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,
the Biotechnologies, and Ecology
Dr. Agr. Sci., Prof. _____ Y.V.Kolomiec
"___" _____, 2023

REWIED AND APPROVED
At the meeting of the department
of Analytical and Bioinorganic
Chemistry & Water Quality
Protocol # 8 24. 04. 2023
Head of the Department
Dr.Chem.Sci, Prof. _____ V.A.Kopilevich

REWIED
Guarantor of EP
Dr.Sci, Prof. _____ O.L.Klyachenko

WORK PROGRAM

Academic Discipline "ANALYTICAL CHEMISTRY"
For EQL (educational and skill level) "Bachelor"

Branch of knowledge – Chemical and Bio-engineering
Speciality – 162 Biotechnologies and Bio-engineering

1. Academic discipline description
Analytical Chemistry

Branch of knowledge, direction, specialty, education and qualification level		
Educational and Qualification level qualification	Bachelor	
Branch of knowledge	16 Chemical and Bio-engineering	
Speciality	162 Biotechnologies and Bio-engineering	
Characteristics of training programme		
Type	Ordinary (standard)	
The total number of academic hours	180	
Number of ECTS credits allocated	6	
Number of modules	2	
Forms of control	Exam	
Indicators of academic discipline for full-time and part-time forms of training course		
	Full-time	Part-time
Year of study (course)	2	No
Semester	3	
Number of lecture, hours	30	
Number of seminars, practical classes	-	
Laboratory sessions (activities)	60	
Independent study	90	
Individual lessons	-	
Number of weekly in-class academic hours for full-time forms of training	6	
Course work (separate program)	40	
Study workshop (separate program)	36	

2. Goal and objectives of academic discipline

Analytical Chemistry is the Chemistry of the differences. From an analytical point of view, analogies of elements, of a same column or period of the periodic table, are left aside in the same way that analogy of organic compounds, having the same functional groups, in order to pay more attention to the specific identity of elements and compounds. In this sense, Analytical Chemistry is closer to the evidences of the life experiences than other chemical disciplines and it can be well understood by our students, who appreciate the different effects of sodium and potassium on soil fertility, in spite of the fact that both are alkaline elements, or the tremendous differences between the toxicity of methanol and ethanol, which have the small difference of a carbon and two hydrogen atoms.

Analytical chemistry is often described as the area of chemistry responsible for characterizing the composition of matter, both qualitatively (what is present) and quantitatively (how much is present). This description is misleading. Almost all chemical disciplines routinely make qualitative or quantitative measurements (Figure

1). The argument has been made that analytical chemistry is not a separate branch of chemistry, but simply the application of chemical knowledge.

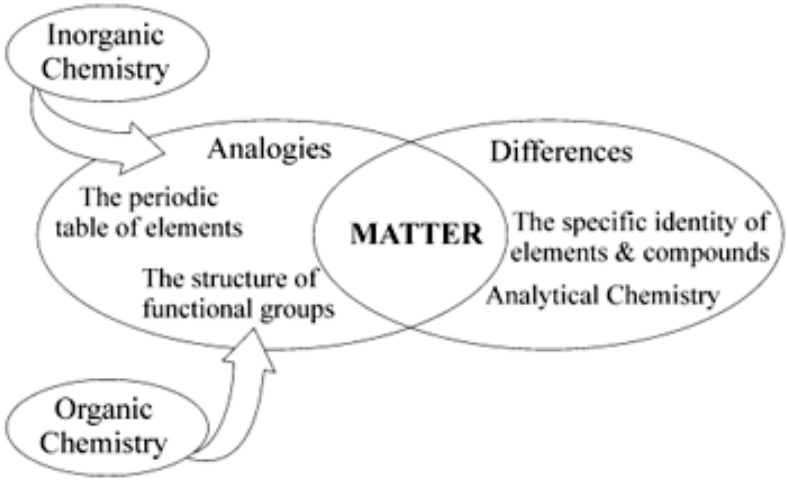


Figure 1 – Analytical Chemistry as the Chemistry of the differences

In fact, students probably have performed quantitative and qualitative analyses in other chemistry courses. For example, many introductory courses in chemistry include qualitative schemes for identifying inorganic ions and quantitative analyses involving titrations. Unfortunately, this description ignores the unique perspective that analytical chemists bring to the study of chemistry. The craft of analytical chemistry is not in performing a routine analysis on a routine sample (which is more appropriately called chemical analysis), but in improving established methods, extending existing methods to new types of samples, and developing new methods for measuring chemical phenomena.

