Appx 2

to the Order of March 23, 2023 № 244

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Analytical and Bioinorganic Chemistry & Water Quality

"CONFIRMED"
Dean of the Faculty
(Prof. Mykola Tsvilikhovskiy)
"__" _____ 2023

"APPROVED"
at the meeting of the department of
Analytical and Bioinorganic Chemistry & Water Quality
Protocol № 7 dated "08" March 2023.
Head of Department
Protocol # 7, "08" March, 2023
Head of the Department
_____(Prof. Volodymyr Kopilevich)

"REVIEWED"
Program Coordinator of Veterinary Medicine Master
Associate Prof. _____ (Nataliia Grushanska)

PROGRAM OF THE COURSE

INORGANIC CHEMISTRY

Specialization 211 – Veterinary Medicine
Educational program – Veterinary Medicine
Faculty of Veterinary Medicine
Developer: Associate Professor, Cand Chem Sci Larysa Voitenko
(position, academic degree, academic title)

Kyiv – 2023

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1. **Description of the course**

Inorganic Chemistry
(title)

Field of knowledge, specialization, educational program, educational degree		
Educational degree	*Master's*	
Specialization	*211 – Veterinary Medicine*	
Educational program	*Veterinary Medicine*	
Characteristics of the course		
Type	Compulsory	
Total number of hours	120	
Number of ECTS credits	4	
Number of content modules	3	
Course project (work) (if applicable)	-	
Form of assessment	*Exam*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Course (year of study)	The 1st	No
Semester	The 1st	
Lecture classes	*15 hr.*	*hr.*
Practical, seminar classes	*hr.*	*hr.*
Laboratory classes	*45 hr.*	*hr.*
Self-study	*60 hr.*	*hr.*
Individual assignments	*hr.*	*hr.*
Number of weekly classroom hours for the full-time form of study	*4 hr.*	

2. **Purpose, objectives, and competencies of the course**

Purpose is mastering knowledge of chemical laws and chemical transformations patterns (chemical transformation and moving of matter) with a focus on professional activity in the field of veterinary medicine and formation of skills in chemical experiment performing

Objectives – 1) To study the foundations of inorganic chemistry as a component of fundamental training in the field of veterinary sciences; knowledge and understanding of the basic principles of the discipline addressed in the different modules and to have understood the topics covered: from the basic principles of Chemistry and statistical process applied to biological data of veterinary interest to the organization, consultation and analysis of data with appropriate IT tools.

2) Appling knowledge and understanding: the student will demonstrate applied skills in: i) solving simple analytical problems related to Inorganic Chemistry, ii) consulting scientific sources and databases, iii) understanding the obtained results; iv)

understanding chemical terminology; v) use of the basic software for the analysis of chemical data, bibliographic references collection and presentation of results.

3) Making judgements: the student will demonstrate autonomy in the efficacious use of the teaching materials made available and in the selection of authoritative scientific sources for the understanding and resolution of basic chemical questions and the use of the main software. These skills are acquired through frontal activities and lab training and also through individual study;

4) Communication: during the frontal and lab activities foreseen in the course and in the exam, the student will demonstrate skills in presenting and organizing the concepts acquired with the most appropriate chemical terminology.

5) Life long learning skills: the student will be able to use the basic tools acquired to update their knowledge, to improve autonomously their skills by consulting bibliographic material and databases. These skills are perfected through individual study and the activities carried out for the preparation for the final test.

Acquisition of competencies:

Integrated competency (IC):

The ability to solve complex tasks and problems in the field of veterinary medicine, which involves conducting research and/or implementing innovations and is characterized by the uncertainty of conditions and requirements.

General competencies (GC):

GC 1. Ability to abstract thinking, analysis and synthesis.

GC 5. Ability to communicate in a foreign language.

GC 7. Ability to conduct research at an appropriate level.

GC 11. Ability to evaluate and ensure the quality of the work performed

Professional (special) competencies (PC):

PC 7. Ability to organize and conduct laboratory and special diagnostic studies and analyze their results.

