Methodological guidelines for the discipline (module)

Chemistry

Educational programme **31.05.01 General Medicine**

Specialization **General Medicine (in a foreign language)**

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Methodological guidelines for the discipline (module) **Chemistry** were reviewed and approved at the Chemistry Department meeting.

General provisions

The purpose of the present guidelines is to provide students with a well-organised learning process, including various self-study activities.

Mastering the discipline requires both in-class learning and self-study work. In-class learning includes lectures and seminars. In-class learning is specified in the programme curriculum and discipline (module) syllabus.

First, it is recommended to review the discipline (module) syllabus, its structure, contents and assessment methods prior to starting the course.

While reviewing the syllabus, pay attention to the following:

- Some topics and units are not covered during lectures instead students are required to do self-study according to the recommended list of main and supplementary literature and educational and methodological manuals;
- Covered theory, methodology and formulas included in the self-study topics and units should be self-assessed according to self-check questions;
- The content of self-studied topics is integrated in the formative and interim assessment.

Each discipline (module) syllabus is accompanied by methodological materials.

Some educational and methodological manuals for the discipline, such as study aids or lecture notes, guidelines to laboratory work and case study, etc., can be found on MAU Electronic Information and Educational Environment (LMS Moodle).

Students are also suggested to get educational literature needed for all types of in-class learning, as well as self-study work, from MAU library.

Types of academic work, scheduled deadlines, as well as assessment system are compiled in the discipline checklist.

Table 1. Formative and interim assessment checklist Б1.О.14 "Chemistry" (interim assessment – "examination")

№	Milestones	Credit points		Assessment period (weeks)
		min	max	
Formative assessment				
1	**Lecture attendance and participation**	8	12	as per the timetable
	75% lecture attendance – 12 pts.; less than 75% - 8 pts.			
2	**Practical work**	22	28	as per the timetable
	Preparation and discussion of a topic for practical work (10 topics) on time – 28 pts. Partial completion and (or) not on time – 22 pts.			
3	**Laboratory work**	16	20	as per the timetable
	Laboratory work on-time completion – 20 pts. Not on-time completion – 16 pts.			
4	**Final test**	14	20	as per the timetable
	20 pts. – final test is completed in full, covers the question clearly and in full. 16 pts. – final test is completed in full, one minor mistake or two (or three) inaccuracies in fundamental factual information is/are present. 14 pts. – final test is completed in full, major mistakes in formulating or more than two-three inaccuracies in fundamental factual information, yet the student has the necessary skills and abilities on the topic. 0 pts. – the absence of required knowledge and skills/abilities is revealed.			
	Final score for the semester	**60**	**80**	
Interim assessment				
	Examination	**10**	**20**	
	Final credit score on the discipline	**70**	**100**	

Mastering the discipline (module) requires a systematic approach. It is necessary to regularly attend lectures, actively participate in class discussions, do written assignments, study lecture notes, and devote time and effort to self-study on the discipline (module) to successfully learn theoretical material on the discipline.

To successfully complete the course (module), students should independently manage the study load according to the study schedule.

1. Guidelines to lectures

Lectures and similar sessions are presentations of study material given by a lecturer.

The purpose of lectures is to introduce students to the science, its basic categories, patterns of the studied discipline and its methodological foundations. All this determines the contents and characteristics of the whole student's study period.

From the very beginning of the lecture, you should prepare yourself for attentive listening. Do not waste space in your notebook (always leave margins), this will allow you to make comments and notes. Remember that any topic and its main ideas should be found in the shortest possible time. Good lecture notes greatly facilitate preparation for seminars, and subsequently for the examination.

Lecture notes are not a copy of a lecture but the representation of its main idea. The notes are written for later reading, meaning that they should be made in such a way that they can be easily and quickly read after some time. Notes help to understand and retain information.

It is recommended to ask the lecturer follow-up questions to deepen the understanding of the theoretical concepts and clarify controversial issues. When preparing for seminars, students can finish the lecture notes by adding relevant ideas from the studied literature indicated in the work program of the discipline.

Lecture topics are listed in the discipline (module) syllabus.

2. Guidelines to preparing for seminars

Seminar sessions are an integral part of the study process at university. They include seminars, practical classes, case studies, laboratory work, colloquiums and similar activities.

The effectiveness of such classes highly depends on the quality of lectures and self-study. Seminar sessions are given within disciplines (modules) that require scientific and theoretical summary of literary sources, they provide advanced knowledge and skills to work with various sources of information.

Seminar sessions outlines, topics, recommended reading, learning goal and objectives are introduced during first classes, and in the methodological guidelines on MAU LMS Moodle.

