DANYLO HALYTSKYI LVIV NATIONAL MEDICAL UNIVERSITY

Department of General, Bioinorganic, Physical and Colloidal Chemistry

APPROVED:
First Vice-Rector for
scientific and pedagogical work
"14" 10 2023

SYLLABUS OF DISCIPLINE
OK 10 GENERAL AND INORGANIC CHEMISTRY

for training of specialists of the 2nd Master's degree of higher education
Branch of knowledge: 22 "Health care" Speciality: 226 "Pharmacy, industrial pharmacy"

for the 1 year students (English Medium)

Discussed and approved
at the meeting of
Department of General, Bioinorganic,
Physical and Colloidal Chemistry
Protocol № 20 Dated "20" June, 2023

Head of the Department
_____ prof. I.Drapak

Approved
at the methodical commission
on Pharmaceutical and Chemical
Disciplines
Protocol № 3 Dated "27" June, 2023

Head of the Methodical Commission
_____ prof. S. Bilous

The Syllabus was developed by:

I.V. Drapak, DSc in Pharmacy, Professor, The head of the Department of General, Bioinorganic, Physical and Colloidal Chemistry, Danylo Halytsky Lviv National Medical University

V.V. Ogurtsov, PhD in Pharmacy, Assoc.Prof., Department of General, Bioinorganic, Physical and Colloidal Chemistry, Danylo Halytsky Lviv National Medical University

O.M. Roman, PhD in Pharmacy, Assoc. Prof., Department of General, Bioinorganic, Physical and Colloidal Chemistry, Danylo Halytsky Lviv National Medical University.

REVIEWERS:

L.I. Kobylinska, DSc in Biology, Professor, The head of the Department of Biological chemistry, Danylo Halytsky Lviv National Medical University

L.V. Gutor, PhD in Pedagogy, Assoc.Prof., Department of Latin and Foreign Languages, Danylo Halytsky Lviv National Medical University.

INTRODUCTION

Syllabus of the Discipline "General and inorganic chemistry" is developed

under the requirements to *the Academic Standard of 2nd Master's degree of higher education*

Branch of knowledge: *22 "Health care"*

Speciality: *226 "Pharmacy"*

Educational program *Master of Pharmacy*

Description of the academic discipline (abstract)

The main objective of the General and Inorganic Chemistry Course is to introduce the basic principles and methodologies of Chemistry to create a sound starting point for the study and comprehension of the correlation between structure and the properties of materials which students will have to study in more detail in the following years. In particular, by means of simple teaching laboratory experiences carried out alongside the theoretical lessons, students should develop the ability to apply critical reasoning, in particular regarding the ability to apply the concepts of basic Chemistry to simple practical problems or simple phenomena.

Knowledge of inorganic chemistry will enable the future specialist to master the most essential skills of qualitative and quantitative prediction of the probability of the course of chemical reactions and the establishment of mechanisms for the interaction of inorganic substances used in medical and pharmaceutical practice, as well as their biotransformation in the human body.

Structure of the discipline	**The amount of credits, hours including**				**Year of study, semester**	**Forms of the control**
	Totally	**Auditorial**		**Individual work**		
		Lectures (hours)	Practical classes (hours)			
Discipline: General and inorganic chemistry ***The number of Thematic modules – 2***	**9credits / 270hours**	**30**	**105**	**135**	**1st year (1-2 semesters)**	**Pass-fail test, exam**
by semesters						
Thematic module 1 General chemistry	**4credits / 120hours**	**14**	**52**	**54**	**1st semester**	**Pass-fail test**
Thematicmodule2 Inorganic chemistry	**5credits / 150hours**	**16**	**53**	**81**	**2st semester**	**exam**

The subject of cource "General and Inorganic Chemistry":

– the relationship of chemical processes and phenomena that accompany them,
– regularities between chemical composition, structure of substances and their properties
– determination of the probability of flow and direction of chemical reactions
– determination of the function of substances in the acid-base and oxidation-reduction processes
– physical and chemical bases for the use of inorganic substances in medicine and pharmacy

Interdisciplinary connections:

The study of the discipline "General and Inorganic Chemistry" directly based on the chemistry of secondary education, as well as the basis of elementary mathematics and physics.Knowledge of the theoretical foundations of inorganic chemistry is necessaryfor studying the Physiology, Physical and Colloidal chemistry, Pharmaceutical Chemistry Biochemistry, General and Molecular Pharmacology and Toxicology, Pharmacognosy and Technology of drugs.

1.The aims and objectives of the academic discipline

1.1. The goal of the academic discipline "General and Inorganic Chemistry" studying is the scientific outlook of studentsformation, the contemporary forms of their theoretical thinking development and the ability to analyze phenomena, the skills and abilities formation for the chemical and physico-chemical laws and processes application during the other disciplines studying and in future practical activities.

1.2**.The main tasks of studying the discipline "General and Inorganic Chemistry"** is to teach studentstouse the basic concepts of chemistry, the basic laws ofchemistry, the theory of atomic structure, and chemical bonds, the theory of solutions, general information about chemical elements and their compounds in solving specific problems in the field of pharmacy in accordance with current needs.

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

The course provides the students' ***competences*** according to the requirements of the High education standard:

1. *general:*

2. the ability to abstract thinking, analysis and synthesis (ЗК01);
3. knowledge and understanding of the subject and profession (ЗК02);
4. ability to communicate in the national language both orally and in writing(ЗК03);
5. the ability to assess and ensure the quality of work (ЗК05).

- *special* (*professional, substantive*):

1. Ability to integrate knowledge and solve complex pharmacy/industrial pharmacy problems in broad or multidisciplinary contexts (ФК01).
2. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy (ФК02).
3. The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and body tissues, to conduct chemotoxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication (ФК11).
4. The ability to ensure the proper storage of medicines and other products of the pharmacy assortment in accordance with their physical and chemical properties and the rules of Good Storage Practices in Health Care Institutions (ФК12).
5. The ability to organize and carry out the production activities of pharmacies for the manufacture of medicinal products in various dosage forms according to the prescriptions of doctors and the requirements (orders) of medical and preventive institutions, including the justification of technology and the selection of auxiliary materials in accordance with the rules of Good Pharmacy Practice (ФК16).
6. The ability to carry out pharmaceutical development, determine the stability of medicinal products and participate in the production of medicinal products in the conditions of pharmaceutical enterprises in accordance with the requirements of Good Manufacturing Practice with the appropriate development and preparation of the necessary documentation (ФК17).
7. The ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current edition of the State Pharmacopoeia of Ukraine, quality control methods, technological instructions, etc.; carry out standardization of medicinal products in accordance with current requirements; to prevent the distribution of low-quality, falsified and unregistered medicinal products (ФК19).
8. The ability to develop and evaluate methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological and pharmaco-technological control methods (ФК20).

The detailing of competencies is given in the form of "Competencies Matrix"

CompetenciesMatrix

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
Integral competencies					

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
The ability to solve common and complex problems and practical problems in professional activities using pharmaceutical regulations, theories and methods of General and Inorganic Chemistry; integrate knowledge and solve complex issues, formulate judgments for insufficient or limited information, clearly and unambiguously communicate their findings and knowledge, reasonably justifying them, to a professional and non-professional audience..					
General competencies					
1.	The ability to abstract thinking, analysis and synthesis (3K01)	To know methods of analysis, synthesis and further contemporary training.	Be able to analyze information, make informed decisions, be able to acquire modern knowledge.	To establish appropriate relationships to achieve goals.	To be responsible for the timely acquisition of modern knowledge.
2.	Knowledge and understanding of the subject area and understanding of the profession. 3K02)	Have a profound knowledge of the structure of professional activity.	Be able to carry out professional activities that require updating and integration of knowledge.	The ability to effectively form a communication strategy in professional activity.	To be responsible for professional development, the ability to further professional training with a high degree of autonomy.
3.	Ability to communicate in the national language both orally and in writing(3K03)			Clear and unambiguous presentation of own knowledge, conclusions and arguments to specialists and non-specialists, in particular, to persons who are studying	
4.	The ability to evaluate and ensure the quality of the work performed (3K05)	Know the methods of evaluating performance quality indicators.	Be able to ensure quality performance of works.	Establish connections to ensure quality performance of works.	To be responsible for quality performance of works.
Special (professional, substantive) competencies					

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
1	Ability to integrate knowledge and solve complex pharmacy/industrial pharmacy problems in broad or multi-disciplinary contexts(ФК01)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	Specialized skills/problem-solving skills needed to conduct research and/or implement innovative activities to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts		- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives
2	Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy (ФК02)	- Critical thinking problems in the industry and on the border fields of knowledge.	The ability to solve problems in new or unfamiliar environments for presence of incomplete or limited information from taking into account the aspects social and ethical responsibility		Management of workers or educational processes that are complex, unpredictable and need new ones strategic approaches.