So, Analytical Chemistry is united with other chemical sciences with common chemical laws and based on studying of chemical properties of substances. Samples are diverse in nature and include mineral rocks, soils, air, animal tissues, plants, agrochemicals, water, fuel, blood, and medicines.

The Objects of Analytical chemistry research:

- To empower students to obtain a skills orientated qualification - laboratory technician:
- To train natural scientists to be employed in various sectors of the economy;
- To train specialists in natural sciences;
- To create further opportunities in research and for post-graduate studies;
- To make a national and international contribution to the promotion of research.

Environmentally Friendly Analytical Chemistry

In past times, after data evaluation, it was considered that an analytical procedure was finished when all the elements to solve a problem were on the table. However, nowa-days, it is imposed by laws and by the compromise between scientists and our world to consider also the side effects of our job. In this new scenario, it is necessary to evaluate and to treat the wastes generated by the measurement processes in such a way that the less pollutant methods would be selected and the laboratory wastes decontamined. The environmental mentality in Analytical Chemistry is a recent compromise of chemistry but should be carefully considered in order to assure the sustainable development of our discipline.

Figure 2 summarizes the different stages in the evolution of the ecological mentality of the analytical laboratories, from the technical development to the bad conscience of the environment damage and the engagement of sustainable practices.

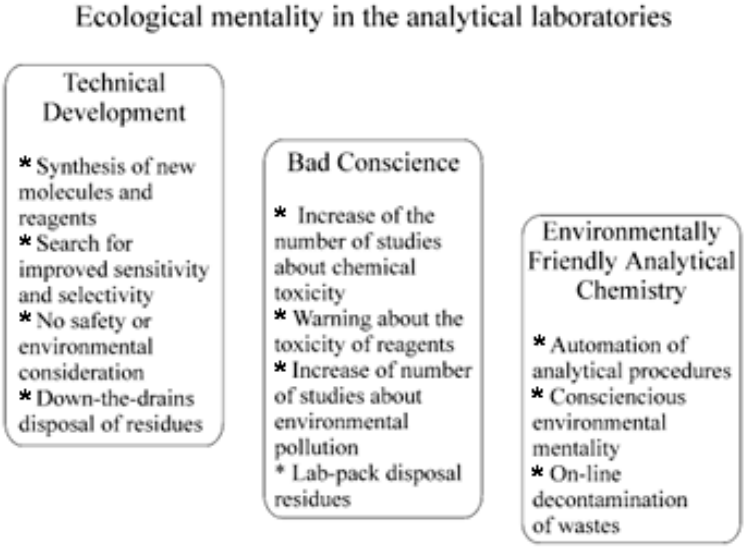


Figure 2 – Stages of the evolution of ecological mentality in the analytical laboratories

Requirements of knowledge and skills acquired during studying the discipline

Aim and Task of Subject

Is formation of Biotechnological students' theoretical and practical bases and skills, needed for the next studying in the estimated professional direction, where used chemical analysis of natural and artificial objects.

Control of knowledge and skills

It is realized in the form:

- Control of lab works preparation;
- Theoretical control tests;
- Control experimental problems;
- Final written exam test.

Requirements to the knowledge and skills

Student must to know:

- Safety technique in analytical laboratory;
- Bases of the qualitative analysis;
- Qualitative reactions of cations and anions;
- Methods of masking for prevent ions;
- Methods of ions separation in solution at qualitative determination;
- Bases of gravimetry (mass analysis) and titrimetry (volume analysis).

