National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of Ecology and Plant Polymers Technology

Special Topics of Biogeochemistry

Working program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	***First (Bachelor)***
Branch of knowledge	*10 Natural Sciences*
Speciality	*101 Ecology*
Educational program	*OPP Environmental Safety*
Status of discipline	*Normative*
Form of training	*full-time/remote/mixed*
Year of preparation, semester	*1 course, spring semester*
Volume of discipline	*5,5 (165)*
Semester control/ control measures	*Passed*
Schedule of classes	*5 hours per week (3 hours of lecture and 2 hours of laboratory classes)*
Language of instruction	*Ukrainian*
Information about the course /teachers	Lecturer: *Ph.D., Assoc., Oksana Tereshchenko, okter789@gmail.com* Laboratory: *Ph.D., Assoc., Oksana Tereshchenko, okter789@gmail.com*
Course placement	https://do.ipo.kpi.ua/course/view.php?id=2514

Program of discipline

1. Description of the discipline, its purpose, subject of study and learning results

Biogeochemistry is a branch of knowledge on the verge of biology and geochemistry that studies the chemical composition of the Earth's geospheres and living organisms and the participation of living matter in the formation and maintenance of the stability of the biosphere.

The processes that occur in the environment and biota depend on the physical, chemical and biological properties of elements and compounds. Knowing them, you can predict the ways of migration, accumulation, entry into living organisms, the impact on functioning. Therefore, without knowledge of the chemistry of elements, it is impossible to understand those grandiose processes that occur in the biosphere. These are the formation of various landscapes, the formation of mineral deposits, the processes of weathering rocks, and the cycle of chemical elements based on the reactions of acid-base interaction, deposition and dissolution, complex formation, oxidation and recovery.

Knowledge of the chemistry of elements will help not only to understand the content of the grandiose processes taking place on the planet, but to learn and predict the consequences of violation of existing balances in the biosphere, find ways to replenish the deficit of individual elements in your own body or, conversely, get rid of them excessively in order to preserve health. And according to the state of vegetation, it is possible to predict the fertility of the soil, and its humidity and even the depth of groundwater.

The subject of the discipline " Specific Topics of Biogeochemistry *" is the formation of the foundation of knowledge and practical skills of specialists in the field of ecology, necessary for the study of professionally oriented and special disciplines.*

The purpose of the discipline " **Specific Topics of Biogeochemistry "**

The purpose of the discipline is to form competencies for students:

- the ability to critically comprehend the basic theories, methods and principles of the natural sciences.

In accordance with the requirements of the program of the discipline " Specific Topics of Biogeochemistry*", students after its assimilation must demonstrate the following programmatic learning results:*

- understand the basic environmental laws, rules and principles of environmental protection and nature management;

understand the basic concepts, theoretical and practical problems in the field of natural sciences, which are necessary for the analysis and decision-making in the field of ecology, environmental protection and optimal nature management;

- to improve the professional level by continuing education and self-education;

- conduct laboratory tests using modern devices, ensure sufficient measurement accuracy and reliability of results, process the results obtained.

2. Prerequisitions and requisition of disciplines (place in the structural and logical scheme of training according to the relevant educational program)

The study of the discipline " Specific Topics of Biogeochemistry *" requires knowledge that is formed on the basis of secondary education, obtained from general and inorganic chemistry, physics, mathematics.*

3. Contents of the discipline

Section 1. Overview of the chemistry of elements: properties of chemical elements and their compounds

Topic 1. Elements of the VIII group.

General characteristics of the group.

A. Subgroup of halogens (p-elements).

B. Subgroup of manganese (d-elements).

Topic 2. Hydrogen.

The location of hydrogen in the Periodic system and the specificity of its properties; physical and chemical properties of hydrogen; hydrogen binary compounds; water; peroxyhydrogen.

Topic 3. Elements of group VI.

General characteristics of the group. The electronic structure of atoms, elements are typical and complete electronic analogues.

A. Oxygen.

B. Subgroup of sulfate (p-elements).

B. Subgroup of chromium (d-elements).

Topic 4. Elements of group V.

General characteristics of the group.

A. Nitrogen (p-element).

B. Phosphorus (p-element).

B. Arsene subgroup (p-elements).

D. Vanadiyu subgroup (d-elements).

Topic 5. Elements of the 4th group.

Electronic structure of atoms, general characteristics of elements, patterns of changes in properties.

A. Carbon (p-element).

B. Silicius (p-element).

B. Subgroup of germanium (p-elements).

Subgroup of titanium (d-elements).

***Topic 6. Elements of the III group**.*

Electronic structure of atoms, general characteristics of elements, their properties.

