NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

AGROBIOLOGICAL FACULTY
DEPARTMENT OF ANALYTICAL AND BIOINORGANIC CHEMISTRY & WATER QUALITY

"APPROVED"

Dean of the Faculty of Plant Protection,
Biotechnology and Ecology
Dr.Agr.Sc., Prof._____M.M. Doliia
"___"_ _ 2015

REWIED AND APPROVED
At the meeting of the department
of Analytical and Bioinorganic
Chemistry & Water Quality
Protocol # 9 "_23_ "__April__2015
Head of the Department
Dr.Chem.Sc., Prof._____V.A. Kopilevich

SYLLABUS

Academic Discipline "INORGANIC CHEMISTRY"
For EQL "Bachelor" 6.090105
Specialty - Plant protection

Syllabus compiled by : Associate Professor N. Prokopchuk, PhD in Chemistry

Kyiv, 2015

1. Academic discipline description

«Inorganic Chemistry»

Field of knowledge, direction, specialty, education and qualification level		
Educational and Qualification level qualification	bachelor	
Direction	6.090105 – Plant protection	
Area of training	0401 – natural sciences	
Characteristics of training programme		
Type	ordinary	
The total number of academic hours	105	
Number of ECTS credits allocated	2,9	
Number of modules	4	
Forms of control	Exam	
Indicators of academic discipline for full-time and part-time forms of training course		
	Full-time	**Part-time**
Year (course)	1	
Semester	1	
Number of lectures	30	
Number of seminars, practical classes		
Laboratory sessions (activities)	45	
Independent study	30	
Individual lessons		
Number of weekly in-class academic hours for full-time forms of training	5	

2. Goal and objectives of academic discipline

Goal is to build a good foundation in chemical knowledge that allows to make qualitative and quantitative inquiries into topics in natural science.

Learning objectives are:

- name ionic and covalent compounds;
- know the properties of acids, bases and salts;
- apply stoichiometry in determining quantity relationships for compounds and chemical reactions;
- demonstrate an understanding of chemical equilibrium;
- understand the structure of matter on atomic and molecular levels and its correlation to chemical and physical properties;
- describe the concentration of a solution in the way that is most appropriate for a particular problem or application;
- use laboratory equipment and make observations to identify chemical and

physical changes.

Learning outcomes :

Upon completion of this course, students should:

know the basic principles and topics of Inorganic Chemistry and their application to real world problems.

be able to

- Compose a proper formula for a compound;
- Describe and name inorganic compounds;
- Write and balance chemical equations;
- Determine the composition of any atom or ion;
- Explain periodicity;
- Distinguish ionic, polar and nonpolar covalent bond;
- Describe characteristics of solutions;
- Balance oxidation-reduction reactions using the electron balance method;
- Analyze the characteristic properties of non-metals and metals;
- Use standard laboratory equipment.

3. The structure of the curriculum of academic discipline for full-time form of training

Themes and modules to be covered	Number of hours											
	Full-time						Part-time					
	Total	including					Total	including				
		lect.	pract.	lab.	ind.	ind.		lect.	pract.	lab.	ind.	ind.
1	2	3	4	5	6	7	8	9	10	11	12	13
Theme module 1. **Theoretical foundations of inorganic chemistry**												
Theme 1. Introduction. General laws of stoichiometry and types of chemical reactions.		2		2		1						
Theme 2. Atomic structure of chemical elements.		2		4		2						
Theme 3. The Periodic Law and Periodic Table of chemical elements.		2		2		2						

Theme 4. Chemical bonding and structure of molecules.		2		6		5						
Theme 5. Chemical kinetics and equilibrium.		2		2		1						
Total with theme module 1.		10		16		11						
Theme module 2. **Solutions, their nature and properties**												
Theme 1. Solutions, their nature and properties.		1		2		1						
Theme 2. Electrolytes and reactions in their solutions.		1		2		1						
Theme 3. Hydrolysis of salts.		2		4		3						
Theme 4. Coordination compounds.		2		4		2						
Total with theme module 2.		6		12		7						
Theme module 3. **Redox reactions. Chemistry of elements**												
Theme 1. Redox reactions.		4		4		3						
Theme 2. Elements of VII-A sub-group.		2		4		2						
Theme 3. Elements of VI-A sub-group.		3		3		4						
Theme 4. Elements of V-A sub-group.		3		4		2						
Theme 6. General properties of metals.		2		2		2						
Total with theme module 3.		14		17		12						
Totally		30		45		30						