Competentions:

Competencies of the educational programme:

Integrative competency (IC): The ability to solve complex specialized problems and practical problems characterized by complexity and uncertainty in biotechnology and bioengineering, or in the learning process, which involves the application of theories and methods of biotechnology and bioengineering.____

General competencies (GC):

3. *Ability to communicate in a foreign language.*

5. Ability to learn and master modern knowledge.

Professional (special) competencies (PC):__

- 2. Ability to use thorough knowledge of chemistry and biology to the extent necessary to achieve others results of the educational program
- 5. The ability to conduct experimental research with improvement of biological agents, including to cause changes in the structure of the hereditary apparatus and functional activity of biological agents_

Program learning outcomes (PLO) of the educational programme: _

- 2. To be able to carry out qualitative and quantitative analysis of substances of inorganic, organic and biological origin, using appropriate methods.
- 22. Be able to take into account social, ecological, ethical, economic aspects, labor and industrial safety requirements sanitation and fire safety during the formation of technical solutions. Be able to use different types and forms of motor activities for active recreation and healthy living way of life.

COURSE STRUCTURE

Topic	Hours (lecture/laboratory, prac/ self)	Learning outcomes	Tasks	Assessment
1 semestr				
Module1				
Lecture # 1. Subjects and objects of the chemical analysis (analytical chemistry).	2/2/4	What is necessary to know , What one should be able to do, What one should be concerned in: Methods of quantitative analysis – chemical and physical-chemical. Subjects of qualitative and quantitative analyses. Methods of qualitative analysis – macro-, semimicro-, micro-, and ultramicromethods.	LABORATORY TRAINING № 1. lab works preparation;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 2. Analytical reactions and requirements to analytical reactions. Examples of qualitative reactions of different visual effects (sedimentation, colorizing etc.).	2/4/4	What is necessary to know , What one should be able to do, What one should be concerned in: "Dry" and "wet" qualitative tests. Pyrochemical methods (idea of borax bead tests, flame tests), microcrystalline analysis, analysis in drops in filter paper. Notions of specific, selective, and group reactions and reagents. Examples.	LABORATORY TRAINING № 2. Examples of qualitative reactions. lab works preparation;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 3. Principles of cations classification – acid-base, sulfide, ammine-phosphate.	2/4/4	What is necessary to know , What one should be able to do, What one should be concerned in: The main group reagents. Analytical purity of reagents. Ukrainian and international degrees of purity (classification техн, ч, чда, хч, осч; Analytical reagent AR, Guaranteed Reagent (GR) etc.).	LABORATORY TRAINING № . lab works preparation;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 4. The methodology of cation mixture analysis.	2/4/4	What is necessary to know , What one should be able to do, What one should be concerned in: Partial and Systematic analysis. Centrifugation, fullness testing.	LABORATORY TRAINING № .lab works preparation; tests;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 5. Expression of	2/4/4	What is necessary to know , What one should be able to	Module2 LABORATORY	-Control of lab works

Concentration:		do, What one should be concerned in: percent (mass) concentrations (percentage weight by weight; volume by volume etc; Molar, Normal (equivalent), and Titr.	TRAINING	preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 6. Formulas of recalculations of concentration units.	2/4/4	What is necessary to know , What one should be able to do, What one should be concerned in: Preparation of solutions. Calculation in quantitative analysis.	LABORATORY TRAINING № .lab works preparation;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 7. Heterogeneous equilibrium.	2/4/4	What is necessary to know , What one should be able to do, What one should be concerned in: Equilibrium In Saturated Solutions of Slightly Soluble Substances. Solubility product. Molar and mass solubility. Examples of calculations.	LABORATORY TRAINING № lab works preparation; experimental problems; tests; Control experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 8. Factors effecting solubility	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: temperature, common ion effect, pH effect. Notion of ionic power (strength), active coefficients, and active concentrations.	LABORATORY TRAINING № lab works preparation; experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 9. Subject of gravimetric analysis.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Equipment and tools (filter paper series). The experimental strategy. Calculations in gravimetric analysis. Tananaev's rule. Amorphous and crystalline sediments. Requirements to sediments in gravimetric analysis. Rules of	LABORATORY TRAINING № lab works preparation; lab works preparation;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;