A. Bohr (r-element).

B. Aluminum (p-element).

B. Galium subgroup (p-elements).

G. Scandium subgroup (d-elements).

Topic 7. Elements of the 2nd group.

General characteristics.

A. Berylius (s-element).

B. Magnesium (s-element).

B. Calcium subgroup (s-elements).

G. Pis a group of zinc (d-elements).

Topic 8. Elements and groups.

General characteristics.

A. Alkali metals (s-elements).

B. Subgroup of cuproom (d-elements).

Topic 9. Elements of group VIII.

General characteristics.

A. Noble gases (s-elements).

B. Family of ferrum (d-elements).

Family of platinum metals (d-elements).

4. Training materials and resources

Basic literature

1. Number of elements: author's lecture course / M.M. Volobuev, M.V. Ved. – Kharkov: NTU "KHPI", 2019. – 200 p.

2. Butchenko L.I., Tereshchenko O.M. Chemical aspects of biogeochemistry: theory and workshop.

3. Levitin E.Ya. General and inorganic chemistry: sub-textbook for students of higher education / E.Y. Levitin, A.M. Bryzytska, R.G. Klyuyev; by ed. E.Y. Levitina. — 3rd type. — Kharkiv : NUPh : Golden Pages, 2017. — 512 p. — (National textbook).

4. General and Inorganic Chemistry: textbook/ V.O. Kalibabchuk, V.V. Ohurstov et al. Kyiv: AUS Medical Publishing, 2019, - 456 p.

5. Kovalchuk I.S., Honcharuk S.V., etc. Inorganic chemistry.

Secondary

6. Tsvetkova L.B. Inorganic chemistry: theory and tasks.

7. *https://studwood.net/1713651/matematika_himiya_fizika/teoriya_solvosistem*

8. Methodology for solving calculation problems in chemistry.

9. Andriyko O.O. Inorganic chemistry of biogenic elements.

10. General and inorganic chemistry: Pidruch. for stud. higher teaching order./ O.M. Stepanenko, L.G. Reiter, V.M. Ledovsky, S.V. Ivanov. – K.: Ped. Press, 2000. – 784 p.

11. *Sorochuk D.I. Course Coordination compounds on moodle platform: Vasyl Stus Donetsk National University, 2020. – 112 p.*

Information resources on the Internet

1. Center for Electronic Learning Materials, access mode: http://193.108.240.69/moodle/

2. Journal of inorganic chemistry, access mode: http://www.geokhi.ru/~zhakh

3. Electronic Library of Literature on General Chemistry: website. URL: https://techemy.com (hit date: 25.05.2019).

4. Center for Electronic Learning Materials: website. URL: http://193.108.240.69/moodle/ (date of appeal: 25.05.2019).

5. Bubliotek Academy of Sciences. Information on English Language: website. URL: http://ban.yu.ru (hit date: 25.05.2019).

6. Povnotective journals on chemistry in English and Russian: website. URL: http://abc.chemistry.bsu.by/free-journals/ (hit date: 25.05.2019).

. Methods of mastering the discipline (educational component)

Lecture removals

Lectures are aimed at: providing modern, holistic, interdependent knowledge from the credit module "Special sections of biogeochemistry", the level of which

– determined by the target installation for each specific topic;

– ensuring in the process of lecturing the creative work of students together with the teacher;

– education of students of professional and business qualities and development of their independent creative thinking;

– formation of the necessary interest in students and providing direction for independent work;

– reflection of methodical processing of the material (allocation of main thoughts and provisions, underlining conclusions, repeating them in different formulations);

– teaching in a clear and clear language, explaining all the newly introduced terms and concepts;

– accessibility for perception by this audience.

No s/p	*The name of the lecture topic and the list of main issues (list of didactic means, references to literature and tasks on the IWS)*
1-5	***Section 1. Overview of the chemistry of elements: properties of chemical elements and their compounds*** ***Topic 1. Elements of group VII:*** ***Subgroup of halogens (p-elements).*** *General characteristics, obtaining, physical and chemical properties. Change in oxidative activity in the subgroup. Change in oxidative properties in a number of oxygen acids of chlorine, bromine, iodine. Halides: patterns of changes in their properties by periods, groups and families of elements. Oxides, acids, salts, their thermodynamic resistance, acid-base and redox properties. Intergalogenic compounds, their hydrolysis. Obtaining and applying chlorine, bromine, iodine and their most important compounds.* ***Literature: [1]. P. 93-103; [2]. P. 8-18, 351-365; [3] CC 431-450, 465-475.*** ***Subgroup of manganese (d-elements).*** *Electronic structure of atoms. Being in nature and obtaining mangan, technology, rheni. Properties of simple substances. Redox properties of compounds. Acids of*

