Chemistry

The test includes the following content blocks:

1. General chemistry

2. Inorganic chemistry

3. Organic chemistry

When preparing for exams, please pay attention to the following questions from the program:

General chemistry

1. Physical and chemical phenomena.

2. Pure substances and mixtures. Separation of mixtures into components.

3. Structural units of matter: atom, molecule, ion.

4. Stoichiometric laws in chemistry. Amount of substance.

5. Chemical element. Simple and complex substances.

6. Chemical formulas of simple and complex substances. Graphic formulas of compounds.

7. Chemical reactions. Signs. Classification. Reaction equations.

8. The structure of atoms of chemical elements: the structure of the nucleus, isotopes, the electron configuration of the atom, the ground and excited states of the atom.

9. The periodic law and the periodic table of chemical elements. Dependence of the properties of elements on their position in the periodic table.

10. Chemical bond. Mechanisms of chemical bond formation. Types of chemical bond. Characteristics of chemical bond (length, polarity).

11. Spatial structure of molecules. Types of hybridization of valence orbitals of atoms that form chemical bonds with other atoms. Spatial structure of crystals. Types of crystal lattices.

12. Fundamentals of chemical kinetics: rate of chemical reaction, dependence of rate on various factors.

13. Reversible chemical reactions. Chemical equilibrium and conditions for its shift.

14. Fundamentals of thermodynamics: thermal effect of a chemical reaction.

15. Solutions, their classification. Solubility of substances. Crystal hydrates. Methods of expressing the concentration of a dissolved substance in a solution. Strong and weak electrolytes. Electrolytic dissociation, degree of dissociation and ionic equations of reactions. Properties of acids, bases and salts in light of the theory of electrolytic dissociation

16. Redox reactions. A series of standard electrode potentials

Inorganic Chemistry

1. Main classes of inorganic substances. Nomenclature. Genetic relationship between them. Chemical properties and obtaining substances.

2. Hydrogen and its compounds.

3. Oxygen and its compounds.

4. Halogens and their compounds.

5. Sulfur and its compounds.

6. Nitrogen and its compounds.

7. Phosphorus and its compounds.

8. Carbon and its compounds.

9. Silicon and its compounds.

10. Metals:

a) main subgroups: alkaline, alkaline earth, aluminum;
b) b) secondary subgroups: iron, zinc, manganese.

Organic chemistry

1. Theory of the structure of organic compounds by A.M. Butlerov. Isomerism. Types of isomerism.

2. Types of organic reactions.

3. Homologous series of organic compounds.

4. Saturated hydrocarbons (alkanes, cycloalkanes).

5. Unsaturated hydrocarbons (alkenes, alkynes).

6. Conjugated systems (alkadienes with conjugated bonds, benzene and its homologues).

7. Monohydric and polyhydric alcohols. Phenol. Comparison of properties with aliphatic alcohols. Simple ethers.

8. Organic compounds containing a carbonyl group: aldehydes, carboxylic acids, esters.

9. Carbohydrates - mono- and polysaccharides.

10. Aliphatic and aromatic amines.

11. High-molecular compounds (HMC) - polymerization, polycondensation and copolymerization reactions. General concepts of HMC chemistry - monomer, polymer, elementary unit, degree of polymerization. Different types of HMC.

List of typical calculation tasks

All the problems presented in the chemistry test do not require complex mathematical calculations and are designed in such a way that you can perform all the calculations without resorting to the help of computing equipment.

- Calculation of the relative molecular mass of a substance based on its formula.

- Calculation of the mass fraction of a dissolved substance in a solution.

- Calculation of the amount of a substance based on its mass.

- Establishing the molecular formula of gaseous substances based on combustion products.

- Establishing the molecular formula of an organic compound using the general formula of the class.

- Calculating the degree of dissociation of electrolytes.

- Calculating the reaction rate depending on various factors - concentration of reactants, temperature, pressure, changes in the volume of the vessel in which the reaction takes place.

Literature on chemistry

1. N. Glinka «General chemistry» Mir publishers Moskow 1970
2. Organic Chemistry, Sixth Edition William H. Brown, Christopher S. Foote, Brent L. Iverson, Eric V. Anslyn;
3. Edexcel International GCSE Chemistry Student Book Second Edition
4. Cambridge IGCSE Chemistry Study and Revision Guide
5. CCEA AS Unit 2 Chemistry Student Guide: Further Physical and Inorganic Chemistry and an Introduction to Organic Chemistry

CHEMISTRY

Part 1

This part of the test contains multiple choice questions. Each question has 4 possible answers, of which only 1 is correct. Circle the correct answer.

№1.

The chemical element with the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2$ is::

A) Cu

B) Sc

C) Fe

D) Ni

№2.