		sedimenting.		
Lecture # 10. Homogeneous equilibrium. Ionic product of water.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: pH notion. Biological function depending pH. Measuring pH. pH calculations of strong acids and bases, weak acids and bases.	LABORATORY TRAINING № gravimetric analysis. lab works preparation; experimental problems; tests;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 11. Hydrolysis and pH calculations of different salts solutions. Buffer solutions.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Calculate of a pH of buffer solutions. Titration curves, equivalent points, titration jump. Acid-base indicators. Choice of indicators. Equivalent law in volumetry.	LABORATORY TRAINING № Ionic product of water. lab works preparation; experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 12. Neutralization method.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Standard and working solutions, possibilities of method. Determination of water temporary hardness.	LABORATORY TRAINING № lab works preparation; experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 13. RedOx volumetry. Nernst equation.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Electrode potential of redox systems. Electromoving force (EMF) of redox systems. RedOx indicators.	LABORATORY TRAINING № Neutralization method. lab works preparation; tests;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Lecture # 14. Foundations of permanganatometry and iodometry.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Bases of method of permanganatometry and iodometry.	LABORATORY TRAINING № RedOx volumetry. Nernst equation. lab works preparation; experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;

Lecture # 15. Complexonometry. Bases of method.	2/4/8	What is necessary to know , What one should be able to do, What one should be concerned in: Standard and working solutions, possibilities of method. Metal-lochromic indicators. Determination of total temporary hardness. Precipitation titration. Mohr' method of chloride determination. Fixation of equivalent point. Experimental strategy.	LABORATORY TRAINING № permanganatometry and iodometry. lab works preparation; experimental problems;	-Control of lab works preparation; -Theoretical control tests; -Control experimental problems;
Total	30/60/90		LABORATORY TRAINING № Complexonometry. lab works preparation; experimental problems; tests;	
Course work	40			(70/30) 100
Study work				70
Exam				30
Total				100

4. CHAPTERS OF SEMINAR TRAINING
No planned

5. CHAPTERS OF PRACTICAL TRAINING
No planned

6. LAB TRAINING CHAPTERS

#	Chapter	Hours
1	Introduction. Lab Safety rules. Semimicro qualitative lab techniques. Basic characteristics of Qualitative tests (sensitivity, selectivity.	4
2	Qualitative classification of cations. Qualitative tests of the I cation group (NH_4^+, K^+, Na^+)	4
3	Qualitative tests of the II cation group (Mg^{2+}, Ca^{2+}, Sr^{2+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, and Al^{3+}). Action of group, selective, and specific reagents.	4
4	Qualitative tests of the III cation group (Zn^{2+}, Cu^{2+}, Co^{2+}, and Ni^{2+}), and the IV cation group (Ag^+, Pb^{2+}). Action of group, selective, and specific reagents.	4
5	Partial and Systematic analyses of cation mixture. Idea of cation separation. *Experimental test.* Determine the composition of cation mixture.	4
6	Qualitative classification of anions. Qualitative tests and methods of separations of anions SO_4^{2-}, SO_3^{2-}, CO_3^{2-}, PO_4^{3-}, SiO_3^{2-}, MoO_4^{2-}, BO_2^-, Cl^-, Br^-, I^-, NO_3^-, NO_2^-, and CH_3COO^-	4
7	*Experimental module test.* Qualitative analysis of soluble salt (1	4

	item), and insoluble substance (1 item) (salts, free metals, oxides).	
8	*Experimental module test.* Determination of barium content in the barium chloride hydrate.	8
9	Neutralization method. Standard and working solutions, possibilities of method. *Experimental module test.* Determination of alkali content in solution, and water temporary hardness.	4
10	RedOx volumetric methods. Permanganatometry method. Standard and working solutions, possibilities of method. *Experimental module test.* Determination of iron(II) content in Mohr's salt solution.	6
11	Iodometry method. Standard and working solutions, possibilities of method. *Experimental module test.* Iodometric determination of copper content in copper vitriol.	6
12	Complexonometry. Bases of method. Standard and working solutions, possibilities of method. *Experimental module test.* Complexonometric determination of Calcium content in solution.	8
	Змістовий модуль 2	60