A two-step approach to preparing for seminars is the following:

Step 1 – organisational. Students plan their work in the following way: understanding the task; identifying relevant reading; making an outline to set the milestones for preparation. Making outlines improves student's self- discipline and time-management skills.

Step 2 – consolidation and deepening of the theoretical knowledge. This step supposes preparation for the seminar. Students are advised to begin with recommended literature. Remember that only some material is covered in lectures. Therefore, working with the recommended literature is mandatory. Pay attention to the main concepts and conclusions, explanations of phenomena and facts, grasping practical application of theoretical material. Students should understand and memorise the main points of the material, examples, as well as

examine visual aids. Finalise your preparation by making an outline (summary) of the material (topic). This allows you to get a concentrated, contracted knowledge of the studied chapters.

There are four types of notes:

Outline notes – a detailed plan that covers points that require explanation.

Summary notes – writing down the most important concepts and facts.

Free-structure notes - writing down clearly and briefly the main statement after comprehending the material. You may include extracts, citations, bullet-points; some material may be organized as an outline.

Issue-related notes – compiling the information from different sources on a particular diagram (issue).

Practical classes are designed for students to work on one or more practice assignments under the guidance of a teacher. While lectures mainly focus on the theoretical part of a course, practical classes teach methods of theory application. The main goal of such classes is to acquire methods of theory application and skills necessary to complete subsequent courses.

The effectiveness of practical classes largely depends on the quality of previous lecture-type classes and students' self-study. Seminar-type classes are conducted in disciplines (modules) that require scientific and theoretical generalization of literary sources, and help students to better understand educational material and acquire skills in creative work with various sources of information. Students should comprehend theoretical problems, connect them with real life and possible ways of their implementation.

The list of topics of practical work

№	Practical work topics	Volume
1	Fundamental chemistry laws. Chemical calculations.	2
2	Quantitative composition of solutions.	2
3	Oxidation and reduction	2
4	General characteristics of non-metals	2
5	General characteristics of metals	2
6	Fundamentals of chemical thermodynamics	2
7	Kinetics of chemical reactions	2
8	Qualitative methods of analysis	2
9	Acyclic hydrocarbons	2
10	Oxygen-containing compounds	2
11	Nitrogen-containing compounds	2
12	Biopolymers: carbohydrates, lipids, proteins	2
13	Lyophilic and lyophobic dispersion systems	2
14	Final test on the discipline	2
	In total:	**28**

Laboratory work is an activity during which students master specific methods of studying the discipline, learn experimental ways of analysing reality, and the ability to work with modern equipment. In preparation for laboratory work, it is necessary to: study or repeat lecture material on the relevant topic; study materials of educational and methodological guidelines on a given topic, paying special attention to calculation formulas; when performing home calculation tasks, study and repeat typical tasks performed in classroom classes.

If necessary, ask the teacher for advice.

The list of topics of laboratory work

№	Laboratory work topics	Volume
1-2	Main classes of inorganic substances: chemical properties and their preparation	4
3	Preparation of solutions	2
4	Qualitative analysis of cations	2

5	Qualitative analysis of anions	2
6	Kinetics of chemical reactions. Chemical equilibrium	2
7	Calorimetric determination of the heat of salt solution	2
8	Aliphatic hydrocarbons: preparation and chemical properties	2
9	Alcohols and phenols: preparation and chemical properties	2
10	Aldehydes and ketones: preparation and chemical properties	2
	In total:	**20**

3. Group and one-to-one office hours

Office hours are times when students can meet the teacher outside of class to discuss the material or related issues.

Office hours are offered:

- to address in detail some practical issues that were insufficiently covered or omitted in lectures;
- to advise on self-study (writing term papers, essays, tests, calculation and graphic papers, course papers (projects), preparing for interim assessment, participating in a conference, etc.);
- to assist students in addressing controversial or difficult issues within the discipline (module).

Before attending office hours, think carefully about the issues that require clarification. If you have difficulty understanding theoretical material, you need to specify which of the points you failed to understand.

If you have difficulty solving a problem or preparing a laboratory work report, indicate the stage of the problem you cannot solve or the requirement you cannot fulfil.

4. Guidelines to organising self-study

Successful competencies development formed by the discipline implies efficient use of time for self-study work.

Self-study is a way of learning that involves studying alone under the teacher's assignment, guidance and observation. Students possessing self-study skills get a better and deeper knowledge of the study material, are better prepared for creative work, self-education and continuing education.

Self-study work can be both in-class and out-of-class. The types of self-study work often overlap.