An atom of aluminum contains:

A) 12 electrons, 12 protons, 14 neutrons

B) 12 electrons, 13 protons, 14 neutrons

C) 13 electrons, 13 protons, 14 neutrons

D) 13 electrons, 13 protons, 13 neutrons

№3.

From the listed chemical elements, choose three that are located in the same period of the Periodic Table of Chemical Elements by D. I. Mendeleev. Arrange the selected elements in order of increasing non-metallic properties.

1) Be

2) Mg

3) Cl

4) Si

5) Zn

A) 2, 4, 3

B) 2, 3, 4

C) 3, 4, 2

D) 1, 2, 5

№ 4.

In the reaction: ? + $3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 6H_2O$ The unknown substance is:

A) Iron

B) Iron(III) hydroxide

C) Iron(II) oxide

D) Iron(II) hydroxide

№5.

What type of chemical reaction is the following?

$2NO_2 + H_2O + O_2 \rightarrow 2HNO_3$

A) Decomposition reaction

B) Combination (synthesis) reaction

C) Single displacement reaction

D) Double displacement reaction

№6.

Determine the type of chemical bond in lithium nitride (Li_3N):

A) Covalent polar

B) Ionic

C) Metallic

D) Covalent nonpolar

№7.

Determine the type of crystal lattice of the solid substance diamond.

A) Ionic

B) Atomic

C) Molecular

D) Metallic

№ 8.

Which chemical formula corresponds to a substance with the following elemental composition: $\omega_{(N)}$–25,9%, $\omega_{(O)}$–74%?

A) N_2O

B) NO

C) N_2O_3

D) N_2O_5

№ 9.

In the transformation scheme:

$Cu \xrightarrow{X} CuO \xrightarrow{Y} CuCl_2 \xrightarrow{Z} Cu(NO_3)_2$

the substances X, Y, and Z are respectively:

A) H_2O, KCl, $AgNO_3$

B) O_2, HCl, $AgNO_3$

C) O_2, NaCl, HNO_3

D) H_2O, HCl, HNO_3

№10.

From what amount of sodium sulfite can 11.2 liters of sulfur dioxide gas (at standard conditions) be obtained by reacting with an excess of hydrochloric acid solution?

A) 126 g

B) 63 g

C) 31.5 g

D) 15.75 g

№11.

Indicate with which substances the metal lithium reacts:

1. **oxygen,**
2. **water (at room temperature),**
3. **hydrochloric acid,**
4. **nitric acid.**

A) 1, 2, 3, 4

B) 1, 3, 4

C) 1, 4

D) 4

№12.

Which of the following salts can undergo hydrolysis?

A) $BaSO_4$

B) NaCl

C) K_2SO_4

D) K_2S

№13.

From the list below, choose two salts whose hydrolysis results in a solution with pH > 7.

1. **$Al_2(SO_4)$**
2. **Na_2CO_3**
3. **KNO_3**
4. **K_2SiO_3**
5. **KCl**

A) 2 and 3

B) 2 and 4

C) 4 and 5

D) 3 and 5

№14.

In the reaction: $MnO_2 + HCl \rightarrow MnCl_2 + Cl_2 + H_2O$ the reducing agent is:

A) Manganese

B) chlorine

C) oxygen

D) hydrogen

№15.

The net ionic equation of the reaction:

$Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$

corresponds to the interaction of the substances:

A) Al_2O_3 and H_2SO_4

B) $Al_2(SO_4)_3$ and KOH

C) $Al(OH)_3$ and H_2SO_4

D) $AlCl_3$ and Na_3PO_4

№16.

Are the following statements true:

1) All substances can participate in ion exchange reactions.

2) Precipitation is a sign of irreversibility of RIO.

A) only the first statement is true

B) only the second statement is true

C) both statements are true

D) both statements are false

№17.

Indicate why one of the reactions is irreversible.

1. Sodium hydroxide + hydrochloric acid
2. Sodium hydroxide + potassium chloride

A) A precipitate is formed

B) A gas is released

C) A weak electrolyte is formed

№18.

Determine for which of the listed processes a change in pressure will cause a shift in equilibrium?

A) $2SO_2 + O_2 \rightleftarrows 2SO_3$ (g)

B) $2HI$ (g) $\rightleftarrows H_2 + I_2$ (g)

C) $CO + H_2O$ (g) $\rightleftarrows CO_2 + H_2$

D) $N_2 + O_2 \rightleftarrows 2NO$

№19.

To increase the yield of sulfur trioxide (VI) in the system:

$2SO_2 + O_2 \rightleftarrows 2SO_3 + Q$, one should:

A) increase pressure and raise temperature

B) B) increase pressure and lower temperature

C) C) decrease pressure and raise temperature

D) D) decrease pressure and lower temperature

№20.