7. INDEPENDENT STUDY

#	Chapter	Hours
1	Application of chemical analysis. Sampling. Types of analysis. Use of literature. Common techniques. Factors affecting the choice of analytical methods. Data acquisition and treatment.	8
2	Principles of sulfide-free methods of cation classifications. Dissolving of the sample. "Soda" extracting. Methods of heterogeneous mixture separating.	8
3	Determination of analytical purity of the chemicals for the different purposes of environmental analysis (air, fresh water, soils, foods, microbiological analysis etc.). Methods of analytical separation of cations in natural systems	10
4	Analytical methods of environmental item qualitative tests	10
5	Training calculations of concentration units recalculations in the environmental application (heavy metals analysis, salty waters mineralization, etc)	10
6	The ionic strength of natural water systems (salty sea waters, blood, cell juice etc.). Osmosis and ionic strength. Calculation of common ion effect and environmental problems (how to immobilize the heavy metals in soils etc.).	18
6	pH graphic method determination. How to prepare of buffer solutions. TRIS solution – preparation and application. How to calculate titration curves of acid mixture titration. Choice of the best acid-base indicators and their preparation.	10
7	RedOx calculation of ionic species of metals of changing valencies in natural systems (iron, manganese). RedOx potential of natural waters and soils. Chemical oxygen demand (COD) of natural waters as application of RedOx volumetric methods in the environmental	8

	analysis.	
8	Chelates as a food additives, drugs, and analytical reagents. Using of complexones in environmental sanitation.	8
	Total	90

8. CONTENT OF THEORETICAL QUESTIONS

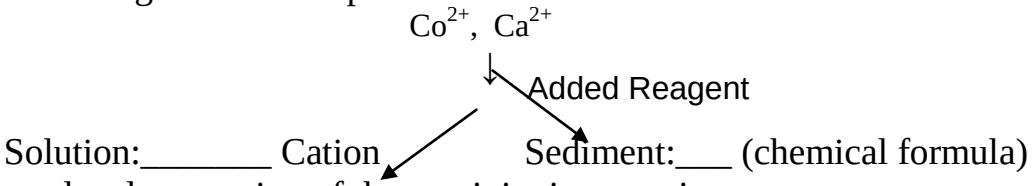
Qualitative analysis

1. Subjects and objects of the chemical analysis (analytical chemistry).
2. Methods of quantitative analysis – chemical and physical-chemical.
3. Subjects of qualitative and quantitative analyses.
4. Methods of qualitative analysis – macro-, semimicro-, micro-, and ultramicromethods.
5. Analytical reactions and requirements to analytical reactions. Examples of qualitative reactions of different visual effects (sedimentation, colorizing etc.)
6. "Dry" and "wet" qualitative tests. Pyrochemical methods (idea of borax bead tests, flame tests), microcrystalline analysis, analysis in drops in filter paper.
7. Notions of specific, selective, and group reactions and reagents. Examples.
8. Principles of cations classification – acid-base, sulfide, ammine-phosphate. The main group reagents.
9. Analytical purity of reagents. Ukrainian and international degrees of purity (classification техн, ч, чда, хч, осч; Analytical reagent AR, Guaranteed Reagent (GR) etc.)
10. Expression of Concentration: 1. percent (mass) concentrations; 2. Molar, 3. Normal (equivalent), and 4. Titr.
11. Formulas of recalculations of concentration units.
12. Heterogeneous equilibrium. Equilibrium In Saturated Solutions of Slightly Soluble Substances. Solubility product. Molar and mass solubility. Examples of calculations.
13. Factors effecting solubility: temperature, common ion effect, pH effect. Notion of ionic power (strength), active coefficients, and active concentrations.
14. Subject of gravimetric analysis. Equipment and tools (filter paper series). The experimental strategy. Calculations in gravimetric analysis.
15. Tananaev's rule. Amorphous and crystalline sediments. Requirements to sediments in gravimetric analysis. Rules of sedimenting.
16. Ionic product of water. pH notion. Biological function depending pH. Measuring pH.
17. pH calculations of strong acids and bases, weak acids and bases.
18. pH calculations of different salts solutions.
19. Buffer solutions. Calculate of a pH of buffer solutions.
20. Titration curves, equivalent points, titration jump. Acid-base indicators. Choice of indicators. Equivalent law in volumetry.
21. Neutralization method. Standard and working solutions, possibilities of method. Determination of water temporary hardness.
22. RedOx volumetry. Nernst equation. Electrode potential of redox systems. Electromoving force (EMF) of redox systems. RedOx indicators.
23. Bases of permanganatometry and iodometry.

24. Complexonometry. Bases of method. Standard and working solutions, possibilities of method. Metallochromic indicators. Determination of total temporary hardness.