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
3	The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and body tissues, to conduct chemotoxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication (ФК11)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	- Specialized skills/problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts - Ability to solve problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility		Managing work or learning processes that are complex, unpredictable and require new strategic approaches
4	The ability to ensure the proper storage of medicines and other products of the pharmacy assortment in accordance with their physical and chemical properties and the rules of Good Storage Practices in Health Care Institutions. (ФК12)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	- Specialized skills/problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts		- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
5	The ability to organize and carry out the production activities of pharmacies for the manufacture of medicinal products in various dosage forms according to the prescriptions of doctors and the requirements (orders) of medical and preventive institutions, including the justification of technology and the selection of auxiliary materials in accordance with the rules of Good Pharmacy Practice (ФК16)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	Specialized skills/problem-solving skills needed to conduct research and/or implement innovative activities to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts		- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives
6.	The ability to carry out pharmaceutical development, determine the stability of medicinal products and participate in the production of medicinal products in the conditions of pharmaceutical enterprises in accordance with the requirements of Good Manufacturing Practice with the appropriate development and preparation of the necessary documentation (ФК17)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	- Specialized skills/problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts		- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives - Ability to continue learning with a high degree of autonomy

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
7.	The ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current edition of the State Pharmacopoeia of Ukraine, quality control methods, technological instructions, etc.; carry out standardization of medicinal products in accordance with current requirements; to prevent the distribution of low-quality, falsified and unregistered medicinal products(ФК19)	- Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	- Specialized skills/problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinary contexts - Ability to solve problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility	Clear and unambiguous presentation of own knowledge, conclusions and arguments to specialists and non-specialists, in particular, to persons who are studying	- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
8.	The ability to develop and evaluate methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological and pharmaco-technological control methods (ФК20)	Specialized conceptual knowledge that includes current scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and conducting research, critical understanding of problems in the field and at the boundaries of fields of knowledge	- Specialized skills/problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures - Ability to integrate knowledge and solve complex problems in broad multidisciplinar y contexts - Ability to solve problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility		-- Management of work or learning processes that are complex, unpredictable and require new strategic approaches - Responsibility for contributing to professional knowledge and practice and/or evaluating the results of teams and collectives - Ability to continue learning with a high degree of autonomy

Learning outcomes:
The integrative final sillabus learning outcomes, the formation of which is promoted by the discipline "Inorganic Chemistry":

ПРН01. Possess specialized conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements, and be able to apply them in professional activities.
ПРН02. Critically understand and analyze scientific and applied problems in the field of pharmacy.
ПРН03. Possess specialized knowledge and abilities/skills for solving professional problems and tasks, including for the purpose of improving knowledge and procedures in the field of pharmacy.
ПРН05. Assess and ensure the quality and efficiency of activities in the field of pharmacy in standard and non-standard situations; adhere to the principles of deontology and ethics in professional activity.
ПРН07. Analyze the necessary information on the development and production of medicinal products, using professional literature, patents, databases and other sources; systematize, analyze and evaluate it, in particular, using statistical analysis.
ПРН11. Determine the advantages and disadvantages of drugs of natural and synthetic origin of various pharmacological groups, taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic and pharmacodynamic features and the type of dosage form. Recommend medicinal products and other products of the pharmacy assortment with the provision of advisory assistance and pharmaceutical care.
ПРН14. Choose biological objects of analysis, determine xenobiotics, toxins and their metabolites in them; to evaluate the obtained results.

ІІРН15. Predict and determine the influence of environmental factors on the quality and consumer characteristics of medicines and other products of the pharmacy assortment, organize their storage in accordance with their physical and chemical properties and the rules of Good Storage Practices.
ІІРН23. Determine the main chemical and pharmaceutical characteristics of medicinal products; choose and/or develop quality control methods for the purpose of their standardization using physical, chemical, physicochemical, biological, microbiological and pharmacotechnological methods in accordance with current requirements.

Learning outcomes for the discipline "General and Inorganic Chemistry":

- *To know:*
  - classification and nomenclature of inorganic compounds;
  - basic concepts and laws of chemistry and methods of their use for solving applied problems;
  - modern theories of the structure of atoms and molecules and the dependence of the properties of matter on its composition and structure;
  - the main regularities of different types chemical reactions;
  - properties and methods of expression of the composition of solutions;
  - properties of chemical elements and their most important compounds and possible transformation
  - the V.Vernadsky doctrine about the biosphere.
- *To be able to:*
  - to classify and called inorganic compounds;
  - to interpret the general laws that underlie the structure of matter;
  - toclassify the properties of solutions of non-electrolytes and electrolytes, calculate the composition of solutions;
  - tointerpret and classify basic types of ion, acid-base and redox balance and chemical processes for forming a holistic approach to the study of chemical and biological processes;
  - touse chemical glassware and weigh the substances;
  - tocalculate the relative error of the experiment;
  - toprepare solutions with a given quantitative composition;
  - toconduct a simple chemical experiment;
  - toclassify chemical properties and transformations of inorganic substances;
  - to carry out qualitative determination of some cations and anions;
  - to interpret the general laws underlying the application of inorganic substances in pharmacy and medicine;
  - to apply the theoretical foundations of General and Inorganic Chemistry and experimental skills acquired in the study of profile disciplines.

2. Information scope of the academic discipline
9 ECTS credits (270 hours) are allocated for academic discipline.

Module 1. «General chemistry»

Topic 1. Chemistry in the system of natural sciences. The history of chemistry. Atomic-molecular concept

Subject, tasks and methods of chemistry. Place of inorganic chemistry in the system of natural sciences and pharmaceutical education. The importance of chemistry for the development of medicine and pharmacy.Substance.Purity of chemicals.Symbols of degree of purity (classification of substances by purity).Theoretical foundations of substances purification.Physical constants as a way to identify a substance.

Basic stages of chemistry development.Atomic-molecular theory. The concept of the atom and its basic characteristics: relative atomic mass, charge and number of the element in the periodic table, chemical symbol. Isotopes.Concept about a molecule, structure of molecules and properties.Relative molecular weight, molar mass of substances.

Topic 2. Nomenclature and classification of inorganic compounds.

The main classes of inorganic compounds. Oxides, their classification and nomenclature. Hydroxides, their classification and nomenclature. Acids, their classification and nomenclature. Salts, their classification (neutral, basic, acidic). Nomenclature of salts.

Topic 3. Basic laws of chemistry

Basic laws of chemistry: the law of conservation of mass, Avogadro's law, ideal gas law. Molar volume of gas. The relationship between the density of gas and its molecular mass.
Chemical formulas, their types, formulas according to chemical analysis or chemical reactions equations. Qualitative and quantitative information arising from chemical formulas and equations. Determination of molecular formulas. Chemical equations and chemical reactions. Writing chemical equations,molecular and ionic equations for various types of chemical reactions. Stoichiometry. Calculations using chemical formulas and equations.

Topic 4. Equivavlents of substances in chemical reactions.

Chemical equivalent, its definition. Molar mass equivalent. Calculations of molar mass equivalent of simple and complex compounds. The equivalent's law.

Topic 5. Structure of atoms

The main stages of development theory of atomic structure. Spectra of atoms. Quantum nature of the absorption and emission of energy. De Broglie equation. The nature movement of electrons in the atom.
Quantum numbers. The principal quantum number(n). The angular momentum quantum number(l). The magnetic quantum number (ml). The electron spin quantum number (ms). Atomic orbitals: s-, p- and d-orbitals of an atom. The energies of orbitals.Electron configuration. The Pauli exclusion principle. Hund's rule.

The principles and rules that define the sequence of filling atomic orbitals by electrons: the principle of least energy, the Pauli principle, the Hund rule, the rules of Klechkovsky, the rule of symmetry. Electronic and electron-graphic formulas of the atoms of elements and their ions.

Radioactivity. Toxic action of radionuclides.Radiopharmaceuticals that are used for treatment (cobalt, phosphorus, iodine) and diagnostics (potassium, phosphorus) of various diseases.

