

Документ подписан простой электронной подписью  
Информация о владельце:  
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Должность: Проректор по учебно-воспитательной работе  
Дата подписания: 26.06.2026 10:08:25  
Уникальный программный ключ:  
e0eb125161f4cee9ef898b5de88f5c7dcefdc28a

**Abstract of the discipline's work program**  
**B1.O.14.02 "Analytical chemistry"**  
**for training specialists in the field of training**  
**36.05.01 Veterinary Medicine**  
**Profile: «General clinical veterinary medicine»**

**The purpose of mastering the discipline:** acquiring skills in using inorganic and analytical chemistry in professional activities, i.e. study of chemicals to assess the possibility of their effective use in animal therapy and surgery.

**Place of discipline in the curriculum:** Discipline B1.O.14.02 "Analytical Chemistry" is a compulsory discipline in Block 1 of the mandatory part of the federal state educational standard of higher education in specialty 36.05.01 "Veterinary Medicine" (specialty level).

Mastered in the 2nd semester - full-time.

**Requirements for the results of mastering the discipline:** studying the discipline should form the following competencies: UC-1, GPC-4.

**A) Universal Competencies (UC):**

UC-1 Able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy:

UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;

UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.

**B) general professional competencies (GPC):**

GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:

GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;

GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.

**Brief content of the discipline:**

Introduction to analytical chemistry. Classification of methods of analytical chemistry. Metrology in analytical chemistry. Titrimetry, its theoretical foundations. Acid-base titration. Complexometric titration. Redox titration.

**Total labor intensity of the discipline:** 2 credit unit (72 hours).

**Final control in the discipline:** test

Ministry of Agriculture of the Russian Federation  
Federal State Budgetary Educational Institution  
higher education  
"St. Petersburg State University of Veterinary Medicine"

APPROVED BY  
Vice-Rector  
for educational work  
and youth policy  
Professor  
A.A. Sukhinin  
April 10, 2026



**Department of Inorganic Chemistry and Biophysics**

**WORKING PROGRAMM**

by discipline

**"ANALYTICAL CHEMISTRY"**

Level of higher education

**SPECIALTY**

**Specialty 36.05.01 Veterinary Medicine**

**Profile: «General clinical veterinary medicine»**

Full-time education

Education starts in 2026

Reviewed and accepted  
at a department meeting  
on March 18, 2026  
Protocol No. 08-03-25/26

Head department of  
Inorganic Chemistry and Biophysics  
Candidate of Chemical Sciences, Associate Professor

  
A.N. Baryshev

Saint Petersburg  
2026

## 1. GOALS AND OBJECTIVES OF THE DISCIPLINE

The main goal of the discipline in the training of veterinarians is to give students fundamental knowledge about chemicals to assess the possibility of their effective use in animal therapy and surgery.

To achieve this goal, it is necessary to solve the following tasks:

a) The general educational task is to in-depth familiarize students with the main chemical substances used in veterinary medicine, their properties and methods of production, which meets the requirements for higher educational institutions of biological profile.

b) The applied task concerns the acquisition of skills in conducting chemical experiments and reactions, including the identification of inorganic substances used as veterinary medicine.

c) The special task is to familiarize students with modern trends and methodological approaches used in inorganic and analytical chemistry, as well as existing achievements in this area.

## 2. LIST OF PLANNED MASTERING RESULTS IN A DISCIPLINE (MODULE), CORRELATED WITH THE PLANNED RESULTS OF MASTERING THE EDUCATIONAL PROGRAM

As a result of mastering the discipline, the student prepares for the following types of activities in accordance with the educational standard of Federal State Educational Standard of Higher Education 36.05.01 "Veterinary Medicine".

Area of professional activity:

13 Agriculture

Types of professional activity tasks:

- medical;
- expert control;
- scientific and educational.

### Student competencies formed as a result of mastering the discipline

Studying the discipline should form the following competencies:

#### A) Universal Competencies (UC):

UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:

UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;

UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.

#### B) General professional competencies (GPC):

GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:

GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;

GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.

### 3. THE PLACE OF DISCIPLINE IN THE STRUCTURE OF THE MPEP

Discipline B1.O.14.02 “Analytical Chemistry” is a mandatory discipline in Block 1 of the mandatory part of the federal state educational standard of higher education in specialty 36.05.01 “Veterinary Medicine” (specialty level).

Mastered in the 2nd semester - full-time.

When teaching the discipline “Analytical Chemistry”, the knowledge and skills acquired by students while mastering the school level of chemistry are used. The discipline “Inorganic and Analytical Chemistry” is the basic one on which most subsequent disciplines are built, such as:

- 1) Organic and physical colloid chemistry.
- 2) Biological chemistry.
- 3) Veterinary microbiology and mycology.
- 4) Veterinary pharmacology.
- 5) Toxicology.
- 6) Physiology and ethology of animals.
- 7) Feeding animals with the basics of feed production.
- 8) Veterinary and sanitary examination.
- 9) Life safety.

### 4. SCOPE OF THE DISCIPLINE “ANALYTICAL CHEMISTRY”

#### 4.1. Scope of the discipline “Analytical Chemistry” for full-time study

Type of educational work	Total hours	Semester
		2
<b>Classroom lessons (total)</b>	<b>72</b>	<b>72</b>
Including:		
Lectures, including interactive forms		
<b>Practical lessons (PL), including interactive forms, of which:</b>	<b>34</b>	<b>34</b>
practical training (PT)	2	2
<b>Independent work (total)</b>	<b>38</b>	<b>38</b>
Control		
Type of intermediate certification (test, exam)	<b>Test</b>	<b>Test</b>
<b>Total labor intensity hours/credits</b>	<b>72/2</b>	<b>72/2</b>

## 5. CONTENT OF THE DISCIPLINE “ANALYTICAL CHEMISTRY”

### 5.1. Contents of the discipline “Analytical Chemistry” for full-time study

№	Name	Formed competencies	Semester	Types of educational work, including independent work of students and labor intensity (in hours)		
				L	PL	PT IW
1.	Introduction to analytical chemistry.	<p><b>UC-1</b> Able to critically analyze problem situations based on a systematic approach and develop an action strategy:</p> <p><b>UC-1ID-1</b> Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;</p> <p><b>UC-1ID-2</b> Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;</p> <p><b>UC-1ID-3</b> Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.</p> <p><b>GPC-4</b> Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:</p> <p><b>GPC-4ID-1</b> Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;</p> <p><b>GPC-4ID-2</b> Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;</p> <p><b>GPC-4ID-3</b> Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	2	2	