Program learning outcomes (PLO):

PLO 1. Know and correctly use the terminology of veterinary medicine.

PLO 3. Determine the essence of physico-chemical and biological processes that occur in animal bodies in normal and pathological states.

Program and structure of the course for:

– complete full-time (part-time) form of study

Names of content modules and topics	Number of hours						
	Full-time form						
	weeks	total	including				
			l	p	lab	ind	self
1	2	3	4	5	6	7	8
Content Module 1. General foundations of Inorganic Chemistry							
Topic 1. Introduction. Subject and tasks of Inorganic Chemistry. Chemistry for veterinary medicine. Atomic-molecular study. The mole concept in chemical calculations. General stoichiometric laws. Allotropy. Types of chemical reactions in inorganic chemistry.	1, 2	10	2		4		4

1	2	3	4	5	6	7	8
Topic 2. The atomic theory and chemical bonding for inorganic compounds. Evolution of atomic ideas. The dual nature of electron. Atomic orbital. Laws of electron distribution around nucleus. The Klechkovsky-Madelung's rule. Electron formulas. Valency as a function of electron structure. Exited state. Quantum numbers. s-, p-, d- and f-elements. "Octet" configuration and oxidation numbers. Types of chemical bonding. Mechanism of formation. Biological role of hydrogen bonding. Electronegativity and its using for calculation of chemical bond type. Mendeleev Periodical Table of the chemical elements and Periodical Law.	3, 4, 5	26	4		6		16
Total for content module 1		**36**	**6**		**10**		**20**
Content Module 2. Acid-Base Chemistry							
Topic 1. Units of Concentration: percent (mass) concentrations (percentage weight by weight; volume by volume etc; Molar, Normal (equivalent), and Titre. Preparation of a solution of known concentration. Titrimetric determination of temporary water hardness.	6, 7	16	2		8		6
Topic 2. Processes in water solutions. The main foundations of electrolytic dissociation theory. Degree of dissociation. Strong and weak electrolytes. Ostwald's dilution Law. Ionic reactions. The main electrolytes in body fluids. Electrolytic drinks. Water as an electrolyte. Ionic product of water. Notion of pH. Measuring pH. Hydrolysis of Salts. Buffer solutions.	7, 8, 9	18	2		10		6
Total for content module 2		**34**	**4**		**18**		**12**
Content Module 3. Properties of inorganic substances in RedOx reactions and complexes							
Topic 1. Redox reactions as processes of electron transfer. Compiling equations of redox reactions. Typical oxidizing and reducing agents. Metals and non-metals as redox agents. Classification of redox reactions. Acids as strong oxidating agents – reacting of metals. Redox reactions in qualitative analysis. Redox reactions in nature and bodies. RedOx properties of the main classes of inorganic substances.	10, 11, 13	28	2		10		16
Topic 2. Verner's Theory of Complex compounds, their chemical nature, type of chemical bonding, isomerism, rules of naming. Coordinative compounds in chemical qualitative analysis. Preparation. Coordinative compounds in nature. Bioinorganic systems as complex compounds.	13, 14, 15	17	2		7		8

1	2	3	4	5	6	7	8
Topic 3. Biogeochemical zoning. Chemical nature of human and animal endemic noninfectious diseases as the results of the abnormal distribution of the chemical elements in the environment.	15	5	1				4
Total for content module 3		**50**	**5**		**17**		**28**
Total hours		**120**	**15**		**45**		**60**

