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ASSESSMENT MATERIALS

Discipline Chemistry

Author(s):
Sagaidachnaya V.V.

Associate Professor

Ph.D. in Pedagogy,
Docent

Approved at the meeting of the
Chemistry Department

Record no. __ dated

Head of the department Dyakina T.A.

signature

1. Criteria and assessment of competencies and their mastery indicators, formed by the discipline (module)

Code and competence name	Code and indicator of competence mastery	Results of training in the discipline (module)			Formative assessment	Interim assessment
		<i>To know</i>	<i>To be able to</i>	<i>To have</i>		
УК-1 Can design action plans and apply systematic approach to critical analysis of problem situations	ИД1УК-1-1 Applies a systematic approach in search and analytical activities to solve assigned problems	theoretical foundations of general, analytical, organic and physical and colloidal chemistry; patterns of chemical processes; properties of chemical systems; chemistry of the most important biogenic elements.	apply chemical knowledge, theories, laws, concepts to master special disciplines and solve professional problems; apply chemical methods for studying inorganic and organic compounds to solve professional problems	knowledge of chemical methods of research, processing and analysis of experimental data; skills in safe handling of chemical reagents, instruments and laboratory equipment	a set of tasks for performing practical and laboratory work, test tasks	examination cards

2. Competencies mastery (indicators of their mastery) level assessment

Competencies mastery (their indicators) indices	Criteria and grading system of competencies mastery (indicators of their mastery) assessment			
	Insufficient («unsatisfactory»)	Sufficient («satisfactory»)	Above average («good»)	Advance («excellent»)
Extent of knowledge	Knowledge level is below the required. Major mistakes occurred.	Minimally allowed knowledge level. Minor mistakes occurred.	Knowledge level corresponds well to the educational programme. Minor errors occurred.	Knowledge level corresponds well to the educational programme.
Ability mastery	Basic abilities were not demonstrated during standard tasks completion. Major mistakes occurred.	Basic abilities were demonstrated. All tasks were completed in full, yet with few errors. All tasks were completed, yet not in full (clarifications are absent, conclusions are incomplete).	Basic abilities were demonstrated. All tasks were completed in full, yet with few errors. All tasks were completed in full, yet with few errors.	Basic abilities were demonstrated. All main and additional tasks were completed without mistakes or errors. All tasks were completed in full without errors.
Ability mastery (having experience)	Basic abilities were not demonstrated during standard tasks completion. Major mistakes occurred.	Minimum set of skills for standard tasks completion, with minor error, is acquired.	Basic skills were demonstrated in completing standard tasks, yet with few errors.	Basic abilities were demonstrated. All main and additional tasks were completed without mistakes or errors. A creative approach to solving non-standard tasks is demonstrated.
Competence mastery characteristics	Competencies have not been acquired. The acquired knowledge, skills, and abilities are not enough to solve practical (professional) tasks. or Insufficient number of credit points as per the established range.	Competencies mastery is adequate. The acquired knowledge, skills, and abilities are mostly sufficient to solve practical (professional) tasks. or Sufficient number of credit points is earned as per the established range	Competencies mastery mainly satisfies the requirements. The acquired knowledge, skills, and abilities are mainly sufficient to solve practical (professional) tasks. or Sufficient number of credit points is earned as per the established range	Competencies mastery satisfies the requirements to the full extent. The acquired knowledge, abilities, and skills are fully sufficient to complete difficult professional tasks, including non-standard. or Sufficient number of credit points is earned as per the established range

3. Criteria and grading system of the formative assessment tasks

3.1 Criteria and grading system of practical tasks and laboratory works

Practical work is included into the discipline to develop skills and abilities within it, allowing students to boost the process of cognition, reveal an understanding of the applied significance of the discipline.

The list of practical tasks, task completion and presentation recommendations, requirements for results, structure, and contents of practical task report, etc., are presented in MAU LMS Moodle.

