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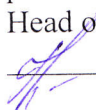
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CURRICULUM ON THE DISCIPLINE ANALYTICAL CHEMISTRY

training of specialists of the second (master's) level of higher education
in the field of knowledge 22 "Public Healthcare"
Specialty 226 "Pharmacy, Industrial Pharmacy"

Discussed and approved

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Toxicological and Analytical Chemistry,
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Head of the department

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«Approved»

by profile methodical commission
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Head of the profile methodical commission

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INTRODUCTION

Description of the discipline (annotation)

The work program on discipline "Analytical chemistry" is intended for students of higher education institutions of the pharmaceutical profile of Ukraine and is an integral part of the state standard of education. This is a fundamental chemical discipline for methods for determining the qualitative and quantitative composition of compounds, their mixtures, as well as the establishment of the chemical structure of substances.

In the working program of analytical chemistry included and the modern chemical and physico-chemical methods of analysis, differing in speed and high sensitivity - spectrophotometry, chromatography, polarography, potentiometry and others.

Knowledge obtained by students in the process of studying analytical chemistry is a theoretical and practical basis for studying specialized disciplines at senior courses. Without knowledge of analytical chemistry, it is impossible to solve problems and problems of biological, pharmaceutical, toxicological chemistry, pharmacognosy and other disciplines, and mastering the methods of planning and performing analysis is necessary for students in their practical work.

Structure of the discipline	Amount of credits, hours, from them				Year of study / semester	Types of control
	Total credits / hours	Auditory		ISW		
		Lectures (hours)	Practical occupations (year)			
Subjects: Analytical chemistry <i>Content module 2</i>	8,0 credits / 240 hrs	20	100	120	Second year (3-4 semesters)	test, exam
For the semesters						
<i>Content module 1</i> Qualitative analysis.	4,0 credits / 120 hours	8	40	72	3 semesters	test
<i>Content module 2</i> Quantitative analysis.	4,0 credits / 120 hours	12	60	48	4 semester	exam

The subjects of the "Analytical Chemistry" discipline are:

- correlation of the analytical properties of the elements and their compounds with the position in the periodic system DI Mendeleev;
- application of the basic provisions of the theory of solutions, the study of chemical equilibrium, chemical kinetics, catalysis, adsorption to the characteristics of the course of chemical reactions;
- principles of conducting qualitative analysis of inorganic and organic substances;
- peculiarities of methods for the selection, distribution and concentration of substances in the preparation of samples for analysis;
- methods of gravimetric and titrimetric quantitative determination of substance content;
- use of modern physico-chemical methods in qualitative and quantitative analysis of inorganic and organic substances;
- evaluation of the fidelity and reproducibility of the quantitative analysis of results by the method of marital statistics
- methods of carrying out qualitative and quantitative analysis of substances and their mixtures by chemical and instrumental methods.

Interdisciplinary connections:

Analytical chemistry as an educational discipline:

- (a) is based on knowledge of inorganic chemistry, physics and mathematics and integrated with organic, pharmaceutical, toxicological, physical, colloid and biological chemistry;
- (b) establishes the basis for the study of pharmaceutical and toxicological chemistry and involves the formation of skills for the use of the knowledge acquired for the study of special disciplines and professional activities.

1. The purpose and tasks of the discipline

1.1. The purpose of teaching the discipline "Analytical chemistry" is to prepare students for the development of medical-biological and special disciplines, for which, based on modern scientific ideas, students develop the necessary knowledge, skills and skills in the field of analytical chemistry.

1.2. The main tasks of studying the discipline "Analytical Chemistry" are:

- formation of students of knowledge and skills, practical skills in analytical chemistry, which is the general theoretical basic discipline in the system of preparation of a pharmacist;
- pharmaceutical chemistry, as well as obtaining the basic chemical knowledge necessary for understanding and assimilating a number of medical, biological, and chemical disciplines studied at the pharmaceutical faculty.

1.3 Competence and learning outcomes, the formation of which is facilitated by discipline (the relationship with the normative content of the training of higher education graduates, formulated in terms of results of study in the Standard of Higher Education).

According to the requirements of the Standard discipline "Analytical chemistry" contributes to the acquisition of students competencies:

integral:

- ability to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity, applying the theoretical principles of the basics of chemical processes and methods of chemical and physical-chemical analysis (qualitative and quantitative) that involves conducting experimental research, introducing innovative methods of analysis, to reasonably justify the results of definitions and to unambiguously communicate their findings and knowledge to the professional and non-physical audience; general:
- ability to apply knowledge in practical situations
- knowledge and understanding of the subject area and understanding of the profession;
- ability to abstract thinking, analysis and synthesis, ability to learn and master modern knowledge;
- skills of using information and communication technologies;
- the ability to evaluate and ensure the quality of performed work;
- ability to conduct research at the appropriate level;
- striving to preserve the environment;

special (professional, subject):

- ability to organize, provide and perform the analysis of the quality of medicinal products in pharmacy and pharmacy control and analytical laboratories in accordance with the State Pharmacopoeia and other regulatory acts;
- ability to test, biopharmaceutical research and methods of drug control;
- ability to determine the list of equipment and reagents for the quality control of medicinal products in accordance with the requirements of the State Pharmacological Center and other regulatory documents;
- ability to prepare reagents for the analysis of drugs using chemical and physical-chemical methods;

- ability to develop methods for controlling the quality of medicinal products, pharmaceutical substances, medicinal plant raw materials and auxiliary substances using physical, physical, chemical and chemical methods of control;
- ability to interpret and evaluate the results of the analysis of medicinal products.

General competences:

GC1 – the ability to act socially responsibly and civically;

GC2 - the ability to apply knowledge in practical situations;

GC3 – striving to preserve the environment;

GC4 – the ability to abstract thinking, analysis and synthesis, the ability to learn and master modern knowledge;

GC5 – the ability to show initiative and entrepreneurship;

GC6 – knowledge and understanding of the subject area and understanding of professional activity;

GC7 – ability to adapt and act in a new situation;

GC 8 – the ability to communicate in the state language both orally and in writing, the ability to communicate in a foreign language (mainly English) at a level that ensures effective professional activity;

GC9 – skills in using information and communication technologies;

GC10 – the ability to choose a communication strategy, the ability to work in a team and with experts from other fields of knowledge/types of economic activity.

GC11 – the ability to evaluate and ensure the quality of performed works;

GC12 – the ability to conduct research at the appropriate level;

GC13 – the ability to realize one's rights and responsibilities as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of a person and a citizen in Ukraine;

GC14 – the ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technology, use different types and forms of motor activities for active recreation and leading a healthy lifestyle.

Special (professional, subject):

FC1 – the ability to carry out sanitary and educational work among the population for the purpose of prevention of common diseases, prevention of dangerous infectious, viral and parasitic diseases, as well as for the purpose of promoting timely detection and support of adherence to the treatment of these diseases in accordance with their medico-biological characteristics and microbiological features;

FC3 – the ability to provide pre-medical assistance to the sick and injured in extreme situations and emergencies;

FC6 – the ability to determine medicinal products, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication;

FC 7 – the ability to ensure proper storage of medicines and other products of the pharmacy assortment in accordance with their physico-chemical properties and the rules of Good Storage Practice (GSP) in health care institutions;

FC 8 – the ability to organize, provide and conduct quality analysis of medicinal products in the conditions of a pharmacy and control and analytical laboratories of pharmaceutical enterprises in accordance with the requirements of the State Pharmacopoeia and other regulatory legal acts;

FC12 – ability to use knowledge of regulatory and legislative acts of Ukraine and recommendations of proper pharmaceutical practices in professional activity;

FC 19 – the ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current SFU and proper practices in pharmacy, to determine methods of sampling for the control of medicinal products and to carry out their standardization in accordance with current requirements, to prevent the distribution of falsified medicinal products;
 FC 20 – the ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, physico-chemical and chemical control methods.

Detail of competencies according to the descriptors of the NQF in the form of "Matrix of competencies".

Matrix of competencies

No.	Competency	Knowledge	Ability	Communication	Autonomy and liability
1	2	3	4	5	6
Integral competencies					
the ability to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity with the application of theoretical principles of the basics of chemical processes and methods of chemical and physical-chemical analysis (qualitative and quantitative) that involves conducting experimental research, introducing innovative methods of analysis, reasonably to substantiate the results of definitions and to unambiguously communicate their findings and knowledge to the professional and non-physical audience.					
General competencies					
1	The ability to apply knowledge in practical situations.	To have specialized conceptual knowledge acquired in the learning process.	To be able to solve complex tasks and problems that arise in professional activity.	Clear and unambiguous presentation of one's own conclusions, knowledge and explanations, which justify them to specialists and non-specialists.	Responsible for acceptance decisions in difficult conditions
2	Knowledge and understanding of the subject area and understanding of the profession	To have deep knowledge of the structure of professional activity	To be able to carry out professional activities that require updating and integration of knowledge	The ability to effectively form a communication strategy in professional activities	To be responsible for professional development, the ability to further professional training with high level of autonomy
3	The ability to self-regulate, lead a healthy lifestyle, the ability to adapt and act in a new situation.	To know the methods of self-regulation, leading a healthy life.	To be able to apply self-regulation tools, to be able to lead a healthy lifestyle and to adapt to new situations of life and activity.	To establish appropriate connections to achieve result	To be responsible for a healthy lifestyle and timely use of self-regulation methods
4	Ability to choose a communication strategy; ability	Know communication tactics and	Be able to choose communication methods and	Use communication strategies and interpersonal skills	Be responsible for choosing and tactics of communication

	to work in a team; interpersonal skills	strategies, laws and methods of communicative behavior	strategies to ensure effective teamwork		methods
5	Ability to communicate in the native language both orally and in writing; the ability to communicate in a second language	Have perfect knowledge of the native language and basic knowledge of a foreign language	Be able to apply knowledge of the native language, both orally and in writing, be able to communicate in a foreign language	Use the native language in professional and business communication and when preparing documents. To use a foreign language in professional activities	To be responsible for fluency in one's native language, for the development of professional knowledge
6	The ability to abstract thinking, analysis and synthesis, the ability to learn and be modernly educated.	To know the methods of analysis, synthesis and further modern learning.	To be able to analyze information, make informed decisions, to be able to acquire modern knowledge.	To establish appropriate connections to achieve goals.	To be responsible for the timely acquisition of modern knowledge.
7	The ability to evaluate and ensure the quality of the work performed.	To know the methods of evaluating performance quality indicators.	To be able to ensure the quality performance of the work.	To establish connections to ensure the quality performance of the work.	To be responsible for the quality performance of the work.
Special (professional, substantive) competencies					
1	Ability to test, biopharmaceutical research and drug control methods	Know chemical and instrumental methods of analysis	Be able to apply chemical and instrumental methods of analysis, conduct biopharmaceutical research for drug control	Reasonably evaluate results review the chemical, physico-chemical and biopharmaceutical methods used in the quality control of medicinal products.	Be responsible for making decisions regarding the evaluation of the results of chemical, physico-chemical and biopharmaceutical methods of medicinal product control.
2	The ability to organize, ensure and conduct quality control of medicines in the conditions of a pharmacy and a pharmaceutical enterprise.	To know the modern requirements for the organization and provision of quality control of medicines in the conditions of a pharmacy and a pharmaceutical enterprise.	To be able to choose chemical and physico-chemical methods of drug quality analysis.	To justify the chosen methods of drug analysis in the conditions of a pharmacy and a pharmaceutical enterprise.	To be responsible for the organization, provision and control of the quality of medicines in the conditions of a pharmacy and a pharmaceutical enterprise.
3	The ability to	To know the	To be able to	To ensure the	Responsible for the

	determine the list of equipment and reagents for the organization of quality control of medicinal products in accordance with the requirements of the State Pharmacopoeia of Ukraine and other regulatory documents.	requirements of the State Pharmacopoeia of Ukraine and other regulatory documents.	prepare the necessary reagents and work with modern equipment of chemical laboratories.	operation of the laboratory in accordance with the requirements of the State Pharmacopoeia of Ukraine and other regulatory documents	organization of quality control of medicinal products in accordance with the requirements of the SFU and other regulatory documents
4	The ability to prepare reagents for the analysis of medicinal products using chemical and physicochemical methods	To know chemical and modern instrumental methods of analysis, to know the specificity and sensitivity of various research methods	To be able to choose methods of drug research and prepare reagents for analysis	Argue the choice of analysis methods	To be responsible for the obtained results of the analysis of medicinal products
5	The ability to interpret and evaluate the results of the analysis of medicinal products.	To know the standard procedures of statistical analysis.	Be able to justify the size of the sample, apply methods of statistical analysis, present the results of statistical data processing	Reasonably evaluate the obtained results	Be responsible for conducting analysis and obtaining reliable and reproducible results