3. Seminars – do not planned.

4. Practical class – do not planned.

5. Laboratory class topics

№	Topic title	Number of hours
1	General rules of working in chemical laboratory. Security techniques. Using of semi-micro method in chemical experiment. Methods of chemicals purification.	4
2	Principles of nomenclature and classification of inorganic elements and their inorganic compounds. Isolation of slightly soluble compounds – analogs of nature bio-active compounds. Structure of atoms of chemical elements. Electron formulas. Interdependence of biological function and physiological properties of elements and their atomic structure.	6
3	Rules for equations combination in solutions of electrolytes. Preparation of weak electrolytes. Studing of reactions in solution. Rules for equations combination of hydrolysis process and determination of pH. Studing of salt hydrolysis. Indicator determination of pH. Reversibility of hydrolysis. Molecular and ionic reactions of salt hydrolysis, determination of pH.	18
4	RedOx reactions, their classification. Methods of RedOx reaction compilation. Direction of RedOx reactions. Influence of medium to RedOx reactions. Studding of oxidation properties of Potassium Permanganate and Potassium Dichromate. RedOx reactions in Qualitative and Quantitative Analysis. Coordinate compounds of bio-metals. Preparation and studding of properties of coordination compounds of Copper, Iron, Cobalt, Zinc, Nickel. Reactions of coordination compounds in Qualitative and Quantitative Analysis.	17
	Total hours	45

6. **Independent work topics**

№	Topic title	Number of hours
1	Modern concepts of inorganic chemistry. Bioactive compounds.	20
2	Main Concepts of Qualitative Analysis. Notion of Qualitative Chemical reagent, Qualitative test, sensibility of qualitative tests. Analytical classification of Cations and Anions. Main Concepts of Quantitative Analysis. Foundations of Neutralization method, Redox methods.	12
3	RedOx calculation of ionic species of metals of changing valencies in natural systems (Fe, Mn). RedOx potential. Typical chemical disinfectants as strong oxiding agents	16
4	Chelates as a food additives, drugs, and analytical reagents. Using of complexones in environmental sanitation.	8
5	Acid-base and RedOx properties of metal and metalloid chemical elements of secondary sub-groups on the examples of bio-active and toxic (Cu, Co, Ag, Pb, Cd, Hg)	4
	Total hours	60

7. Samples of control questions, tests for assessing the level of knowledge acquisition by students.

List of theoretical questions

1. Subjects and tasks of inorganic chemistry.
2. The foundations of atomic-molecular theory. Notions of an atom, molecule, ion, simple and complex compounds, chemical formulas. Allotropy.
3. Types of the chemical reactions.
4. The laws of stoichiometry (law of Safe, Equivalents etc).
5. The mole concept, Avogadro's Number. Relations of amount of substance, numbers of moles.
6. Evolution of atomic ideas.
7. The dual nature of electron.
8. Names and physical content of quantum numbers.
9. General rules for electronic formulas compilation - principle of energy minimum, Pauli exclusion Principle, Rule of Klechkovsky, Hund's Rule.
10. "Filling" of electrons on the examples Cu, Cr, Pd.
11. Electron formulas. Mechanism of exiting.
12. Valence as a function of electron configuration.
13. Types of the chemical bonding (ionic, covalent, metallic, hydrogen).
14. Abnormal water properties as a result of hydrogen bonding. Intermolecular hydrogen bonding in the structure of DNA double helix.
15. The Periodical Law and Mendeleev's Periodical Chart of the chemical elements.
16. Classification of inorganic substances.
17. Relations between the main classes of inorganic substances.

18. The amphoterity as acid-base duality.
19. The preparation and properties of the main classes (oxides, bases, acids, salts).
20. Structural-graphic formulas of chemical compounds. Examples.
21. Solutions. Basic units of concentration (mass concentration, molarity, normality, titr). Recalculations of units.
22. Theory of electrolytic dissociation. Degree of dissociation. Strong and weak electrolytes.
23. Main classes of inorganic substances from viewpoint of theory of electrolytic dissociation.
24. Ionic reactions. Conditions of interactions in the solutions of electrolytes. Examples.
25. Ionic product of water. Notion of pH. Acid-base indicators.
26. Hydrolysis of salts. Types of hydrolysis. Determination of pH.
27. Notion of oxidation numbers. Types of Redox reactions.
28. Balancing of Redox reactions by method of electron balance.
29. Acids as strong oxiding agents. Reactions of metals, metalloids, and non-metals with acids.
30. Werner's theory of complex compounds.
31. Structure of complex compounds. Preparation of complex compounds. Their naming, isomerism. Complexes in veterinary drugs.
32. Isomerism of complex compounds.
33. Endemic diseases of humans and animals as the result of chemical disproportion of the non-biotic environment.