Grade/points	Assessment criteria
<i>Excellent</i>	The task is completed correctly and in full. The report on practical work has been prepared in accordance with the requirements. Answers to the teacher's questions (during the presentation) are full.
<i>Good</i>	The task is completed in full, yet without sufficient justification or a minor error, which does not impact the argumentation sequence, occurred. All task completion requirements are satisfied.
<i>Satisfactory</i>	The task is completed partially, with mistakes. The task within laboratory/practical work has been completed at the average level. Most of the requirements have been fulfilled.
<i>Unsatisfactory</i>	The task is completed with a significant number of mistakes and at a low level. Many requirements for the assignment have not been satisfied. OR The task has not been completed

The list of test questions and tasks, as well as test procedure description are presented in methodological guidelines on mastering the discipline, as well as in MAU LMS Moodle.

Assessment materials include a typical test variant:

Grade/points	Assessment criteria
<i>Excellent</i>	90-100% of correct answers
<i>Good</i>	70-89% of correct answers
<i>Satisfactory</i>	50-69% correct answers
<i>Unsatisfactory</i>	49% or less correct answers

Criteria and grading system of the class attendance

3.3. Student attendance is determined in percentage correlation

Points	Assessment criteria
10	attendance 75-100%
5	attendance 50-74%
0	Attendance is less than 50%

4. Criteria and grading system of the discipline results during the interim assessment

4.1. Criteria and grading system for the discipline results

For the disciplines that are graded upon examination, the interim assessment result is comprised of points gained during the formative assessment and after the examination.

Assessment materials include the list of questions and tasks for the examination:

The list of examination questions:

1. The structure of the atom: nucleus, protons, neutrons, electrons. Notion of atomic orbitals and quantum numbers. Principles and procedure of filling energy levels with electrons in atoms of periods I-III of the Periodic Table.
2. Main properties of the atom: nuclear charge, radius, ionization potential, electron affinity, electronegativity. Change of these properties by periods and groups. Metallic and non-metallic properties of elements depending on their position in the Periodic Table.
3. Main classes of chemical compounds: binary compounds, hydroxides (acids and bases), salts (acidic, basic, neutral, double). Nomenclature, main methods of preparation.
4. Chemical properties of main classes of inorganic compounds (*question 3*).
5. Nature and types of chemical bonds: covalent, polar, ionic, coordinate covalent. Hydrogen bond. Energy and bond length, unsaturated bonds.
6. Fundamental notions of chemical thermodynamics: systems, parameters, processes.
7. Hess's Law and its consequences. Thermochemical equations. Calculation methods of heat effects of chemical reactions.
8. Criteria for spontaneous chemical processes. Notion of Gibbs energy. Enthalpy and entropy factors of chemical processes.
9. Coordination complexes.
10. Fundamentals of chemical kinetics. Chemical reaction rate, reaction rate constant and its dependence on temperature and catalyst. Notion of activation energy.
11. Chemical equilibrium. Law of mass action. Equilibrium constant, equilibrium shift. Concentration, temperature and pressure effect on equilibrium.
12. Solutions. Chemical theory of solutions. Solution preparation.
13. Types of concentration: mass fraction, molarity, normality, titre (*question 3*).
14. Electrolytic dissociation of acids, bases and salts from the viewpoint of the equilibrium. Degree of dissociation, dissociation constant. Strong and weak electrolytes (*question 3*).
15. Oxidation-reduction reactions (redox). Oxidants and reductants. Ion-electron balance method in balancing redox equations (*question 3*).
16. Notion of electrolysis. Electrolysis of molten salts of hydrides, aqueous solution of acids, bases, alkalis and salts. Laws of electrolysis (*question 3*).
17. Colligative properties of solutions.
18. Properties of non-electrolytic solutions.
19. Constant and degree of dissociation. Ostwald's law of dilution.
20. pH indicator. pH calculations (*question 3*).
21. Precipitation-dissolution equilibrium. Solubility equilibrium. Solubility. Factors affecting solubility.
22. Hydrolysis of salts: essence of hydrolysis, hydrolysis equilibrium shift (*question 3*).
23. Galvanic cell. Nernst equation (*question 3*).
24. Main provisions of structural theory of organic compounds (A.M. Butlerov)
25. Alkanes. Structure, isometry, nomenclature. Main methods of preparation. Physical and chemical properties of alkanes.
26. Alkenes. Structure, isometry, nomenclature. Main methods of preparation. Polymer compounds (polyethylene, polypropylene)
27. Physical and chemical properties of alkenes.