2.	<p>Basic concepts. Methods of analysis. Classification of analytical chemistry.</p>	<p>UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:  UC-1IID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;  UC-1IID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;  UC-1IID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.  GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:  GPC-4IID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;  GPC-4IID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;  GPC-4IID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	6	8
3.	<p>Aggregate states of matter and solutions of non-electrolytes. Electrolyte solutions.</p>	<p>UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:  UC-1IID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;  UC-1IID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;  UC-1IID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.  GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:  GPC-4IID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;  GPC-4IID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;  GPC-4IID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	6	8

4.	<p>Titrimetric methods of analysis. Acid-base titration. Titration curves.</p>	<p><b>UC-1</b> Able to critically analyze problem situations based on a systematic approach and develop an action strategy:  <b>UC-1ID-1</b> Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;  <b>UC-1ID-2</b> Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;  <b>UC-1ID-3</b> Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.  <b>GPC-4</b> Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:  <b>GPC-4ID-1</b> Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;  <b>GPC-4ID-2</b> Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;  <b>GPC-4ID-3</b> Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	6	2	4
5.	<p>Complex connections.</p>	<p><b>UC-1</b> Able to critically analyze problem situations based on a systematic approach and develop an action strategy:  <b>UC-1ID-1</b> Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;  <b>UC-1ID-2</b> Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;  <b>UC-1ID-3</b> Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.  <b>GPC-4</b> Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:  <b>GPC-4ID-1</b> Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;  <b>GPC-4ID-2</b> Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;  <b>GPC-4ID-3</b> Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	6	6	8

6.	<p>Redoximetry. Complexometric titration. Chelatometry.</p>	<p>UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:  UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;  UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;  UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.  GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:  GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;  GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;  GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	2	6	2	38
<b>TOTAL FOR 2ND SEMESTER</b>		32	2	38		

## 6. LIST OF EDUCATIONAL AND METHODOLOGICAL SUPPORT FOR INDEPENDENT WORK

### 6.1. Guidelines for independent work

1. Analytical chemistry: an educational and methodical manual for students of the first year of the Russian Academy of Medical Sciences, VSE, BEC, and VBRiA / comp.: T. P. Lutsko, A.V. Osipova, A. N. Baryshev, P. M. Sargaev; Ministry of Agriculture of the Russian Federation, SPbGAVM. - Saint Petersburg : FSBEI HE SPbGAVM, 2017. - 37 p. - Access mode: for authors. EB SPbGUVM users. - URL: <https://search.spbguvvm.informsystema.ru/viewer.jsp?aWQ9NTUzJnBzPTM3> (date of access: 03/18/2026) - Text : electronic.

### 6.2. Literature for independent work

1. Analytical chemistry: educational method. aid for students 1st year FVM, VSE, BEC, VBRiA / comp. T. P. Lutsko [and others]; SPbGAVM. - St. Petersburg. : Publishing house SPbGAVM, 2016. - 39 p. – URL: <https://search.spbguvvm.informsystema.ru/viewer.jsp?aWQ9MTQ5JnBzPTQw> (date of access: 03/18/2026). – Text: electronic.

## 7. LIST OF BASIC AND ADDITIONAL LITERATURE REQUIRED FOR MASTERING THE DISCIPLINE

### a) basic literature:

1. Analytical Chemistry : a teaching aid for 1st year students of the Faculty of Veterinary Medicine / A. N. Baryshev, T. P. Lutsko, V.S. Fedorov [et al.] ; Ministry of Agriculture of the Russian Federation, St. Petersburg State University of Veterinary Medicine. - Saint Petersburg : Publishing House of SPbGUVVM, 2024. - 53 p. - Access mode: for authors. EB SPbGUVVM users. - URL: <https://search.spbguvvm.informsystema.ru/viewer.jsp?aWQ9MTg4NDEmcHM9NTM=> (access date: 03/18/2026) - Text : electronic.

### b) additional literature:

1. Inorganic and Analytical Chemistry : a teaching aid for 1st-year students of the Faculty of Veterinary Medicine, as well as for the Faculty of Veterinary Medicine in full-time and part-time (evening) education / A. N. Baryshev, P.M. Sargaev, T. P. Lutsko, R. A. Zlotnikova ; Ministry of Agriculture of the Russian Federation, St. Petersburg State University - 4th ed., revision and additional. - St. Petersburg : FSBEI HE SPbGAVM, 2016. 112 p. - Access mode: for authors. EB SPbGUVVM users. - Text : electronic. URL: <https://search.spbguvvm.informsystema.ru/viewer.jsp?aWQ9NjYxJnBzPTEyNA> (access date: 03/18/2026) - Text : electronic.

## 8. LIST OF RESOURCES OF THE INTERNET INFORMATION AND TELECOMMUNICATION NETWORK NECESSARY FOR MASTERING THE DISCIPLINE

To prepare for practical classes and perform independent work, students can use the following Internet resources:

1. <https://meduniver.com> – Medical information site.
2. <http://vanat.cvm.umn.edu>– Inorganic and Analytical Chemistry University of Minnesota

### Electronic library systems:

1. [EBS "SPBGUVVM"](#)
2. [EBS "Student Consultant"](#)
3. [Legal reference system "ConsultantPlus"](#)
4. [University information system "RUSSIA"](#)

5. Full text database POLPRED.COM
6. Scientific electronic library ELIBRARY.RU
7. Russian Scientific Network
8. Electronic library system IQlib
9. Web of Science International Science Citation Index Database
10. Full-text interdisciplinary database for agricultural and environmental sciences  
ProQuest AGRICULTURAL AND ENVIRONMENTAL SCIENCE DATABASE
11. Electronic books from the publishing house "Prospekt Nauki"  
<http://prospektnauki.ru/ebooks/>
12. Collection "Agriculture. Veterinary" publishing house "Kvadro"  
<http://www.iprbookshop.ru/586.html>

## 9. METHODOLOGICAL INSTRUCTIONS FOR STUDENTS ON MASTERING THE DISCIPLINE

Methodological recommendations for students are a set of recommendations and explanations that allow the student to optimally organize the process of studying this discipline. The content of methodological recommendations, as a rule, may include:

- Tips for planning and organizing the time needed to study the discipline. Description of the sequence of student actions, or "scenario for studying the discipline."