Topic 6. The Periodic law and Periodic table by D. Mendeleev

The periodic law and the periodic table. Development of the periodic table. Periodic classiffication of the elements. The structure of the periodic table of elements: periods, groups, families. Periodic variation in physical properties. Effective nuclear charge. Atomic radius. Ionic radius. Variation of physical properties across a period and within a group. Ionization energy. Electron affiniity. Properties of oxides, hydrides across a period.

T*opic 7. The nature of chemical bonds and structure of chemical compounds*

The mechanism of formation of the chemical bond between atoms. Types of chemical bonds. Physical and chemical properties of compounds with covalent, ionic and metallic bond. Experimental characteristics of bonds: energy, length.

Covalent bond. Lewis formulas. Coordinate covalent bond. Octet rule. Multiple bonds. Polar covalent bond. Single bond. Double and triple bonds. Electronegativity and oxidation number. Formal charge and Lewis structure. Delocalized bonding. Bond length and bond order. Ionic compounds. Comparison of the properties of covalent and ionic compounds. Hybridization of atomic orbitals. The polar and nonpolar molecules.

Metallic bond.Hydrogen bond and its biological role.

Hybridization of atomic orbitals.Polar and nonpolar molecules.

Topic 8. Solutions

The role of solutions in the organisms life. Classification of solutions. Mechanism of dissolution processes. Thermodynamic approach to the process of the dissolution. The solubility of the substances.
The solubility of gases in liquids. The dependence of the solubility of gases on the pressure (Henry-Dalton's law), nature of the gas and solvent, temperature. Effect of electrolytes on the solubility of gases (Sechenov's law). Solubility of gases in the blood. Decompression sickness. The solubility of liquids and solids in liquids. The dependence of solubility on temperature and the nature of the solute and solvent.

Topic 9. Preparation of a solution of known concentration

The values that characterize the quantitative composition of solutions. Preparation of solutions of a given quantitative composition Mass percentage of solute. Mass fraction of solute, volume fraction of solute. Molar

concentration of solute. Molar concentration of solute equivalent. Molality solution. Mole fraction of solute.The titr of the solution.

Topic 10. Colligative properties of solutions

Colligative properties of diluted nonelectrolytes solutions. Lowering of the vapor pressure of the solvent above the solution. Raoult's law. Ideal solutions. Depression of the freezing point of a solution and boiling point elevation of a solution. Osmosis and osmoticpressure. Vant' Hoff's law. Colligative properties of diluted nonelectrolytes solutions. Isotonic coefficien. Hypo-, hyper- and isotonic solutions.

Cryometry, ebuliometry, osmometry, and their use in biomedical research. The role of osmosis in biological systems. Osmotic pressure of blood plasma. Haller equation. Oncotic pressure. Plasmolysis and hemolysis.

Topic 11. The basic terms of chemical thermodynamics. Thermochemistry.

The special fiels of chemical thermodynamics. Basic terms of chemical thermodynamics: thermodynamical system (isolated, closed, open, homogeneous, heterogeneous), the state variables (extensive and intensive), thermodynamical processes (reversible, irreversible). Living organisms as open thermodynamical systems. Irreversibility of life processes.

The first law of thermodynamics. Enthalpy. Thermochemical equations. Standard enthalpies of formation and combustion. Hess's law. Calorimetry techniques. Biochemical processes energetic characteristics. Thermochemical calculations for the foods fuel capacity (caloricity) evaluation and making rational and therapeutic diets.

Topic 12. The second law of thermodynamics. The direction of chemical processes passage

Spontaneous and non-spontaneous processes. The second law of thermodynamics. Entropy. Thermodynamic potentials: Gibbs' free energy, Helmholtz' free energy. Termodynamical equilibrium conditions. The criteria for the spontaneous processes direction.

The basic principles of thermodynamics applying to living organisms. ATP as an energy source for biochemical reactions.

Topic 13. Chemical kinetics and catalysis.

Chemical kinetics as the basis for the rates and mechanism of biochemical reactions studying. The reaction rate. Concentrationtion affection the reaction rate. The law of mass action for the reaction rate. Rate constant. The reaction order. Kinetical equations for zero-, first- and second-order reactions. Half-life. The reaction mechanism concept and the reaction molecularity.

The temperature influence the reaction rate. Van't Hoff's rule.

Activation energy. Collision theory. Arrhenius equation. The concept of the transition state theory.

The kinetics of complex reactions: parallel, successive, conjugated, chain. The concept of antioxidants. Free radical reactions in living organisms. Photochemical reactions, photosyntheses.

Catalysis and catalysts. Features of catalysts. Homogeneous, heterogeneous and microheterogeneous catalysis. Acid-base catalysis. Autocatalysis. The mechanism of catalytical action. Promoters and catalytic poisons.

The kinetics of enzymatic reactions. Enzymes as biological catalysts. Enzymes features: selectivity, efficiency, temperature and reaction medium affections. The concept of the enzymes action mechanism.

Topic 14.Chemical equilibrium

The concept of equilibrium and the equilibrium constant. Quantitative characteristic of chemical equilibrium. Predicting the direction of a reaction.

Equilibrium constant and its relationship with the standard Gibbs' energy. Factors that affect chemical equilibrium. Le Chatelier' principle. Change in concentration. Change in volume and pressure. Change in temperature. The effect of a catalyst.

Topic 15.The concept of strong and weak electrolytes

The concept of strong and weak electrolytes. Theory of strong electrolytes solutions. Properties of solutions of strong electrolytes. Ionic force of a solution. Activity and activity coefficient of ions in a solutions of strong electrolytes. Solutions of weak electrolytes. The degree of dissociation. The dependence of the degree of dissociation on concentration (Ostwald dilution law). Dissociation constant.

Topic 16.The equilibrium in feebly soluble electrolytes solutions

Equilibrium between solution and precipitate of feebly soluble electrolytes. The solubility product constant (Ksp). Condition of formation and dissolving of precipitates.

Topic 17.Acids and bases theories. Self-ionization of water. pH

Theories of acids and bases (Arrhenius, Brendsted-Lowry, Lewis). Amphoteric electrolytes. Electrolyte solutions. The degree and the dissociation constant of weak electrolytes. Properties of solutions of strong electrolytes. Water and electrolyte balance - a necessary condition for homeostasis. Dissociation of water. Ionic product of water. pH and pOH. The pH values for different liquids of the human body in normal and pathological conditions.

Topic 18.Protolytic processes

Protolytic processes and their directionality. Hydrolysis of cations, and anions. Degree and constant of hydrolysis. The shifting of protolytic reactions equilibrium. Role of protolytic reactions in the metabolism of medicines and their analysis. Chemical incompatibility of medicinal.

Topic 19.Reactions with electrons transferring. Oxidation – Reduction reactions

Electronic theory of redox reactions. Oxidation-reduction properties of elements and their compounds, depending on their position in the periodic system. The oxidation number of the atoms of elements in compounds and rules of its determination. Redox duality. Definition of the redox processes direction, oxidation-reduction potentials, the standard Gibbs energy in the oxidation-reduction processes. Use of the redox reactions in chemical analysis. The role of oxidation-reduction processes in metabolism.

Topic 20. Coordination compounds. Reactions of coordination compounds formation

Complex formation reactions. Werner coordination theory and modern understanding of the structure of complex compounds. The concept about complexing agent (central ion). The dissociation constant Kd of a complex ion. Nature, coordination number, hybridization of central atom orbitals. The concept about ligands. Denticity of ligands. The inner and external sphere of the coordination compounds. Geometry of the complex ion. The nature of the chemical bond in complex compounds. Classification of compounds according to the charge on the inner sphere and the nature of ligands.

Classification, nomenclature and isomerism of complex compounds. Complex acids, bases, salts. The biological role. Formation of complexes between inorganic and biological compounds. Metal-ligand homeostasis. Chemical basis for the use of the complex compounds in pharmaceutical analysis and medicine.

Thematic module 2. «Inirganic chemistry»

Topic 21.Chemical elements, their classification

The concept of the chemical elements; their classification by origin, chemical properties, the structure of the outer energy level, spreading in nature and importance for living organism. Classification of bioelements; their content in human body.Connection between physico-chemical parameters of the elements and their position in the periodic system and the content in the body.

Topic 22.A human and biosphere

V. Vernadsky's doctrine about biosphere and biogeochemistry. The concept of migration of chemical elements.Relationship between endemic diseases and features of biogeochemical provinces.