28. Dienes. Structure, isometry, nomenclature, classification. Electronic structure. Main methods of preparation.
29. Physical and chemical properties of dienes. Application. Natural caoutchouc and its synthetic analogues.
30. Alkynes. Structure, isometry, nomenclature. Main methods of preparation. Physical and chemical properties of alkynes.
31. Arenes (aromatic compounds). Benzene molecule structure. Benzene homologues, their isometry and nomenclature. Multinuclear arenes and their nomenclature. Methods of arenes preparation.
32. Physical and chemical properties of arenes.
33. Alcohols and phenols. Classification, structure, isometry, nomenclature. Methods of preparation.
34. Physical and chemical properties of alcohols.
35. Physical and chemical properties of phenols.
36. Aldehydes and ketones. Classification, structure, isometry, nomenclature. Properties and methods of preparation.
37. Carboxylic acids. Classification, structure, isometry, nomenclature. Methods of preparation.
38. Physical and chemical properties of carboxylic acids.
39. Fats as type of esters.
40. Monosaccharides. Classification, isometry, nomenclature. Biological importance.
41. Disaccharides. Sources of preparation, structure, physical and chemical properties.
42. Polysaccharides. Sources of preparation, structure, physical and chemical properties.
43. Amines. Classification, structure, isometry, nomenclature. Properties and methods of preparation.
44. Amino acids. Classification, isometry, nomenclature. Physical and chemical properties of amino acids.
45. Proteins. Structure, properties. Peptide synthesis.
46. Nucleic acids. Structure, properties.

Answers to the questions must be illustrated with examples using chemical substances and, if necessary, chemical reaction equations. Pay attention to chemical terminology – chemical symbols and respective chemical formulas.

Examination card variant:

<p>MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER EDUCATION “MURMANSK ARCTIC UNIVERSITY” EXAMINATION CARD no. 1 “Chemistry”</p>
<ol style="list-style-type: none"> 1. Solutions. Chemical theory of solutions. Solution preparation 2. How will the rate of the forward reaction change in the system: $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$, $\Delta H = -192$ KJ if the pressure is increased three times? 3. What is the pH of a 0.15 M hydrochloric acid solution?
<p>Head of the Department _____ Dyakina T.A. Record No. ____ dated « ____ » _____ 202</p>

Grade	Answer assessment criteria
<i>Excellent</i>	Student understands the material thoroughly; reproduces it fully, clearly and logically; applies theory to practice; has no inhibitions in answering an altered question. Uses specific terminology; demonstrates extensive knowledge in the subject; provides references to specialized resources, including online-resources, while answering the questions.
<i>Good</i>	Student understands the material thoroughly; reproduces it logically and to the point, without major errors in answering the question; uses specific terminology well; may experience some difficulties in answering clarifying questions on the subject; generally demonstrates extensive knowledge in the subject.
<i>Satisfactory</i>	Student understands only basic material without details; makes mistakes and not fully correct wording; is poorly familiar with specific terminology; makes significant mistakes in answering; poorly uses special information resources.
<i>Unsatisfactory</i>	Student does not understand a major part of the material, makes significant mistakes, violations of the logical sequence in presenting the material, does not know special terminology, does not use special information resources. No answer to the posed question was given.

The grade, earned at the examination, is then converted into points (“5/excellent” – 20 points; “4/good” – 15 points; “3/satisfactory” – 10 points) and is added to the points, earned during the formative assessment.