The morning time is the most fruitful for educational work (from 8-14 o'clock), then the afternoon (from 16-19 o'clock) and the evening time (from 20-23 o'clock). The most difficult material is recommended to be studied at the beginning of each time interval after rest. After 1.5 hours of work, a break (10-15 minutes) is required; after 4 hours of work, the break should be 1 hour. Part of the scientific organization of labor is mastering the technique of mental work. Normally, a student should devote about 10 hours a day to studying (6 hours at the university, 4 hours at home).

- Recommendations for working on lecture material

When preparing for a lecture, the student is recommended to:

- 1) review the recordings of the previous lecture and recall previously studied material in memory;
- 2) it is useful to review the upcoming material of the future lecture;
- 3) if independent study of individual fragments of the topic of the last lecture is assigned, then it must be completed without delay;
- 4) prepare yourself psychologically for the lecture.

This work includes two main stages: taking notes of lectures and subsequent work on lecture material.

Note-taking means drawing up notes, i.e. a brief written statement of the content of something (oral presentation - speech, lecture, report, etc. or a written source - document, article, book, etc.).

The method of work when taking notes on oral presentations differs significantly from the method of work when taking notes from written sources.

By taking notes from written sources, the student has the opportunity to repeatedly read the desired passage of text, reflect on it, highlight the main thoughts of the author, briefly formulate them, and then write them down. If necessary, he can also note his attitude to this point of view. While listening to a lecture, the student must put off most of the above-mentioned work for another time, trying to use every minute to record the lecture, and not to comprehend it - there is no time left for this. Therefore, when taking notes from a lecture, it is recommended to separate fields on each page for subsequent entries in addition to the notes.

After recording a lecture or taking notes, you should not leave work on the lecture material until you begin preparing for the test. It is necessary to do as early as possible the work that accompanies note-taking of written sources and which was not possible to do while recording the lecture - read your notes, deciphering individual abbreviations, analyze the text, establish logical

connections between its elements, in some cases show them graphically, highlight main thoughts, note issues that require additional processing, in particular, teacher consultation.

When working on the text of a lecture, the student needs to pay special attention to the problematic questions posed by the teacher when giving the lecture, as well as to his assignments and recommendations.

For each lecture, practical lesson and laboratory work, the number, topic, list of issues covered, volume in hours and links to recommended literature are provided. For classes conducted in interactive forms, their organizational form must be indicated: computer simulation, business or role-playing game, analysis of a specific situation, etc.

- Recommendations for preparing for practical classes

Practical (seminar) classes constitute an important part of students' professional training. The main goal of conducting practical (seminar) classes is to develop analytical, creative thinking in students by acquiring practical skills. Practical classes are also conducted with the aim of deepening and consolidating the knowledge gained at lectures and in the process of independent work on regulatory documents, educational and scientific literature. When preparing for a practical lesson for students, it is necessary to study or repeat theoretical material on a given topic.

When preparing for a practical lesson, the student is recommended to adhere to the following algorithm;

- 1) familiarize yourself with the plan for the upcoming lesson;
- 2) study the literature sources that were recommended and read the introductory notes to the relevant sections.

Methodological instructions for practical (seminar) classes in the discipline, along with the work program and schedule of the educational process, refer to methodological documents that determine the level of organization and quality of the educational process.

The content of practical (seminar) classes is recorded in the working curriculum of the disciplines in the sections "List of topics for practical (seminar) classes."

The most important component of any form of practical training is assignments. The basis of the assignment is an example, which is analyzed from the perspective of the theory developed in the lecture. As a rule, the main attention is paid to the formation of specific skills and abilities, which determines the content of students' activities - problem solving, laboratory work, clarification of the categories and concepts of science, which are a prerequisite for correct thinking and speech.

Practical (seminar) classes perform the following tasks:

- stimulate regular study of recommended literature, as well as attentive attention to the lecture course;
- consolidate the knowledge gained in the process of lecture training and independent work on literature;
- expand the scope of professionally significant knowledge, skills and abilities;
- allow you to check the correctness of previously acquired knowledge;
- instill skills of independent thinking and oral presentation;
- promote free use of terminology;
- provide the teacher with the opportunity to systematically monitor the level of students' independent work.

Methodological instructions for practical (seminar) classes in the discipline should be focused on modern business conditions, current regulatory documents, advanced technologies, on the latest achievements of science, technology and practice, on modern ideas about certain phenomena and the reality being studied.

- Recommendations for working with literature.

Working with literature is an important stage of a student's independent work in mastering a subject, contributing not only to consolidation of knowledge, but also to broadening his horizons, mental abilities, memory, ability to think, present and confirm his hypotheses and ideas. In addition, research skills necessary for future professional activities are developed.

When starting to study literature on a topic, it is necessary to make notes, extracts, and notes. It is imperative to take notes on the works of theorists, which allow one to comprehend the theoretical basis of the study. For the rest, you can limit yourself to extracts from studied sources. All extracts and quotations must have an exact "return address" (author, title of work, year of publication, page, etc.). It is advisable to write an abbreviated name of the question to which the extract or quotation relates. In addition, it is necessary to learn how to immediately compile a card index of specialized literature and publications of sources, both proposed by the teacher and identified independently, as well as refer to bibliographic reference books, chronicles of journal articles, book chronicles, and abstract journals. In this case, publications of sources (articles, book titles, etc.) should be written on separate cards, which must be filled out in accordance with the rules of bibliographic description (surname, initials of the author, title of work. Place of publication, publisher, year of publication, number of pages, and for journals articles – journal name, year of publication, page numbers). On each card, it is advisable to record the thought of the author of the book or a fact from this book on only one specific issue. If the work, even in the same paragraph or phrase, contains further judgments or facts on another issue, then they should be written out on a separate card. The presentation should be concise, accurate, without subjective assessments. On the back of the card you can make your own notes about this book or article, its contents, structure, what sources it was written on, etc.

- Explanations about working with test materials for the course, recommendations for completing homework.

Testing is a check that allows you to determine whether the actual behavior of a program corresponds to what is expected if you run a specially selected set of tests. A test is the fulfillment of certain conditions and actions necessary to verify the operation of the function being tested or its part. Each question in the discipline must be answered correctly by choosing one option.