Program learning outcomes

The educational discipline "Analytical Chemistry" is aimed at students achieving the following learning outcomes:

PLO 1	To carry out professional activities in social interaction based on humanistic and ethical principles; to identify future professional activity as socially significant for human health.
PLO 2	Apply knowledge from general and specialized disciplines in professional activities.
PLO 3	To comply with the norms of the sanitary and hygienic regime and the requirements of safety equipment when carrying out professional activities.
PLO 4	Demonstrate the ability to independently search, analyze and synthesize information from various sources and use these results to solve typical and complex specialized tasks of professional activity.
PLO 5	To position one's professional activity and personal qualities on the pharmaceutical labor market; formulate the goals of one's own activity taking into account public and industrial interests.
PLO 6	Argue information for decision-making, bear responsibility for them in standard and

	non-standard professional situations; adhere to the principles of deontology and ethics in professional activity.
PLO 7	To perform professional activities using creative methods and approaches.
PLO 8	To carry out professional communication in the modern Ukrainian literary language, use oral communication skills in a foreign language, analyzing specialized texts and translating foreign language information sources.
PLO 9	To carry out professional activities using information technologies, "Information databases", navigation systems, Internet resources, software and other information and communication technologies.
PLO 10	Adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.
PLO 11	Use methods of evaluating indicators of the quality of activity; identify reserves for increasing labor efficiency.
PLO 12	Analyze information obtained as a result of scientific research, generalize, systematize and use it in professional activities.
PLO 13	To carry out sanitary and educational work in professional activities in the event of outbreaks of infectious, viral and parasitic diseases.
PLO 15	Provide pre-medical assistance to patients in emergency situations and victims in extreme situations.
PLO 16	Determine the influence of factors that affect the processes of absorption, distribution, deposition, metabolism and excretion of the medicinal product and are caused by the condition, features of the human body and physico-chemical properties of medicinal products.
PLO 17	Use the data of clinical, laboratory and instrumental studies to monitor the effectiveness and safety of the use of medicinal products.
PLO 19	Predict and determine the impact of environmental factors on the quality of medicinal products (reagents) during their storage.
PLO 24	Plan and implement professional activities on the basis of normative legal acts of Ukraine and recommendations of proper pharmaceutical practices.
PLO 25	Determine the advantages and disadvantages of drugs of various pharmacological groups, taking into account their biopharmaceutical, pharmacokinetic and pharmacodynamic features; Recommend to consumers medicinal products and products of the pharmacy assortment with the provision of advisory assistance.
PLO 26	Perform technological operations: weigh, measure, dose various medicinal products (reagents).
PLO 30	Ensure quality control of medicinal products and document its results.
PLO 31	Carry out all types of quality control of pharmaceuticals, taking into account the requirements of current regulatory documents, SFU and the results of quality control. Develop specifications and quality control methods in accordance with the requirements of the current SFU.
PLO 32	To carry out sanitary and educational work in professional activities in the event of outbreaks of infectious diseases.

Learning outcomes:

Integrative final program learning outcomes, which contributes to the formation of a training course "Analytical Chemistry":

general

- apply knowledge of general and specialized courses in professional *activities*;
- use the search results of independent research and professional information using modern computer tools, networking, databases and knowledge;

- to argue information for decision-making, to bear responsibility for them in standard and non-standard professional situations; adhere to the principles of deontology and ethics in professional activities;

- use methods for evaluating performance indicators; to identify reserves for improving labor efficiency;

- analyze information obtained as a result of scientific research, generalize, systematize and use it in professional activity

- independently apply the methods and means of knowledge, learning and self-control to acquire new knowledge and skills.

professional

- research both in a group and independently, realizing with special means and methods of obtaining new knowledge;

- organization functioning analytical laboratory;

- ability to prepare reagents for the analysis of drugs through chemical, biological and physico-chemical methods in accordance with the requirement the Pharmacopoeia;

- organization of logistics and quality control of drugs I in pharmacies and pharmaceutical company;

- determining the list of equipment and reagents for the monitoring of the quality of drugs, according to the requirements of HFCs and other legal documents, organize timely metrological verification equipment.

- choose the method of sampling for input control drugs according to current requirements.

- identify key indicators of quality medicines modern physical and chemical methods of analysis;

Learning outcomes for the course "Analytical Chemistry":

Know:

- basic concepts and laws underlying analytical chemistry;
- the main stages of the development of analytical chemistry, its current state;
- the basic provisions of the theory of ionic equilibrium with respect to the reactions of the acid-base, oxidative-reduction, sedimentation and compleximetric nature;
- methods and methods of performing qualitative analysis;
- methods, techniques and methods of chemical and physical-chemical analysis to determine the qualitative composition and quantitative definitions;
- methods of detecting cations and anions;
- methods of separating substances (chemical, chromatographic, and extraction);
- the basis of mathematical statistics regarding the evaluation of the correctness and reproducibility of the results of quantitative analysis;
- safety rules when working in a chemical laboratory;
- the role and importance of analytical chemistry in pharmacy, in the practice of pharmacist;
- basic literature, reference books on analytical chemistry.

Be able:

- use measuring utensils, analytical scales;
- have the technique of performing basic analytical operations in qualitative and quantitative analysis of a substance, prepare and standardize solutions of analytical reagents;
- to select the average sample, to draw up a scheme of analysis, to conduct qualitative and quantitative analysis of the substance within the framework of the use of the basic methods and methods provided by the program;
- work with the main types of instruments used in the analysis (microscope, photoelectric, spectrophotometer, potentiometer, conductivity, polarimeter, etc.);

- to choose an optimal method of qualitative and quantitative analysis of a substance;
- construct titration curves and install them on the base of the volumes of titrant spent on each component of the mixture;
- to conduct separation of cations and anions by chemical and chromatographic methods;
- to conduct laboratory experiments, to explain the essence of specific reactions and their analytical effects; to draw up the reporting documentation according to experimental data;
- perform initial calculations, final calculations using statistical analysis of the results of quantitative analysis;
- work independently with educational and reference books on Analytical Chemistry;
- apply the theoretical foundations of analytical chemistry and acquired experimental skills in the study of profile disciplines.

2. Information amount of discipline

In studying the discipline given **8** ECTS credits / **240** hours.

Content module 1. Qualitative analysis. Methods of separation and concentration. Chromatographic methods of analysis.

Topic 1. Analytical Chemistry. Classification of methods of analysis. Basis of qualitative analysis.

Subject, tasks and methods of analytical chemistry. Basic concepts of analytical chemistry. Principles and methods of qualitative analysis. Classification methods of qualitative analysis. Fractional and systematic analysis, their differences.

Analytical substances. Analytical reactions, requirements to them. Types of analytical reactions and reagents (group reagent).

Ways of performing qualitative reactions. Characteristic analytical sensitivity reactions (limiting dilution limit concentration, minimum volume extremely dilute solution, you limit the appearance) and how to improve it. Specific, selective and group reactions and reagents.

Analytical classification of cations, their advantages and disadvantages. Essence and group reagents of the acid-base classification of cations.

Overview of Analytical Group I cations (K^+ , Na^+ , NH_4^+). Relationship of the analytical properties of cations with the electronic structure and position in the periodic system of D.I. Mendeleev corresponding elements. Qualitative reaction cations appearance you I analytical group and the conditions for their implementation.

Topic 2. Theory strong electrolyte solutions. Use of the law of active masses to equilibrium in homogeneous systems. Heterogeneous equilibrium.

Basics of the theory of strong electrolytes and application of this theory in qualitative and quantitative analysis and. S solution ionic strength, ion activity, activity coefficient, the relationship between them and the calculation of these characteristics.

The law of active masses and the constant of chemical equilibrium. You equilibrium constants K . The direction of displacement reactions and chemical equilibrium in the analysis.

Chemical-analytical characterization cations II analytical group. Qualitative reaction cations detect II Analytical first group and the conditions of their implementation.

Heterogeneous equilibrium in the "sediment-solution." Applying the law of mass to the equilibrium of sediment - saturated solution of soluble electrolyte. Ways of expressing solubility soluble electrolyte. Solubility product (K_{sp}) soluble electrolyte (thermodynamic and concentration). The relationship between the product of solubility and solubility.

Terms sedimentation. Factors affecting the completeness of sedimentation and deposition. The influence of extraneous impurity electrolyte ions of similar solubility slightly soluble electrolytes. Salt effect, its explanation under Rule DR.

Terms dissolution of precipitates, examples dissolution of precipitates in the analysis of cations II and III analytical groups (Translated ions precipitate as malodysotsiyovanu, or complex gaseous compound).

Chemical and analytical in characteristic cations III Analytical first group and.

Qualitative reaction cations detect III Analytical first group and the conditions of their implementation.

Theme 3. Systematic analysis of progress mixture of cations I - III analytical groups by acid-base classification. The final lesson of theory and practice cation analysis I-III analytical groups.

What is the basis for classification for analytical group cations. Advantages and disadvantages of acid-base classification.

Chemical and analytical properties of compounds cations I, II, III analytical groups. A systematic analysis of progress mixture of cations I-III analytical groups by acid-base classification. In as and consistency are analyzing mixtures of cations I-III analytical groups?

The value of previous studies in the analysis of mixtures of cations. What cations should be determined in previous studies?

Which group with reagents and conditions used to separate cations II and III analytical groups? Action group reagent conditions cations separation and transfer of sediment in solution. The solubility of chlorides and sulfates.

Application to the theory of solutions and the law of mass claims and to justify the choice of analytical reactions you appearing cations I-III analytical groups and analyzing mixtures of these cations.

The formation and dissolution of sediments, factors affecting these processes. The use of deposition processes in chemical analysis.

Examples of reactions of dissolution and precipitation in the analysis of cations I-III analytical groups. For what purposes and under what conditions conduct these reactions?

Qualitative reaction cations I analytical group (K^+ , Na^+ , NH_4^+), II analytical group (Ag^+ , Hg_2^{2+} , Pb^{2+}) and III analytical group (Ba^{2+} , Sr^{2+} , Ca^{2+}) with common reagents: sodium hydroxide, ammonia, hydrogen sulfide and sulfides.

Specific and selective, the eaktsiyi identify cation -III analytical groups. Requirements for execution of these reactions and their application in the analysis.

Concluding session

Introduction to qualitative analysis

Subject and problems of analytical chemistry, basic concepts, principles and methods of qualitative chemical analysis.

The essence and objectives of qualitative analysis. Classification methods of qualitative analysis. Fractional and systematic analysis.

Chemical and analytical properties of cations and their relationship with the relevant elements in the periodic system of Mendeleev.

Analytical reactions and methods of implementation. Characteristics of the sensitivity of analytical reactions and ways to improve it. Specific, selective and group reactions and reagents.

The theory of electrolyte solutions in analytical chemistry

Basics of the theory of strong electrolytes and application of this theory in qualitative analysis.

Ionic strength solutions, ion activity, activity coefficient, the relationship between them and the calculation of these characteristics.

The law of mass action and constant chemical equilibrium. Directions reactions and shift chemical equilibrium.

Application to the theory of solutions and the law of mass action to justify the requirements and selection of analytical determination cations reactions I-III analytical groups and analyzing mixtures of these cations.

Heterogeneous equilibrium in the system deposit - saturated solution of soluble electrolyte

Applying the law of mass to the equilibrium of sediment - saturated solution of soluble electrolyte. Ways of expressing solubility soluble electrolyte. The product of solubility soluble electrolyte.

The formation and dissolution of sediments, factors affecting these processes. The use of deposition processes in chemical analysis.