A human and biosphere.Noosphere.Technological progress and ecology.

Topic 23. Hydrogen and its compounds

General characteristics of Hydrogen.Position in the periodic table of elements. Reactions with oxygen, halogens, metal oxides. Characteristics and reactivity of hydrogen compounds with other common elements: oxygen, nitrogen, carbon, sulfur. Ions of hydrogen, hydronium and ammonium.

Water as an important compound of hydrogen.Its physical and chemical properties. Aquacomplexes and crystall hydrates. Distilled and non-pyrogenic water - preparation and use in pharmacy.Natural water, pollution of water, mineral water.

Hydrogen peroxide.The structure of the molecule.Methods of obtaining.Acid-base and redox properties of hydrogen peroxide, use in medicine and pharmacy.

Topic 24. s-elements of the IA group. Alkali metals

General characteristics of IA group elements. Occurrence in nature.Biological role of *s*-elements in mineral balance of a human body.Macroelements.

The difference between lithium and other alkali metals. Binary compounds of alkali metals: hydrides, oxides, peroxides, superoxide.

Alkali metals hydroxides, salts, their properties and use. Use of lithium, sodium and potassium compounds in medicine.

Topic 25. s-elements of the IIA group. Beryllium, Magnesium, and Alkaline earth metals

General characteristics of *s*-elements of IIA group.Reducing properties of elements.Comparison of beryllium, magnesium and calcium properties.Reactions of simple substances with water, acids and bases solutions.

Beryllium.Chemical properties.*sp*-hybridization of atomic orbitals of beryllium. Beryllium oxide and hydroxide, their amphoteric properties.Aqua- and hydroxocomplexes of beryllium.Solubility and hydrolysis of beryllium salts.

Magnesium.Magnesium oxide and hydroxide.Solubility and hydrolysis of magnesium salts.Mg^{2+} ion as a complex formation agent.Chlorophyll.

Alkaline earth metals.General characteristics.Physical properties and occurrence.Chemical properties.Basic oxides and hydroxides of the alkaline earth metals.Solubility in water. Reactions of identification of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+} ions. Hardness of water.Methods of softening.

Calcium compounds in the bone tissue. The toxic action of beryllium and barium.The biological role of calcium and magnesium.Uses of magnesium, calcium and barium compounds in medicine and pharmacy.

Topic 26. p-elements of the IIIA grup. Boron and Alluminium

General characteristics of IIIA group elements. Electron deficiency and its influence on the properties of elements and their compounds.General characteristics of Boron.Simple substance and its chemical activity.Borides.Compounds with hydrogen (boranes).Boron halogenides, hydrolysis and complex formation.Boron oxide and boric acids.Equilibrium in aqueous solution.Sodium tetraborate.Boric acid esthers. Organoaluminium compounds of boron. The biological role of boron.Antiseptic properties of boric acid and its salts.

Aluminium.General characteristics.Simple substance and its chemical activity.Amphoteric properties of aluminum and its oxide and hydroxide.Aluminate.Aluminum ion as a complexing agent. Anhydrous aluminum salts and crystalline hydrates. Halides.Aluminum hydride.Uses of aluminum and its compounds in medicine and pharmacy.

Topic 27. p-elements of the IVA group. Carbon and its inorganic compounds

General characteristic of IVA group elements.Carbon allotropes.Hybridisation.Carbon as the basis of all organic molecules.Biological role of carbon.Physical and chemical properties of its inorganic compounds.Activatedcharcoal.

Compounds of carbon with negative value of the oxidation state.Carbides, their properties and use.

Compounds of carbon(II). Carbon oxide(II), its acid-base and redox properties. Carbon oxide(II) as a ligand.

Hydrogen cyanide.Toxic action.

Carbon dioxide(IV). Equlibrium in water solution.Carbonic acid, carbonates and hydrogencarbonates.Hydrolysis and thermolysis of carbonic acid salts.

Compounds of carbon with halogens and sulfur. Carbon chloride(IV). Carbon disulfide and tiocarbonates.Thiocyanates and cyanates.Physical and chemical properties.

Topic 28. Silicon and its compounds

Silicon.General characteristic.The biological role.Silicides.Compounds with hydrogen (silane), hydrolysis of silane.Silicon tetrafluoride and tetrachloride, their hydrolysis.Hexafluorosilicates.

Compounds of silicon with oxygen, silicon dioxide(IV) (silica). Glass, its properties and stability.Silicic acids.Silicates, their solubility and hydrolysis.Silicone polymers. The use of silicon compounds in medicine.

Topic 29. p-elements of the IVA group. Germanium family elements (Germanium, Tin, and Lead)

Genaral characteristics of Germanium, Lead and Tin.Compounds with hydrogen.Compounds with halogens EF_2 and EF_4, their behavior in aqueous solutions.Oxides.Amphoteric properties of oxides.Stannic acid.Stannites (Na_2SnO_2) and stannates (Na_2SnO_3).in and lead hydroxocomplexes. Reducing properties of tin (II) compounds. Lead (IV) oxide as a strong oxidizing agent. Soluble and insoluble salts of tin and lead.Redox reactions in solutions.The toxic effects of Pb compounds.

Uses of lead compounds (lead (II) oxide and lead acetate) in medicine and pharmacy. Uses of tin and lead compounds in the pharmaceuticals analysis.Toxic effect of lead organic compounds.

Topic 30. p-elements of the VA group. Nitrogen and its compounds

General characteristics of the elements of VA group.Nitrogen, phosphorus, arsenic.Their biological role in the nature and human body.

Nitrogen.General characteristics.Compounds with different oxidation states.Nitrogen as a simple substance.The reasons for its low chemical activity.Nitrogen molecule as a ligand.Compounds with negative oxidation states.Nitrides.Acid-base and redox properties of ammonia.Amides.Ammonia ion and its salts, acid-base properties, thermal decomposition.Acid-base and redox properties of hydrazine and hydroxylamine.

Compounds of nitrogen with a positive oxidation state.Nitrogen oxides.Methods of preparation.Acid-base and redox properties.Nitrous acid and nitrites.Nitric acid and nitrates, acid-base and redox properties.Thermal decomposition."Royal water".Toxic action of nitrogen oxides and nitrates.

Topic 31. Phosphorus and its compounds

Phosphorus.General characteristics.Allotropic modifications of phosphorus.Chemical activity of phosphorous compounds.Phosphides and phosphine.The comparison of the phosphides and phosphine with the corresponding compounds of nitrogen.

Phosphorus compounds with positive oxidation states. Hydrolysis of the halides.Oxides of phosphorous.

Ortophosphorous and hypophosphorous acids, structure of molecules, acid-base and redox properties.Phosphoric acid and its ions.Dihydrogenphosphates, hydrogenphosphates and phosphates.Pyrophosphoric acid.Metaphosphoric acid.

Reaction of phosphate ion identification.The biological role of phosphorus and its compounds.

Topic 32. p-elementsof the VA group. Arsenic family elements (Arsenic, Antimony, Bismuth)

The elements of Arsenic subgroup.General characteristics.Compounds of arsenic, antimony and bismuth with hydrogen in comparison with ammonia and phosphine.

Detection ofarsenic and antimony by the Marsh test.

Compounds with positive oxidation states.Oxidesandhydroxidesofelementsandtheiracid-baseandredoxproperties.Arsenites and arsenates.Their acid-base and redox properties.Salts of antimony and bismuth.Oxosalts formation.Bismuthates and their stability.

Applicationinmedicineandpharmacy ofoxidesandsaltsofarsenic, antimonyandbismuthandcompoundsp-elementsofVAgroup.

Topic 33. p-elements of the VIA group. Oxygen and its compounds

General characteristics of the elements of VIA group.Oxygen.General characteristics, occurence in nature.Features of the electronic structure of oxygen molecules.

Stereochemistry and nature of bonds in molecule of Ozone. Binary compounds: oxides, peroxides, superoxides, ozonides. Compound of oxygen with fluorine.

The biological role of oxygen.Use of oxygen and ozone in medicine and pharmacy.

Topic 34. p-elements of the VIA group. Oxygen, Sulfur, Selenium, Tellurium

General characteristics and biological role of Sulphur.Compounds of sulfur with negative oxidation states.Acid-base and redox properties of hydrogen sulfide.Metal and non-metal sulphides, their water solubility and hydrolysis.Identification reaction of sulfide-ion.