- Recommendations for completing course work (if it is included in the curriculum), defining their thematic focus, goals and objectives of implementation, requirements for content, volume, design and organization of management of their preparation on the part of departments and teachers.

## 10. EDUCATIONAL WORK

As part of the implementation of the discipline, educational work is carried out to form a modern scientific worldview and a system of basic values, the formation and development of spiritual, moral, civil and patriotic values, a system of aesthetic and ethical knowledge and values, attitudes of tolerant consciousness in society, the formation in students of the need to work as the first vital necessity, the highest value and the main way to achieve success in life, to understand the social significance of your future profession.

## 11. LIST OF INFORMATION TECHNOLOGIES USED IN THE EDUCATIONAL PROCESS

### 11.1 The educational process in the discipline provides for the use of information technologies:

- ✓ conducting practical classes using multimedia;
- ✓ interactive technologies (conducting dialogues, collective discussion of various approaches to solving a particular educational and professional problem);
- ✓ interaction with students via email;
- ✓ joint work in the Electronic Information and Educational Environment of St. Petersburg State University of Mathematics and Mathematics: <https://spbguvvm.ru/academy/eios/>

### 11.2. Software

#### List of licensed and freely distributed software, including domestically produced ones

No.	Name of technical and computer training aids recommended by sections and topics of the program	License
1	MS PowerPoint	67580828
2	LibreOffice	free software

3	OS Alt Education 8	AAO.0022.00
4	ABIS "MARK-SQL"	02102014155
5	MS Windows 10	67580828
6	System ConsultantPlus	503/KL
7	Android OS	free software

**12. MATERIAL AND TECHNICAL BASE REQUIRED FOR THE IMPLEMENTATION OF THE EDUCATIONAL PROCESS IN THE DISCIPLINE**

<b>Name of the discipline (module), practice in accordance with the curriculum</b>	<b>Name of special premises and premises for independent work</b>	<b>Equipping special rooms and rooms for independent work</b>
Analytical chemistry	104 (196084, St. Petersburg, Chernigovskaya str., building 5) Classroom for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification	<i>Specialized furniture:</i> desks, chairs, blackboard. <i>Visual aids and educational materials:</i> Periodic table of chemical elements D.I. Periodic table, Solubility table
	105 (196084, St. Petersburg, Chernigovskaya str., building 5) Classroom for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification	<i>Specialized furniture:</i> desks, chairs, blackboard. <i>Visual aids and educational materials:</i> Periodic table of chemical elements D.I. Periodic table, Solubility table
	206 Large reading room (196084, St. Petersburg, Chernigovskaya str., building 5) Room for independent work	<i>Specialized furniture:</i> tables, chairs <i>Technical training aids:</i> computers with an Internet connection and access to the electronic information and educational environment
	214 Small reading room (196084, St. Petersburg, Chernigovskaya str., building 5) Room for independent work	<i>Specialized furniture:</i> tables, chairs <i>Technical training aids:</i> computers with an Internet connection and access to the electronic information and educational environment
	324 Department of Information Technologies (196084, St. Petersburg, Chernigovskaya str., building 5) Room for storage and preventive maintenance of educational equipment	<i>Specialized furniture:</i> tables, chairs, special equipment, materials and spare parts for preventive maintenance of educational equipment
	Box No. 3 Carpentry workshop (196084, St. Petersburg, Chernigovskaya str., building 5) Room for storage and preventive maintenance of educational equipment	<i>Specialized furniture:</i> tables, chairs, special equipment, materials for preventive maintenance of specialized furniture

Annex 1 on 22 pages

**Developer:**

Candidate of Chemical Sciences, Associate Professor



A.N. Baryshev

Ministry of Agriculture of the Russian Federation  
Federal State Budgetary Educational Institution of  
Higher Education  
"St. Petersburg State University of Veterinary Medicine"

**Department of Inorganic Chemistry and Biophysics**

FUND OF ASSESMENT TOOLS  
for the discipline

for discipline

**"ANALYTICAL CHEMISTRY"**

Level of higher education

SPECIALTY

**Specialty 36.05.01 Veterinary Medicine**

**Profile: General clinical veterinary medicine**

Full-time education

Education starts in 2026

Saint Petersburg  
2026

## 1. PASSPORT OF THE ASSESSMENT FUND

**Table 1**

No.	Molded competencies	Controlled sections (topics) of the discipline	Evaluation tool
1.	<p><b>UC-1</b> Able to critically analyze problem situations based on a systematic approach and develop an action strategy:</p> <p>UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;</p>	Introduction to analytical chemistry.	Colloquium, tests
2.	<p>UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;</p>	Basic concepts. Methods of analysis. Classification of analytical chemistry.	Colloquium, tests
3.	<p>UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.</p>	Aggregate states of matter and solutions of non-electrolytes. Electrolyte solutions.	Colloquium, tests
4.	<p>GPC-4 Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:</p>	Complex connections.	Colloquium, tests
5.	<p>GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;</p> <p>GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;</p> <p>GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	Titrimetric methods of analysis. Acid-base titration. Titration curves.	Colloquium, tests
6.	<p>GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;</p> <p>GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;</p> <p>GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	Redoximetry. Complexometric titration. Chelatometry.	Colloquium, tests

## 2. Approximate list of assessment tools

table 2

No.	Name evaluation tool	Brief description of the evaluation tool	Presentation of the assessment tool in the fund
1.	Colloquium	A means of monitoring the assimilation of educational material of a topic, section or sections of a discipline, organized as a training session in the form of an interview between a teacher and students	Questions on topics/sections of the discipline
2.	Test	A system of standardized tasks that allows you to automate the procedure measuring the level of knowledge and skills of the student	Test task fund

### 3. INDICATORS AND CRITERIA FOR ASSESSING COMPETENCIES AT VARIOUS STAGES OF THEIR FORMATION, DESCRIPTION OF ASSESSMENT SCALES