In-class self-study is performed under the teacher's assignment during learning sessions, including:

- individual tasks, tests;
- practical assignments;
- problem solving, drawing up images (such as schemes, diagrams, tables, etc.);
- reviewing reference, methodological, and special literature;
- writing a report on performed work;
- preparation for discussions, completing tasks in a role-play simulation, etc.

Out-of-class self-study (in MAU library, laboratory, at home, in self-study rooms, etc.) is obligatory (according to the syllabus) and it does not involve immediate and constant guidance from the teacher.

Out-of-class self-study may include:

- preparation for in-class learning sessions (lectures, seminars, etc.) and homework;
- self-studying single chapters of the course (module) according to the syllabus;
- reviewing the recommended list of main and supplementary literature in connection to lecture notes;
- writing reports, essays, preparing presentations, compiling glossaries, etc.;
- preparing for different types of practical training and completing the tasks according to the syllabus;
- preparing for different types of formative, interim and final assessment;
- participating in research, project and creative activities within a discipline (module);
- preparing for competitions, Olympiads, conferences, work in student scientific associations and clubs;
- other types of self-study.

The syllabus of the discipline, practical training, final assessment programme determine the contents of self-study work. The assignments for self-study have scheduled deadlines.

Any type of self- study includes the following steps:

1. Setting the goal.
2. Specifying a learning (problem or practical) objective.
3. Self-assessing your preparedness to work independently on an assigned or selected objective.
4. Selecting a course of action to address the objective.
5. Planning (independently or with the instructor) self-study to address the solution.
6. Following the self-study plan.
7. Checking the progress of self-study, assessing the results.
8. Reflecting on your study performance.

Reviewing the scientific and educational literature

Reviewing educational and scientific literature is the keynote of self-study; it is necessary to read for seminars, quizzes, tests, and "credit" assessments.

While reviewing educational and scientific literature, students can:

- make a short or detailed outline (make a list of the main issues);
- summarise (cite the most important information from an article or monograph, make a short summary of the key ideas expressed by the author);
- make abstracts (a short summary of the main issues);
- make notes (detailed information).

Upon selecting the appropriate resource, students should find the relevant chapter in the contents or index, as well as related lecture notes or chapter from a textbook. In case understanding the educational material is difficult, students may refer to other sources that may cover the issue more clearly. It should be noted that the skill of reviewing literature helps to gain better knowledge within a discipline and becomes a part of being a professional practitioner.

Preparing for tests

The purpose of a test is to assess students' knowledge of the theoretical material on the discipline (the content and scope of general and special concepts, terms, factors and mechanisms) and the development of educational skills.

Tests also let students control their level of knowledge, identify knowledge gaps and address them. Tests include key questions on theoretical and practical foundations of a discipline (module).

To prepare for testing, students should:

- review the material on the discipline,
- learn the details of testing in advance: how many tests you will need to take, how much time is allotted, the result assessment system, etc.

While taking a test, it is necessary to:

- carefully and fully read the questions and the given answers, choose the correct one(s) (there may be several correct answers);
- use different approaches to complete the tasks (this allows you to find the solution flexibly and effectively);
- skip “difficult” questions on the first pass, go back to them later;
- leave time to double-check the answers to avoid any errors.

Typical test tasks can be found in the assessment materials on the discipline (module).

5. Guidelines to preparing for interim assessment

Б1.0.14 “Chemistry” discipline (module) ends in “examination” assessment according to the syllabus.

The interim assessment is aimed at checking the results of completing the discipline.

To prepare for the examination, it is suggested:

- to study the list of questions attentively and determine what resources may give the required data to answer the questions;
- to read the suggested literature attentively;
- to make brief notes of the answers (answer plans).

While reviewing the material, it is recommended to use a limited amount of literature sources. The main source for examination preparation is the lectures notes. It is suggested to learn the terminology and categories because these contain the characteristics that help understand their nature and differentiate them from other terms. While preparing, students should pay attention not only to their memorization, but also to the degree of understanding of these categories and real professional problems. Preparation for the examination should be aimed both at memorizing and understanding the educational material equally. During this period, communication between students and teachers either in group or individually may be useful.

Examination card preparation should begin with what you remember best. However, when preparing for a particular question, keep writing notes on other questions that come to your mind.

During the exam, students may use the syllabus, as well as reference literature with the permission of the examiner.

After completing the answer, the examiner may ask the student additional and clarifying questions.

The student's desire to present various points of view on the issue under consideration, express their attitude to it, and apply theoretical knowledge to modern problems is welcomed.

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 hydracids, 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.