Competence mastery level	Final grade	Total sum of points	Assessment criteria
<i>Advanced</i>	<i>Excellent</i>	91-100	All milestones of the formative assessment have been completed at a high level. The exam is passed.
<i>Above average</i>	<i>Good</i>	81-90	All milestones of the formative assessment have been completed. The exam is passed.
<i>Sufficient</i>	<i>Satisfactory</i>	70-80	The milestones have been completed partially. The exam is passed.
<i>Insufficient</i>	<i>Unsatisfactory</i>	69 or less	The milestones have not been completed, or the exam is not passed.

5. Diagnostic tasks for the assessment of the educational results in the discipline (module) within the framework of internal and external independent assessment of the quality of education

Assessment materials contain tasks for assessing knowledge, skills and abilities that demonstrate the level of competence mastery and indicators of their mastery.

The set of tasks is designed so as to assess each competence in written form.

The set of tasks includes: *test*

Set of tasks for diagnostics

YK-1 Can design action plans and apply systematic approach to critical analysis of problem situations	
1	Topic: The structure of the atom and the periodic system. (choose one answer) The electronic configuration of the valence energy level $3d^54s^1$ corresponds to the ground state of the element atom...1)Mo; 2) S ; 3) Se; 4) Cr
2	Topic: Chemical bonding and structure of matter. (choose one answer)

	The formula of a substance whose molecule contains the same number of σ - and π -bonds is... SiO_2 2) HNO_3 3) CO_2 4) HClO_4
3	Topic: Classes of inorganic compounds. (choose two answers) When ammonia is passed into a solution of orthophosphoric acid, salts are formed, the formulas of which are ___ and ____. $\text{NH}_4\text{H}_2\text{PO}_4$ 2) $(\text{NH}_4)_3\text{PO}_4$ 3) $(\text{NH}_4)_2\text{HPO}_4$ 4) NH_4PO_3
4	Topic: Methods of expressing the composition of solutions. Calculate the mass fraction of sodium chloride in the solution obtained after evaporating 300 g of water from an 800 g solution with a mass fraction of 10%. Give your answer in % (to the nearest whole number).
5	Topic: Equilibria in electrolyte solutions. The formula of a salt whose pH value in an aqueous solution is less than 7 is... 1) $(\text{NH}_4)_2\text{SO}_4$ 2) CH_3COONa 3) $(\text{NH}_4)_2\text{S}$ 4) Na_2SO_4
6	Topic: Redox reactions. Molar mass of an oxidizing substance in a redox reaction, the scheme of which has the form of $\text{KBr} + \text{KBrO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Br}_2 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O}$, equals ___ g/mol. 1) 160; 2) 119; 3) 167; 4) 98
7	Topic: Theoretical foundations of analytical chemistry. (give a solution, write down the answer to the nearest tenth) Calculate the pH of a 0.05 M KOH solution.
8	Topic: Qualitative chemical analysis. When an excess of aqueous ammonia solution acts on a solution containing ions Al^{3+} , Fe^{3+} , Zn^{2+} , Cu^{2+} , ... precipitate. $\text{Al}(\text{OH})_3$ и $\text{Cu}(\text{OH})_2$; 2) $\text{Al}(\text{OH})_3$ и $\text{Fe}(\text{OH})_3$; 3) $\text{Fe}(\text{OH})_3$ и $\text{Zn}(\text{OH})_2$; 4) $\text{Zn}(\text{OH})_2$ и $\text{Cu}(\text{OH})_2$
9	Topic: Quantitative analysis. When determining the carbonate hardness of water by acid-base titration, ... is used as an indicator. 1) methyl orange; 2) phenolphthalein; 3) murexide; 4) eriochrome black
10	Topic: Physico-chemical and physical methods of analysis. The glow of atoms or molecules that occurs when electrons transition from an excited state to a ground state is called... 1) relaxation; 2) photoemission; 3) photolysis; 4) luminescence
11	Topic: Theory of the structure of organic compounds 1) butane; 2) cyclopentene; 3) benzene; 4) butine.
12	Topic: Hydrocarbons. Hydrocarbons that correspond to the homological formula are... 1) alkanes; 2) cycloalkenes; 3) alkenes; 4) cycloalkanes.
13	Topic: Alcohols, phenols, carbonyl compounds. When saturated ketones are hydrogenated in the presence of a catalyst, ... 1) esters; 2) primary alcohols; 3) ethers; 4) secondary alcohols
14	Topic: Carboxylic acids and their derivatives. When sodium benzoate is fused with sodium hydroxide, the main product is... 1) biphenyl; 2) 1,2-diphenylethane; 3) toluene; 4) benzene
15	Topic: Fundamentals of chemical thermodynamics. According to the basic principles of thermodynamics, for the state of equilibrium in isobaric-isothermal systems the following expression is true... $\Delta G=0$ 2) $\Delta H<0$ 3) $\Delta S=0$ 4) $\Delta G < 0$
16	Topic: Chemical kinetics and catalysis. (give a solution, write down the answer to the nearest integer) The rate of a chemical reaction increased 16 times when the temperature increased from 200C to 600C. Calculate the temperature coefficient of the rate of this reaction.
17	Topic: Chemical equilibrium.