Examples of reactions of dissolution and precipitation in the analysis of cations I-III analytical groups. For what purposes and under what conditions conduct these reactions?

Chemical properties and analytical analysis of cations I-III analytical groups

Analytical classification of cations, their advantages and disadvantages.

Acid-base classification. The principle of separation of cations in study groups and group reagents. Fractional and systematic course of analysis.

Chemical and analytical properties of compounds cations I-III analytical groups by acid-base classification. Action group reagent conditions cations separation and transfer of sediment in solution. The solubility of chlorides and sulfates.

Qualitative reaction cations I analytical group (K^+ , Na^+ , NH_4^+), II analytical group (Ag^+ , Hg_2^{2+} , Pb^{2+}) and III analytical group (Ba^{2+} , Sr^{2+} , Ca^{2+}) with common reagents: sodium hydroxide, ammonia, hydrogen sulfide and sulfides. Reactions determination cation -III analytical groups. Requirements for execution of these reactions and their application in the analysis.

A systematic analysis of progress mixture of cations I-III analytical groups by acid-base classification.

Content module 2. Application of the law of active masses to the acid-base equilibrium and to the equilibrium of complex formation, their role in analytical chemistry. Theory and practice of analysis of cations of IV-VI analytical groups.

Topic 4. Acid-base balance in analytical chemistry.

Protolytic equilibrium in aqueous electrolytes. Types protolitiv (molecular, cationic, anionic acid or base, amfolity). Conjugate acid-base pair.

The relationship between the values of acidity or basicity constants, parameters and constants of acid or base strength.

Calculation of pH in aqueous solutions of strong and weak acids, strong and weak bases, buffer systems and coley formed by weak base and a weak acid.

Buffer solutions protolytic balance them, buffer capacity. The values of buffer solutions in qualitative analysis.

Solvolysis, hydrolysis terms of protolytic acid-base reaction. Quantification of hydrolysis. Value hydrolysis qualitative analysis and the analysis of cations V analytical group.

Characteristics of chemical-analytical properties cations IV analytical group on the basis of their position in the periodic table of the elements Mendeleev.

Features fractional and systematic analysis of IV analytical group cations. Qualitative reaction cations detecting IV analytical groups and conditions for their implementation.

Topic 5. Equilibrium in the reactions of complex formation.

Complex (coordination) compounds, their composition and structure. Types of complex compounds that are most widely used in qualitative analysis.

The composition and structure of chelate compounds. Features organic ligands.

Equilibrium in solutions of complex compounds. Stability of complex compounds.

General characteristics of the VI analytical group cations. Application reactions cations VI analytical group and group common reagents, reactions of complex formation in the analysis of

mixtures of cations VI analytical group for: separation and detection of ions dissolving sludge masking of interfering ions.

Qualitative reaction cations VI analytical group and the conditions of their conduct.

Protolytic equilibrium in analytical chemistry.

Protolytic acid-base reaction types protolytes.

Applying the law of mass action to the acid-base balance and their role in analytical chemistry.

Protolytic balance in the water. Characteristics of weak electrolytes, strength of acids and bases, acidity and basicity constants, pK_a and pK_b .

Calculation of pH and pOH in aqueous solutions of acids, bases, amphotiv. Hydrolysis of salts, calculation constants for a degree of hydrolysis of salts hydrolyze. Use phenomenon amphoteric and hydrolysis analysis cations IV-VI analytical group.

Protolytic equilibrium in buffer systems and solutions amphotiv.

Protolytic balance in non-aqueous solvents avtoprotolizu constant (solvolysis) and the degree of solvolysis.

Complexation reactions in analytical chemistry.

Complex compounds, their composition, structure, types of bonds. Factors that influence the complex formation.

Classification of complex compounds of charge according to the number and type of ligands.

Applying the law of mass action to complexation reactions. Constant education and constant instability of complex compounds, as they characterize the stability of the complex ion and the connection between them.

The value of complex compounds in analytical chemistry. Examples of use in analyzing reactions of complex cations IV-VI groups for analytical separation, masking and determination of cations.

Organic reagents in analytical chemistry and their application. Functionally active group (FAG) and analytic-active group (AAG). Denticity ligands, chelate effect. The structure of chelate compounds.

Redox equilibrium in analytical chemistry

Redox reactions, their mechanism.

Redox potential redox couples.

Potential reactions (EMF). The direction of the flow of oxygen-reduction reaction.

The influence of various factors on the value of Oxred potential and direction of flow of the reactions of oxidation-reduction.

Completeness flow of oxygen-reduction reaction. Equilibrium Constants Redox process.

The use of oxygen-reduction reactions in qualitative analysis.

Topic 6. Final lesson on the theory and practice of analysis of cations IV-VI analytical groups.

Effects of general agents, alkalis, ammonia solution, hydrogen sulphide or sulphide. Using these responses in the analysis. Group separation reagents and conditions cations.

Reactions detection of cations IV-VI analytical group, subject to their fulfillment.

Fractional progress and systematic analysis of mixtures of cations IV-VI analytical group.

Content module 3. *Application of the law of active masses to redox equilibrium. Methods of separation and concentration. Theory and practice of analysis of anions and unknown sample.*

Topic 7. Redox balances in analytical chemistry. Theory and practice of anion analysis. Chemical-analytical properties of anions 1 of the analytical group.

The essence of redox reactions. The oxidation process and the recovery process. Major oxidizing and reducing agents, which are used in the analysis, redox-amphoteric compound.

The concept electrode potential, nature of its origin, the calculation of the value of the electrode potential (Nernst equation). The concept of redox couples. Standard redox potential redox potential real formal redox potential.

The influence of various factors on the value of the redox potential. Electromotive force (EMF) system, the equilibrium constant (K_p), oxidation-reduction reactions, formulas for calculating them.

Ability direction and completeness of the reactions of oxidation-reduction.

Overview of anions and anions analytical classification groups. Qualitative reaction detection of anions and conditions of their implementation.

The principle of separation of anions on analytical group. Group agents and their role in the analysis of anions.

Chemical and analytical properties of anions.

Qualitative reactions of anions I analytical group (SO_4^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, PO_4^{3-} , $\text{B}_4\text{O}_7^{2-}$, CO_3^{2-} , $\text{S}_2\text{O}_4^{2-}$, AsO_3^{3-} , AsO_4^{3-} , $\text{C}_4\text{H}_4\text{O}_6^{2-}$, $\text{C}_6\text{H}_5\text{O}_7^{3-}$).

Topic 8. Theory and practice analysis of anions. Chemical analysis of anions properties I analytical group.

II analytical group (Cl^- , Br^- , I^- , SCN^- , S^{2-} , $\text{C}_6\text{H}_5\text{COO}^-$) and III analytical group (NO_3^- , NO_2^- , BrO_3^- , CH_3COO^- , $\text{C}_6\text{H}_4\text{ONSOO}^-$).

Analysis of the mixture of anions I-III analytical groups.

Qualitative reaction detection of anions II-III analytical groups. Conditions of their performance.

What conclusions can be drawn based on the solubility of barium salts and anions of the group?

What are the reactions in sequence and to which external effects occurring when adding chlorinated water acidified dropwise to a solution containing I^- and Br^- ions in the presence of benzene or chloroform? Is it possible to identify this reaction I^- and Br^- ions with compatibility? Why Chloric necessary to add water drops on?

What anions and reactions which can determine a dry sample (solid sample)?

Qualitative responses you appearing anions And I - III analytical groups and conditions for their implementation.

How can I determine iodide- and thiocyanate-ions at their joint presence in the solution?

Is it possible to determine the water yodyd- chloride and bromide ions at their joint presence in the solution? In that sequence will be referred oxidation ions? A confirm using values of redox potentials corresponding redox couples.

As anions divided into groups according to the solubility of salts of barium and silver? What is the separating anions by redox properties? As used redox properties of anions in the analysis of anions mix? What anions discoloration can be determined by potassium permanganate in acidic and neutral media?

What anions discolor iodine solution?

What anions can be determined by release of iodine from potassium iodide solution in an acidic environment?

What anions in interaction with hydrochloric acid gas release? How to define these gases?

What information about the presence or absence of anions can be obtained on the basis of the pH value of an aqueous solution? The presence of anions which can be excluded in the acidic environment? How to determine nitrite and nitrate ions at their joint presence in the solution?

How to analyze the following mixture of anions I - III analytical groups:

- Cl^- , Br^- , I^- ;

- SO_4^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, S^{2-} ;

- AsO_4^{3-} , AsO_3^{3-} , PO_4^{3-} ;
- SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, CO_3^{2-} ;
- NO_2^- , NO_3^- .

Theme 9. Methods of separation and concentration of substances in analytical chemistry. Extraction. Chromatographic methods of analysis. Determination of alkali metal salts in solution by ion exchange chromatography. TLC and sedimentary paper chromatography.

The essence and classification methods for separation and concentration. The value in analytical chemistry.

Precipitation and coprecipitation. The concept of adsorption, occlusion, isomorphism.

Extraction in analytical chemistry. The principles of the method of extraction. General laws and quantitative characteristics. The use of extraction for identification and separation of cations and anions.

Chromatography, the essence of the method.

Classification of chromatographic analysis methods for the separation mechanism, state of aggregation phase technique experiment. Field and value of pharmacy.

Affinity chromatography. Partition chromatography. Paper and thin layer chromatography. Precipitation and paper chromatography columns. Separation of the mixture by ion chromatography sedimentary.

Separation and identification of substances by the method of chromatography in a thin layer of sorbent.

Nature and chromatography capabilities in qualitative and quantitative analysis of individual substances and mixtures.

The theoretical basis of ion exchange chromatography. Ion exchange reactions, occurring on the cation and anion. Ion-exchange equilibrium. Constant ion exchange. The kinetics of ion exchange. The exchange capacity.

Ion exchange chromatography sorbent, requirements. The chemical nature of resins. Prepare them for work.

Chromatography theory: the theory of theoretical plates and kinetic theory.

Ion-exchange chromatography, theoretical foundations. Ion exchange reactions, occurring on the cation and anion. Ion-exchange equilibrium. Constant ion exchange. The kinetics of ion exchange. The exchange capacity.

Ion-exchange chromatography sorbent, requirements. The chemical nature of resins. Prepare them for work.

Application of ion-exchange chromatography to separate compounds and quantified components of mixtures.

The concept of ion, the ion-pair and ligand-exchange chromatography.

Nature and chromatography capabilities in qualitative and quantitative analysis of individual substances and mixtures.

Theme 10. Analysis compounds of unknown composition. The final lesson of theory and practice analysis of anions, separation and concentration techniques and chromatography.

General stages of analysis compounds of unknown composition.

Preliminary test and study a mixture of dry salts.

The choice of solvent for the transfer of solid sample into solution.

Detection of cations and anions.

Content module 2. Quantitative analysis. Titrimetric and instrumental analysis methods.

Topic 1. Gravimetric analysis. The use of gravity for the analysis of chemicals and drugs.

The essence of the problem and quantitative analysis. Scope quantitative analysis.

Classification methods of quantitative analysis.

Gravimetric analysis. The essence of the method. Classification of gravimetric methods. The theory of sedimentation. Stages gravimetric analysis.

The precipitation form demands it. Gravimetric form demands it. Osadzhuvacha choice. Amorphous precipitates.

Co-precipitation. Types of co-precipitation, adsorption, occlusion, images, isomorphic and amended. Ways to reduce SP and vosadzhennya. Conditions for obtaining crystalline precipitate. Conditions for obtaining amorphous precipitates. Calculations of the analysis. Gravimetric factor. The use of gravimetric methods.

Advantages and disadvantages of gravity.

Identifying a mass fraction of magnesium salts and iron (III) by precipitation.

Determination of moisture in the compounds BaCl_2 , KCl , NaCl and pharmaceutical preparations by gravimetry.

Errors in quantitative analysis. Classification errors. Systematic and random errors and their causes. Accuracy and reproducibility analysis.

Statistical analysis of the results of the analysis, the average sample variance, standard deviation, standard deviation of the mean result, confidence intervals, relative error of average.

What methods of detecting gross errors (failures) are used in mathematical statistics?

What are Q-criterion and factors on which it depends?