	mangan and rhine and their salts. Oxidative properties of permanganate. The use of mangan and rheni and their most important compounds. ***Literature: [1] P. 127-135; [2]. P. 19 – 26; [3] CC 465-475.*** *Tasks on the IWS. Degree of oxidation. Redox reactions. homogeneous redox systems in aqueous solutions.*
6	***Topic 2. Hydrogen:*** *The location of hydrogen in the Periodic system and the specificity of its properties; physical and chemical properties of hydrogen; hydrogen binary compounds; water; peroxyhydrogen.* ***Literature: [1] P. 104-109; [2]. 28-29, 37-38.*** *Tasks on the IWS. Solving typical problems by chemical equations.*
7-11	***Topic 3. Elements Vand group. Main subgroup.*** *r-Elements of group VI. General characteristics of elements. The electronic structure of atoms, elements are typical and complete electronic analogues. Natural change in properties.* ***Oxygen.*** *The structure of the atom and molecule O_2. Prevalence, natural compounds, production, oxidative activity, oxygen use. Ozone: the formation and structure of the molecule from the standpoint of the VZ method, production, oxidative activity, application.* *Peroxohydrogen: the structure of the molecule, properties, production, application. Peroxides, superperoxide, ozoneids. Application.* ***Subgroup of sulphur: sulfour, selenium, tellurium, polonium.*** *Natural compounds. Composition and structure of simple substances. Sulfur allotropy. Oxidative and restorative properties of simple substances, interaction with water, acids and alkalis. Interaction of sulphur, selenium and tellurium with hydrogen, comparison of the structure and properties of chalcogenides. Metal sulfides: classification in relation to acids and water, hydrolysis. Sulfoanhydrides, sulfoxyslotes and sulfosoli. Sulfides and polysulfides.* *Sulfate oxide (IV): production, structure of the molecule, solubility in water. Sulphite acid and its salts. Akisnival-restorative properties. Sulfate oxide (IV), its structure in gaseous, liquid and solid states, production, interaction with water. Sulfuric acid: production, properties. Salts of sulfuric acid. The use of sulfate, selenium, tellurium and their most important compounds.* ***Subgroup of chromium.*** *The electronic structure of atoms, and their possible oxidation degrees and coordination numbers in compounds. Being in nature and obtaining chromium, molybdenum, tungsten. Compounds: (oxides, hydroxides, salts). Complex compounds. The use of chromium, molybdenum, tungsten and their most important compounds.* ***Literature: [1]. 27-60; [2]. CC. 407-431.*** *Tasks on the IWS. 1) Problems of the "ozone layer" in human life.* *2) Comparison of properties of sulfate compounds (IV), selenium (IV), tellurium (IV).* *3) The composition and most characteristic properties of polysulphate acids ("oleum"), thiosulphate acid and thiosulfates, supersulphate, fluorine and chlorosulfonic acids.*
12-17	***Topic 4. Elements of the V group.*** *The electronic structure of atoms and the general characteristics of properties.* ***Nitrogen (p-element).*** *Being in nature, obtaining and properties of a simple substance. The structure of*