Test example.
Module 1, topic the 1st

1. Calculate the relative molecular mass and the molar mass of Potassium Orthophosphate K_3PO_4.

2. How many atoms and moles of atoms are contained in 64 g of Oxygen ^{16}O? Calculate a mass (in grams) of one atom of Oxygen.

3. How many moles of H_2SO_4 are contained in 4,9 grams of this substance?

4. How many moles of Sulphuric acid is it possible to prepare from 6,4 kg of Sulphur?

5. How many moles of slacked lime $Ca(OH)_2$ is it possible to prepare from 0,1 g of chalk $CaCO_3$ if chalk completely changed into slacked lime?

6. To calculate mass (grams) of molecules of Chlorine Cl_2, carbonic gas CO_2, ammonia gas NH_3.

7. How many grams of Barium Sulphate $BaSO_4$ may be prepared from 6,1 g of salt $BaCl_2 \cdot 2H_2O$? Calculate the mass of Sulphuric acid used in this reaction.

8. Solution, contained 12,6 g of Nitric acid HNO_3, was mixed with 7,2 g of Caustic soda NaOH. What substance will be in leftovers and in which quantity?

9. Determine type of the next chemical reaction: $2C_2H_2 + 5O_2 = 8CO_2 + 2H_2O$:

A.	Redox;	**C.**	Neutralization;
B.	Double replacement;	**D.**	Complex formation.

10. Determine type of the next chemical reaction: $3Fe_3O_4+8Al=4Al_2O_3+9Fe$:

A.	Double replacement;	**C.**	Redox;
B.	Neutralization;	**D.**	Single replacement.

11. Calculate the equivalent weight of H_3PO_4 (M=97,994 g/mol).

12. Note mathematical expression of the law of equivalents:

A.	$E=mc^2$;	**C.**	$\frac{m_1}{m_2}=\frac{E_1}{E_2}$
B.	$P_1V_1=P_2V_2$;	**D.**	$m = N \cdot V \cdot E$.

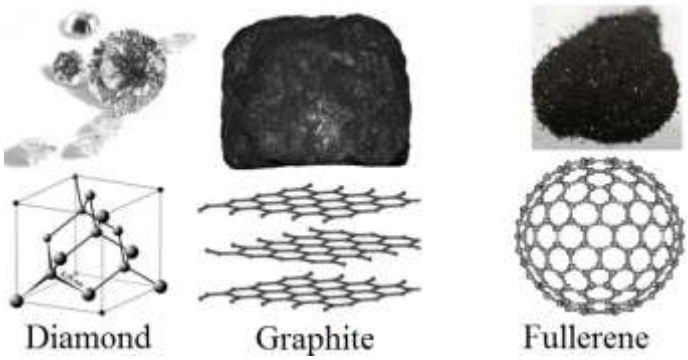
13. How many phosphorus atoms are there in 2,57 g of P?

A.	$4{,}79 \cdot 10^{25}$
B.	$1{,}55 \cdot 10^{24}$
C.	$5{,}00 \cdot 10^{22}$
D.	$8{,}30 \cdot 10^{-2}$
E.	2,57

14. Calculate the A_r of carbon C, if it is known, that the natural chemical element C is presented of the two stable isotopes ^{12}C and ^{13}C; their relative abundances are 98,9 % and 1,1 % respectively.

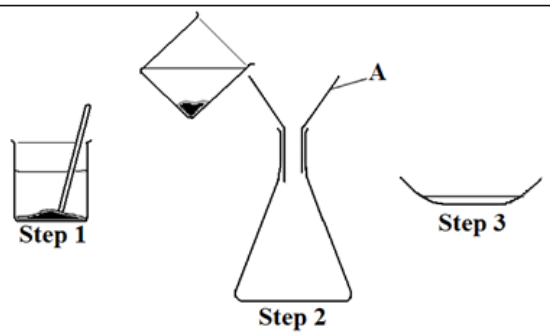
15. Calculate the A_r of hydrogen H, if it is known, that the natural chemical element H is presented of the two stable isotopes ^{1}H and ^{2}H (or D); their relative abundances are 99,985 % and 0,015 % respectively.