Sulfur (IV) compounds - oxide, sulfurous acid, sulfites and hydrogensulfites, their acid-base and redox properties. The interaction of sulfites with sulfur.Identification reaction of sulfite-ion. Properties of thiosulfate: reactions with acids, oxidizing agents (chlorine, iodine), metal cations, complexation reactions. Identification reaction of thiosulfate-ion.

Sulfur (VI) compounds – oxide, hexafluoride, dioxochloride, sulfuric acid, sulfates. Theis acid-base and redox properties.Oleum.Disulfuric acid.Chlorosulfonic acid.

The use of sulfur compounds in medicine, pharmacy and pharmaceutical analysis. Selenium and tellurium.General characteristics.Acid-base and redox properties of the compounds.The biological role of selenium.

Topic 35. p-elements of the VIIA group. Halogens

General characteristics of the halogens.Properties of fluorine as the most electronegative element.Simple substances, their chemical activity.

Compounds of halogens with hydrogen.Solubility in water.Acid-base and red-ox properties.Ionic and covalent halides.Halide ions as ligands in complex compounds.Reactions of identification of halide ions.

Halogens with positive oxidation states.Compounds with oxygen.Reactions of halogens with water and aqueous solutions of alkalis.Oxoacids of halogen and their salts.Chlorate, bromates and iodates. The biological role of chlorine, fluorine, bromine and iodine.

The bactericidal action of chlorine and iodine.The use of bleach, iodine and fluoride, chloride, bromide, iodide for disinfecting and sterilizing.

*Topic 36. p-elements of the VIIIA group***.**

General characteristics of p-elements of the VIIIA group.Features of the structure of molecules.Physical and chemical properties.The relativity of the concept of "noble gases".The compounds of inert gases with fluorine.Features in the structure and properties of helium atom.The use of noble gases in medicine.

Topic 37. General characteristic ofd-elements. Types of chemical reactions with their participation.

General characteristics of d-elements. Characteristic features of d-elements: oxidation, complex formation, colored cationic and anionic complexes involved in the redox reactions. Change of acid-base and redox properties of compounds with changing oxidation state.

Secondary periodicity in families of d-elements, Lanthanide contraction.Lanthanides and actinides as analogues of d-elements of the IIIB group.The reasons for the similarity of f-elements, valence electrons.The concept of biogenic trace elements and their content in the body.

Topic 38. d-elements of the IB group. Copper, Silver, Gold

General characteristics of the group IB elements.Physical and chemical properties of simple substances.Reactions with acids, oxygen, halogens.

Compounds of copper (I) and copper (II), their acid-base and red-ox properties, ability to form complexes.Complex compounds of copper (II) with ammonia, amino acids.

Oxide and halides of copper (I). Complex compounds of copper (I) with chlorides and ammonia.The use of copper compounds in medicine and pharmacy.

Silver compounds, their acid-base and red-ox properties. The ability to form complexes with halide-ions, ammonia, thiosulfate ions.The antimicrobial properties of Ag^+ ions.The use of silver compounds in medicine and pharmaceutical analysis.

Gold.Oxidation of gold by oxygen in the presence of cyanide ions.Attitude of gold to "aqua regia".Compounds of gold (I), gold (III) and their acid-base and red-ox properties, ability to form complexes.The use of gold and its compounds in medicine and pharmacy.

Topic 39. d-elements of the IIB group. Zinc, Cadmium, Mercury

General characteristics of the elements of group IIB. Physical and chemical properties of simple substances.

Zinc. General characteristics. Chemical activity of simple substance. Acid-base and redox characteristics of zinc compounds. Zinc salts, their solubility and hydrolysis. Complex compounds of zinc with ammonia, water and hydroxide ions. Zinc-containing enzymes. Use of zinc compounds in medicine and pharmacy.

Cadmium and its compounds compared to similar compounds of zinc.

Mercury. General characteristics, properties that differ from zinc and cadmium. Reaction of mercury with sulfur, nitric acid and iron (III) chloride. Mercury nitrates. Hydrolysis. Basic salts. Mercury(I) and mercury(II) compounds. Acid-base and redox characteristics, the ability to form complexes. Calomel and mercury chloride, their reaction with ammonia. The toxic effects of cadmium and mercury compounds. Use of mercury in medicine and pharmacy.

Topic 40. d-elements of the IIIB – VB groups of the periodic table. Titanium, Vanadium. Lanthanides

d-elements of the IIIB group (scandium subgroup). General characteristics, similarities and differences of elements of IIA group. The biological role of scandium, its chemical properties.

f-element as analogues of *d*-elements of the IIIB group, similarities and differences. The use of cerium(IV) compounds in analytical chemistry. *d*-elements IVB and VB groups. General characteristics. Chemical basis of a simple substances and compounds of titanium, niobium, tantalum and vanadium in medicine and pharmacy.

Topic 41.d -elements of the VIB group. Cromium family

General characteristics of d-elements of VI group. Chromium compounds in nature. Simple substance and its chemical activity. Chromium carbonyl.

Chromium (II) compounds and their acid-base and redox characteristics. Chromium (III) compounds and their acid-base and redox characteristics. The ability to form complexes. Identification reaction of Cr3+ ion. Chromium (VI) compounds – oxide and dichromic acid. Chromates and dichromates, their acid-base and redox properties. Chromium peroxide.

Molybdenum and Tungsten, general characteristics. The ability to form iso-poly- and hetero-polyacids, redox properties of the compounds. Biological role of chromium and molybdenum. Use of chromium, molybdenum and tungsten compounds in pharmaceutical analysis and medicine.

Topic 42. d-elements of the VIIB group. Manganese elements family

General characteristics of manganese. Chemical activity of simple substance. The ability to form coordination compounds (formation of carbonyles).

Manganese (II) and manganese (III): acid-base and red-ox properties, coordinaton compounds formation. Determinaton of Mn^{2+} ion. Manganese (IV) oxide, acid-base and red-ox properties, effect of pH on the redox properties. Manganese (VI) compounds. Manganese (VII) compounds: acidic oxide, permanganic acid, its salts, red-ox properties, oxidation of organic compounds, thermal decomposition. The biological role of manganese. Application of potassium permanganate in pharmaceutical analysis and as antiseptics solutions.

Topic 43. d-elements of the VIIIB group. Iron and its compounds

General characteristic of iron, its ionic state, coordination number. Occurrence in nature. Chemical activity of iron. Complex formation ability. Corrosion of iron products.

The compounds of iron (II) - acid-base and red-ox properties. Complex compounds with cyanide and thiocyanate ions, porphyrins. Biological role of hemoglobin. Iron (III) compounds. Iron (III) oxide and hydroxide. Iron (III) chloride and its hydrolysis. Complex compounds of iron (III). Determination of Fe2+ and Fe3+ cations. Iron (VI) compounds. Preparation of ferrates and their oxidizing properties.

Application of iron and its compounds in medicine.

Topic 44. d-elements of the VIIIB group. Cobalt and Nickel

Cobalt and Nickel. Valence states. Chemical activity. The most important compounds of cobalt (II), cobalt (III) and nickel (II). Characteristics of redox properties. Hydrolysis of cobalt (II) and nickel (II) salts. Complex compounds with cyanide, thiocyanate and fluoride ions. Aqua-complexes. Vitamine B_{12}. Reactions of Co^{2+} and Ni^{2+} cations identification. Chugaev elimination.

The biological significance and chemical basis of application of cobalt and nickel compounds in medicine and pharmacy.

Platinum metals, general characteristics of simple substances and their interaction with acids. Physical properties and applications of platinum metals. Complex compounds of platinum (II) and platinum (IV), coordination numbers, structure, oxidation reactions, reduction reactions and replacement. Oxides of osmium (VIII) and ruthenium (III). Chemical basis of application of platinum group metals compounds in medicine.

Topic 45.d-elements of the VIIIB group. Platinum metals

Platinum metals, general characteristics of simple substances and their interaction with acids. Physical properties and applications of platinum metals. Complex compounds of platinum (II) and platinum (IV), coordination numbers, structure, oxidation reactions, reduction reactions and replacement. Oxides of osmium (VIII) and ruthenium (III). Chemical basis of application of platinum group metals compounds in medicine.