4. Themes of laboratory activities

#	Name of theme	Number of hours
1	General rules of activity in chemical laboratory. Rules of laboratory research. Control test – level of the secondary school knowledge.	2
2	Principles of classification of inorganic compounds and these ranges.	4
3	Studying of the chemical properties of different types of inorganic compounds. Control test – classification and properties of inorganic compounds.	2

4	Rules of composition of electronic formulas of the chemical elements, determination of their possible valence and oxidation numbers.	6
5	Types of chemical bonding and structure of molecules of acids, bases, salts, oxides. Control test – compilation of electronic formulas and determination of types of chemical bonding.	2
6	The rules of the chemical reactions compilation in the solutions of electrolytes. Control test: ionic reactions.	2
7	The rules of the chemical reactions compilation of the salts hydrolysis and determination of pH. Lecture's control test: hydrolysis of salts.	2
8	Rules of compilation of red-ox reactions. Control test.	4
9	Rules of compilation of coordinative compounds formulas and reactions with their participation. Studying of their properties. Control test.	4
10	Halogens and their compounds on the example of chlorine and bromine.	4
11	Oxygen, sulfur and their compounds.	4
12	Nitrogen, phosphorus and their compounds. Control Test.	3
13	Chemical properties of the same metals of main and secondary sub-groups. Control Test.	4
14	Final test.	2
	Totally	**45**

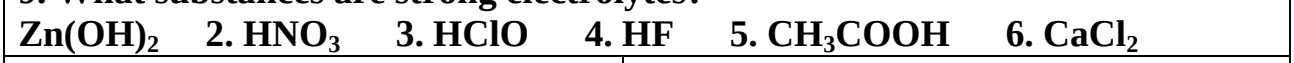
5. Independent study

#	Name of theme	Number of hours
1	Molar ratios, molar masses, balancing and interpreting equations, conversions between grams and moles.	1
2	The electronic arrangements and dots-and-crosses diagrams.	2
3	Atomic number as the basis for the Periodic Law. Long form periodic table.	2
4	Lewis Structures. Exceptions to Regular Lewis Structures - resonance structures	5
5	Catalysts and catalysis. Dynamic equilibria.	1
6	Colligative properties of solution.	1
7	Dilute concentrations units: ppm, ppb,ppt.	1
8	Use of Hydrolysis in the "Real World".	3
9	Lewis Acid-Lewis base approach to bonding in complexes.	2
10	Half-reactions. Nernst Equation.	2

11	Metal halides. Interhalogen compounds.	2
12	Allotropes of Oxygen and Sulfur.	4
13	Occurrence of pnictogens.	2
14	Properties of alkali and alkali-earth elements.	2
	Totally	**30**

6. Test questions for final assessment

Екзаменаційні питання			
1. Atomic structure. Quantum numbers of electrons in atoms. Write complete electron configuration of the Sulfur atom and draw all possible exited states. Note valences, maximum and minimum oxidation numbers of this element.			
2. Bases. Classification, preparation and examples of bases. Which substances may react with each other: P_2O_5, NaOH, ZnO, HF, CaO? Write corresponding reactions.			
Тестові завдання			
1. Which formula contains error?			
A.	**$CaHSO_4$**	**C.**	**NH_4HSO_4**
B.	**$(NH_4)_2SO_4$**	**D.**	**$CaHPO_4$**
2. Point the correspondence between formula of compound and type of a chemical bond:			
A.	**$BaCl_2$**	**1.**	**A metallic bond**
B.	**Zn**	**2.**	**An ionic bond**
C.	**O_2**	**3.**	**A non-polar covalent bond**
D.	**NH_3**	**4.**	**A polar covalent bond**
A._____, B._____, C._____, D._____.			
3. Percent by mass of solution contained 15 g of $(NH_4)_2SO_4$ in 250 g of water, is:			
A.	**3,9%**	**C.**	**4,8%**
B.	**1,5%**	**D.**	**5,7%**
4. What is it necessary to add to K_3PO_4, so that K_2HPO_4 can be formed:			
A.	**KOH**	**C.**	**H_2SO_4**
B.	**KCl**	**D.**	**H_3PO_4**
5. Write all possible reactions between $Ba(OH)_2$ and H_2SO_4 (taking into account the possibility of neutral, acidic and basic salts forming).			
6. Note oxidation number and coordination number of the central atom in the complex compound - $[Cr(NH_3)_5Br]SO_4$.			