On what basis can judge the presence of bias.

Comparison of two methods for reproducibility.

Subject 2. Titrimetric methods of analysis. Acid-base titration.

Titrimetric methods of analysis. Basic concepts.

Classification of methods titrimetric analysis by type of chemical reaction.

Requirements to nominate titrimetric reactions.

Terms of titrimetric determinations.

Measuring volumes. Measuring utensils. Check containers measuring vessels.

Titrant. Methods of cooking. Primary and secondary standards. Requirements put forward to primary standards. Ways of expressing the concentration of titrant.

Methods of execution titration (Pipetting and individual navazhok). Methods Titration (direct titration, back titration, replaceable titration)

Calculations in titrimetric analysis. The expression measurements.

Subject 3. Acid-base titration. Titration of strong acids and strong bases vice versa.

Reactions underlying method of acid-base titration. The essence atsydy- and Alkalimetry.

Features acid-base titration.

Reactions acid-base interactions and requirements.

Fixing endpoint titration.

The theory of acid-base indicators. Ion chromophore and chromophore-ionic theory of indicators. Interval transition acid-base indicator, the indicator titration Hg.

Methods of selection indicators.

Titration curve.

Methods for the preparation of volumetric solution of acids and alkalis and their standardization.

Subject 4. Acid-base titration. Titration polybasic acids polyacidic bases and salts thereof, mixtures of acids or bases. Errors in quantitative analysis.

Titration weak electrolytes in aqueous medium with the indicator fixing the end of the titration.

Titration curves of weak acids, weak bases.

Features titration many major bahatokyslotnyh acids and bases.
Calculation of pH titration solutions at many major bahatokyslotnyh acids and bases.
The analysis of titration curves.
Constant titration rate constants titration. Justification opportunities titration steps polybasic acids and bases and bahatokyslotnyh. Calculation results of titrimetric analysis.
Equilibria in aqueous solutions amfolitiv. The method of acid-base titration amfolitu.
Calculations constant acidity or basicity amfolitu.
Signal error acid-base titration, proton (hydrogen) hydroxide, acidic, basic. Their causes.
Calculation error indicator.

Subject 5. Acid-base titration. Titration of weak acids, alkalis and weak bases strong acids. Titration amfolitiv. The use of acid-base titration to quantify the chemicals and drugs. Determination of substances in non-aqueous environments.

The final lesson from the section "Gravimetric Analysis. Titrimetric methods of analysis. Acid-base titration. Statistical analysis of the results of the analysis".

The use of acid-base titration to quantify the functional groups (carboxyl, sulfo-, amino, aldehyde, alcohol hydroxyl).

The use of acid-base titration for elemental analysis. Determination of nitrogen by Kieldal. Determination of sulfur, chlorine, bromine.

Determination of ammonium salts, amino acids and so on.

Justification possibility of differential titration of mixtures of acids or bases. Calculate the pH of solutions of mixtures of acids or bases.

The final lesson

Gravimetric analysis

The essence of the method. Classification of gravimetric methods. Stages gravimetric analysis.

The precipitation form demands it. Gravimetric form requirements neyi. Vybira osadzhuvacha.

The theory of sedimentation. Amorphous precipitates. Crystalline precipitates.

Co-precipitation. Types of co-precipitation, adsorption, occlusion, izomorfizm. Ways to reduce co-precipitation.

Calculations of the analysis. Gravimetric factor.

The use of gravimetric methods. Advantages and disadvantages of gravity.

Titrimetric methods of analysis

Essence and classification titrimetric methods of analysis.

Requirements reactions titrimetric methods of analysis.

Titrant (standard solutions), methods for their preparation.

Ways of expressing concentration titrants: molar concentration equivalent molar concentration, titer, titer is determined by the substance factor correction.

Methods (direct, reverse and substitution) and methods (individual and Pipetting navazhok) titration. The essence of the advantages and disadvantages.

The equivalence point, endpoint titration. Ways to fix the equivalence point.

Measuring utensils, its classification. Accuracy volumes. Calibration of measuring vessels.

Calculations in titrimetric methods.

Formula for calculation: sample substances titrant equivalent molar concentration, titer, titer for the titrant detectable substance mass and the mass fraction of substance on the results of titration for various titration methods and techniques to suit different ways of expressing concentration titrants.

Precision measurements and record the results of the expression analysis results in significant numbers.

Accuracy and reproducibility analysis. Errors in quantitative analysis. Statistical analysis of the results of the analysis.

Acid-base titration

The essence of acid-base titration. Acidimetry. Alkalimetry.

Acid-base properties of substances. The concept of acids and bases. Cationic, anionic and molecular acids and bases. Amfolyty. Acidity and basicity constants.

Influence of solvent on the acid-base properties of substances. Classification of non-aqueous solvents: protogene (acid) protofilni (basic) and amfiprotni aprotini.

The chemistry of acid-base titration interaction in strong and weak acids (cationic, anionic, molecular) conjugate acid-base pair.

Titration method of acid-base titration. Preparation and standardization of solutions of acids and alkalis. Primary and secondary standards and atsydy- Alkalimetry.

Ways to fix the equivalence point in acid-base titration. pH indicators.

The main characteristics of pH indicators: indicator titration transition interval indicator. The structure and color of methyl orange and phenolphthalein in different environments.

Methods of selection of pH indicators: qualitative and quantitative.

The principle of constructing titration curves. Calculation of pH titration curve. The nature of the various titration curves of acids and bases (strong, weak, polybasic). Selection indicator for the titration curve.

Signal error. Calculation of the proton, hydroxide, acidic and basic errors.

Features and field of application of the method of acid-base titration. Justification possibility of determining the substances with acid-base properties based on the acidity or basicity constants and constants titration:

- Titration of strong acids strong bases (and vice versa);
- titration of weak acids and strong bases strong acids, weak bases;
- titration bahatokyslotnyh polybasic acids and bases.

Titration in non-aqueous media (protolitometriya). Titration and indicators method. Fields of application. Advantages and disadvantages.

Elemental analysis: quantification of nitrogen, sulfur, chlorine, bromine.

Functional analysis: quantification of compounds containing carboxyl, sulfo-, amino, aldehyde group, alcoholic hydroxyl.

Alkalimetrychne definition:

- for direct titration method:

free acids (inorganic and organic salts (cationic and anionic acid));

- the method of reverse titration:

ammonium salts, esters of organic acids;

- by way of substitution:

boric acid in the presence of glycerol or mannitol; ammonium salts; amino acid in the presence of formaldehyde; formaldehyde in formalin and more.

Atsydymetrychne definition:

- by way of direct titration:

strong and weak bases, salts (anionic bases and amfolitiv) mixture of sodium carbonate and sodium bicarbonate, sodium hydroxide and sodium carbonate;

- the method of reverse titration:

solution of ammonia, nitrogen bases and alkaloids soluble calcium, magnesium, etc; hexamethylenetetramine (hexamine); mercury (II) amidohloridu;

- by way of substitution:

chlorides and nitrates for Tananayevym; oxide of mercury (II).

Determination of substances in non-aqueous environments:

- titration solvent among protofilnyh sulfonamides, phenols;
- titration solvent among protogene sulfonamides;
- titration among amfiprotnyih amine solvents and acids.

Statistical analysis of the results of the analysis.

Errors in quantitative analysis. Classification pohybok. Systematychni and random error of prychyny. Pravylnist and reproducibility analizu. Statystychna processing of the analysis, the average sample variance, standard deviation, standard deviation of the mean result, confidence intervals, relative error of average.

Comparison of two methods for reproducibility.

Subject 22. Redox titration and its application in the analysis of chemical compounds and drugs. Permanganometry.

The method redox titration. Classification methods redox titration.

Requirements reactions in IWT. Fixing endpoint titration in the methods and equipment. Indicators redox titration classification. Redox indicators, their characteristics.

Curves redox titration. Calculation of redox potentials at different titration.

Permanhanatomychno titration. The essence and the basic equation method. Terms of permanhanatomychno titration.

Titrant method. The method of its preparation. The primary method of standards, standardization of potassium permanganate for oxalic acid.

Fixing endpoint titration in permanganometry.

Application of permanganometry: determination of hydrogen peroxide and iron (II), nitrites, neutral substances (calcium, barium and others), oxidants, organic compounds.

Content module 2. *Redox titration and its application in the analysis of chemical compounds and drugs. Sedimentation titration, compleximetric titration. Application of methods in the analysis of chemical compounds and drugs.*

Topic 6. Redox titration and its application in the analysis of chemical compounds and drugs. Permanganometry.

The essence of redox titration methods. Classification of redox titration methods.

Requirements for reactions in weapons. Fixation of the end point of titration in the methods of weapons. Indicators of redox titration, their classification. Redox indicators, their characteristics.

Redox titration curves. Calculation of redox potentials at different moments of titration.

Permanganometric titration. The essence and basic equation of the method. Conditions for permanganometric titration.

Titrant method. The method of its preparation. Primary standards of the method, standardization of potassium permanganate solution by oxalic acid.

Fixation of the end point of titration in permanganometry.

Application of the method of permanganometry: determination of hydrogen peroxide, iron (II), nitrites, indifferent substances (salts of calcium, barium and others), oxidants, organic compounds.

Topic 7. Redox titration. Iodometry.

The method yodymetriyi and Iodometry.

Ways to fix the endpoint of the titration during yody- and iodometric determinations.

Yody- titrant methods and Iodometry. Production of standard solutions of iodine and sodium thiosulfate their standardization and storage. Titration methods while reducing yodymetrychnomu definition.

Titration method in determining oxidants.

Terms of yody- and iodometric determinations.

Application yody- and Iodometry for determining reducing (oxides of arsenic (III) sulphate, hydrazine, formaldehyde in formaldehyde, sulfites, mercaptans, etc.) , Oxidants (hydrogen peroxide, the active chlorine bleach, chlorine bleach active B, copper (II), potassium dichromate, potassium bromate, etc.) Unsaturated organic compounds (ascorbic acid, etc.). Aromatic and

heterocyclic compounds (antipyrine, etc.) mineral acids, metal cations that form precipitates with chromate ions (barium, strontium, lead).

Topic 8. Redox titration. Bromatometry, bromometry. Nitritometry.

The method bromatometry. Titrant method, its standardization.

Indicators bromatometry method. The mechanism of action of irreversible azoindicators (methyl orange and methyl red). Features of bromatometrychnoho titration using azoindicators.

The method bromometry. Titrant method.

Ways to fix end point of bromometric titration.

Methods titration in bromometry.

Application bromatometry to determine the oxidizing and reducing agents.

Application bromometriyi for determination of organic compounds that can brominate, etc. For the analysis of metal cations that are deposited or 8-oxyquinoline anthranilic acid.

Nitrytometriyi essence, bahatoyakisnist properties of sodium nitrite, the basic equation method.

Titrant method of its preparation method and characteristics of standardization. Terms diazotization reaction. Ways to fix the KTT. External and internal indicators, their mechanism of action.

Nitritometric determination of reducing agents, oxidants, aromatic amines.

Topic 9. Complexometric titration. Complexometry. Mercurymetry.

Complexometric titration. The essence of the method. Requirements reactions complexometric titration.

Complexometry. Complexons that are used in titrimetric analysis of their properties.

Curves complexometric titration. Dependence jump titration of stability constants of complex compounds, pH, etc.

Working solutions complexonometry. Preparation and standardization of working solution Trilon B.

Fixing ETT in complexonometry. Metallochromic indicators, mechanism of action and the requirements put forward to them. Properties and application metallochromic indicator, Eriochrome Black T, murexide, xylenol orange.

Terms of complexometric titration.

Complexometric titration methods (direct, reverse and substitution).

Scope complexonometry. Determination of the total hardness of water. Application complexonometry in pharmacy and cosmetology.

Mercurimetry. The method, titrant and how to fix ETT. Application mercurymetry.

Topic 10. Precipitation titration. Argentometry. Mercurometry. Final lesson in the section of redox titration, complexometry and precipitation titration.

The theoretical basis of methods precipitation titration. Requirements reactions used in the precipitation titration. Classification of methods precipitation titration.

Precipitation titration curves.

