 2012. XHMHH.[TeKcT] 1l KJiaGG / ABT. COGT. A.A. KaBepHHa, @.O. Qo6-]3OTHH, O. H. MepBepeB. - BHHOM. Xa6OpaTOpH:I 3H£tHHIl, 20 12. (USE 2012. Chemistry. [Text] Grade 11 / Ed. Compliers. A.A. Kaverina, D.Yu. Dobrotin, Yu. N. Medvedev. - Binom. Knowledge Laboratory, 2012.)
7. EFG 20 13. XHMHIL[TeKcz] 11 KJiaGG. VacTb C / ABT. OGT. H.B. B£t]3bIIIIOB£t. - HHOM. a6O £tTO]3H:i 3HaHHii (USE 2013. Chemistry. [Text] Grade 11. Part C / Ed. Compliers. I.V. Baryshova. - Binom. Knowledge laboratory)
8. EFG-2013. XHMHH: [Texcr] TxHOBaIe oroaMeHai;HOHHi.Ie BapHaHzbI: 10 BapHaHTOB / Gop pep. A.A. KaBepHHOii. — M.: HapaTeni.cTBO «HauHOHaJIi.Hoe O6}3£tzOBaHHe», 2012. — (EFG-2013. &HHH-iuKoiie) (USE-2013. Chemistry: [Text] standardised test papers: 10 tests / Ed. A.A. Kaverina. - M .: Publishing house "Natsionalnoye Obrazovanie", 2012. - (USE-2013. FIPI (FIPM) for school))
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