EXAMPLES OF CALCULATING TASKS AND REACTIONS QUESTIONS

1. All specific reagents and reactions of cation analysis.
2. Propose the reagent for the separation of cations:



Write the molecular equation of the precipitation reaction.
3. Write the equation of the chemical reaction of group reagent $(NH_4)_2HPO_4$ (in the presence of ammonia $NH_3 \cdot H_2O$ and soluble Magnesium salt (in MOLECULAR form):$Mg(NO_3)_2 + (NH_4)_2HPO_4 + NH_3 \cdot H_2O$ = _____
Write the equation of the dissolving of obtained sediment in the Acetic acid CH_3COOH.

4. Special tests of anions (used in analysis of unknown salts).

5. Calculate gravimetric factor *f* for the quantitative determination of Magnesium content in the form MgO (M=23,015 g/mol), if the weighted form of the sediment is $Mg_2P_2O_7$ (M=222,57 g/mol).
6. Calculate ionic strength I of solution contained 17,43 g K_2SO_4 (M=174,26 g/mol) per 1 L.
7. Determine the active concentrations ($a = \gamma \cdot c$) of 0,01 M Cl^- solution and 0,0001 M Al^{3+} solution in soil solution where ionic power of solution is equals to 0,0005 (SEE APPENDIX).
8. Calculate equivalent weight of a $K_2Cr_2O_7$ (M=294,10 g/mol) for RedOx titration in acidic medium
9. Calculate equivalent weight of a H_3PO_4 (M=97,99 g/mol) for neutralization reaction:

$$H_3PO_4 + NaOH = NaH_2PO_4 + H_2O.$$

10. Calculate volume (in mL) of 50% Sulfate acid solution (density d=1,40 g/cm^3) for preparation of 5 L 0,01 N solution (Molar weight (H_2SO_4) = 98 g/mol).
11. Calculate molarity of HCl solution of the Titr 0,o1 g/mL.
12. Calculate pH of a 0,1 N NH_4Cl solution (pK ($NH_3 \cdot H_2O$)=4,77)
13. Calculate pH of a 10 N hydrochloric acid HCl (to consider as a strong acid, dissociated completely)
14. Calculate the pH of a 0.1 M H_3PO_4 (pK_1=1,96; pK_2=6,70; pK_3=12,44)
15. Calculate the pH of a 0.01 M NaClO (pK_{acid} = 7,50)
16. Calculate the pH of a 1 M Na_2CO_3 (pK_1 = 6,52; pK_2 = 10,22)
17. Calculate ppm concentration of solution contains 0,05 g of solute per 1000 g of solution.

18. Calculate solubility (in mol/L and g/L) of $Ni(OH)_2$ ($SP=1,6\cdot10^{-14}$, Molar weight 92,71 g/mol) in solution of 0,1 N KOH (*Be attentive: effect of the common ion into solubility*).

19. Sample of lime (m_{sample} = 0,8960 g) was dissolved in the nitrate acid and total volume of obtained solution was equal to 200 mL ($V_{measuring\ flack}$). Aliquot of this solution (20 mL, $V_{pipette}$) was titrated triply by 0,0505 N Trilon B and obtained the next results: 14,6; 13,6; 13,5 mL. Calculate Calcium content (%) in this sample.

20. Calculate mass of $FeSO_4\cdot7H_2O$ (MW=278,01 g/mol) for the Iron gravimetric determination on the form of Fe_2S_3 (MW=207,89 g/mol) according to the Tananaev's recommendation.

21. Calculate Copper (A=63,548 g/mol) percent content in 1,0000 g malachite sample, if for iodometric titration 20 mL solution taken of 200 mL measuring flack was used 15,0 mL 0,0500 N $Na_2S_2O_3$.