A.	**+2, 4**	**D.**	**+3, 6**
B.	**+2, 6**	**E.**	**+4, 6**
C.	**+3, 4**		
7. Complete Redox reaction. Write electron balance. Determine oxidizing and reducing agents calculate sum of coefficients in equation: 			
A.	**16**	**C.**	**17**
B.	**18**	**D.**	**10**
8. Calculate a sum of coefficients in the molecular equation for 1st step hydrolysis of Zinc Sulfate and write molecular, complete ionic, and net-ionic reactions.			
A.	**8**	**C.**	**6**
B.	**4**	**D.**	**7**
9. What substances are strong electrolytes? 			
A.	**1 i 4**	**D.**	**3 i 5**
B.	**2 i 6**	**E.**	**2 i 3**
C.	**3 i 4**		
10. Bonds of central atom with ligands in complex compounds are realized due to:			
A.	**Ionic bond;**	**C.**	**Covalent bond;**
B.	**Donor-acceptor covalent bond;**	**D.**	**Metallic bond.**

7. Teaching Methods

A **teaching method** comprises the principles and methods used for teaching. Commonly used teaching methods for studying subject Water Resources Management include class participation, demonstration, recitation, memorization, or combinations 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.

Explaining, or lecturing, is the process of teaching by giving spoken explanations of the subject that is to be learned. Lecturing is often accompanied by visual aids to help students visualize an object or problem.

Demonstrating is the process of teaching through examples or experiments. For example, a science teacher may teach an idea by performing an experiment for students. A demonstration may be used to prove a fact through a combination of visual evidence and associated reasoning.

Demonstrations are similar to written storytelling and examples in that they allow students to personally relate to the presented information. Memorization of a list of facts is a detached and impersonal experience, whereas the same information, conveyed through 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 learning.

Collaboration allows students to actively participate in the learning 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 student's abilities to work as a team, leadership skills, or presentation abilities.

Collaborative discussions can take a variety of forms, such as fishbowl discussions. After some preparation and with clearly defined roles, a discussion may constitute most of a lesson, with the teacher only giving short feedback at the end or in the following lesson.

Learning by teaching is the method, when students assume the role of teacher and teach their peers. Students who teach 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.

7. Forms of control

The main forms of knowledge control are control at the lectures at seminars and workshops, outside the classroom, at the consultations, tests and exams.
I. Control of the lectures can be conducted as a selective oral questioning of students or tests using the previously laid material, particularly in sections of the course that are necessary for the understanding of the lecture topics, read, or to establish a degree of mastery of the material lectures (held by the manner of the late first or early second hour lectures).
Testing during lectures designed to teach students to systematic elaboration covered material and prepare for the upcoming lectures, establish the degree of assimilation theory to identify the most difficult students to read chapters from the following explanation of them. Control of the lectures has to subtract time.
By spending time to control oral examination yields control, programmable for cards.
II. Current control on practical, seminar and laboratory studies conducted to elucidate ready students for employment in the following forms:

1. Writing (45 min.) Control work.

2. Colloquium on separate sections of theoretical courses (modules or themes).
III. Credits. Some subjects (theoretical courses, practical training) is applied differential test of performance appraisal on a five point scale. In a lecture course or its individual parts, which are not accompanied by laboratory or practical classes, the teacher may conduct interviews or colloquium, offer oral or written (with tickets) questions. TeacherUseful browse the students' notes. Often, students are subject to crediting as minor, insignificant and do not give enough time to prepare for it. Of the major courses before credit of Colloquium useful.

Term papers are the product of many days of work. They include elements of scientific research. Protecting course work - a special form of offset in the commission of two or three teachers. Best of coursework submitted for scientific

student conference.
IV. Examinations. Exam is the 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 attestation rating – 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.

Evaluation and grading

Grading system: National and ECTS

National grade	Оцінка ECTS	Grade according to national system	Percentage score
passed	**A**	Excellent	90 – 100
	B	Very good	82-89
	C	Good	74-81
	D	Satisfactory	64-73
	E	Satisfactory enough	60-63
Not-passed	**FX**	Unsatisfactory	35-59
	F	Unsatisfactory– serious work is needed	0-34

9. Technology and methodological requirements

1. Inorganic Chemistry. Manual. Voytenko L., Kosmatiy V., Kopilevich V., Prokopchuk N. - Kyiv: NAU Publish., 2014. - 148 p.
2. Workbook on Inorganic Chemistry. Voytenko L., Kosmatiy V., Kopilevich V., Prokopchuk N. - Kyiv: NAU Publish., 2014. - 85 p.

10. Required and recommended literature

Basic

1. Introduction in General, Organic and Biochemistry, 7th Edition, by Morris Hein, Leo R. Best, Scott Pattison and Susan Arena, Brooks/Cole Publishing Co., 2001, 872 pp.
2. Inorganic Chemistry, second edition, D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman and Co., New York, 1994, 913 pp.
3. Glinka N.N. General Chemistry. Moscow: Nauka, 1966, 432 pp.