3. Structure of the academic discipline

Topic	**Lectures**	**Practical and laboratory classes**	**Self-study**	**Individual work**
Thematic module I. General chemistry				
1. Topic 1. Atomic-molecule concept.	0	1	2	-
2. Topic 2. Nomenclature and classification of inorganic compounds	0	1	4	
3. Topic 3. Basic laws of chemistry.	0	2	2	
4. Topic 4 Equivalents of substances in chemical reactions.	0,5	4	2	
5. Topic 5. Structure of atoms	0,5	1	2	
6. Topic 6. The Periodic law and Periodic table by D. Mendeleev	0,5	1	2	
7. Topic 7. The nature of chemical bonds and structure of chemical compounds	0,5	2	2	
8. Topic 8. Solutions.	0,5	4	2	

9. Topic 9. Ways of expressing concentration of solutions	0,5	4	2	
10 Topic10. Colligative properties of solutions	1	4	2	
11. Topic 11. The basic terms of chemical thermodynamics. Thermochemistry	0,5	2	2	
12. Topic 12. The direction of chemical processes passage.	0,5	2	2	
13. Topic 13. The rate and mechanism of chemical reactions	0,5	2	2	
14. Topic 14. Chemical equilibrium	0,5	2	4	
15. Topic 15. The concept of strong and weak electrolytes	1	2	2	
16. Topic 16. The equilibrium in feebly soluble electrolytes solutions	1	2	2	
17. Topic 17. Acids and bases theories. Self-ionization of water. pH	1	4	2	
18. Topic 18. Protolytic processes	1	4	2	
19. Topic 19. Reactions with electrons transferring. Experimental studying of reduction-oxidation reactions	2	4	7	
20. Topic 20. Coordination compounds. Reactions of coordination compounds formation.	2	4	7	
In total for thematic module1	***14***	***52***	***54***	
Thematic module 2. Inorganic chemistry				
21. Topic 21. Chemical elements and their classification.	0,25	1	2	
22. Topic 22. A human and biosphere.	0,25	1		
23. Topic 23. General characteristic of *s*-Elements. Hydrogen and its compounds.	0,5	1	2	
24. Topic 24. *s*-Elements of the I group of the Periodic Table. Alkali metals.	0,5	1	2	
25. Topic 25. *s*-Elements of the II groups of the Periodic Table. Beryllium, Magnesium, and Alkaline earth metals.	0,5	4	2	
26. Topic 26. General characteristic of*p*-Elements. *p*-Elements of IIIA Group. Boron and Alluminium	0,5	3	2	
27. Topic 27. p-Elements of IVA Group. Carbon, Silicon	0,5	1	2	
28. Topic 28. Silicon and its compounds	0,5	2	5	
29. Topic 29. *p*-Elements of IVA Group. Germanium family elements (Germanium, Tin, and Lead)	0,5	1	2	
30. Topic 30. *p*-Elements of VA Group. Nitrogen and its compounds	2	4	2	-
31. Topic 31. Phosphorus and its compounds	1	4	4	
32. Topic 32. *p*-Elements of VA Group. Arsenic family elements (Arsenic, Antimony, and Bismuth)	1	3	3	
33. Topic 33. *p*-Elements of VIA Group. Oxygen	0,5	2	2	
34. Topic 34. *p*-Elements of VIA Group. Sulfur, Selenium, Tellurium	0,5	2	2	
35. Topic 35. *p*-Elements of VIIA Group. Halogens	1	4	5	
36. Topic 36. p-elementsofVIIIAGroup. Noblegases			6	
37. Topic 37. General characteristic of *d*-Elements.	0,5	2	6	
38. Topic 38. *d*-Elements of IB Group. Copper, Silver, Gold	0,5	2	2	
39. Topic 39. *d*-Elements of IIB Groups. Zinc, Cadmium, Mercury	1	3	3	
40. Topic 40. d-elementsofIIIV - VBgroups. Titanium, Vanadium. Lanthanides			3	

41. Topic 41. *d*-Elements of VIB Group. Chromium elements family	1	4	4	
42. Topic 42. *d*-Elements of VIIB Group. Manganese elements family	1	4	2	
43. Topic 43. *d*-Elements of VIIIB Group. Iron and its compounds.	1	2	6	
44. Topic 44. *d*-ElementsofVIIIB Group.CobaltandNickelcompounds.	0,5	1	6	
45. Topic 45. *d*-ElementsofVIIIB Group. Platinum metals	0,5	1	4	
In total for thematic module2	***16***	***53***	***81***	
In total 270 hours/9 ECTS credits	**30**	**105**	**135**	
Final control				Exam

4. Thematic schedule of lectures

№.	TOPIC	Duration, hours
	Thematic module 1. General Chemistry	
1.	Atomic-molecule concept. Basic laws of chemistry. Chemical equivalents of substances. Structure of atoms. The Periodic law and Periodic table by D. Mendeleev .The nature of chemical bonds and structure of chemical compounds	2
2.	Solutions. Ways of expressing concentrations of solutions. Colligative properties of solutions	2
3.	Chemical thermodynamics. Thermochemistry. The direction of chemical processes passage. Chemical kinetics and equilibrium	2
4.	The concept of strong and weak electrolytes. The equilibrium in feebly soluble electrolytes solutions.	2
5.	Acids and bases theories. Dissociation of water. pH. Protolytic processes	2
6.	Reactions with electrons transferring.	2
7.	Coordination compounds. Reactions of coordination compounds formation	2
	Totally:	***14***
	Thematic module2. Inorganic Chemistry	
1.	Chemical elements and their classification. A human and biosphere. Hydrogen and alkali metals	2
2.	*s*-Elements of IIA Group. Beryllium, Magnesium, and Alkaline earth metals	2
3.	*p*-Elements of IIIA Group, IVA and VA Groups Boron, Aluminium. *p*-Elements of IVA Group. Carbon, Silicon . *p*-Elements of. Germanium family elements.	2
4.	*p*-Elements of VA Group. Nitrogen and its compounds.Phosphorus and its compounds	2
5.	*p*-Elements of VA and VIA Groups. Arsenic family elements. Oxygen and its compounds	2
6.	*p*-Elements of VIA and VIIA Groups. Sulfur, Selenium, Tellurium. Halogens	2
7.	*d*-Elements of IB and IIB Groups	2
8.	d-Elements of VIB and VIIB Groups. Chromium and Manganese families elements. *d*-Elements of VIIIB Group. Iron family elements. Platinum metals	2
	Totally:	***16***
	Totally	***30***

5. Thematic schedule of laboratory and practical studies

№	TOPIC	Duration, hours
	Thematic module 1. General Chemistry	
1.	Atomic-molecule concept. Nomenclature and classification of inorganic compounds. Basic laws of chemistry	4
2.	Equivalents of substances in chemical reactions	4
3.	Structure of atoms. The Periodic law and Periodic table by D. Mendeleev. The nature of chemical bonds and structure of chemical compounds	4

4.	Solutions. Ways of expressing concentration of solutions	4
5.	Preparation of a solution of known concentration	4
6.	Colligative properties of solutions	4
7.	The basic terms of chemical thermodynamics. Thermochemistry. The direction of chemical processes passage	4
8.	The rate and mechanism of chemical reactions. Chemical equilibrium	4
9.	The concept of strong and weak electrolytes. The equilibrium in feebly soluble electrolytes solutions	4
10.	Acids and bases theories. Self-ionization of water. pH	4
11.	Protolytic processes	4
12.	Reactions with electrons transferring. Experimental studying of reduction-oxidation reactions	4
13.	Coordination compounds. Reactions of coordination compounds formation. Experimental studying of coordination compounds properties	4
	Totally:	***52***
Thematic module2 Inorganic Chemistry		
1.	Chemical elements and their classification. A human and biosphere. General characteristic of *s*-Elements. Hydrogen and its compounds.*s*-Elements of the I group of the Periodic Table. Alkali metals	4
2.	*s*-Elements of the II groups of the Periodic Table. Beryllium, Magnesium, and Alkaline earth metals.	4
3.	General characteristic of *p*-Elements. *p*-Elements of IIIA Group. Boron and Alluminium	3
4.	*p*-Elements of IVA Group. Carbon, Silicon. *p*-Elements of IVA Group. Germanium family elements (Germanium, Tin, and Lead)	4
5.	*p*-Elements of VA Group. Nitrogen and its compounds in the negative oxidation states. *p*-Elements of VA Group. Nitrogen and its compounds in the positive oxidation states	4
6.	*p*-Elements of VA Group. Phosphorus and its compounds	4
7.	*p*-Elements of VA Group. Arsenic family elements (Arsenic, Antimony, and Bismuth)	3
8.	*p*-Elements of VIA Group. Oxygen, Sulfur, Selenium, Tellurium	4
9.	*p*-Elements of VIIA Group. Halogens	4
10.	General characteristic of*d*-Elements. *d*-Elements of IB Group. Copper, Silver, Gold	4
11.	*d*-Elements of IIB Groups. Zinc, Cadmium, Mercury	3
12.	*d*-Elements of VIB Group. Chromium elements family	4
13.	*d*-Elements of VIIB Group. Manganese elements family	4
14.	*d*-Elements of VIIIB Group. Iron and its compounds. Cobalt and Nickel compounds. Platinum metals	4
	Totally:	***53***
	Totally	***105***