Table 3

Planned results of mastering the competency	Mastery level			Evaluation tool	
	unsatisfactory	satisfactorily	Fine		Great
UC-1Able to critically analyze problem situations based on a systematic approach and develop an action strategy:	Level of knowledge in volume, appropriate program preparation, without errors.				
UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;	Knowledge level below minimum requirements, had the place is rude errors	Minimum acceptable knowledge level, a lot was allowed minor mistakes	Level of knowledge in volume, appropriate program preparation, admitted a few rough ones errors	Level of knowledge in volume, appropriate program preparation, without errors.	Colloquium, tests
UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;	When deciding standard tasks Not basic skills demonstrated, there were rough errors	The main skills, solved typical tasks with not rude mistakes, all completed tasks, but not in full	All the main ones are demonstrated skills, all solved main tasks with not rude mistakes, all completed assignments in full volume, but some with shortcomings	All the main ones are demonstrated skills, all solved main tasks with separate insignificant shortcomings, all completed assignments in full volume	Colloquium, tests
UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to	When deciding standard tasks Not demonstrated basic skills there were rough	Available minimum set skills for solutions standard tasks with some	Basic skills demonstrated when deciding standard tasks with some shortcomings	Demonstrated skills in decision non-standard tasks without errors and	Colloquium, tests

solve them; demonstrating value judgments in solving problematic professional situations.	errors	shortcomings	shortcomings	shortcomings
<p><b>GPC-4</b> Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:</p>				
<p>GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;</p>	<p>Knowledge level below minimum requirements, had the place is rude errors</p>	<p>Minimum acceptable knowledge level, a lot was allowed minor mistakes</p>	<p>Level of knowledge in volume, appropriate program preparation, admitted a few rough ones errors</p>	<p>Level of knowledge in volume, appropriate program preparation, without errors.  Colloquium, tests</p>
<p>GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;</p>	<p>When deciding standard tasks Not basic skills demonstrated, there were rough errors</p>	<p>The main skills, solved typical tasks with not rude mistakes, all completed tasks, but not in full</p>	<p>All the main ones are demonstrated skills, all solved main tasks with not rude mistakes, all completed assignments in full volume, but some with shortcomings</p>	<p>All the main ones are demonstrated skills, all solved main tasks with separate insignificant shortcomings, all completed assignments in full volume  Colloquium, tests</p>
<p>GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.</p>	<p>When deciding standard tasks Not demonstrated basic skills there were rough errors</p>	<p>Available minimum set skills for solutions standard tasks with some shortcomings</p>	<p>Basic skills demonstrated when deciding standard tasks with some shortcomings</p>	<p>Demonstrated skills in decision non-standard tasks without errors and shortcomings  Colloquium, tests</p>

## 4. LIST OF CHECK TASKS AND OTHER MATERIALS REQUIRED FOR THE ASSESSMENT OF KNOWLEDGE, ABILITIES, SKILLS AND ACTIVITY EXPERIENCE

### 4.1. Typical tasks for ongoing progress monitoring

#### 4.1.1. Questions for the colloquium

Competency assessment questions:

UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:

UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

1. Methods of expressing the concentrations of solutions and their mutual transition.
2. Working solutions, methods of their preparation.
3. Titrated, standard and standardized solutions.
4. What is a normal (standard substance)? What standard substances do you know?

UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;

5. Rules for using a burette and pipette.
6. Rules for selecting the test sample.
7. Measuring utensils, their purpose.
8. The principle of titrimetric analysis. Scope of its application.
9. The essence of acid-base titration.

UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.

10. Acid-base titration indicators. Ionic theory of indicators. Color transition area and indicator titration index.
11. Titration of strong and weak bases with a strong acid. Reactions underlying definitions. The solution environment at the equivalence point.
12. Titration curves of strong and weak bases with strong acids and selection of indicators.
12. Titration of strong and weak acids with a strong base. Reactions underlying definitions. The solution environment at the equivalence point.
13. Titration curves of strong and weak acids with a strong base and the choice of indicators.
14. Equivalence point and rules for its determination.
15. Is it possible to determine the quantity of:  
NH<sub>4</sub>OH, HNO<sub>3</sub>, K<sub>2</sub>SO<sub>3</sub>, NH<sub>4</sub>NO<sub>3</sub>, NaOH, H<sub>2</sub>SO<sub>4</sub>, K<sub>2</sub>SO<sub>4</sub>? What working solutions should be used to titrate solutions of these substances, if titration is possible?

Competency assessment questions:

GPC-4Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:

GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

16. Redox reactions as the basis of the permananatomy method.
17. Equivalent to oxidizing and reducing agents. Equivalent to potassium permanganate depending on the medium.
18. Preparation of a standardized solution of potassium permanganate. Conditions for its storage.
19. Initial substances used to standardize potassium permanganate solution.
20. Preparation and storage of working solutions of iodine and sodium thiosulfate.

GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;

21. Indicators of the iodometry method.
22. How is the equivalence point established in the permanganometry method?
23. How is the equivalent of oxidizing agents and reducing agents calculated in redoximetry methods? Give examples of reactions used as the basis for the calculation.
24. How is the equivalence point established in the iodometry method?

GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones.

25. Formulas for calculating normality, titer and mass of the analyte in the methods of permanganometry and iodometry.
26. The quantities of what substances can be determined by permanganometry?
27. The quantities of what substances can be determined by iodometry?
28. What reactions are the basis of permanganometry methods?
29. What reactions are the basis of methods and iodometry?
30. Difference between equivalence points in the neutralization method and redoximetry?

#### 4.1.2. Tests

UC-1 Able to critically analyze problem situations based on a systematic approach and develop an action strategy:

UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

### CLOSED TYPE TASKS

**Tasks of a combined type with the choice of one correct answer from the proposed options**

UC-1.1 Knows the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

#### Task 1.



View		Principle	
A	Acid-base	1	Formation of colored coordination compounds
B	Oxidation-reduction	2	Exchange reactions of acids with bases
IN	Complexometric	3	Precipitation of analyte by titrant
G	Potentiometric	4	Transfer of electrons between substances
		5	Change in electrochemical potential

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A2B4B1G5

#### Task 7.

*Read the task and match.*

Establish a correspondence between the titrant analyte and the expected equivalence point

Titrant-analyte		TE	
A	strong to-ta + strong. basis	1	pH>7
B	weak to-ta + strong. basis	2	pH=7
IN	strong k-ta + weak. basis	3	indefinable
G	weak k-ta + weak. basis	4	pH<7

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A2B1B4G3

#### Task 8.

*Read the task and match.*

Match the titrant with the type of redoximetry

Titrant		Type of redoximetry	
A	KMnO <sub>4</sub>	1	Nitritometry
B	I <sub>2</sub>	2	Permanganatometry
IN	KBrO <sub>3</sub>	3	Iodometry
G	NaNO <sub>2</sub>	4	Bromatometry

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A2B3B4G1

### Task 9.

*Read the task and match.*

Establish a correspondence between the reagent and the photometrically determined ion

Reagent		Photometrically determined ion	
A	Potassium thiocyanate	1	Zn(II)
B	Alizarin	2	Fe(III)
IN	Ditisol	3	Ni(II)
G	Dithiocarbamate	4	Al(III)

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A2B4B1G3

### Task 10.

*Read the task and match.*

Match an ion with a quality reagent for its detection.