	the ammonia molecule, its properties in liquid, gaseous and dissolved states. Ammonium hydroxide and ammonium salt. Nitrides, amids and imids. Hydrazine and hydroxylamine: composition and structure of molecules, properties. Nitrite acid and its salts - nitrites, their production and properties, redox properties. Nitrate acid: production, oxidative properties, interaction with metals and nonmetals. ***Phosphorus (p-element).*** *Being in nature. Obtaining, allotropic modifications and properties of a simple substance. Phosphorus compounds with oxygen and halogens.* ***Arsene subgroup (p-elements).*** *Extraction. Physical properties. Application. Chemical properties of arsenic subgroup elements. Hydrogen compounds of arsenic subgroup elements. Compounds of arsenic subgroup elements and their derivatives. Sulphides of arsenic subgroup elements. Halides of arsenic subgroup elements. The biological function of the elements of the arsenic subgroup and the toxic effect of their compounds.* ***Vanadiu subgroup (d-elements).*** *Being in nature. Physical properties. Application. Chemical properties of elements of the vanadiyu subgroup.* ***Literature: [1]. P. 57-76; 182-190; [2]. P. 66-87.*** *Tasks on the IWS. Nitrogen fertilizers. Phosphate fertilizers.* ***Vanadiu subgroup (d-elements).*** *Being in nature. Physical properties. Application. Chemical properties of elements of the vanadiyu subgroup.*
18-22	***Topic 5. Elements IV group.*** *Electronic structure of atoms, general characteristics of elements, patterns of changes in properties.* ***Carbon (p-element)****).* *Carbon. Being in nature, allotropy of a simple substance (diamond, graphite, carbine, fullerene), their structure and properties. Carbides of metals. Carbon monoxide (II), production, structure of the molecule, properties. Carbonyls of metals. Carbon monoxide (IV), production, structure of the molecule, properties. Carbonate acid and its salts. Cyanide, cyanide, thiocyanic acids and their salts. Carbon compounds with sulfur and halogens. The use of carbon and its most important compounds.* ***Silicius (p-element).*** *Being in nature, obtaining and properties of a simple substance. Silicium oxide (IV), its allotropic modifications, interaction with acids and alkalis. Silicium acids, silica gel. Simple silicates, glass. Complex natural silicates, allumosilicates. Zeolite. Silicium compounds with hydrogen (silannas), metals (silicides), carbon (carborund), and halogens. The use of silicium and its most important compounds.* ***Subgroup of germanium (p-elements).*** *Being in nature, obtaining simple substances. Allotropic modifications of the state. Interaction of simple substances with acids and alkalis. Oxides, hydroxides, their salts: production, acid-basic properties, hydrolysis, oxidative and restorative properties. Compounds with hydrogen, halogens. The use of germanium, stanum, plumbum and their most important compounds.* ***Literature: [1]. 37-56; [2]. 87-106.*** *Tasks on the IWS.* ***Titanium subgroup (d-elements).*** *Extraction. Physical properties. Application. Chemical properties of titanium subgroup elements.*
23-	***Topic 6. Elements of the III group****.*

25	*Electronic structure of atoms, general characteristics of elements, their properties.* ***Bohr (p-element).*** *Obtaining, structure and properties of a simple substance. Interaction with acids, alkalis and active metals. Compounds with hydrogen (borans): their production and properties. Borids. Boron oxide, boric acids, borates. Boron compounds with halogens, sulfate, nitrogen. Bororganic compounds. The use of boron and its most important compounds.* ***Literature: [1]. 20-28; [2]. 108-115.*** ***Aluminum (p-element).*** *Prevalence in nature, obtaining, properties. Interaction with water, acids and alkalis. Aluminum oxide and hydroxide, aluminates, aluminum salts. The use of aluminum and its most important compounds.* ***Literature: [1]. 28-32; [2]. 115-119.*** ***Halium subgroup (p-elements).*** *Extraction. Physical properties. Application. Chemical properties of elements of the galley subgroup.* ***Literature: [1]. 32-36.*** ***Scandium subgroup (d-elements).*** *Extraction. Physical properties. Application. Chemical properties.* ***Literature: [1]. 168-174.*** *Tasks on the IWS. Lanthanides, actinoids.*
26-27	***Topic 7. Elements of the 2nd group.*** *General characteristics.* ***Beryllium (s-element).*** *Extraction. Physical properties. Application. Chemical properties of beryllium. Toxic effect of beryllium compounds.* ***Magnesium (s-element).*** *Extraction. Physical properties. Application. Chemical properties of magnesium. Biological action of magnesium compounds.* ***Calcium subgroup (s-elements).*** *Extraction. Physical properties. Application. Chemical properties of the calcium subgroup. Binary compounds of calcium subgroup elements with oxygen and their hydroxides. Salt elements of the calcium subgroup. Hydrides, nitrides, carbides of calcium subgroup elements. Biological function and toxic effect of compounds of alkali-land metals.* ***Zinc subgroup (d-elements).*** *Extraction. Physical properties. Application. Chemical properties of the zinc subgroup. Oxides, hydroxides of elements of the zinc subgroup and their derivatives. Halides of elements of the zinc subgroup.* ***Literature: [1]. 12-19; [2]. 108-118.*** *Tasks on the IWS. Polycations of mercury. Cluster compounds containing mercury.*
	Topic 8. Elements and groups. *General characteristics.* ***Alkali metals (s-elements).*** *Spread in nature. Extraction. Properties of alkali metals. Salts of alkali metals. Biological function of alkali metals.* ***Subset of the cuproom (d-elements).*** *Spread in nature. Extraction. Properties of cuprum, argumentum and aurum.*