6.Thematic schedule of students' individual work

№	TOPIC	Duration, hours	Forms of assessment
Thematic module 1. General Chemistry			
1.	Chemistry as the nature science. The history of chemistry. Atomic-moleculeconcept	2	The current control during practice classes activities
2.	classification and nomenclature of inorganic compounds.	4	
3.	Basic laws of chemistry.	2	
4.	Equivalents of substances in chemical reactions.	2	
5.	Structure of atoms.	2	
6.	The Periodic law and Periodic table by D. Mendeleev	2	
7.	The nature of chemical bonds and structure of chemical compounds	2	
8.	The study of solutions	2	
9.	Ways of expressing concentration of solutions	2	
10.	Colligative properties of solutions	2	
11.	The basic terms of chemical thermodynamics. The first law of	2	

	thermodynamics. Thermochemistry.		
12.	The second law of thermodynamics. The direction of chemical processes passage	2	
13.	The rate and mechanism of chemical reactions	2	
14.	Chemical equilibrium	4	
15.	The concept of strong and weak electrolytes	2	
16.	The equilibrium in feebly soluble electrolytes solutions	2	
17.	Acids and bases theories. Self-ionization of water. pH	2	
18.	Protolytic processes	2	
19.	Reactions with electrons transferring	7	
20.	Coordination compounds. Reactions of coordination compounds formation	7	
	Totally:	***54***	
Thematic module2. Inorganic Chemistry			
1.	Chemical elements and their classification	2	The current control during practice classes activities
2.	A human and biosphere	2	
3.	General characteristic of *s*-Elements. Hydrogen and its compounds	2	
4.	*s*-Elements of the I group of the Periodic Table. Alkali metals	2	
5.	*s*-Elements of the II groups of the Periodic Table. Beryllium, Magnesium, and Alkaline earth metals	2	
6.	General characteristic of*p*-Elements. *p*-Elements of IIIA Group. Boron and Alluminium	2	
7.	*p*-Elements of IVA Group. Carbon and its inorganic compounds	5	
8.	Silicon and its compounds	2	
9.	*p*-Elements of IVA Group. Germanium family elements (Germanium, Tin, and Lead)	2	
10.	*p*-Elements of VA Group. Nitrogen and its compounds	4	
11.	Phosphorus and its compounds	3	
12.	*p*-Elements of VA Group. Arsenic family elements (Arsenic, Antimony, and Bismuth)	2	
13.	*p*-Elements of VIA Group. Oxygen and its compounds	2	
14.	*p*-Elements of VIA Group. Sulfur, Selenium, Tellurium	5	
15.	*p*-Elements of VIIA Group. Halogens	6	
16.	*p*-Elements of VIIA Group. Noble gases	6	
17.	General characteristic of d-Elements. Types of chemical reactions with their involvement	2	
18.	*d*-Elements of IB Group. Copper, Silver, Gold	3	
19.	*d*-Elements of IIB Groups. Zinc, Cadmium, Mercury	3	
20.	*d*-Elementsof IIIB – VB Groups. Titanium, Vanadium. Lanthanides.	4	
21.	*d*-Elements of VIB Group. Chromium elements family	2	
22.	*d*-Elements of VIIB Group. Manganese elements family	6	
23.	*d*-Elements of VIIIB Group. Iron and its compounds	6	
24.	*d*-Elements of VIIIB Group. Cobalt and Nickel compounds. Platinum metals	4	
25.	*d*-Elements of VIIIB Group. Platinum metals	2	
	Totally:	***81***	
	Totally	***135***	

7. Individual tasks for full-time students are not provided.

1. Teaching methods

In the process of "General and inorganic chemistry" disciplines studying the following teaching methods are usedfor students:

- by the cognitive activity type:
  - explanatory-illustrative;
  - reproductive;
  - problematic presentation;
  - the logic of cognition;

- analitical;
- inductive;
- deductive;

- according to the main stages of the process:
  - knowledgeformation;
  - skills and abilitiesformation;
  - knowledge application;
  - generalization;
  - fixing;
  - assesment;
- by the system approach:
  - stimulation and motivation;
  - assessment and self-assesment;
- by sources of knowledge:
  - verbal – lecture, explanation;
  - visual – demonstration, illustration;
- according to the individual mental activity level:
  - problematic;
  - partially discovering;
  - explorative;
  - the method of problematic teaching.

2. **Methods of control**

The current control is a regular check of educational trained achievements, fulfiled by the teacher according to syllabus of the discipline. It is carried out on each practical class according to the specific objectives, during the individual work of the teacher with the student for those topics which are not part of the structure of practical classes. The objective (standardized) control of theoretical and practical knowledge and skills of students is used.

The following means of the level of students' knowledge assessment are used: testing, situational problems solving, laboratory research activities and their results interpreting and evaluating, practical skills evaluation.

At each practical class the student gives answers on 20 questions (multiple choice questions on the topic of the practical classes, standardized questions, knowledge of which is necessary for understanding the current topic, the issue of a lecture course and individual work related to the current class, demonstrates knowledge and skills of practical abilities in accordance with the topic of the practical class).

The exam is the form of final control for the discipline "General and inorganic chemistry" studying. Students, who completed all types of activities provided by the syllabus, attended all practical classesand were scored with thepoints number not less than the minimum.

Methodology and means of standardized evaluation for the final

Regulations of the final semester exam realization

The final control is carried out in the standardized form and includes the theoretical and practical skills assessment.

It should be performed in writing as 66 multiple choice questions (1 point for each correct answer) and 7 numerical problems (2 points for each in the case of being solved correctly).

Final control consists of the following stages:

I stage – written answer to test questions in the multiple choice format (the answering blankwithcomputerchecking).

The student meets the test package. Each package contains 66 multiple choice format tests for each thematic module, and is rated at 1 score point for each correct answer.

II stage - written answer to 7 situational tasks. Each correct answer is assessed by 2 score points.

10. The current control is realized during the practical classes and aims at checking the learning of educational material.

The form of the current control assessment during the classes is defined by syllabus of discipline.Forms of current educational activities assessment are standardized and include the control of theoretical and practical training. The 4-point (traditional) scale is used in evaluating the learning of each topic for current educational activitytaking into account the approved evaluation criteria

10.1. The current educational activity assessment.When evaluating the educational activitees achievements of each topic for the current educational activity, the student is assessed with grades in the 4-graiding scale (national). It takes into account all types of activities provided for by the discipline sullabus. A student should gain an assessment from each topic for further conversion of 4-grading scale points into 200-grading scale points.

Test control is performed at each practice class according to specific objectives. Theoretical students' self-preparation control is performed in writing by answering 18 multiple choice questions in the form one-of-five, the correct answer to each is estimated at 1 point, and two numerical problems, the correct solving being estimated at 2 points. The maximum score for the entire test is 22 points.The minimum score points number a student must gain for the successful assessment of the theoretical part is 13 points (50 % of the correct answers).

At each practical class, the teacher assesses the knowledge of each student in a four-grading scale.

Grade "excellent" ("5") – student answers all standardized questions of the topic correctly (90 – 100 %), clearly, logically and completely (including questions of lectures and individual work). Student closely applies theory and practice and correctly solves the problems of higher complexity with the professional content.Completed the planned individual work.

Grade "very good" ("4") – student answers 70 – 89 % ofstandardized questions of the topic correctly. He/she uses the the eoretical knowledge to solve the practical problems correctly. Student is able to solve easy and medium level problems with the professional content.A student has the necessary practical skills and methods of their application in an amount that exceeds the required minimum.

Grade "satisfactory" ("3") – student answers 50-69% ofstandardized questions of the topic. The answers are not complete, with additional questions (including questions of lectures and individual work). He/she is not able to give clear and logical answer. Student makes mistakes and solves only the easiest tasks in answers and practical demonstrations.