Ions		Reagent	
A	Ba <sup>2+</sup>	1	HNO <sub>3</sub>

B	Ag <sup>+</sup>	2	Soluble bases
IN	Fe <sup>3+</sup>	3	(NH <sub>4</sub> ) <sub>2</sub> S
G	Mn <sup>2+</sup>	4	HCl
		5	H <sub>2</sub> SO <sub>4</sub>

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A5B4B2G3

### Closed-ended tasks to establish a sequence

#### Task 11.

*Read the task and establish the sequence.*

Arrange the following elements in order of increasing electronegativity

- Li
- Ba
- P
- Cl

Answer: 2134

#### Task 12.

*Read the task and establish the sequence.*

Arrange the following acidic residues in order of increasing oxidizing strength.

- Cl<sup>-</sup>
- ClO<sub>4</sub><sup>-</sup>
- ClO<sub>3</sub><sup>-</sup>
- ClO<sub>2</sub><sup>-</sup>

Answer: 1432

UK-1.3 Has the ability to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identify problems and use adequate methods to solve them; demonstrate value judgments in solving problematic professional situations.

#### Task 13.

*Read the task and establish the sequence.*

Place scientific discoveries in chronological order

- Creation of galvanic cells
- Law of conservation of energy
- Discovery of hydrogen
- Methods of nuclear fission

Answer: 3124

**Task 14.**

*Read the task and establish the sequence.*

Arrange the elements in order of increasing valence electrons on the outer electron shell.

1. S\*\*;
2. S+6
3. S\*;
4. S0.

Answer: 2431

**Task 15.**

*Read the task and establish the sequence.*

When the chromium compound was placed in an acidic medium, the solution turned orange. Then, when the solution was neutralized and the following reaction was carried out, a green precipitate was obtained. By adding alkali, the precipitate was dissolved and a stable emerald solution was obtained. List the chromium compounds in the order they were mentioned.

1. Cr(OH)<sub>3</sub>
2. CrO<sub>4</sub><sup>2-</sup>;
3. Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>;
4. [Cr(OH)<sub>6</sub>]<sup>3-</sup>.

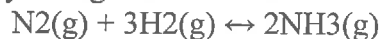
Answer: 2314

### OPEN-TYPE TASKS

**Task 16.**

*Read the task and give a reasoned answer.*

How will the entropy change in the reaction:



Give an explanation for your answer. Will this process occur spontaneously?

Answer: In this reaction, the entropy of the system decreases, because the number of gas molecules decreases. Random occurrence of the process is statistically unlikely.

**Task 17.**

*Read the task and give a reasoned answer..*

What is Fixanal? How is Fixanal used in practice?

Answer: Fixanal is the amount of substance in a sealed glass ampoule required to prepare 1 dm<sup>3</sup> of exactly 0.1 N or 0.01 N solution. The amount of substance in the ampoule corresponds to a certain number of gram equivalents of the given substance, and when it dissolves, a solution of known normality is formed.

Fixanal is used in practice for the rapid preparation of precise solutions. The contents of the ampoule are quantitatively transferred into a measuring flask and the solution is diluted with distilled water, bringing its volume to the mark.

**Task 18.**

*Read the task and give a reasoned answer..*

Describe the rules for selecting the test sample.

Answer: General rules for sampling: the sample must be taken in a form and volume that corresponds to the research method and is sufficient for conducting the analysis; the sample must be stored and delivered to the laboratory under such conditions that the composition of the components being studied and the properties remain unchanged; in professional practice, accompanying documentation is completed, which must reflect the conditions of sampling.

**Task 19.**

*Readtask and give a reasoned answer.*

What mass of potassium hydroxide must be dissolved in 300 ml of water to obtain a 15% solution? What ratio does the indicated concentration express?

Answer: It is customary to indicate the mass fraction in percentages, expressing the ratio between the mass of the dissolved substance and the mass of the solution. Having composed the equation of this ratio, we obtain the required mass of hydroxide - 52.9 g.

**Task 20.**

*Read the text and give a detailed, reasoned answer.*

Is it possible to determine the amount of  $\text{NH}_4\text{OH}$ ,  $\text{HNO}_3$ ,  $\text{K}_2\text{SO}_3$ ,  $\text{NH}_4\text{NO}_3$ ,  $\text{NaOH}$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{K}_2\text{SO}_4$  using the neutralization method? What working solutions should be used to titrate solutions of the indicated substances, if titration is possible?

Answer:  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  can be determined by titration with alkali,  $\text{NH}_4\text{OH}$  and  $\text{NaOH}$  can be determined by titration with a strong acid. Other methods are used to determine  $\text{NH}_4\text{OH}$ ,  $\text{K}_2\text{SO}_3$ ,  $\text{K}_2\text{SO}_4$ .

GPC-4 Capable of using in professional activities methods of solving problems using modern equipment in the development of new technologies and using modern professional methodology to conduct experimental research and interpret its results:

GPC-4.1 Knows the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

GPC-4.2 Able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;

GPC-4.3 Possesses skills in working with specialized equipment to implement assigned tasks during research and development of new technologies, including digital ones.

## CLOSED TYPE TASKS

### Tasks of a combined type with the choice of one correct answer from the proposed options

GPC-4.1 Knows the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

**Task 21.**

*Read the task and choose the correct answer.*

Isotopes of a chemical element differ from each other:

1) by the number of neutrons 3) by the number of electrons

3) by the number of protons 4) by position in the periodic table

Write down the number under which the correct answer is indicated.