Supplemental

1. Concepts and Models of Inorganic Chemistry, third edition, B. E. Douglas, D. H. McDaniel and J. J. Alexander; John Wiley & Sons, Inc., New York, 1994. 993 p.
2. Inorganic Chemistry, A Modern Introduction, T. Moeller; John Wiley & Sons, New York, 1982. 846 p.
3. Chemistry of the Elements, N. N. Greenwoo and A. Earnshaw; Pergamon Press, New York, 1984. 1542 pp.

11. Normative literature

1. ISO 6353-2:1983 Reagents for chemical analysis -- Part 2: Specifications -- First series.
2. ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method ISO 6058:1984, Water quality - Determination of calcium content - EDTA titrimetric method.
3. ISO 6059 – 1984 Water quality – Determination of the sum of calcium and magnesium – EDTA titrimetric method.

12. IT resources

1. http://www.informika.ru/text/database/chemy/Enu/Data/Ch1-7.html
2. http://dbhs.wvusd.k12.ca.us/AcidBase/Kw.html
3. http://dbhs.wvusd.k12.ca.us/AcidBase/Hydrolysis.html
4. http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/bond.html
5. http://chemlab.pc.maricopa.edu periodic/triangletable.html
6. http://www.pc.chemie.uni-siegen.de/pci/versuche/english/kapite14. html

НУБіП України **Ф-7.5-2.1.6-24**

«***Бланк тестових завдань***»

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ

Факультет захисту рослин
Напрям підготовки **6.090105** ”Захист рослин”
Форма навчання денна
Семестр 1 Курс 1
ОКР «Бакалавр»
Кафедра аналітичної і біонеорганічної хімії та якості води
Дисципліна: **INORGANIC CHEMISTRY**
Викладач доц. Прокопчук Н.М.

«Затверджую»
Завідувач кафедри, поф., д.х.н. (Копілевич В.А.)
«____» _____ 2015 р.

Білет № 1

1. Name the following compound $CoCl_3$ using the Stock system:

(to write name)
_____

2. The relative molecular weight of Phospharus (III) Oxide is equal to:

(to write answer as figure)

3. Determine type of the next chemical reaction: $ZnCl_2 + Na_2CO_3 = ZnCO_3 + 2NaCl$:

1	RedOx;	**Answer: _____**
2	Neutralization;	
3	Double replacement;	
4	Complex formation.	

4. To point the correspondence of the oxide formulas and their chemical nature:

A.	Basic	1. B_2O_3	**Answer:**
B.	Amphoteric	2. NO	**A - _____;**
C.	Acidic	3. P_2O_3	
D.	Non-salted	4. SiO_2	**B -_____;**
		5. BaO	
		6. PbO	**C - _____;**
		7. Cl_2O	
		8. BeO	**D - _____.**

5. Note chemical formula of the Chlorate (I) acid:

1	HCl	**Answer: _____**
2	HClO	
3	$HClO_2$	
4	$HClO_4$	

6. Write a formula of acidic salt, formed in the reaction between H_2S and $Ca(OH)_2$

Answer: *(chemical formula)*_____

7. Note mathematical expression of conservation law:

1	$E=mc^2$;	**Answer:** _____
2	$P_1V_1=P_2V_2$;	
3	$V_1N_1=V_2N_2$;	
4	$M = N \cdot V \cdot E$.	

8. Indicate reactions where a pressure growth in system gives the gain in yield of reaction products (shift the equilibrium to the right): (*possible more than one true variant*)

A.	$2H_2O_{(gas)} \leftrightarrow 2H_{2\,(gas)} + O_{2\,(gas)}$	**Answer:** _____
B.	$N_{2\,(gas)} + 3H_{2\,(gas)} \leftrightarrow 2NH_{3\,(gas)}$	
C.	$CaCO_{3\,(solid)} \leftrightarrow CaO_{\,(solid)} + CO_{2\,(gas)}$	
D.	$C_{\,(solid)} + H_2O_{\,(vapor)} \leftrightarrow CO_{2\,(gas)} + H_{2\,(gas)}$	
E.	$2\,NO_{\,(gas)} + 4HI_{\,(gas)} \leftrightarrow 2\,I_{2\,(gas)} + 2H_2O_{(vapor)}$	