Grade "poor" ("2")– student does not know the topic and gives the correct answers to less than 50% of the tests. He/she is not able to give logical answer, gives no answer to additional questions and does not understand the topic. He/she makes significant and serious mistakes in answers and practical demonstrations.

At each practical class, student's knowledge is assessed on a four-grade scaling system ("5", "4", "3", "2") according to the criteria for evaluating the student's current activity.

The practical skills gained and the laboratory experiments carrying out assessment is performed after the laboratory work fulfilling by assessing the quality and fullness of its performance, the ability to interpret the obtained results. For the practical part of the lesson the student can get:

4 points if laboratory work is completely fulfilled and the student correctly explains the experiments interpret the results and make conclusions;

2 points if the laboratory work is done with some errors, the student can not fully explain and summarize the obtained results;

0 points if the laboratory work is not performed or the student can not explain and summarize the obtained results.

The final score for the class is determined by the sum of the points for the current theoretical control and the laboratory experiments carrying out points as follows:

Total score points	Grade in 4-point scale
from22to26	5
from 17 to 21	4
from 13 to 16	3
< 13 points for the current theoretical control or 0 points for the laboratory experiments carrying out	2

The students' individual work issues and achievements which are provided by the syllabus in the content of practical training practical class activities, are evaluated during the current control of the topic at the

appropriate practical class. The evaluation of the topics submitted for individual study and not included into the content of the practical class training is monitored during the final control.

11. The exam if the form of the final control and students' knowledge assessment during their "General and inorganic chemistry" studying.

Final control at the end of semester is a form of final control, which is aimed to assess the students' theoretical and practical material knowledge and skillson the academic discipline.Semester exam is a form of final control of the student theoretical and practical material from discipline.Students who completed all types of works provided by the syllabus, attended all practical classes and were scored with the points number not less than the minimum.

The final control is carried out in the standardized form and includes the theoretical and practical skills assessment.

It should be performed in writing as 66 multiple choice questions (1 point for each correct answer) and 7 numerical problems (2 points for each in the case of being solved correctly).

12. Theregularitiesforgrades and score points number gaining by students:

The highest possible scorepoints which a student can gain for the current educational activity for the semester for admission to the exam is 120 points.

Minimal number of score points which a student must gain for current educational activity for the semester for admission to the exam is 72 points.

Calculation of the points number is based on grades gained by student under the traditional scale (by calculation of the arithmetic mean (*AM*) rounded to two decimal places). The resulting value is converted into points by multi-points scale as follows:

$$x = \frac{CA \times 120}{5}$$

Conversion of the average grade for current educational activity to the point scale for discipline which is finished with exam

4-grading scale	200-grading scale
5.00	120
4.95	119
4.91	118
4.87	117
4.83	116
4.79	115
4.75	114
4.70	113
4.66	112
4.62	111
4.58	110
4.54	109
4.50	108
4.45	107
4.41	106
4.37	105
4.33	104
4.29	103

4-grading scale	200-grading scale
4.25	102
4.20	101
4.16	100
4.12	99
4.08	98
4.04	97
3.99	96
3.95	95
3.91	94
3.87	93
3.83	92
3.79	91
3.74	90
3.70	89
3.66	88
3.62	87
3.58	86
3.54	85

4-grading scale	200-grading scale
3.49	84
3.45	83
3.41	82
3.37	81
3.33	80
3.29	79
3.25	78
3.20	77
3.16	76
3.12	75
3.08	74
3.04	73
3.00	72
Менше 3	Недос-татньо

Individual work of students is evaluated during the current control of topic on the appropriate class. Mastering of topics for individual work is controlled at the final control.

The highest possible score points which a student can get in exam is 80.

A minimum point required for passing is 50.

An assessment of the discipline which is finished with examis defined as the sum of score points number for the current educational activity (not less than 72) and the score points number for the exam (not less than 50).

Points on discipline are converted regardless both in ECTS scale and a 4-point scale. Scores of ECTS scale can not be converted into 4-point scale and vice versa. Scores of students taking into account the number of points on the discipline are ranked on a ECTS scale so that:

Grade in ECTS	Statistical index
A	Top 10 % of students
B	The next 25 % of students
C	The next 30 % of students
D	The next 25 % of students
E	The last 10 % of students

A, B, C, D, E rankings are awarded to students of the whole course, of the same specialty and successfully completed the studying of discipline. Students who were scored as FX, F ("2") ratings are not included into the ranking list. Students with an FX score after reassembly automatically receive a "E" score

Points on discipline for students who completed the program successfully are converted into a traditional 4-point scale by absolute criteria, which are listed in the table below:

Points on discipline	Grade in 4-point scale
From170 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
Lower than minimum number of points that a student must score	2

The ECTS score points are not converted into traditional scale score because the ECTS scale and the four-point scale are independent.

The objectivity of students' educational activity assessment is verified by statistical methods (correlation coefficient between ECTS assessment and national scale assessment).

13. METHODICAL PROVIDING:

- thesis of lectures on discipline;
- thematic schedules of lectures, practical and laboratory classes and the students' individual work;
- guidance for practical training for students;
- teaching materials, providing individual work;
- test and control tasks for practical classes;
- questions and tasks for final control (exam).

14. Recommended literature

Main sources

1. General and inorganic chemistry / Levitin Ye.Ya. Vedernikova I.A. – Kharkiv: Publishing House of NUPh: Golden Pages, 2009. – 360 p.
2. Raymond Chang. Chemistry (6th Edition). – WCB/McGraw-Hill. – 1998. – 995 p.
3. John McMurry, Robert C. Fay. Chemistry (3rd Edition). – Prentice Hall. – 2001. – 1067 p.
4. David E. Goldberg. Fundamentals of Chemistry (2nd Edition). – WCB/McGraw-Hill. – 1998. – 561 p.

Additional sources

1. Rodney J. Sime Physical Chemistry. Methods. Techniques. Experiments. – Saunders College Publishing. – 1990. – 806 p.
2. John McMurry, Robert C. Fay. Chemistry (3rd Edition). – Prentice Hall. – 2001. – 1067 p.
3. David E. Goldberg. Fundamentals of Chemistry (2nd Edition). – WCB/McGraw-Hill. – 1998. – 561 p.

4. Theodore L. Brown, H.Eugene LeMay, Bruce E. Bursten. Chemistry. The Central Science. – Prentice Hall. – 2000. – 1017 p.
5. John Olmsted III, Gregory M. Williams. Chemistry. The Molecular Science. – Mosby. – 1994. – 977 p

15. Information resources

When studying the discipline students use the following information resources and knowledge bases through the use of local and global computer networks,:

- Wikipedia(https://www.wikipedia.org/)
- http://chemistry.inf.ua

Wolfram|Alpha (http://www.wolframalpha.com/)

Electronic versions of teaching and studying support:

1. Inorganic chemistry study guide for the 1st year students of pharmaceutical faculty (Thematic module 1. General chemistry). http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Engl_Metodychne_zabezpechennaj/Engl_Method_inorg_farm_M-1.pdf

2. Chemistry of *s*- and *d*-elements. Lectures for the 1st year students of pharmaceutical faculty (Thematic Module 2. Inorganic chemistry) http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Engl_Metodychne_zabezpechennaj/Engl_Lectures_1_pharm_Mod_2_s-d-elements.pdf

3. Chemistry of *p*-elements. Lectures for the 1st year students of pharmaceutical faculty (Thematic Module 2. Inorganic chemistry) http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Engl_Metodychne_zabezpechennaj/Engl_Lectures_1_pharm_Mod_2_p-elements.pdf

4. Inorganic chemistry study guide for the 1st year students of pharmaceutical faculty (Thematic module 2. Inorganic chemistry).

5. Multiply choice questions on inorganic chemistry (Thematic module 1. General Chemistry).For the 1st year students of pharmaceutical faculty. http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Engl_Tests/Engl_Neorgan_Chem_Tests_M-1.pdf

6. Multiply choice questions on inorganic chemistry (Thematic module 2.Inorganic chemistry). For the 1st year students of pharmaceutical faculty. http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Engl_Tests/Engl_Neorgan_Chem_Tests_M-2.pdf

7. **Internet-textbook for English-speaking students** http://www.meduniv.lviv.ua/files/kafedry/bioneorgan/Chemistry/index.htm