Detection endpoint titration. Indicators precipitation titration method (precipitation, absorption, metallochromic). The mechanism of action of indicators. Terms of use and the choice of adsorption indicators.

Arhentometrychne titration. The essence of the method. Titrant method of preparation and standardization. Varieties Argentometry.

More Method: Method titration method titrant indicator method, chemical reactions, the possibilities of the method.

Method Fajans-Fischer-Hodakov: a way of titration, titrant method indicator method, chemical reactions, the possibilities of the method.

Volgard Method: Method titration method titrant indicator method, chemical reactions, the possibilities of the method. Features hloryd- definition and iodide ions by Volgard.

Merkurometrychne titration. The essence of the method. Titrant method of its preparation, standardization. Opportunities method.

Indicators merkurometriyi method. The mechanism of action zalizotiotsianatnoho indicator when determining merkurometrychnomu halides. The role of "idle experiment."

Application analysis methods precipitation titration.

Concluding session

General redox titration

The method redox titration. Requirements reactions in IWT. The equilibrium constant reaction and its relationship with standard potentials of redox couples. The influence of various factors on the value of the redox potential redox pairs (Nernst-Peters equation) and the direction of reactions. Induced reactions (conjugated) reaction, catalytic and autocatalytic reactions in analytical chemistry. Classification methods redox titration.

Fixing endpoint titration in the methods and equipment. Indicators redox titration classification. Redox indicators, their mechanism of action and conditions of use.

Curves redox titration. Principles, calculation redox potentials at different titration. Selection of redox indicators for the titration curve.

Methods redox titration

Permanganometry. Yodo- and yodyometriya. Bromato- and bromometriya. Nitrytometriya. Dyhromatometriya. Yodatometriya. Hloryodyometriya. Tserimetriya.

The essence of the method. Basic equations.

Titrant, methods of preparation and standardization, primary and secondary standards.

Ways to fix the endpoint of the titration. Indicators.

Terms of the definitions, methods of titration, pH, Temperature, catalysts, additives, etc. administration.

Application of ROT in the analysis

Reducing Permanhanatometrychne definition (iron (II), hydrogen peroxide, sodium nitrite, arsenic (III), etc.), oxidants (by way of reverse titration) and some neutral substances (calcium salt (II), Ba (II), etc.).

Reducing Yodyometrychne definition (arsenic (III), sulfites, sulfides, sodium thiosulfate, hydrazine sulfate, formaldehyde, etc.), unsaturated organic compounds (ascorbic acid), heterocyclic compounds (antipyrine).

Iodometric determination of oxidants (hydrogen peroxide, the active chlorine bleach, active chlorine to chloramine B, copper (II), dichromate, potassium bromate, potassium, etc.) And cations of some metals (Pb (II), Ba (II), Hg (I), Hg (II), etc.).

Reducing Bromometrychne definition (arsenic (III), antimony (III), sulfate, hydrazine, hydrogen peroxide, etc.)

Bromometrychne determination of organic compounds containing primary aromatic group or phenolic hydroxyl (sodium salicylate, phenol, resorcinol, streptocide, benzocaine, procaine), salts of certain metals (Al (III), Mg (II), Bi (III), etc.).

Reducing Nitrytometrychne definition (arsenic oxide (III), antimony (III), tin (II), hydrazine sulfate, etc.), Oxidants (potassium permanganate, potassium dichromate, etc.), Organic compounds containing a primary amino group and heterocyclic compounds (procaine, streptocide, antipyrine, etc.).

Reducing Hloryodyometrychne definition (arsenic (III), iodides, etc.) and organic compounds (salicylic acid, sulfonamides, procaine).

Zer and metric definitions reducers (mercury (I), antimony (III), arsenic (III), iron (II), iodide, nitrite, hydrogen peroxide, ascorbic acid).

Reducing Dyhromatometrychne definition (iron (II), sulfites, iodide, arsenites, ascorbic acid) and oxidants (nitrates, chlorates, permanganates).

Reducing Yodatometrychne definition (arsenic (III), tin (II), mercury (I), iron (II), iodides, etc.) and oxidants (lead oxide (IV), manganese oxide (IV), hydrogen peroxide, etc.).

The precipitation titration

The theoretical basis of methods precipitation titration. Requirements reactions used in the precipitation titration. Classification of methods precipitation titration.

Detection endpoint titration. Indicators precipitation titration method (precipitation, absorption, metallochromic). The mechanism of action of indicators. Terms of use and the choice of adsorption indicators.

Arhentometrychne titration. The essence of the method. Titrant method of preparation and standardization. Varieties Argentometry.

More Method: Method titration method titrant indicator method, chemical reactions, the possibility of the method.

Method Fajanc-Fischer-Hodakov: a way of titration, titrant method indicator method, chemical reactions, the possibilities of the method.

Volgard Method: Method titration method titrant indicator method, chemical reactions, the possibilities of the method.

Merkurometrychne titration. The essence of the method. Titrant method of its preparation, standardization. Indicators merkurometriyi method. Opportunities method.

Complexometric titration

Complexometric titration. The essence of the method. Requirements reactions complexometric titration.

Kompleksonometry. Complexons that are used in titrimetric analysis of their properties.

Working solutions kompleksonometry. Preparation and standardization of working solution Trilon B.

Fixing ETT in kompleksonometry. Metallochromic indicators, mechanism of action and the requirements put forward to them.

Terms of kompleksonometric titration. Methods of direct, inverse and substitution titration in kompleksonometry.

Mercurymetry. The method, titrant and how to fix ETT. Application merkurymetriyi.

Content module 3. Optical methods of analysis. Chromatographic and electrochemical methods.

Topic Subject 11. Optical methods of analysis. Photocolorimetry. Conditions of photometric determination.

The essence of optical analysis methods and their classification.

Molecular absorption spectroscopy, the nature and basic concepts (transmittance, absorbance, molar and specific absorption rates).

Beer light absorption laws. The reasons for deviation of Beer law of light absorption. Rule additivity of optical densities.

Photometric reactions requirements.

Selecting the optimal conditions of photometric determinations.

Colorimetry methods:

- Method standard series;
- The method of equalization colours;
- Dilution method.

Methods Photocolorimetry:

- Standard Method;
- The method of calibration chart;
- The method for determining molar absorption coefficient and specific;
- Method additives.

Determination of several substances in their joint presence (using the law of additivity optical density).

Differential photometric analysis.

Extraction-photometric analysis.

Photometric titration.

Topic 12. Optical methods of analysis. Spectrophotometry. Refractometry. Polarimetry. Determination of test solution.

The essence refractometry. Snell's law of refraction as well.

The refractive index (absolute and relative). Factors affecting the value of the refractive index.

Determination of concentration by refractometry.

Advantages and disadvantages refractometry.

The essence polarimetry.

The optical rotation. The angle of optical rotation. The specific optical rotation.

Determination of polarimetric method.

Advantages and disadvantages of polarimetry.

Topic 13. Electrochemical methods of analysis. Potentiometric analysis. Potentiometric titration.

Essence and classification potentiometric analysis methods.

The electrodes in potentiometry, classification (for families, by conduction, by appointment).

Direct potentiometry. pH meter, electrode electrochemical processes used electrodes.

The essence of the potentiometric titration method capabilities, its advantages and disadvantages.

Types of chemical reactions used in potentiometric titration. Indicator electrochemical reactions requirements.

Selection of electrodes depending on the type of reaction that underlies potentiometric titration.

Potentiometric titration curves (integral, differential, with faces). Principles of constructing and determining the equivalence point.

Examples of potentiometric titration quantitatively analyzing substances using oxidation-reduction reactions, precipitation, complexation and acid-base interactions.

Topic 14. Gas chromatography and high performance liquid chromatography. The final sessions of sections "Optical, electrochemical and chromatographic methods of analysis".

Gas chromatography. The structure and principle of the gas chromatograph and. Qualitative analysis. Alkyl nitrites identification using retention settings and by "tags". Quantitative gas chromatographic analysis. Determination of water by ethyl nitrite absolute calibration and internal standard method.

Topic 15. Final lesson from the sections "Optical, electrochemical and chromatographic methods of analysis".

Optical methods

The essence of optical analysis methods and their classification.

Nature and properties of electromagnetic radiation. Spectral characteristics: wavelength, wave number.

Molecular absorption spectroscopy, the nature and basic concepts (transmittance, absorbance, molar and specific absorption rates).

Rule of optical densities additivities.

Monochromatic light. Methods of light monochromatisation.

Photometric reactions requirements.

Colourimetry. Standard series method, a method of equalizing colours, dilution method. Their essence.

Photocolorimetry, spectrophotometry. The method, advantages and disadvantages, application.

Quantitative analysis of the photometric, photometric determination conditions (choice of photometric reaction analytical wavelength, cell, concentration of the solution), determining the concentration of the sample solution.

Differential photometric analysis.

Extraction-photometric analysis.

Photometric titration.

Fluorescent analysis. The essence of the method. Classification.

Fluorimetriya. Stokes-Lommel law and Vavilov law. Methods for determining the concentrations of substances in quantitative analysis.

Refractometry. The method and application in the analysis of single-component and multi-component mixtures.

Polarimetry. The essence of the method. Methods for determining concentrations. Application analysis of medications and cosmetics.

Emission spectral analysis. The essence of the method. Scope. Application analysis.

Atomic absorption spectrometry fiery. The essence of the method. Application analysis.

Infrared spectroscopy. The essence of the method. Scope.

Nephelometry and turbidimetry. The theoretical basis of methods.

Electrochemical methods

Potentiometric analysis.

Classification of electrodes used in potentiometry, the mechanism of formation potential, by virtue of repayment, by appointment.

Ionoselective membrane electrodes.

Electrochemical reactions. Requirements. Give examples of electrochemical reactions.

Direct potentiometry (ionometry). Classification. Signal electrodes. Methods for determining the concentration of substances by ionometry.

pH meter. Electrodes, electrode electrochemical processes.

Potentiometric titration. Essence. Opportunities method. Advantages and disadvantages of the method. Application analysis.

Potentiometric titration curves (integral, differential, with faces). Principles of constructing and determining the equivalence point.

Examples of potentiometric titration quantitatively analyzing substances using oxidation-reduction reactions, precipitation, complexation and acid-base interactions.

Conductometric analysis. The principle of the method, the basic concepts. How concentrations of electrolyte solutions to their electrical conductivity.

Direct conductometry. Using the analysis.

Conductometric titration. The essence of the method. Types conductometric titration curves. Benefits conductometric titration.

Polarographic analysis. The principle of the method. Polarographic wave and its characteristics. Factors that affect the value of the half-wave potential.

Quantitative polarographic analysis. Methods for determining the concentration of substances. Terms of polarographic analysis.

Amperometric titration. Amperometric titration curves. Advantages and disadvantages of amperometric titration method.

Coulometric method of analysis. Classification methods. Direct coulometry. The essence of direct coulometry at constant potential. Methods for determining the quantity of electricity passed through the solution in direct coulometry.

Coulometric titration, conditions, indication of the equivalence point, the use of chemical and pharmaceutical analysis.

Classification of chromatographic methods for the separation mechanism, state of aggregation phase technique experiment. Field and value of pharmacy.

Gas chromatography and HPLC

Gas and gas-liquid chromatography. The essence of the method. Options Options detention and separation. Chromatographic column and gas chromatography detectors. Methods for quantitative processing chromatograph. Application analysis.

High performance liquid chromatography. The essence of the method. Application analysis of substances and mixtures.