	The equation for the equilibrium constant of the heterogeneous chemical reaction of dilution of magnesium carbonate has the form...
18	Topic: General properties of solutions. (give a solution, write down the answer to the nearest tenth) The freezing point of a solution containing 12.0 g of formaldehyde in 400 g of water is ____ °C
19	Topic: Electrochemical processes. Galvanic cell. Corrosion of metals. Draw a diagram of a galvanic cell consisting of iron and nickel electrodes immersed in 0.5 M solutions of their sulfates. Write the equation for the reaction that occurs at the anode.
20	Topic: Electrochemical processes. Electrolysis The formula of a salt whose solution after electrolysis with inert electrodes has a pH < 7 is ... 1) $\text{Cu}(\text{NO}_3)_2$ 2) HNO_3 3) NaCl 4) NaNO_3
21	Topic: Surface phenomena and adsorption. During the process of adsorption of a substance at the interface, the entropy of the system ... 1) remains constant; 2) increases; 3) decreases; 4) approaches zero
22	Topic: Dispersed systems. Dispersed systems, called suspensions, include ____ and ____ in water. 1) clay; 2) oil; 3) rosin; 4) sugar
23	Topic: Colloidal solutions. The process of neutralizing the electrical charge and removing the hydration shell of colloidal particles, resulting in the formation of a precipitate, is called: 1) coagulation; 2) coacervation; 3) recharging; 4) solubelization
24	Topic: Properties and application of colloidal solutions. $\text{Fe}(\text{OH})_2$ sol was obtained by mixing equal volumes of 0.01 N. KOH solution and 0.015 N. FeCl_2 solution. Write the formula of a sol micelle. Which of the following electrolytes will have a stronger coagulating effect: lead nitrate, manganese sulfate or potassium phosphate, provided that cations cause coagulation of the sol? Specify the formula of the coagulant electrolyte.
25	Topic: Organic and inorganic polymers A representative of synthetic inorganic polymers is... 1) graphite; 2) corundum; 3) quartz; 4) ebonite
26	Topic: Methods for producing polymers. (– choose one answer) The formula of the substance that is the starting monomer for the production of polyvinyl chloride is ... 1) $\text{ClCH} = \text{CHCl}$; 2) $\text{Cl}_2\text{C} = \text{CCl}_2$; 3) $\text{CH}_2 = \text{CHCl}$; 4) $\text{CH}_2 = \text{CHCH}_2\text{Cl}$
27	Topic: Structure and properties of polymers. The process of crosslinking rubber macromolecules as a result of its interaction with sulfur when heated is called... 1) stabilization; 2) structuring; 3) vulcanization; 4) polycondensation
28	Topic: Biopolymers One of the characteristic features of the primary structure of a protein macromolecule is the presence of ____ bonds in it. 1) covalent polar; 2) ethereal; 3) peptide; 4) donor-acceptor