	Oxides, hydroxides of elements of the kuprum subgroup and their derivatives. Salts of cuprum, argumentum and aurum. Biological function of cuprum, argumentum and aurum. ***Literature: [1]. p. 4-11; 152-160; [2]. C. 143-160.*** *Tasks on the IWS. Features of the chemical behavior of lithium. Ammonia method of soda extraction.*
	Topic 9. Elements of group VIII. *General characteristics.* ***Noble gases (s-elements).*** *General characteristics. Chemical compounds of noble gases.* ***Family ferm (d-elements).*** *Extraction. Physical properties. Application. Chemical properties of elements of the iron family. Oxides, hydroxides E(II) and E(III) of the iron family and their derivatives. Biological function and toxic effect of compounds of elements of the iron family.* ***Literature: 152-160; [1]. C. 136-143; [2]. C. 164-176; [10]. CC 515-527*** *Tasks on the IWS.* ***Family of platinum metals (d-elements***

Laboratory classes (computer workshop)

Laboratory work allows students the ability to work with chemical reagents, dishes and devices, carry out a chemical experiment and conduct primary scientific research. To increase the cognitive activity of students and obtain their primary skills of scientific research, elements of a scientific experiment were introduced into these classical laboratory works, namely:

a) independently select reagents for a particular reaction;

b) explain the course of one reaction and not the course of another, at first glance, similar reaction; and so on.

During the laboratory workshop, conditions are created for the most independent performance of laboratory work by students. Therefore, laboratory classes begin with an express survey on the theoretical material necessary for the performance of work (with evaluation), verification of plans for laboratory work prepared by students in the framework of independent work and ends with an assessment of the student's work in the laboratory and the results obtained by them.

Work number	*Content of laboratory work*	*Number of hours*
1.	*Determination of halogen properties.*	*4*
2.	*Study of the properties of compounds of manganese and chromium*	*4*
3.	*Sulphur and its compounds.*	*4*
4.	*Hydrogen, oxygen and their compounds.*	*2*
5.	*Nitrogen and its compounds.*	*2*
6.	*Carbon, silicium and their compounds.*	*2*
7.	*Study of the properties of magnesium and alkaline earth metals.*	*2*
8.	*doctrine of the properties of zinc, cadmium and their compounds.*	*3*
9.	*Copper and argumentum. Family of Ferum.*	*3*
10.	*Synthesis of inorganic compounds.*	*6*
11.	*Modular control work on topics 1-9*	*4*
Total hours		*36*

6. Independent work

Independent work of students takes about 45% of the course study time, also includes the preparation of calculation and graphic work and preparation for the exam. The main task of independent work of students is the mastery of scientific knowledge in the field of analytical chemistry, which are not included in the list of lecture issues, through personal search for information, the formation of an active interest in the creative approach in educational work and in the implementation of calculation and graphic work.

No s/p	Name of the topic submitted for self-study	Number of hours of SRS
Section 1. Overview of the chemistry of elements: properties of chemical elements and their compounds		
1	**Елементи VII групи.** *Ступінь окиснення. Окисно-відновні реакції. Гомогенні окисно-відновні системи у водних розчинах.* ***Література: [6]. С. 208 – 232.***	6
2	***Гідроген:*** *Теорія сольвосистем.* *Розв'язування типових задач за хімічними рівняннями* ***Література: [7]; [3]. с. 276 – 279; [6]. с. 256 – 266.*** **Елементи VI групи.** *Проблеми "озонового шару" в життєдіяльності людини. Порівняння властивостей сполук сульфуру (IV), селену (IV), полонію (IV). Склад і найбільш характерні властивості полісульфатних кислот ("олеум"), тіосульфатної кислоти і тіосульфатів, надсульфатної, фтор- і хлорсульфонової кислот.* ***Література: [10]. с. 109 – 134.***	6
3	***Елементи V групи.*** *Азотні добрива. Фосфорні добрива.* ***Підгрупа ванадію (d-елементи).*** *Знаходження в природі. Фізичні властивості. Застосування. Хімічні властивості елементів підгрупи ванадію.* ***Література: [10]. с. 259-263.***	6
4	**Тема 5. Елементи IV групи.** ***Підгрупа титану (d-елементи).*** *Добування. Фізичні властивості. Застосування. Хімічні властивості елементів підгрупи титану.* ***Література: [1]. с. 175 – 181; [10]. с. 253 – 259.***	6
5	**Тема 6. Елементи III групи**. Лантаноїди, актиноїди. ***Література: [1]. с. 168-174; [10]. с. 313– 321***.	5
6	**Тема 7. Елементи II групи.** Комплексні сполуки. Полікатіони ртуті. Кластерні сполуки, що містять ртуть. Металорганічні сполуки. ***Література: [11]. С. 47– 53; 67 – 71 .***	5