Answer: 1

**Task 22.**

*Read the task and choose the correct answer.*

Solutions of which salts are characterized by pH values  $> 7$ ?

1)  $\text{NaBr}$

2)  $\text{AgNO}_3$

3)  $\text{FeCl}_3$

4)  $\text{MgSO}_3$

Write down the number under which the correct answer is indicated.

Answer: 4



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Answer: A2B4B1G3

**Task 27.**

*Read the task and match.*

Establish a correspondence between the complexometrically determined ion and the specific indicator.

Complexometrically determined ion		Indicator	
A	Fe III	1	Murexide
B	Mg II	2	Xylene Orange
IN	Ca II	3	Eriochrome black
G	Ni III	4	Trilon-B
		5	Pyrocatechin

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A2B3B1G5

**Task 28.**

*Read the task and match.*

Match the ion with the analytical group it represents.

Ion		Analytical group	
A	Manganese	1	1
B	Barium	2	2
IN	Sodium	3	3
G	Lead	4	4
		5	5

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

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Answer: A3B2B1G5

**Task 29.**

*Read the task and match.*

Match the filter value to the beam color in photometry

Filter value		Beam color	
A	490 nm	1	blue
B	550 nm	2	scarlet
IN	630 nm	3	blue
G	700 nm	4	orange
		5	green

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A3B5V4G2

**Task 30.**

*Read the task and match.*

Match an ion with a quality reagent for its detection.

Ion		Quality reagent	
A	NO <sub>3</sub> <sup>-</sup>	1	Ba
B	PO <sub>4</sub> <sup>3-</sup>	2	Na
IN	S <sub>2</sub> <sup>-</sup>	3	H <sub>2</sub> SO <sub>4</sub>
G	CrO <sub>4</sub> <sup>2-</sup>	4	Ag
		5	Pb

Write the selected numbers in the table under the corresponding letters.

A	B	IN	G

Answer: A3B4B5G1

### Closed-ended tasks to establish a sequence

#### Task 31.

*Read the task and establish the sequence.*

Arrange the following elements in order of increasing electronegativity

1. Br
2. Fe
3. O
4. Cs

Answer: 4213

#### Task 32.

*Read the task and establish the sequence.*

Arrange the following acid residues in order of decreasing acid strength.

1. Cl<sup>-</sup>
2. ClO<sub>4</sub><sup>-</sup>
3. ClO<sub>3</sub><sup>-</sup>
4. ClO<sub>2</sub><sup>-</sup>

Answer: 1234

OPK-4.3 Possesses skills in working with specialized equipment to implement assigned tasks during research and development of new technologies, including digital ones.

#### Task 33.

*Read the task and establish the sequence.*

Arrange the characteristics of electrons in an atom in order to create a descriptive model

1. Spin
2. Energy
3. Orbital
4. Level
5. Magnetic moment

Answer: 43512

#### Task 34.

*Read the task and establish the sequence.*

Arrange the stages of heterogeneous catalysis in chronological order.

1. Physical adsorption of reacting molecules on the active centers of the catalyst surface and then their chemisorption;
2. Desorption of products from the catalyst surface;
3. Diffusion of reactants to the surface of a solid;
4. A chemical reaction between reacting molecules;
5. Diffusion of product from the catalyst surface into the general flow.

Answer: 31425

#### Task 35.

*Read the task and establish the sequence.*

When the manganese compound was placed in the reaction, a black precipitate was obtained. Then, when the reaction continued in the medium, a flesh-colored precipitate was obtained. By adding a strong oxidizer, this precipitate was converted back to a black color. With

prolonged contact with air, the initial compound was returned. Specify the necessary medium for carrying out the reactions.

1. Sour
2. Alkaline
3. Neutral

Answer: 3121

## OPEN-TYPE TASKS

### Task 36.

*Readtask and give a reasoned answer*

How to calculate the ratio of concentrations of a weak acid and its salt (CA:CS) in a buffer solution if  $\text{pH} = 1.74$  and  $\text{pK}_a = 3.74$ ? Provide the resulting ratio.

Answer: The general formula for calculating the acidity of a buffer solution is  $\text{pH} = \text{pK}_a + \lg[\text{CA}:\text{CS}]$ . Given that the difference between  $\text{pH} = \text{pK}_a$  is 2, we can assume a concentration ratio of 100:1.

### Task 37.

*Read the task and give a reasoned answer..*

How to prepare and store working iodine solutions?

Answer: Standard iodine solutions can be prepared directly from an exact weighed portion of chemically pure crystalline iodine (primary standard). Iodine dissolves slowly in potassium iodide solution, especially at low iodide concentrations. Therefore, it is necessary to completely dissolve a weighed portion of crystalline iodine in a small volume of concentrated potassium iodide solution, and then dilute it to the required volume. Store avoiding contact with organic materials.

### Task 38.

*Readtask and give a reasoned answer.*

How is the equivalence point established in the permanganometry method?

Answer: The equivalence point in the permanganometry method is determined by the change in color of the titrated solution. This is caused by an excess of colored standard solution. In this case, permanganate can act as an indicator for itself.

### Task 39.

*Readtask and give a reasoned answer.*

How can the presence of lead nitrate in a solution be confirmed? What rule does such a reaction illustrate?

Answer: Since lead nitrate is a soluble salt, an ion exchange reaction can be carried out to obtain a characteristic yellow precipitate - lead iodide. This reaction illustrates Berthollet's rule.

### Task 40.

*Read the text and give a detailed, reasoned answer.*

What substances can be measured using iodometry?

Answer: Strong oxidizers. Substitution titration and other indirect methods are used to determine oxidizers ( $\text{H}_2\text{O}_2$ ,  $\text{KMnO}_4$ ), phenol and its derivatives, pyrazole, tetrazole, purine alkaloids, and some antibiotics.

## 3.2. Typical tasks for intermediate certification

### 3.2.1. Questions for testing

**Formed competencies:**

**UC-1** Able to critically analyze problem situations based on a systematic approach and develop an action strategy:

UC-1ID-1 Know the methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis;

1. Tasks and classification of methods of analytical chemistry.
2. Types and methods of analysis.
3. Analytical properties and reactions.
4. Methods of expressing the composition of a solution.
5. Electrolytic dissociation.
6. Chemical equilibrium.