16. How to name the phenomenon when one chemical element exists in the form of a few different simple substances (see carbon forms):



17. Use words from the box to complete the sentences. Each word may be used once, more than once or not at all.

Beaker	**Bunsen burner**	**Burette**	**Conical flack**
Funnel	**Glass rod**	**Thermometer**	**Water**

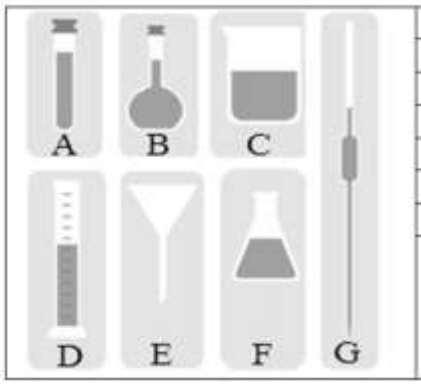


In **Step 1,** the mixture of salt and sand is placed in a ____, containing ____ and stirred with a ____.

In **Step 2,** the mixture from **Step 1** is poured through a ____ into a ____.

In **Step 3,** the liquid is transferred to a basin to allow the ____ to be removed.

18. The diagram shows some pieces of apparatus that it may find in a chemical veterinary laboratory. Complete the table by giving the name of peace of apparatus.



Letter	Name
A	Test-tube
B	
C	
D	
E	
F	
G	

19. Sodium nitrate decomposes when heated, as shown by the equation

$2NaNO_3 \rightarrow 2\ NaNO_2 + O_2$.

A 1,70 g sample of sodium nitrate (M=84,994 g/mol) was completely decomposed to sodium nitrite ($NaNO_2$) and oxygen O_2. Calculate the mass of sodium nitrite (M=68,995 g/mol) and volume of Oxygen (at STP) formed.

20. Point the correctness of the statement: *All chemical elements exist as one simple substance.*

A.	True	**B.**	False

8. Teaching methods.

Most university classes in inorganic chemistry are taught in **a lecture** format. An alternative to lecturing is the use of cooperative learning. Cooperative learning offers the potential to develop skills such as teamwork, communication, and problem-solving that is more difficult to impart in a lecture format. The laboratory component of inorganic chemistry courses is an indispensable learning resource.

Commonly used teaching methods include **on-time participation, demonstration, recitation, memorization, or combination** of these. The choice of teaching method or methods to be used depends largely on the information or skill that is being taught, and it may also be influenced by the aptitude and enthusiasm of the students.

Demonstrating is the process of teaching through examples or experiments. A demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning.

Demonstrations in inorganic chemistry and own experiment are permit to obtain experimental skills needed for diagnostics, qualitative medicine tests etc. Memorization of a list of facts is a detached and impersonal experience, whereas the same information, conveyed though demonstration, becomes personally relatable. Demonstrations help to raise student interest and reinforce memory retention because they provide connections between facts and real-world applications of those facts. Lectures, on the other hand, are often geared more towards factual presentation than connective leaning.

Collaboration allows students to actively participate in the leaning process by talking with each other and listening to other points of view. Collaboration establishes a personal connection between students and the topic of study and it helps students think in a less personally biased way. Group projects and discussions are examples of this

teaching method. Teachers may employ collaboration to assess students' abilities to work as a team, leadership skills, or presentation abilities.

Learning by teaching in the method, when students assume the role of teacher and teach their peers. Students who each others' as a group or as individuals must study and understand a topic well enough to teach it to their peers. By having students participate in the teaching process, they gain self-confidence and strengthen their speaking and communication skills.

9. Forms of assessment

The main forms of knowledge control are control works and tests that are executed by students using E-learn platform.

They include:

1. Lab work protocols assessment;
2. Tests;
3. Module control works.

The point rating of each kind of activity is established depends on it's complexity.