3. Structure of discipline

Topic	Hours			
	Lectures	Practice	ISW	Ind. work
1	2	3	4	5
Module 1. Qualitative analysis. Methods of separation and concentration. Chromatographic methods of analysis.				
<i>Content module 1.</i> Analytical chemistry and chemical analysis. Theory of solutions of strong and weak electrolytes. The law of active masses and its application to different types of equilibria in analytical chemistry. Application of the law of active masses to equilibria in heterogeneous systems. Theory and practice of analysis of cations of I-III analytical groups.				
Topic 1. Analytical Chemistry. Classification of methods of analysis. Basics of qualitative analysis.		4	6	
Topic 2. The theory of solutions of strong electrolytes. Using the law of mass action to equilibrium in homogeneous systems.	1	4	6	
Topic 3. Systematic analysis of progress mixture of cations I–III analytical groups by acid-base classification. The final lesson of theory and practice cation analysis I-III analytical groups.		4	10	
<i>Content module 2.</i> Application of the law of active masses to the acid-base equilibrium and to the equilibrium of complex formation, their role in analytical chemistry. Theory and practice of analysis of cations of IV-VI analytical groups.				
Theme 4. Acid-base balance in analytical chemistry.	1	4	5	
Topic 5. Equilibria in complexation reactions	2	4	5	
Topic 6. Final lesson on the theory and practice of analysis of cations IV-VI analytical groups.		4	10	
<i>Content module 3.</i> Application of the law of active masses to redox equilibrium. Methods of separation and concentration. Theory and practice of analysis of anions and unknown sample.				
Topic 7. Redox balances in analytical chemistry. Theory and practice of anion analysis. Chemical-analytical properties of anions 1 of the analytical group.	2	4	5	
Topic 8. Theory and practice of anion analysis. Chemical-analytical properties of anions of II-III analytical groups. Analysis of a mixture of anions of I-III analytical groups.		4	5	
Topic 9. Methods of separation and concentration of substances in analytical chemistry. Extraction. Chromatographic methods of analysis. Thin layer chromatography and sediment chromatography on paper.	2	4	10	
Total for module 1	8	40	72	
Module 2. Quantitative analysis. Titrimetric and instrumental methods of analysis.				

Content module 1. Gravimetric analysis. Acid-base titration and its application in chemical and pharmaceutical analysis.				
Topic 1. Gravimetric analysis. Application of gravimetry for analysis of chemicals and drugs.		4	3	
Topic 2. Titrimetric methods of analysis. Acid-base titration	1	4	3	
Topic 3. Acid-base titration. Titration of strong acids with strong bases and vice versa.		4	3	
Topic 4. Acid-base titration. Titration of polybasic acids, multiacid bases and their salts, mixtures of acids or bases. Errors in quantitative analysis.	1	4	3	
Topic 5. Acid-base titration. Titration of weak acids with alkalis and weak bases with strong acids. Titration of ampholytes. Application of acid-base titration for quantitative determination of chemicals and drugs. Determination of substances in non-aqueous media. Statistical processing of analysis results.		4	3	
Content module 2. Redox titration and its application in the analysis of chemical compounds and drugs. Sedimentation titration, compleximetric titration. Application of methods in the analysis of chemical compounds and drugs.				
Topic 6. Redox titration and its application in the analysis of chemical compounds and drugs. Permanganatometry.	2	4	3	
Topic 7. Redox titration. Iodimetry, iodometry.	1	4	3	
Topic 8. Redox titration. Bromometry, bromometry. Nitritometry	1	4	3	
Topic 9. Compleximetric titration. Complexometry. Mercurimetry	1	4	3	
Topic 10. Sedimentation titration. Argentometry. Mercurimetry. Final lesson in the section of redox titration, complexometry and precipitation titration.	1	4	3	
Content module 3. Optical methods of analysis. Chromatographic and electrochemical methods.				
Total module 2	12	60	48	
Total hours 240/8 ECTS credits	20	100	120	
Final control				Exam

4. Thematic plan of lectures

No.	The theme of the lecture	Hours
Module 1. Qualitative analysis. Methods of separation and concentration.		
1	Analytical chemistry and chemical analysis. Theory of solutions of strong and weak electrolytes. The main provisions of the theory of strong electrolytes. Total and active concentration of ions, the relationship between them, the coefficient of activity.	2
2	The law of active masses and its application to different types of ionic equilibria in analytical chemistry. Application of the law of active masses to equilibria in heterogeneous systems and its significance in analytical chemistry.	2
3	Application of the law of active masses to acid-base equilibria and their role in analytical chemistry.	2
4	Application of the law of active masses to the equilibria of complex formation and their role in analytical chemistry. Application of the law of active masses to	2

	equilibria in homogeneous systems. Redox balances.	
	Total	8
Module 2. Quantitative analysis. Titrimetric and instrumental methods of analysis.		
1	Quantitative analysis. Classification. Titrimetric analysis. Basic concepts. Classification of methods. Acid-base titration. Indicators of the method of acid-base titration. Acid-base titration curves. Selection of indicators by titration curves. Application of acid-base titration for quantitative determination of chemicals and drugs.	2
2	Redox titration. Classification of methods. Requirements for redox reactions. Redox titration curves. Redox titration indicators. Selection of redox indicators. Permanganatometric titration.	2
3	Iodimetric and iodometric titration. Bromato- and bromometric titration. Nitritometric titration. Iodchlorometry, dichromatometry, cerimetry, iodometry. Theoretical bases of methods and their application.	2
4	Sedimentation titration. Classification of methods. Argentometric. Thiocyanatometric and mercurometric titration. Indicators. Application of methods in chemical and pharmaceutical analysis. Compleximetric titration. Complexometry. Titrants, their standardization. Metal-chrome indicators. Mercurimetric titration. Possibilities of methods.	2
5	Classification of physical methods of analysis. Optical methods of analysis, their classification. Molecular absorption spectrophotometry. Refractometry. Polarimetry. Fluorescence analysis.	2
6	Gas chromatography and HPLC. Features techniques. Application analysis.	2
	Total	12
	TOTAL	20

5. Thematic plan of practice lessons

No.	topic	Hours
Module 1. Qualitative analysis module. Methods of separation and concentration		
1.	Terms of security and chemical-analytical laboratory. Basics of qualitative analysis. Qualitative reaction cations and analytical group (K^+ , Na^+ , NH_4^+), subject to their fulfillment.	4
2.	Qualitative reaction cations II (Ag^+ , Hg_2^{2+} , Pb^{2+}) and III (Ca^{2+} , Ba^{2+} , Sr^{2+}) analytical group.	4
3.	Analysis mixture cations I-III analytical groups. <i>The final lesson of theory and practice analysis cations I-III analytical groups.</i>	4
4.	Qualitative reaction cations IV analytical group (Al^{3+} , Cr^{3+} , Zn^{2+} , As^{III} , As^V , Sn^{II} , Sn^{IV}). Analysis mixture IV analytical group cations.	4
5.	Qualitative reaction cations V analytical group (Mg^{2+} , Mn^{2+} , Fe^{2+} , Fe^{3+} , Bi^{3+} , Sb^{III} , Sb^V). Analysis mixture V analytical group cations.	4
6.	Qualitative reactions VI analytical group (Cu^{2+} , Co^{2+} , Cd^{2+} , Hg^{2+} , Ni^{2+}). Analysis mixture VI analytical group cations. <i>The final lesson of theory and practice analysis cations IV-VI analytical group.</i>	4
7.	Qualitative reactions of anions I analytical group.	4
8.	Qualitative reactions of anions II-III analytical groups.	4
9.	The use of extraction for identification and separation of metal cations. Sedimentary and paper chromatography columns. The separation of mixtures of substances by chromatography in a thin layer of sorbent (TLC).	4
10.	Analysis of compounds of unknown composition.	4

	<i>The final lesson of analysis of anions and theory and practice of chromatography and separation techniques.</i>	
	Total	4
Module 2. Quantitative Analysis. Titrimetric and instrumental methods of analysis.		
1.	Quantitative analysis. Technology weighing on an analytical balance. Gravimetric analysis. Defining a mass fraction of magnesium salts, iron (III) by precipitation. Determination of moisture in the compounds BaCl ₂ , KCl, NaCl and pharmaceuticals.	4
2.	Titrimetric analysis. Measuring utensils, its calibration. Check capacity volumetric flasks, pipettes, burettes. Titrant their preparation. Calculations in titrimetric analysis. Statistical treatment of the results of the analysis.	4
3.	Titrimetric methods of analysis. Acid-base titration. Titration of strong acids and strong bases vice versa.	4
4.	Acid-base titration. Titration polybasic acids, polyacidic bases, mixtures of acids or bases.	4
5.	Acid-base titration. Titration of weak acids, alkalis and weak bases strong acids. The use of acid-base titration to quantify the chemicals and drugs. The final lesson of the section "Gravimetric Analysis. Titrimetric methods of analysis. Acid-base titration. Statistical analysis of the results of the analysis."	4
6.	Redox titration. Permanganometry. Preparation and standardization of potassium permanganate. Determining the mass-volume concentration of H ₂ O ₂ , mass fraction of iron salts (II), H ₂ C ₂ O ₄ ·2H ₂ O, Na ₂ C ₂ O ₄ , NaNO ₂ and others.	4
7.	Redox titration. Iodometric determination of oxidants and reducers; preparation and standardization of sodium thiosulfate solution and iodine. Determination of the mass fraction of formaldehyde, iodine, chlorine and others.	4
8.	Bromo- and bromatometry. Production of 0.1 m. solution of potassium bromate. Quantitative determination of As ₂ O ₃ , Na ₃ AsO ₃ , in the preparation of sodium salicylate. Nitritometry. Preparation and standardization of titrants. Determination of streptocid mass fraction and others.	4
9.	Complexometric tytrovannya. Complexometry complexometric titration. Mercurymetry. Complexometry. Preparation and standardization of titrants: mercury (II) nitrate Trilon B. Determination of the mass fraction of KCl, NaCl mercurymetric method. Complexonometric determining the mass fraction of salts of Ca ²⁺ , Mg ²⁺ , determine the total water hardness.	3
10.	Sedimentary titration. Argentometry. Merkurometry. Preparation and standardization of titrants: silver nitrate, mercury (I) nitrate. Determination of KCl, KBr, NaCl, NaBr argentometric and mercurometric methods. Concluding session of the sedimentary section and complex metric titration. The final lesson of the section "Redox titration. Complexometry. Sedimetry."	4
11.	Photometric determination of concentrations of potassium permanganate, potassium dichromate, iron (II) and others in solutions by photolorimetry.	4
12.	UV spectrophotometry of p-aminobenzoic acid derivatives. Identification and assay. Spectrophotometric determination of concentrations of components in mixtures amidopyrin and caffeine, potassium chromate and potassium permanganate and others.	4
13.	Potentiometric determination of the content of individual compounds, the analysis of binary mixtures. Ionometry determination of pH, concentration of halide ions, cations alkali and alkaline earth metals. Determination of iron (II), a mixture of components in hydrochloric and boric acid hloryd- and iodide ions by potentiometric titration.	4
14.	Gas chromatography. The structure and principle of the gas chromatograph. Qualitative analysis. Alkyl nitrites identification using retention settings and by	4

	"tags". Quantitative gas chromatographic analysis. Ethylnitrite determination in water by the absolute calibration method and internal standard.	
15.	Final lesson of section "Optical, electrochemical and chromatographic methods of analysis". Final control of section "Photometric electrochemical and chromatographic methods of analysis".	4
	Total	60

6. Thematic plan of students' individual work

No	Topic	Hours	Type of control
Content module 1. Qualitative analysis. Methods of separation and concentration.			
1	Master the skills of basic concepts of qualitative chemical analysis. Solve problems of quantitative characteristics of the sensitivity of analytical reactions. Analytical classification cations into groups (sulfide, ammonium phosphate, acid-base). Advantages and disadvantages of each classifications. Strong and weak electrolytes. The main provisions of strong electrolytes.	6	Current control practices in their classes,
2	Heterogeneous equilibrium.	6	
3	Analysis mixture of cation-III analytical groups.	10	
4	Using the law of mass action in analytical chemistry. The main types of equilibria that are used in analytical chemistry. The constant chemical equilibrium. Acid-base balance. The concept of protolytic theory of acids and bases. Hydrolysis.	5	
5	General characteristics of complex compounds. Equilibrium in solutions of complex compounds. Functional-analytic and analytic-active groups in the organic reagents. Analytical reactions and reagents yaks are used in qualitative analysis.	5	
6.	Analysis mixture cations IV-VI analytical group.	10	
7.	The oxidation-reduction and their use in analytical chemistry. Nernst equation. The equilibrium constant. The use of redox reactions in the analysis. Analytical classification of anions. Analytical reactions anions of the I group.	5	
8.	Analysis mixture of anions I-III analytical groups.	5	
9.	Methods of separation and concentration in analytical chemistry. Extraction. Chromatography. Chromatographic methods of analysis. Thin layer chromatography and paper.	10	
10.	The analysis of an unknown sample.	10	
	Total	72	
Content module 2. Quantitative Analysis. Titrimetric and instrumental methods of analysis.			
1.	Quantitative analysis. Gravimetric analysis. Classification methods of gravimetric analysis. The main stages of gravimetric determination. Gravimetric and precipitation form. Requirements for these forms. Calculations in gravimetric analysis.	3	Current control practices in their classes
2.	General concept of titrimetric methods. Fundamentals of quantitative analysis. Quantitative analysis. Ways of expressing the concentration of titrant. Calculations in quantitative analysis. Mathematical processing of results of quantitative analysis.	3	
3.	Acid-base titration. Titrant method. Primary and secondary standards. Standardization of titrants.	3	