7	***Елементи I групи.*** *Особливості хімічної поведінки літію. Аміачний спосіб добування соди. Будова найважливіших комплексних сполук купруму, арґентуму, ауруму.* ***Література: [9]. С. 57– 70.***	5
8	***Тема 9. Елементи VIII групи.*** *Родина платинових металів (d-елементи). Добування, фізичні властивості та застосування. Сполуки платинових металів з киснем та їх похідні. Токсична дія сполук платинових металів.* ***Література: [1]. С. 143–151.***	6
9	Розрахунково-графічна робота *Література: 1 - 7.*	15
10	Модульна контрольна робота по темам 1-9	5
11	Залік	15
Total hours		75

Politics and control

6. Policy of discipline (educational component)

Rules for attending classes and behavior in classes

For objective reasons (for example, illness, international internship), training can take place individually (online in agreement with the dean of the faculty). Students are obliged to take an active part in the educational process, not to be late, not to be distracted by actions that are not related to the educational process.

Rules for assigning incentive and penalty points

Semester certification is carried out in the form of an exam. To assess the results of training, a 100-point rating system and a university scale are used.

Encouraging points can be credited by the teacher only for the performance of creative works in the discipline or additional passage of online specialized courses with the receipt of the appropriate certificate (in agreement with the teacher):

-https://www.coursera.org/learn/advanced-chemistry;

- https://www.coursera.org/learn/general-chemistry;

- https://www.lectorium.tv>chemistry.

The certificate was not re-issued (previously granted last semester). The amount of incentive points may not exceed 25% of the rating scale.

Deadline and overlay rules

Works that are submitted in violation of deadlines without good reason are rated lower (up to 75% of the planned number of points). The transfer of modules takes place with the permission of the lecturer if there are valid reasons (for example, sick leave).

Evaluation of laboratory work is carried out on the basis of the result of the work and its protection.

Academic Integrity Policy

Write-offs during control works and exams are prohibited (including using mobile devices). Works should have correct text links to the literature used.

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" https://kpi.ua/code.

Policy of academic behavior and ethics

Students should be tolerant, respect the opinion of others, object to form in the correct form, constructively maintain feedback in the classroom.

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" https://kpi.ua/code.

7. Types of control and rating system for assessing learning outcomes (RCOs)

Distribution of teaching time by types of classes and tasks from the credit module according to the working curriculum

Semester	School time		Training hours				Control measures		
	Loans	akad.h	Lectz.*		L/r	IWS	MCT*	HCW	Semester certification
2	5,5	165	54	-	36	75	1	1	test

** - in accordance with the number of students in the group, the number of lecture, practical and laboratory classes can be proportionally changed taking into account individual classes*

The student's rating from the credit module consists of points that he receives for:

1) four control works (MKR is divided into 4 works lasting 22 minutes);
2) performance of 9 laboratory works;
3) performance HCW;
4) answer to the exam.

System of rating (weight) points and evaluation criteria:

1. Modular control.

Weight point – 10. The maximum number of points for all control works is equal to:
10 points x 4 robots = 40 points.

Criteria for evaluation of control works

Mark	Completeness of the answer
10-9	"excellent" – a complete answer (at least 90% of the necessary information);
8-7	"good" – a sufficiently complete answer (at least 75% of the required information), or a complete response with minor inaccuracies;
6-5	"satisfactory" – incomplete response (at least 60% of the required information) and minor errors;
4-0	"unsatisfactory" – the task is not completed, the MCT is not counted.

2. Laboratory work.

Weight point 4:

Mark	Completeness of the answer
4	timely registration of the protocol, flawless execution and protection of laboratory work;
3	timely execution of the protocol, performance of laboratory work with minor defects or protection of work with minor defects;
2	untimely execution of the protocol, performance of laboratory work or protection of work with certain shortcomings;
1-0	the work is not credited (the task is not completed or there are gross errors)

3. *HCW:*

Weight point – 20 point.

Mark	*Completeness of the answer*
20 – 19	*work with additional literature, correct performance of all tasks, timely presentation of work;*
18 – 15	*the work was done with minor flaws;*
14 – 12	*the work was done with certain errors;*
11 – 0	the work is not credited (the task is not completed or there are gross errors)

The presence of a positive grade in the RGR is a condition for admission to the credit test.

The condition of the first attestation is obtaining at least 8 points and performing all laboratory work at the time of attestation. The condition of the second attestation is to obtain at least 30 points, perform all laboratory work during the attestation and credit calculation and graphic work.

The sum of the rating points received by the student during the semester is transferred to the final grade according to the table. If the sum of points is less than 60, the student completes a credit test. In this case, the sum of the points for the RGR, control papers and control crediting work is transferred to the final grade according to the table.