UC-1ID-2 Be able to obtain new knowledge based on analysis, synthesis, etc.; collect and summarize data on current scientific issues related to the professional field; search for information and solutions based on actions, experiment, experience, information and communication technologies;

7. Homogeneous chemical equilibrium.
8. Heterogeneous chemical equilibrium.
9. Salt effect.
10. Fractional precipitation.
11. Main types of chemical reactions.
12. Calculation of pH in aqueous solutions of acids.

UC-1ID-3 Be able to study the problem of professional activity using analysis, synthesis and other methods of intellectual activity, including the use of information and communication technologies; identifying problems and using adequate methods to solve them; demonstrating value judgments in solving problematic professional situations.

13. Characteristics of complex compounds.
14. Oxidation – reduction reactions.
15. Qualitative chemical analysis: reactions, reagents, methods, classification of cations.
16. Analytical reactions of cations of analytical group 4.
17. Analytical classification of anions using the example of groups 1 and 2.
18. Elemental and functional analysis of organic compounds.
19. Quantitative chemical analysis: gravimetric analysis.

**Formed competencies:**

**GPC-4** Able to use methods for solving problems in professional activities using modern equipment when developing new technologies and use modern professional methodology to conduct experimental studies and interpret their results:

GPC-4ID-1 Know the technical capabilities of modern specialized equipment, methods for solving problems of professional activity;

20. Quantitative chemical analysis: titrimetric.
21. Acid - basic titration.
22. Complexometric titration.

GPC-4ID-2 Be able to apply modern technologies, including digital ones, and research methods in professional activities, interpret the results obtained;

23. Oxidation-reduction titration.

24. Precipitation titration.

25. Electrochemical methods of analysis: characteristics, indicator electrodes and comparisons.

GPC-4ID-3 Possess skills in working with specialized equipment to implement assigned tasks when conducting research and developing new technologies, including digital ones

26. Spectroscopic methods and their classification.

27. Atomic spectral methods.

28. Molecular spectral methods.

29. Sorption is the basis of chromatography.

30. Types of indicators.

#### 4. METHODOLOGICAL MATERIALS DETERMINING PROCEDURES FOR ASSESSING KNOWLEDGE, ABILITIES AND SKILLS AND ACTIVITY EXPERIENCE CHARACTERIZING THE STAGES OF COMPETENCY FORMATION

Criteria for assessing students' knowledge during the colloquium:

- **Mark "excellent"**- the student clearly expresses his point of view on the issues under consideration, giving relevant examples.

- **Mark "good"** - the student makes some errors in the answer

- **Mark "satisfactory"**- the student discovers gaps in knowledge of the basic educational and regulatory material.

- **Mark "unsatisfactory"** - the student reveals significant gaps in knowledge of the basic principles of the discipline, inability, with the help of the teacher, to obtain the correct solution to a specific practical problem.

Criteria for assessing students' knowledge during testing:

The test result is assessed on a percentage rating scale. Each student is offered a set of test tasks consisting of 5 questions:

- **Mark "excellent"** – 5 correct answers.

- **Mark "good"** – 4 correct answers.

- **Mark "satisfactory"** – 3 correct answers.

- **Mark "unsatisfactory"** – less than 2 correct answers

**Criteria for assessing knowledge during the test:**

- **Grade "passed"** must meet the parameters of any of the positive ratings ("excellent", "good", "satisfactory").

- A "failed" grade must correspond to the parameters of an "unsatisfactory" grade.

- **Mark "excellent"** – all types of academic work provided for by the curriculum have been completed. The student demonstrates the correspondence of knowledge,

skills and abilities to the indicators given in the tables, operates with acquired knowledge, skills and abilities, and applies them in situations of increased complexity. In this case, inaccuracies and difficulties may occur during analytical operations and the transfer of knowledge and skills to new, non-standard situations.

- Mark “good” – all types of educational work provided for by the curriculum have been completed. The student demonstrates the correspondence of knowledge, skills and abilities to the indicators given in the tables, operates with acquired knowledge, skills and abilities, and applies them in standard situations. In this case, minor errors, inaccuracies, and difficulties during analytical operations and the transfer of knowledge and skills to new, non-standard situations may be made.

- Mark “satisfactory” – one or more types of academic work provided for by the curriculum have not been completed. The student demonstrates incomplete compliance of knowledge, abilities, skills with the indicators given in the tables, significant mistakes are made, a partial lack of knowledge, abilities, and skills is manifested in a number of indicators, the student experiences significant difficulties in operating knowledge and skills when transferring them to new situations. –

- The mark “unsatisfactory” means that the types of educational work provided for by the curriculum have not been completed. demonstrates incomplete compliance of knowledge, abilities, and skills with those given in the tables of indicators, significant errors are made, a lack of knowledge, abilities, and skills is manifested in a larger number of indicators; the student experiences significant difficulties in operating knowledge and skills when transferring them to new situations

## 5. ACCESSIBILITY AND QUALITY OF EDUCATION FOR PERSONS WITH DISABILITIES

If necessary, disabled people and persons with limited health capabilities are given additional time to prepare an answer for the test.

When carrying out the procedure for assessing the learning outcomes of people with disabilities and people with limited health capabilities, their own technical means can be used.

The procedure for assessing the learning outcomes of people with disabilities and people with limited health capabilities in the discipline provides for the provision of information in forms adapted to the limitations of their health and perception of information:

For people with visual impairments:	– in printed form in enlarged font, – in the form of an electronic document.
For people with hearing impairments:	– in printed form, – in the form of an electronic document.
For persons with musculoskeletal disorders	– in printed form, device: – in the form of an electronic document.

When carrying out the procedure for assessing the learning outcomes of disabled people and persons with limited health capabilities in the discipline, it ensures the fulfillment of the following additional requirements depending on the individual characteristics of the students:

a) instructions on the procedure for conducting the assessment procedure are provided in an accessible form (orally, in writing);

b) an accessible form for submitting assignments of assessment tools (in printed form, in printed form in enlarged font, in the form of an electronic document, assignments are read out by the teacher);

c) an accessible form of providing answers to assignments (written on paper, typing answers on a computer, orally).

If necessary, for students with disabilities and people with disabilities, the procedure for assessing learning outcomes in the discipline can be carried out in several stages.

The procedure for assessing the learning outcomes of disabled people and persons with limited health capabilities is permitted using distance learning technologies.