4.	Acid-base titration. pH indicators. Titration curve. Titration of strong acids, alkalis and vice versa. Titration of weak acids, alkalis and weak bases strong acids. Titration polybasic acids, mixtures of acids and bases. Titration of ampholytes.	3
5.	Acid-base titration in non-aqueous environments. The use of acid-base titration in the chemical and pharmaceutical analysis.	3
6.	Redox titration. Redox indicators. Titration curve. Permanganometry. Application permanganometry to determine the reducing, oxidizing and neutral substances.	3
7.	Redox titration. Iodometry. Iodimetry. Iodatometry. Application methods for determining reducers, oxidants and some organic compounds.	3
8.	Redox titration. Bromatometry. Bromometry. Nitritometry. Application methods for determining reducers, oxidants, phenol derivatives and aromatic amines.	3
9.	Redox titration. Ceriummetry. Dihromatometry. Applications in the chemical and pharmaceutical analysis.	3
10.	The precipitation titration. Titration curve. Indicators precipitation titration. Argentometry (Mohr and Volhard methods). Mercurometry. Complexometric titration. Complexometry. Complexons. Metallochromic indicators. Application complexometry analysis cosmetics and drugs.	3
11.	Classification of physical methods of analysis. Their advantages and disadvantages of optical analysis techniques. Molecular absorption analysis. The essence of the basic concepts. Laws light absorption. Rule additivity optical densities. Determination of photometric methods.	3
12.	Fluorescent analysis. Emission spectral analysis. Atomic absorption photometry flame. IR spectrophotometry. Polarimetry. Nephelometry and turbidimetry.	3
13.	Electrochemical methods of analysis. General characteristics. Applications in pharmaceutical analysis. Polarography. Conductometry. Coulometry. Amperometric titration.	6
14.	Gas chromatography. Liquid chromatography.	3
15.	Methods of analysis of the salt sample.	3
	Total	48
	TOTAL	120

7. Individual tasks *for full-time students provided*

8. Tasks for independent work

1. Calculate the ionic strength of the solution obtained by mixing equal volumes of 0.06 M solution of ammonium sulfate and ammonium chloride.
2. Calculate the ionic strength determine the coefficient of activity and concentration of active ion Al^{3+} and Cl^- a 0,1 M solution $AlCl_3$.
3. Calculate the pH of the 0,001 M solution of hydrochloric acid and without taking into account the ionic strength of the solution.
4. Calculate in which the pH starts magnesium hydroxide precipitation with 0.1 M solution of its salt. If $PR = 6 \times 10^{-10}$.

5. Calculate the solubility product of silver chloride if its concentration of saturated solution is 1.33×10^{-5} mol/l.
6. Calculate the solubility product of calcium phosphate, knowing that 1 liter nasichenoho at 18 °C solution it contains 2.215×10^{-4} grams of salt.
7. Do barium sulfate precipitate is formed while pouring an equal volume of 2×10^{-14} M solution of barium chloride and sodium sulfate?
8. Calculate how many times the solubility (in g/l) carbonate of lead in clean water solubility it in a 0.01 M solution of sodium carbonate?
9. Calculate pH 0.1 M solutions of hydrochloric acid and sodium hydroxide. Specify how it will change to diluted solutions of 100 times.
10. Calculate the concentration of formate ions in a solution of 1 liter which contains 0.1 mol of formic acid and 0.01 mol of hydrochloric acid, assuming full dissociation of the latter.
11. Calculate the hydrogen ion concentration and pH of the solution obtained by mixing 20 ml of 0.05 M solution of nitrous acid and 30 ml of 1.5 M sodium nitrite
12. Calculate the constant and the degree of hydrolysis of 0.01 M solution of potassium formate if $R(\text{HCOOH}) = 1.8 \times 10^{-4}$.
13. Calculate the concentration of complexing ions and ammonia in 0,1 M solution of sulphate tetrammin copper (II) ($K_{\text{NEST}}[\text{Cu}(\text{NH}_3)_4]^{2+} = 9.33 \times 10^{-13}$).
14. Does the residue dissolved in a solution of silver iodide of potassium cyanide? ($K_{\text{NEST}} K[\text{Ag}(\text{CN})_2] = 1, 41 \times 10^{-20}$).
15. Determine the redox potential of the system: $\text{Cr}_2\text{O}_7 + 14\text{H}^+ + 6\text{e}^- \leftrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$, if the concentration of ions in solution equal to: 1) $[\text{Cr}_2\text{O}_7^{2-}] = 1 \text{ mol / l}$; $[\text{Cr}^{3+}] = 0.1 \text{ mol / l}$; $[\text{H}^+] = 1 \text{ mol / l}$.
16. Calculate the value of K_p , estimate the direction and completeness of the reaction: $\text{SO}_4^{2-} + 2\text{I}^- + 2\text{H}^+ \leftrightarrow \text{SO}_3^{2-} + \text{I}_2 + \text{H}_2\text{O}$ at pH = 1.
17. At what value EPC and K_p reaction: $\text{AsO}_2^- + \text{I}_2 + 2\text{H}_2\text{O} \leftrightarrow \text{HAsO}_4^{2-} + 2\text{I}^- + 3\text{H}^+$ will go forward to?
18. Is it possible influence of potassium dichromate in an acidic environment oxides: a) Fe^{2+} to Fe^{3+} ; b) Mn^{2+} to MnO_4^- ; a) SO_3^{2-} to SO_4^{2-}
19. Calculate weight dekahidratu sodium tetraborate ($M = 381,4 \text{ g / mol}$) for the preparation of 200.0 mL of 0.05000 n. solution.
20. The sample of sodium carbonate 1.083 g dissolved in a volumetric flask 200.0 ml. Calculate the molar concentration and titer obtained solution.
21. To 20 ml 0,1 M solution of NaOH added 10 ml 0,1 M solution of HCl. Calculate the pH of the solution.
22. Calculate the molar concentration equivalent adjustment coefficient titer and sodium hydroxide solution, if the titration of 20.00 mL 0,05075 M solution of oxalic acid spent 19.50 ml of this solution.
23. At what pH titration should finish 0,1 M ammonia solution 0,1 M solution of hydrochloric acid?
24. The sample of ammonium salts weight of 1,000 g treated with excess concentrated solution of NaOH. Ammonia released, swallowed 50,00 ml 1,072 M solution of HCl and excess acid have titrated 25.40 ml of NaOH ($T_{(\text{NaOH})} = 0,004120 \text{ g / ml}$). Calculate the mass fraction (in%) NH_3 in the sample.
25. Calculate the pH in the first and second equivalence point titration with 0,1 M solution of maleic acid 0,1 M sodium hydroxide solution.
26. The sample mixture NaOH and Na_2CO_3 1.8017 grams dissolved in a volumetric flask of 500.0 mL. Titration 25,00 ml in the presence of phenolphthalein takes 20.50 ml, and in the presence of methyl orange - 21.53 ml of 0,1035 M HCl solution. Calculate the mass fraction (in%) Na_2CO_3 in the sample.
27. Determine the type and calculate an error indicator titration with 0,1 M ammonia solution 0,1 M solution of hydrochloric acid with methyl red ($RT = 5.0$).

26. To the solution of amino acids mixture containing 0.1046 grams of glycine ($M = 75.07 \text{ g / mol}$) and 0.0848 g of alanine ($M = 89.10 \text{ g / mol}$), added excess formalin previously neutralized by phenolphthalein. The obtained compound have titrated 0,1016 M solution of NaOH. Calculate the volume of titrant.
27. In determining the calcium gravimetric method obtained the following results CaO (in %): 12.86; 12.90; 12.93; 12.84. Calculate the standard deviation in the determination of calcium.
28. Calculate the redox potential of the solution obtained, when added to 20.00 ml of 0,1 m. sulfate solution of iron (II) 18,00 ml 0,1 m. potassium permanganate.
29. In determining the content yodymetrychnomu aspirin in a formulation prepared 25,00 ml solution containing 0.2015 grams of aspirin. In this solution titration spent 12,00 ml of iodine solution = 0.01667 g / mL). Determine the weight of aspirin in the original navazhtsi and mass fraction (in %) aspirin as a drug.
30. Aluminum sulfate solution of aluminum deposited as oksyhinolinatu, the precipitate filtered, washed, dissolved in HCl. 8-hydroxyquinoline, which was isolated after addition of potassium bromide, potassium bromate solution have titrated indicator methyl red. Calculate the concentration (mg / ml) salt solution metal if the titration of 25.00 mL of sample solution spent 23,00 ml 0.1085 n. solution of potassium bromate.
31. Determine the mass fraction (in %) oxide antimony (III) in the analyzed sample containing impurities indifferent if a sample weighing 0.6215 grams dissolved in hydrochloric acid and spent titration of 12.50 mL of 0.05000 n. solution of potassium bromate.
32. After the dissolution of iron oxide sample weighing 0.1000 grams and recovery iron to Fe^{2+} titration spent 12.61 ml 0,0993 IM solution monochlorides iodine. To determine which formula is analyzed oxide: FeO , Fe_2O_3 , Fe_3O_4 ?
33. What is the substance taken for analysis (NaBr or KBr), if the titration of 0.2332 g his method Mopa spent 18.77 ml of 0,1044 M solution of AgNO_3 ?
34. What is the mass of sodium contained in the sample solution is taken, if after his deposition as $\text{NaZn}(\text{UO}_2)_3(\text{CH}_3\text{COO})_9 \cdot 6 \text{H}_2\text{O}$ the resulting precipitate was separated, dissolved have titrated zinc and 20.85 ml of 0,1000 M sodium EDTA ($K_p = 0.9194$)?
35. With coal sample weighing 2.6248 grams after appropriate treatment received 0.3248 g BaSO_4 . Calculate the mass fraction (in %) sulfur coal. List the mass fraction of sulfur on a dry basis, if the moisture content is 2.58%.
36. The optical density of the solution is 0.205. Calculate the light transmission of the solution in percentage (%).
37. In determining iron in a monosulfosalicylatu optical density of a solution containing 0.23 mg of iron in 50 ml, equal to 0.264 for layer thickness of 2 cm. Calculate the value of the molar ratio light absorption monosulfosalicylatu iron.
38. salt solution of iron (II I), containing 6.8 mol/L HCl extracted with an equal volume of ethyl ether 78% iron (II I). What percentage of iron (II I) go into the organic solvent after 3-times extraction?
39. What is the total amount of chloroform should be taken to reduce the concentration of substance X to 1×10^{-4} , if 25 ml 0,1 M solution X were titrated portions of solvent, 2 ml ($E = 9.6$).
40. The test sample weighing 1.8617 grams, containing sodium nitrate and ionic impurities dissolved in a volumetric flask 100.0 ml passed through a column with cation exchangers in H-form. The resulting eluate have titrated 20.15 ml 0.09886 M sodium hydroxide solution. Calculate the mass fraction of sodium nitrate in the sample.
41. The solution containing cations of silver, lead and mercury (I) passed through a column filled with a carrier that is saturated with sodium iodide. In what order are located in areas chromatographic column. A justification calculations.
42. In determining the CH_3COOH 10,00 ml analyzing diluted in a volumetric flask 100.0 ml. 10,00 ml of this solution have titrated 0,05000 M sodium hydroxide solution. Define the content (g / l) CH_3COOH on the following data:

V _{NaOH} , ml	8.00	9.00	10,00	11,00	12,00	13,00	15,00	17,00
Resistance, Ohm	75.0	68.1	62.3	57.0	43.2	50.8	51.5	52.1

43. A sample of hydrochloric acid volume of 20.00 ml coulometrically titrated hydroxide ions created at a constant amperage 21.48 mA. To achieve equivalence moment needed to carry out power generation over 686.4 sec. Calculate the concentration of HCl in the solution (mol/l).