EXAMPLE OF MODULE TEST 1

Question 1. Note the specific analytical reagent of Nickel Ni^{2+} ions:

A	NH_3 (concentrated) in excess	F	Ammonium Thiocyanide NH_4SCN
B	Yellow blood salt $K_4[Fe(CN)_6]$	J	Ammonium oxalate $(NH_4)_2C_2O_4$
C	Red blood salt $K_3[Fe(CN)_6]$	K	Zinc-Uranyl-Acetate $Zn(UO_2)_3(CH_3COO)_8$
D	Hydrochloric acid HCl	L	Nessler's reagent $K_2[HgI_4]$+KOH
E	Dimethylglioxime (Chugaev's reagent) $C_4H_8N_2O_2$ in ammonia medium	M	Ammonium chloride NH_4Cl

Write the correspondent equation of the chemical reaction in MOLECULAR form:

$Ni(NO_3)_2$ + _____ = _____

Visual effect, corresponded the reaction _____

(precipitation, odor, change of color etc.)

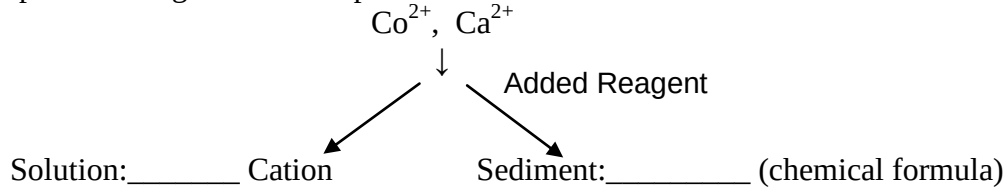
Question 2. 2.1. Write the equation of the chemical reaction of group reagent $(NH_4)_2HPO_4$ (in the presence of ammonia $NH_3\cdot H_2O$ and soluble Magnesium salt (in MOLECULAR form):

$Mg(NO_3)_2$ + $(NH_4)_2HPO_4$ + $NH_3\cdot H_2O$ = _____

2.2. Write the equation of the dissolving of obtained sediment in the Acetic acid CH_3COOH:

_____↓ + CH_3COOH= _____

Question 3. Propose the reagent for the separation of cations:



Write the molecular equation of the precipitation reaction.

TEST QUESTIONS FOR FINAL ASSESSMENT

Екзаменаційні питання

1. pH calculations of strong acids and bases, weak acids and bases. Examples.

2. Write the equation of the chemical reaction of group reagent $(NH_4)_2HPO_4$ (in the presence of ammonia $NH_3 \cdot H_2O$) and soluble Strontium soluble salt (for example, $Sr(NO_3)_2$) in molecular from. Write the equation of the dissolving of obtained sediment in the Acetic acid CH_3COOH.

Тестові завдання різних типів

1. Point the correspondence of the compound formulas and type of the analytical reagents (ammonium-phosphate classification):*(possible more than one true variant)*

A	Group	1	$K_4[Fe(CN)_6]$
B	Specific	2	$NaBiO_3 + HNO_3$ (diluted)
C	Selective	3	HCl
		4	$K_3[Fe(CN)_6]$
		5	NaOH
		6	H_2SO_4

2. Calculate ionic strength I of solution contained 17,43 g K_2SO_4 (M=174,26 g/mol) per 1 L.

A	0, 10 mol/L	B	0,20 mol/L	C	0,30mol/L	D	0,50mol/L

3. Note types of analytical tools used for mass analysis (gravimetry):


A


B


C


D


E


F

4. Note the characteristic analytical test of Molybdate MoO_4^{2-} anions:

A	Action of Hydrogen peroxide H_2O_2 and water ammonia $NH_3 \cdot H_2O$	C	Action of Silver nitrate $AgNO_3$ and the following dissolving of isolated sediment in water ammonia $NH_3 \cdot H_2O$
B	Action of $FeSO_4$ (saturated) and H_2SO_4 (concentrated)	D	Action of Potassium Permanganate $KMnO_4$ in presence of H_2SO_4 (diluted)

Write the correspondent equation(s) of reaction(s) in molecular form.

5. Note mixtures used as buffer solutions *(possible more that one true variant):*

A	NaCl + HCl	C	$NH_4OH + NH_4Cl$
B	$CH_3COONa + CH_3COOH$	D	NaOH + NaCl

6. Equivalent mass of Bi^{3+} cation (A=208,98 g/mol) in reaction with Trilon B is, g-eq/g :

A	104,49	B	208,98	C	52,25	D	69,66

7. Calculate gravimetric factor *f* for the quantitative determination of Magnesium content in the form MgO (M=40,31 g/mol), if the weighted form of the sediment is $Mg_2P_2O_7$ (M=222,57 g/mol).