Examinations. Exam is a final step in the study of the whole or part of the discipline and are designed to test students' knowledge on the theory and identify the skills apply the acquired knowledge in solving practical problems, as well as independent work skills with educational and scientific literature.

Student's rating of knowledge of an academic discipline consists of training work rating – 70 points and final attestation – 30 points. Thus, rating of content modules, that are constituents of an academic discipline, makes 70 points. Rating of content modules as well as attestation rating are also measured by 100-point-scale.

10. Distribution of grades received by students. Evaluation of student knowledge is carried out on a 100-point scale and is converted to national grades according to Table 1 "Regulations and Examinations and Credits at NULES of Ukraine" (order of implementation dated 03.03.2021, protocol №7)

Student rating, points	**National grade based on exam results**	
	Exams	**Credits**
90-100	**Excellent**	**Passed**
74-89	**Good**	
60-73	**Satisfactory**	
0-59	**Unsatisfactory**	**Not passed**

In order to determine the rating of a student (listener) in the discipline $\mathbf{R_{dis}}$ (up to 100 points), the rating from the exam $\mathbf{R_{ex}}$(up to 30 points) is added to the rating of a student's academic work $\mathbf{R_{aw}}$ (up to 70 points): $\mathbf{R_{dis} = R_{aw} + R_{ex}}$ **.**

11. Educational and methodological support.

The training materials for educational components were published in a related course and can be accessed at the following link:
https://elearn.nubip.edu.ua/course/view.php?id=3629

12. Recommended sources of information

Basic

1. Chambers, C., Holliday A.K. Modern Inorganic Chemistry. http://www.torrentz.com/be251001769c5a5cebbaa177a46e524d225fdff2
2. Inorganic Chemistry: a laboratory workbook for the English-speaking Master Students in 211 Veterinary Medicine / N.M. Prokopchuk, V.A. Kopilevich, R.V. Lavryk, L.V. Voitenko. – Kyiv: Expo-Druk, 2021. – 164 pp.
3. Workbook for specialist' student in veterinary medicine. Subject Bio-Inorganic chemistry and examples of tests (part I). –NUBIP Publish., 2010. – 120 pp.
4. Workbook for specialist' student in veterinary medicine. Subject Bio-Inorganic chemistry and examples of tests (part II). –NUBIP Publish., 2010. – 100 pp.

Supplemental

1. Nelson, Peter G. Introduction to Inorganic Chemistry. Key ideas and their experimental basis (2011). Peter G. Nelson & Ventus Publishing ApS. – 177 p. Available at: http://197.14.51.10:81/pmb/CHIMIE/introduction-to-inorganic-chemistry.pdf.
2. Fenyes, Maria. Applied Chemistry Chemistry 101 Laboratory Manual: Los Angeles Mission College. – 191 p. Available at: https://mymission.lamission.edu/userdata%5Cpaziras%5CChem101%5CLab_Manual.pdf.

Normatives

1. ISO 6353-2:1983 Reagents for chemical analysis - Part 2: Specifications - First series.
2. ISO 6353-2:1983/Add.2:1986(en) Reagents for chemical analysis - Part 2: Specifications — First series ADDENDUM 2.
3. Codex Alimentarius. General Standard For Food Additives Codex STAN 192-1995. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B192-1995%252FCXS_192e.pdf.

IT resources

1. VIPEr. Virtual inorganic pedagogical electronic resource: a community for teachers and students of inorganic chemistry. HTTPS://WWW.IONICVIPER.ORG/VIRTUAL-INORGANIC-PEDAGOGICAL-ELECTRONIC-RESOURCE
2. Periodical Table - http://www.webqc.org/periodictable.php.
2. Calculator of Molar weight (FW) - http://www.graphpad.com/quickcalcs/Molarityform.cfm
3.Units convertor - http://www.webqc.org/unitconverters.php.
4. pH calculator - http://www.webqc.org/phsolver.php.
8. Sigma-Aldrich reagents - https://www.sigmaaldrich.com/