44. The sample of ore weighing 1.2540 grams dissolved in acid, restored iron to iron (II) and transferred to the volumetric flask 250.0 ml. An aliquot 2.00 ml have titrated coulometric vanadium (V), electrogenerated of vanadium electrode. Calculate the mass fraction (%) iron ore if the generation of vanadium (V) was performed at a current of 40 mA during 15 min 40 sec.

45. Identify the characteristics of capillary polarographic if 50 droplets have a mass 445 mg, the formation of one drop is 4.5 sec.

9. teaching methods

In studying the subject "Analytical chemistry", the following methods of teaching students:

by sources of knowledge:

- verbal - Lecture, explanation, instruction;
- visual - demonstration, illustration;
- practical - practical work, case studies.

knowledge of the nature of logic :

- analytical,
- synthetic,
- analytical and synthetic,
- inductive, deductive.

the level of individual mental activity :

- problem,
- partial retrieval,
- research.

on the main stages of the process :

building knowledge,
formation and skills,
application of knowledge,
generalization,
fixing,
audit

by sytemnym approach :

stimulation and motivation,
control and self-control

10. control methods

Current control is carried out on each class according to specific objectives topic. All workshops used objective monitoring of independent work and theoretical training of practical skills.

Apply the following diagnostic tools of training students: testing, solving situational problems, laboratory research, interpretation and evaluation of the results, control skills.

In each class the student is responsible for tests (a theme workshops, standardized questions, knowledge is required for understanding the current topic, the issue of lectures and self-study related to this occupation; demonstrates knowledge and skills practical skills according to the theme workshops).

The form of final control in the study of "Analytical Chemistry" is a test. Before final control students who complete all kinds of work, provided the curriculum, worked all training sessions and during a module gained scores higher than the minimum level.

Methods and means of standardized testing of final control

Examination Regulations

The form of the final control is standardized, include control of theoretical and practical training.

Final control consists of the following stages:

Stage - written answers to tests of format (blank). The student is responsible for 40 tests format of the topics of each module and semantic estimated 1 point for each correct answer.

Phase II - 8 written response to questions from which one task situational task of analyzing mixtures of compounds, three tasks - tasks and estimated 4 theoretical aspects of the course material "Analytical Chemistry". **Assessment II** - a written response to a theoretical question and situation tasks (8 tasks).

Each issue a written response estimated - 5 points - "**excellent**"

4 points - "**good**"

3 points - "**satisfactory**"

0 points - "**unsatisfactory**"

"**Excellent**" for the answer the student receives when fitting correctly, comprehensively, deeply and thoroughly presented the material correctly solving the problems.

"**Good**" - student logically, intelligently essentially answers the question without making significant errors in theory and in the calculations.

"**Satisfactory**" - student without detailing answers posed a theoretical question, admits inaccuracies and incorrect answers in wording raises consistency of the material makes mistakes in calculations and formulas of mathematical operations in the computational tasks.

"**Unsatisfactory**" - student permits substantial and serious errors, not responding to tasks.

Score is the sum test points for answering tests and theoretical questions.

The maximum number of points at the exam is 80. The minimum number of points - 50.

11. Current control is carried out during the classes and aims to verify mastering academic material. Forms assessment of current educational activity are standardized and include control of theoretical and practical training.

11.1 Evaluation of current educational activity. In each class the student is responsible for 10 tests, 5 questions on the topic of workshops, knowledge of which is essential for understanding the current topic, the issue of lectures and self-study related to this occupation; demonstrates knowledge and skills practical skills according to the theme of practical employment.

Evaluation criteria

I. Current control. Each lesson is conducted evaluation of students' knowledge on a 4-point scale (national) scale. This takes into account all kinds of work, provided the program discipline. The student receives an assessment of each topic for further conversion of marks into balls by multi (200-point) scale.

Excellent ("5"). The student correctly answered 100-90% test format A. Correct, clear, logical and meets current standardized question topics, including issues of lectures and self-study. Closely related ' yazuye theory with practice and the right shows the performance (knowledge) skills. Free reading test results, solve case studies of high complexity, can synthesize material has methods of chemical analysis. Lab fully implemented and the student freely and properly explained studies and gives them a rating.

Good ("4"). Student matching correctly matches on 70-89% test format, properly and essentially answers the question standardized current topics of lectures and self-study. Demonstrates performance (knowledge) skills. Correct use theoretical knowledge in solving practical problems.

Able to solve easy and medium difficulty situational problems. Have the necessary practical skills and techniques of their implementation in an amount greater than the required minimum. Lab performed with minor mistakes, but the student correctly explain the study and give them a rating.

Outstanding ("3"). The student correctly answered the test format 50-69% A. incomplete with additional questions, answers standardized questions of current topics, lectures and independent work. Is unable to build a clear, logical answer. When the response and demonstrate practical skills the student makes mistakes. The student solves only the easiest task has only minimal binding methods. Laboratory work is done correctly, the student can not fully explain the study.

Poor ("2"). The student responded to less than 50% of the test format A. does not know the current theme of the material can not build a logical response does not answer any questions, do not understand content material. When the response and demonstrate practical skills in making significant, serious errors. Laboratory work not done or student can explain the study.

Each practical class knowledge students are evaluated on a four-point system ("5", "4", "3", "2") on assessment of current activities of the student.

Control of laboratory research and learning practical skills made after the laboratory work by assessing the quality and completeness of its implementation, the ability to interpret the results. For the practical part of classes a student can gain:

4 points if the lab work is done in full and the student freely and properly explained studies and gives his assessment;

2 points if the lab work is done with some errors, the student can not fully explain the studies and evaluate them;

0 points if not done laboratory work or student can explain the studies and evaluate them.

The final grade for classes defined by the sum of the results of the test control and the laboratory work as follows:

Total points	Assessment by the four-point scale
from 30 to 34	5
from 22 to 29	4
from 15 to 21	3
<9 points for test control or 0 points for the practical part	2

Independent student work is evaluated under the current control of theme on the proper auditorium classes. Evaluation topics submitted for independent study and not included in the topics of practical classes are monitored during the tests and final exam.

12. The form of the final control of the success of training in the study " Analytical chemistry" is the test.

Semester exam - a form of final control of the student theoretical and practical material on the discipline. Before final control students who complete all work provided Initial program worked all training sessions and during the study module scored the number of points not less than the minimum.

The form of the exam is a standardized, include control of theoretical and practical training and consist of the following stages:

Stage I - a written response to the tests of format (blank check with the computer).

The student is responsible for a package of tests. Each package contains 40 test format with topics every semantic module, and is estimated to be 1 point for each correct answer.

Stage II - a written response to 8 theoretical issues of situational we task s for which liability student makes writing. Evaluation answers to the questions listed in paragraph 10.

11. 3. The scheme of calculation and distribution points that get students :

The maximum number of points that a student can collect for current educational activity for admission to the exam - 120 points.

The minimum number of points , which student can get for current activity for admission to the exam is 72 points.

Calculating the number of points is based on the student received scores of 4-point scale by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted into points by multipoint scale follows converted into points by multipoint scale follows:
 $x = CA \times 120 / 5$.

Recalculation of the average score for current activities multimark scale carried out in the table below:

Recalculation average of analytical chemistry for current activities multipoint scale

4 Bal - on scale	5	4.95	4.91	4.87	4.83	4.79	4.75	4.7	4.66	4.62	4.58	4.54	4.5
200 Bal - on scale	120	119	118	117	116	115	114	113	112	111	110	109	108
4 Bal - on scale	4.45	4.41	4.37	4.33	4.29	4.25	4.2	4.16	4.12	4.08	4.04	3.99	3.95
200-point scale	107	106	105	104	103	102	101	100	99	98	97	96	95
4 Bal - on scale	3.91	3.87	3.83	3.79	3.74	3.7	3.66	3.62	3.58	3.54	3.49	3.45	3.41
200 Bal - on scale	94	93	92	91	90	89	88	87	86	85	84	83	82
4 Bal - on scale	3.37	3.33	3.29	3.25	3.2	3.16	3.12	3.08	3.04	3	Less 3		
200 Bal - on scale	81	80	79	78	77	76	75	74	73	72	Lack of		

Independent student work is evaluated under the current control of theme on the proper auditorium classes. Evaluation topics submitted for independent study and not included in the topics of practical classes are monitored during the tests and final exam.

The maximum number of points that a student can collect in the preparation and sleeps is 80.
The minimum number of points at the exam - at least 50.

Ranking by assigning ratings of "A", "B", "C", "D", "E" is held for the students of this course, studying at one of the specialty and successfully completed the study subjects. Students who have received assessment FX , F («2») are not made to the list of students who ranked. Students with an estimate FX after retaking automatically receive a score of "E".

Scores of discipline for students who successfully completed the program, converted into traditional 4-point scale for absolute criteria listed in the table below:

Scores on discipline	Score 4-point scale
From 170 to 200 points	5
From 140 to 169 points	4
From 139 points to the minimum number of points that a student must score	3
Below the minimum number of points that a student must collect	2

Assessment ECTS in traditional scale is not converted because the scale of ECTS and independent four-point scale.

Objectivity evaluation of educational activities of students tested statistical methods (correlation coefficient between the assessment ECTS and evaluation on a national scale).

14. Methodological Support

The list and contents of teaching of the study course "Analytical Chemistry" includes:

- outline plan or extended lectures;
- thematic plans of lectures, workshops, independent work of students;
- Reference for laboratory work and independent work of students;
- issues, tasks, objectives for current and final control of knowledge and skills of students, comprehensive tests, monitoring pislyaatestatsiynoho acquired knowledge and skills with discipline.

15. Recommended Books

Compulsory literature

1. Skoog D.A., West D.M., Holler F.J., Crouch S.R. Fundamentals of Analytical Chemistry. – Cengage Learning, 2021. – 1072 p.
2. Treadwell F.P., Hall W.T. Analytical Chemistry (Volume I) Qualitative Analysis. – Alpha Edition, 2020. – 556 p.
3. Harris D.C. Quantitative Chemical Analysis. – W. H. Freeman, 2015. – 792 p.
4. Tissue B.M. Basics of Analytical Chemistry and Chemical Equilibria. – Wiley, 2013. – 426 p.

Auxiliary literature

1. Alhasan H.S., Alahmadi N. Principles Of Qualitative Inorganic Analysis:

- Precipitation, Separation and Identification of Cations. – Bentham Science Publishers, 2021. – 76 p.
2. Verma R.M. Analytical Chemistry Theory and Practice. – CBS Publishers and distributors PVT LTD, 2020. – 561 p.
 3. Pungor E., Horvai G. A Practical Guide to Instrumental Analysis. – CRC Press, 2020. – 394 p.
 4. Hamilton L.F. Calculations on Analytical Chemistry – Alpha Edition, 2020. – 402 p.
 5. Miller J.N., Miller J.C. Statistics and Chemometrics for Analytical Chemistry. – Prentice Hall, 2010. – 278 p.
 6. Harvey D. Modern Analytical Chemistry. – McGraw-Hill, 2000 – 798 p.

16. Information Resources

1. [http:// www.meduniv.lviv.ua/index.php?option=com_ ontent&view=article&idvalue=150&Itemid=188&lang=uk](http://www.meduniv.lviv.ua/index.php?option=com_content&view=article&idvalue=150&Itemid=188&lang=uk)
2. http://www.meduniv.lviv.ua/files/kafedry/tokshim/Analytical%20chem/Methodichki/Quality_Analis_Ukr.pdf
3. http://www.meduniv.lviv.ua/files/kafedry/tokshim/Analytical%20chem/Methodichki/Quantative_Analis_Part_1.pdf
4. http://www.meduniv.lviv.ua/files/kafedry/tokshim/Analytical%20chem/Methodichki/Quantative_Analis_Part_2.pdf