8. Put in the sentence missing word: *The reaction of group reagent is realized in presence of mixture $NH_4OH + NH_4Cl$ named _____ mixture, which keeps pH of solution equal to 10.*

9. Note the absorption indicator for redox method of volumetric method:

A	Eriochrome black T	C	Methyl orange
B	Starch	D	Phenolphthalein

10. Calculate ppt (‰) concentration of solution contains 0,01 g of solute per 50 g of solution.

A	0, 200	B	1,000	C	0,500	D	0,001

9. TEACHING METHODS

Before teaching a course, the instructor must identify what she or he intends for the students to learn. For most analytical chemistry instructors, this usually involves an assessment of what methods and techniques to include and at what depth to cover them. There are many other skills, though, that will be important to students for their future success. Most university classes in analytical 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 are more difficult to impart in a lecture format. The laboratory component of analytical chemistry courses is often an underutilized learning resource. More often than not, the lab is used to demonstrate fundamental wet and instrumental analysis techniques and develop rudimentary laboratory skills. The analytical lab should also be used to develop meaningful problem-solving skills and to demonstrate and have students participate in the entire analytical process.

A teaching method comprises the principles and methods used for students teaching. Commonly used teaching methods for styding subject "Analytical chemistry" 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.

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 chemistry teacher must 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 in analytical chemistry and own experiment are permit to obtain experimental skills needed for environmental monitoring 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 bacts 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.

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 a lesson, with the teacher only giving short feedback at the end or in the following lesson.

Learning by teahing 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.

10. FORMS OF CONTROL

The main forms of knowledge control are control at the lectures at labs and workshops, outside the classrooms, and 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 ther lectures has to subtract time. By spending time to conrol oral examination yields control, programmable for cards.

II. Current control on laboratory studies conducted to elucidate ready students for employment in the following forms:

1. Writing (30 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 questions. Often, students are subject to crediting as a minor, insignificant and do not give enough time to prepare for it. Of a major cources 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 course work submitted for scientific student conference.

IV. 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 consistuents of an academic discipline, makes 70 points. Rating of content modules as well as attestation rating are also measured by 100-point-scale.

Assessment and grading.

ASSESSMENT POLICY

Policy regarding deadlines and resits:	Assignments submitted after the deadline without valid reasons will be graded lower. Resitting of modules will be allowed with the permission from the lecturer and in the presence of valid reasons (e.g. medical reasons).
Academic honesty policy:	Cheating during tests and exams is strictly prohibited (including the use of mobile devices). Coursework and research papers must contain correct citations for all sources used.
Attendance policy:	Class attendance is mandatory. In case of objective reasons (such as illness or international internships), individual learning may be allowed (in online format by the approval of the dean of the faculty).

SCALE OF ASSESSMENT OF STUDENT KNOWLEDGE

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

11. Technology and methodological requirements

1. Analytical Chemistry: Tutorial : [for students of higher educational institutions III-IV accreditation level, speciality 162 Biotechnologies and Bio-engineering»] / Voitenko L.V., Prokopchuk N.M., Lavrik R.V.,– Kyiv: NULES Publ., 2018. – 402 p.
2. Introduction in General, Organic and Analytical Chemistry, 7th Edition, by Morris Hein, Leo R. Best, Scott Pattison and Susan Arena, Brooks/Cole Publishing Co., 2010, 872 pp.
3. Chemistry: the Molecular Nature of Matter and Change, 2nd ed. Martin S. Silberberg, McGraw-Hill Companies, 2000, 1086 pp.
4. Analytical Chemistry, second edition, D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman and Co., New York, 2017, 913 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.

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.

IT resources

1. https://elearn.nubip.edu.ua/course/view.php?id=1185
2. http://www.informika.ru/text/database/chemy/Enu/Data/Ch1-7.html
3. http://dbhs.wvusd.k12.ca.us/AcidBase/Kw.html
4. http://dbhs.wvusd.k12.ca.us/AcidBase/Hydrolysis.html
5. http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/bond.html
6. http://chemlab.pc.maricopa.edu periodic/triangletable.html
7. http://www.pc.chemie.uni-siegen.de/pci/versuche/english/kapite14. html