9. To point the correctness of the statement: Maximum valency of Sulfur is IV.

1	True	**Answer:** _____
2	False	

10. Determine compound with the most ionic bond

1	HCl	**Answer:** _____
2	KCl	
3	$CaCl_2$	
4	$AlCl_3$	

11. Put in the sentence a missing figure:

Covalent bonding is formed by two atoms with difference of electronegativity in the range

_____- _____ units.

12. To point the correspondence of the compound formulas and type of the chemical bonding of ones: (*possible more than one true variant*)

A.	Ionic	1	Ca	**Answer:**
B.	Metallic	2	$SrCl_2$	**A - _____;**
C.	Covalent polar	3	F_2	**C - _____;**
D.	Covalent non-polar	4	NH_3	
		5	OF_2	**B -_____;**
		6	K_3N	**D - _____.**

13. Molar concentration of solution, contained 3,33 g of H_3PO_4 per liter, is:

Solution:

Answer: ____ M.

14. In the result of hydrolysis of Salt $Ca(NO_2)_2$ medium of solution is…

_____ (alkali or acidic or neutral)

15. Note molecular, ionic and net ionic form of the reaction between: $Al(OH)_3$ and NaOH:

:

Molecular: _____ ↔_____;

Ionic: _____ ↔_____;

Net ionic: _____ ↔_____.

16. Calculate pH of 0,001 N NaOH.

pH = _____

17. To write the 1st step of hydrolysis in the form of molecular, ionic and net ionic reactions for salt $AlCl_3$:

Molecular: _____ ↔_____;
Ionic: _____ ↔_____;
Net ionic: _____ ↔_____.

18. Note reaction, where Oxygen is reducting agent:

1	$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$	**Answer: _____**
2	$2H_2 + O_2 \rightarrow 2H_2O$	
3	$2\ SO_2 + O_2 \rightarrow 2\ SO_3$	
4	$2\ F_2 + O_2 \rightarrow 2\ OF_2$	

19. Complete Redox reaction with electron balance and determine coefficients:

__ $KMnO_4$ + __ Mg + __ H_2SO_4 →	___ + ___ $\bar{e} \rightarrow$ _____	____ oxiding agent
_____	___ - ___ $\bar{e} \rightarrow$ _____	____ reducing agent

20. Determine correspondence of the biological function of the chemical elements in the alive body:

A.	Ultramicronutrient, in high concentration - toxicant	1	I	**Answer: A - _____;**
		2	Fe	
B.	Micronutrient, in high concentration - toxicant	3	Ca	**B -_____;**
		4	Cu	
C.	Not active	5	Si	**C - _____.**
		6	Se	

21. The structure of the last energy level of the Halogens is:

A.	ns^2np^6;	**Answer: _____**
B.	ns^2np^5;	
C.	ns^2np^4;	
D.	$ns^2np^{0.}$	

22. The additional bonds of central atom with ligands in complex compounds are realized due to:

A.	Ionic bonding;	**Answer: _____**
B.	Covalent bonding;	
C.	Donor-acceptor covalent bonding;	
D.	Metallic bonding.	

23. Complete complexation reaction (coordination number of Co^{3+} is equal 6) and calculate sum of coefficients:

__ $CoCl_3$ + __ $NH_{3\ (excess)}$ → [___(___)_] ____
Sum of coefficients:____

24. As usual, central atoms in compex compounds are:

A.	s-elements;	**Answer: _____**
B.	p-elements;	
C.	d-elements;	
D.	Non-metals.	

25. Calculate equivalent mass of $H_4P_2O_7$ (M=178 g/mol) is:

E ($H_4P_2O_7$) = _____g/g-eq.

26. Note possible values of spin quantum figure m_s: _____.

27. Biological function of calcium consists in:

A.	This element is a component of chlorophyll;	**Answer: _____**
B.	This element is a component of blood gem;	
C.	This element is a component of bones and enamel;	
D.	This element is a part of adenozinetriphosphate acid (ATF).	

28. What's formula determine maximum quantity of electrons on the energy level?

A.	$2n^2$;	**Answer: _____**
B.	$2(2l + 1)$;	
C.	$2(2m + 1)$;	
D.	$3(n + 1)^2$;	
E.	$2(2l + m)$.	

29. To write chemical formula of compound: Calcium Chlorate (V): Answer:_____.

30. Determine substance *X* and quantity of electrons, lost by reducing agent in reaction:

$Ag + HNO_{3\,(concentrated)} \rightarrow AgNO_3 + X + H_2O$

	X	Coefficient		
A.	NO_2	1	2	**Answer:** **X -** _____,
B.	NH_4NO_3	2	3	
C.	NO	3	5	**Coefficient -** _____ .
D.	N_2O	4	1	