Thus, the rating semester scale for the credit module is:

$$R_C = 4 \cdot 10 + 10 \cdot 4 + 20 = 100 \text{ points.}$$

A student who received at least 60 points in the semester can take part in the credit test. In this case, the points obtained by him on the control work are final.

Students perform a written test on the final test. Each task contains five questions (tasks). Each question (task) is estimated at 40 points according to the following criteria

Mark	*Completeness of the answer*
40 – 36	*"excellent" – complete answer (at least 90% of the required information);*
35 – 30	*"good" - a sufficiently complete answer (at least 75% of the required information), or a complete answer with minor inaccuracies;*
29 – 24	*"satisfactory" - incomplete answer (at least 60% of the required information) and minor errors;*
23 – 0	*the work is not credited (the task is not completed or there are gross errors)*

To obtain a passing grade, the sum of all rating points R received during the semester is converted according to the table:

Points. $R = R_C + R_{EK3}$	*Test assessment*
100…95	*Perfectly*
94…85	*Very good*
84…75	*Fine*
74…65	*Satisfactorily*
64…60	*Enough*
Less than 60	*Unsatisfactorily*
There are not credited laboratory work or not credited calculation and graphic work or $R_C < 26$	*Not allowed*

9. Additional information on the discipline (educational component)

An approximate list of questions submitted for semester control

1. Explain the classification of elements according to the electronic structures of atoms of D. I. Mendeleev's periodic system of elements. Explain internal and secondary periodicity. Formulate the meaning of the periodic law D.I. Mendeleev.

2. Explain the change in the properties of elements in a period, group.

3. Formulate general provisions about chemical bonding. Explain the concepts of "ionization energy", "electron affinity", "electronegativity".

4. Explain redox processes as electron transfer reactions. Define oxidizing agents and reducing agents.

5. Explain how the equations of redox reactions occurring in aqueous solutions are formed by the method of ion-molecular half-reactions.

6. Explain the types of redox reactions.

7. Name the most important oxidizing agents and reducing agents.

8. Formulate the basic concepts of the process of complex formation. Explain the course of complexation reactions in aqueous solutions.

9. To describe coordination compounds, their preparation, classification.

10. Explain what a complexing agent is, ligands, external and internal coordination spheres, coordination number, dependence of the coordination number on the charge and radius of the complexing agent, general and graded stability constants.

11. Explain the nomenclature of coordination compounds, the chemical bond in complex compounds.

12. Hydrogen. Explain the position of hydrogen in the periodic table, give a general characteristic, describe its physical and chemical properties. To characterize binary compounds of hydrogen.

13. Halogens. Give a general description, the main methods of production, physical and chemical properties, change in oxidation activity in a subgroup, change in oxidation properties in a series of oxyacids of chlorine, bromine, iodine.

14. Characterize halides: patterns of changes in their properties by periods, groups and families of elements.

15. Characterize oxides, acids, salts, their thermodynamic stability, acid-base and redox properties.

16. Characterize interhalogen compounds, their hydrolysis. Explain the methods of obtaining and using chlorine, bromine, iodine and their most important compounds.

17. r-Elements of the VI group. Give a general characteristic of elements, explain the electronic structure of atoms, elements of typical and complete electronic analogues. Explain the natural change of properties.

18. Oxygen. Explain the structure of the O_2 atom and molecule, its prevalence in nature. Describe natural compounds, production, oxidative activity, use of oxygen.

19. Ozone. Explain the formation and structure of the molecule from the standpoint of the VZ method, its preparation, oxidation activity, and application.

20. Hydrogen peroxide. Explain the structure of the molecule, properties, production, application. Characterize peroxides, peroxide, ozone, and applications.

21. Sulfur, selenium, tellurium, polonium. Describe natural compounds. Explain the composition, structure of simple substances, allotropy of sulfur.

22. Explain redox properties of simple substances, interaction with water, acids and alkalis. Explain the interaction of sulfur, selenium and tellurium with hydrogen, compare the structures and properties of chalcogenides.

23. Metal sulfides. Explain the classification in relation to acids and water, hydrolysis. Characterize sulfanhydrides, sulfonic acids and sulfosalts, sulfides, and polysulfides.

24. Characterize compounds of sulfur, selenium, and tellurium in positive oxidation states. Sulfur oxide (IV): production, structure of the molecule, solubility in water. Sulfitic acid and its salts. Redox properties.

25. Characterize sulfur oxide (IV), explain its structure in gaseous, liquid and solid states, production, interaction with water. Sulfuric acid. Explain the methods of obtaining, properties, properties of sulfuric acid salts.

26. Explain the use of sulfur, selenium, tellurium and their most important compounds.

27. Nitrogen. To explain the presence in nature, production and properties of a simple substance.

28. Explain the structure of the ammonia molecule, its properties in liquid, gaseous and dissolved states. Characterize ammonium hydroxide and ammonium salts.

29. Characterize nitrides, amides and imides.

30. Characterize hydrazine and hydroxylamine: composition, structure of molecules, their properties.

31. Describe nitrogen oxides.

32. Characterize nitrite acid and its salts - nitrites, their production and properties, redox properties.

33. Characterize nitric acid: production, oxidizing properties, interaction with metals and nonmetals. Explain what nitrogen fertilizers are.

34. Phosphorus. Explain the occurrence in nature, production, allotropic modifications and properties of a simple substance.

35. To characterize compounds of phosphorus with oxygen and halogens, phosphorus fertilizers.

36. Carbon. Explain the occurrence in nature, allotropic forms of a simple substance (diamond, graphite, carbine, fullerene), their structure and properties. To characterize metal carbides.

37. Describe carbon (II) oxides, production methods, molecular structure, properties. Characterize metal carbonyls. To characterize carbon oxides (IV), production, molecular structure, properties.

38. Illustrate the properties of carbonic acid and its salts. Illustrate the properties of cyanic, cyanic, thiocyanic acids and their salts. To illustrate the properties of compounds of carbon with sulfur and halogens. Application of carbon and its most important compounds.

39. Silicon. To explain the presence in nature, production and properties of a simple substance. To illustrate the properties of silicon oxide (IV), its allotropic modifications, interaction with acids and alkalis.

40. Illustrate the properties of silicic acid, silica gel.

41. Illustrate the properties of simple silicates, glass. To illustrate the properties of complex natural silicates, aluminosilicates. Illustrate the properties of zeolite, compounds of silicon with hydrogen (silanes), with metals (silicides), with carbon (carborundum), with halogens.

42. Show the application of silicon and its most important compounds.

43. Aluminum. Explain the prevalence in nature, production, properties. Explain the interaction with water, acids and bases.

44. Illustrate the properties of aluminum oxide and hydroxide, aluminates, aluminum salts. Show the application of aluminum and its most important compounds.

45. Illustrate the properties of aluminum oxide and hydroxide, aluminates, aluminum salts. Show the application of aluminum and its most important compounds.

46. Elements of the first group (alkali metals). Show the presence in nature, the production of simple substances, their relationship to non-metals, water, acids. Oxides, peroxides, hydroxides, salts. Application of alkali metals and their most important compounds.

47. Elements of the second group. Finding in nature, obtaining simple substances, their interaction with non-metals, water, acids and alkalis. Quick and slaked lime. Hardness of natural waters, methods of removing hardness. Explain the use of beryllium, magnesium, alkaline earth metals and their most important compounds.

48. Chromium subgroup. Explain the electronic structure of atoms, their possible degrees of oxidation and coordination numbers in compounds. Finding in nature and obtaining chromium, molybdenum, tungsten. Illustrate the properties of compounds: (oxides, hydroxides, salts). Illustrate the properties of complex compounds. Application of chromium, molybdenum, tungsten and their most important compounds.

49. Subgroup of manganese. Explain the electronic structure of atoms. Show the presence in nature and obtaining manganese, technetium, rhenium. Illustrate the properties of simple substances.

50. Explain the redox properties of compounds of the manganese subgroup. To illustrate the properties of manganese and rhenium acids and their salts. Illustrate the properties of the oxidizing properties of permanganate. Show the application of manganese and rhenium and their most important compounds.

51. Iron family. Explain the electronic structure of atoms, their possible oxidation states and coordination numbers in compounds. Show being in nature. Illustrate the properties of simple substances: position in a series of voltages, interaction with nonmetals, acids.

52. Oxides and hydroxides. Illustrate the properties of salts, their redox properties and hydrolysis. Illustrate the properties of complex compounds. Show the use of metals and their most important compounds.

53. Subgroup of copper. Explain the electronic structure of atoms. Show being in nature and receiving. To illustrate the properties of simple substances, oxides, hydroxides and salts of copper, their stability and redox properties. Show the use of cuprum, argentum, aurum and their most important compounds.

Work program of the discipline (syllabus):

Compiled by Assoc. Prof., Ph.D., Tereshchenko O.M.

Approved by the Department of E and TRP (protocol № 14 of 08.06.2022)

Approved by the Methodical Commission of the faculty [1] (protocol № 10 from 24. 06.2022)