Identify the type of dispersion system: water + clay.

A) Suspension

B) Emulsion

C) Colloidal solution

D) True solution

№21.

Calculate the mass of the precipitate formed when 360 g of magnesium sulfate reacts with sodium hydroxide.

A) 58 g

B) 174 g

C) 87 g

D) 120 g

№22.

Determine the empirical formula of a hydrocarbon, upon complete combustion of which with a mass of 2 g, 4.5 g of water is formed. Calculate the molar mass of the hydrocarbon.

A) 32

B) 48

C) 16

D) 54

№23.

In the reaction:

$CH_2 = CH_2 + [O] + H_2O \xrightarrow{KMnO_4} ?$

A) carbon dioxide

B) polyethylene

C) ethylene oxide

D) ethylene glycol

№ 24.

Name the unknown substance in the reaction:

$C_2H_5OH \xrightarrow{t^0\ H_2SO_{4(conc)}} X + H_2O$

A) Ethanal

B) Ethylene

C) Diethyl ether

D) Ethyl acetate

№ 25.

In which of the following substances are there two π- and six σ- covalent bonds between atoms?

A) Hexene-1

B) Propane

C) Propyne

D) Butadiene-1,2

№26.

The following reaction scheme is given:

$$CH_3CH_2Cl \xrightarrow{X} CH_3CH_2OH \xrightarrow{Y} CH_3CHO.$$

Determine which of the listed substances are reagents X and Y.

1. **H_2**
2. **CuO**
3. **$Cu(OH)_2$**
4. **NaOH (aqueous solution)**
5. **NaOH (alcoholic solution)**

A) 1, 3

B) 4, 2

C) 4, 5

D) 2, 3

№27.

Due to the presence of hydroxyl groups in the glucose molecule, it:

A) participates in the “silver mirror” reaction

B) is oxidized by copper(II) hydroxide

C) forms esters

D) is reduced to a polyhydric alcohol

№ 28.

The mass fraction of carbon in the hydrocarbon is 83.3%, and the relative vapor density compared to hydrogen is 36. The molecular formula of the hydrocarbon is:

A) C_4H_8

B) C_5H_{12}

C) C_2H_6

D) C_3H_{10}

Part 2

This part of the test contains matching tasks. Next to the letter of the element from the left column, write the number of the corresponding element from the right column (i.e. pair the two corresponding elements). Each element on the left corresponds to only one element on the right. One element from the right column is extra.

№ 2.1.

Match the followings:

	Process Diagram		**Number of Accepted or Donated Electrons**
A	$S^{-2} \rightarrow S^{+4}$	1	Accepted 6 $\bar{e}$
B	$N_2^0 \rightarrow 2N^{+2}$	2	Donated 6 $\bar{e}$

C	$S^{-2} \rightarrow S^{0}$	3	Donated 2 $\bar{e}$
D	$O_2^{0} \rightarrow 2O^{-2}$	4	Donated 4 $\bar{e}$
		5	Accepted 4$\bar{e}$

Answer:

A	
B	
C	
D	

№ 2.2..

Match the formula of a simple substance with the formulas of reagents it can react with:

For each lettered item, choose the corresponding numbered reagent group.

	SIMPLE SUBSTANCE		**REAGENTS**
A	Cl_2	1.	HCl, $CuSO_4$, O_2
B	S	2.	HNO_3(conc., cold), $AgNO_3$, Br_2
C	Fe	3.	Al, O_2, HNO_3
D	Cu	4.	HBr, H_2, K_2S
		5.	NaOH, $CaCO_3$, F_2

Answer:

A	
B	
C	

D	

Part 4.

This part of the test contains short-answer tasks. The answer is any whole number from 0 to 9999. Write the sequence of numbers in the cells, filling in from the first cell on the left. Write only one number in one cell.

№ 4.1.

20 g of a mixture of sodium and sodium oxide were dissolved in water, releasing 4,48 liters of gas (at standard conditions). Determine the mass fraction of sodium oxide in the original mixture.

Answer:

№ 4.2.

What volume does a mixture of 2 moles of nitrogen and 3 moles of oxygen occupy at STP?

Answer:

№ 4.3.

To 180 g of a solution containing 20% salt, 20 g of salt were added. What is the mass fraction of salt in the new solution?

Answer:

№ 4.4.

As a result of the reaction with the thermochemical equation:

$SO_3 + H_2O \rightarrow H_2SO_4 + 88$ kJ,

264 kJ of heat was released. Calculate the mass (in grams) of sulfuric acid formed.

Answer: