NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCE OF UKRAINE
DEPARTMENT OF ANALYTICAL AND BIOINORGANIC CHEMISTRY AND WATER QUALITY

"**APPROVED**"
Faculty of Plant
Protection, Biotechnology and Ecology

"_21___"__May___2025.

CURRICULUM OF ACADEMIC DISCIPLINE

INORGANC AND ANALYTICAL CHEMISTRY

Field of knowledge G – Engineering, Manufacturing and Construction
Specialty G 21- "Biotechnology and Bioengineering"
Education and professional program Biotechnology and Bioengineering
Faculty of the Plant Protection, Biotechnology and Ecology
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Description of the discipline INORGANIC AND ANALYTICAL CHEMISTRY

The natural sciences fall into two general categories – the biological sciences and the physical ones. The biological sciences are concerned primarily with the living things, and the physical sciences are concerned primarily with nonliving things, including rocks, the stars, electricity, the weather, energy from the sun, and the composition of all materials.

Chemistry is a physical science. In general, Chemistry is the study of the composition, structure, and the properties of substances and the changes they undergo. This definition may suggest to you that chemistry has little to do with everyday life. This is not true. Your way of life would be radically different without the practical applications of chemistry. Imagine a supermarket offering only fruits and vegetables grown without manufactured fertilizers and pesticides. The quantities and varieties offered would be far fewer. Imagine drinking water from your tap that had not been purified. The unpurified water would probably make you sick. Try to imagine a world without gasoline or heating oil. It would be very different from the world we live in. Chemistry is s very broad subject. Most chemists would describe themselves as working in one of the following major areas of the science:

Inorganic chemistry – the study of all substances not classified as organic chemicals, which includes the chemistry of all substances containing elements other than organic carbon; *Analytical chemistry* – the identification of substances and the qualitative and quantitative determination of the composition of materials.

Academic degree, specialty, academic programme		
Academic degree	bachelors	
Specialty	G 21- "Biotechnology and Bioengineering"	
Academic programme	G- Engineering, Manufacturing and Construction	
Characteristics of the discipline		
Type	ordinary	
The total number of academic hours	150	
Number of ECTS credits allocated	5	
Number of modules	4	
Forms of control	Exam	
Indicators of academic discipline for full-time and part-time forms of university study		
	Full-time	**Part-time**
Year of study	1	
Semester	2	
Lectures	45	
Laboratory classes	75	
Self-study	30	
Number of weekly in-class academic hours for full-time forms of training Independing woork	8 2	

1. Aim, objectives, competenteces and expected learning outcomes of the discipline

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

Learning Objective sare:

- 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 chemicale quilibrium;
- 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.

- ***Competencies of the educational programme:***
- *Integrative competency (IC):* The ability to solve complex specialized problems and practical problems characterized by complexity and un certainty in biotechnology and bioengineering, or in the learning process, which involves the application of theories and methods of biotechnology and bioengineering.
- ***General competencies (GC):***
  - GC1. Ability to apply knowledge in practical situations;
  - GC03. Ability to communicate in a foreign language;
  - GC05. Ability to learn and master modern knowledge;
  - GC09. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.
- ***Professional (special) competencies (SC):***

  SC11. Ability to use a thorough knowledge of chemistry and biology to the extent necessary to achieve other out comes of the educational program.
- ***Program learning outcomes (ELO) of the educational programme:***
- ELO2. Be able to carry out qualitative and quantitative analysis of substances of inorganic, organic and biological origin, using appropriate methods;

  ELO12. Using microbiological, chemical, physical, physicochemical and biochemical methods, be able to carry out chemical control (determining the concentration of solutions of disinfectants, titration agents, concentration of nutrient medium components, etc.);

  ELO22. Beable to take into account social, ecological, ethical, economic aspects, labor and industrial safe tyre quirements sanitation and fire safety during the

formation of technical solutions. Beable to use different types and forms of motor activities for activere creation and healthy living way of life.

2. **Program and structure of the discipline**

for full-time form of training

Topics and modules to be covered	Number of hours												
	Full-time							partl-time					
	w.	s	including					total	including				
			l	p	lab	ind	st w		l	p	lab	ind	st w.
Topic module 1. Theoretical foundations of inorganic chemistry. Basic laws of chemical transformations													
Topic 1.Chemistry as a component of natural scientific disciplines	1	8	2		4		2						
Topic 2. Structure of atoms of chemical elements	2	8	2		4		2						
Topic 3.The periodicity of changes in the structure and properties of elements and their compounds	3	6	2		2		2						
Topic 4. Chemical bond and structure of molecules	3	6	2		2		2						
Total with mod. 1	1-3	28	8		12		8	36					
Topic module 2. Basic laws of chemical transformations													
Topic 5. Chemical kinetics and equilibrium	4	4	2		1		1						
Topic 6. Solutions and their properties. Electrolyte solutions and electrolytic dissociation.	4	8	4		3		1						
Topic 7.Salt hydrolysis reactions	5	7	2		4		1						
Topic 8.Oxidation-reductionreactions	6-7	14	4		8		2						
Topic 9. Complex (coordination) compounds	7	7	2		4		1						
Total with mod. 1+2	4-7	40	14		20		6	34					
Topic module 3. Chemistry of elements and qualitative analytical analysis													
Topic 10.Subject, task, meaning of analytical chemistry. Analytical research technique in natural sciences.	8	5	2		2		1						
Topic 11.Chemical-analytical properties of cations on the example of s-elements of I-A and II-A groups, p-elements of	8-9	17	4		10		3						

Topics and modules to be covered	Number of hours												
	Full-time							partl-time					
	w.	s	including					total	including				
			l	p	lab	ind	stw		l	p	lab	ind	stw.
III-A and IV-A groups and d-elements of periods 4 and 5.													
Topic 12. Chemical-analytical properties of anions on the example of p-elements VII-A, VI-A, V-A and IV-A groups. Qualitative analysis of an unknown substance (salt, acid, base, oxide).	10	13	3		8		3						
Total with mod. 1+2	8-10	36	9		20		7	34					
Topic module 4.Theoretical and experimental foundations of quantitative chemical analysis													
Topic 13. Equilibrium in heterogeneous and homogeneous systems. Reactions of precipitation and dissolution of sediments and their significance for analysis.	11	9	4		3		2						
Topic 14. Theoretical foundations of measurement and processing of results in chemical analysis. The essence and task of quantitative measurements and calculations.	12	6	2		2		2						
Topic 15.The essence of equilibrium in titrimetry. The practice of measuring by the method of neutralization.	13	12	4		6		2						
Topic 16.Measurement by redoxmetry methods**.**	14	10	2		6		2						
Topic 17.Measurement by the method of complexometry.	15	9	2		6		1						
Total with mod. 1+2+3+4	12-15	46	14		23		9	46					
Total	**1-15**	**150**	**45**		**75**		**30**	**150**					

3. Topic of Lectures

#	Name of topic	Number of hours
1	Chemistry as a component of natural scientific disciplines	2
2	Structure of atoms of chemical elements	2
3	The periodicity of changes in the structure and properties of elements and their compound	2
4	Chemical bond and structure of molecules	2
5	Chemical kinetics and equilibrium	2
6	Solutions and their properties. Electrolyte	4
7	Salt hydrolysis reactions	2
8	Oxidation-reductionreactions	4
9	Complex (coordination) compounds	2
10	Subject, task, meaning of analytical chemistry. Analytical research technique in natural sciences.	2
11	Chemical-analytical properties of cations on the example of s-elements of I-A and II-A groups, p-elements of III-A and IV-A groups and d-elements of periods 4 and 5	2
12	Chemical-analytical properties of anions on the example of p-elements VII-A, VI-A, V-A and IV-A groups. Qualitative analysis of an unknown substance (salt, acid, base, oxide).	3
13	Equilibrium in heterogeneous and homogeneous systems. Reactions of precipitation and dissolution of sediments and their significance for analysis.	4
14	Theoretical foundations of measurement and processing of results in chemical analysis. The essence and task of quantitative measurements and calculations.	2
15	The essence of equilibrium in titrimetry. The practice of measuring by the method of neutralization.	4
16	Measurement by redoxmetry methods**.**	2
17	Measurement by the method of complexometry.	2
	Totally	**45**

4. Topic of laboratory classes

#	Name of topic	Number of hours
1	General rules of work in a chemical laboratory. Techniques of laboratory works. A slice of chemistry knowledge. Study of chemical properties of various types of compounds.	4
2	Rules for compiling electronic formulas of elements, determination of their possible valence and degrees of oxidation.	4

3	The periodicity of changes in the structure and properties of elements and their compounds.	2
4	Qualitative assessment of types of chemical bonds and structure of molecules of acids, bases, salts, oxides.	2
5	Studying the rules for composing equations in electrolyte solutions	4
6	Studying the rules for compiling the equations of hydrolysis reactions and determining pH	4
7	Study of the rules of composition of equations of redox reactions. Study of types of redox reactions.	8
8	Rules for compiling formulas of coordination compounds and equations with their participation. Study of their properties	4
9	Subject and task of analytical chemistry. Qualitative analysis. The technique of performing qualitative analytical reactions.	2
10	Study of chemical and analytical properties of s-cations Na, K, Mg, Ca, Sr, Ba	2
11	Study of chemical-analytical properties of p-cations Al, Pb	2
12	Study of chemical and analytical properties of d-cations Zn, Cu, Mn, Fe, Ag	3
13	Study of the chemical-analytical properties of anions on the example of p-elements VII-A, VI-A, V-A, IV-A and III-A groups B, C, Si, N, P, O, S, Cl, Br, I	3
14	Analytical classification of cations. Study of qualitative reactions of the opening of cations of groups I-IV and their separation according to the ammonia-phosphate classification	2
15	Analytical classification of anions. Qualitative reactions for the determination of anions: SO_4^{2-}, SO_3^{2-}, CO_3^{2-}, PO_4^{3-}, Cl^-, Br^-, I^-, NO_2^-, NO_3^-.	2
16	Analysis of an unknown substance. Two experimental control tasks for the analysis of chemical compounds.	6
17	Techniques of work in quantitative analysis: weighing, measuring vessels, filtering. Volumetric analysis. Calculations in volumetric analysis. Method of neutralization. Preparation of working solutions. Experimental control tasks on the definition of: - alkali solution concentration; - temporary water hardness.	8
18	Measurement by redoxmetry methods. Preparation of working solutions for permanganatometry and iodometry. A control task for determining the percentage of iron in Mohr's salt by the permanganatometry method and the percentage of copper in	8

	copper sulfate by the iodometry method.	
19	Complexonometry method. Preparation of working solutions. Control problems by definition: - general water hardness; - calcium content in the solution.	5
	Totally	**75**

5. Topic for self-study

#	Topic title	Number of hours
1	Application of the laws of chemical stoichiometry.	1
2	Atomistic theory.	1
3	The structure of the substance in the condensed state.	2
4	Speed of chemical reactions and chemical equilibrium	1
5	Solutions and theirc on centration	2
6	Intramolecular hydrolysis	1
7	Redox potentials. Standard electrode potentials of metals. Galvanic elements. The direction of redox reactions. Electrolysis as a redox process. Corrosion of metals as a redox process.	2
8	Isomerism of complex compounds. The state of complex compounds in solution.	2
9	Water as a source of life and a building material for the creation of living matter. Features of the biological action and chemistry of selenium and its compounds.	2
10	Arsenic as an analogue of phosphorus.	1
11	Silicon compounds in the biosphere. Borides and boranes, polyborates. Aluminates and aluminosilicates.	1
12	Strontium and barium as analogs of calcium. Their role in living nature. Lithium, rubidium and cesium and their compounds in plant and animal metabolism.	1
13	Geochemical and biogeochemical cycles of copper, zinc, manganese as trace elements. Cadmium and mercury and their compounds as toxic bioelements.	1
14	Types of analytical reactions and reagents, their features; classification of analytical reagents and calculations of reaction sensitivity indicators.	1
15	Methods of qualitative analysis of the content of cations and anions.	2
16	Methods of qualitative analysis of the composition of binary compounds.	2
17	Calculations in the preparation of solutions of various concentrations and their ratios.	2
18	Properties of sediments, purity of sediments.	1

19	Calculations of the solubility of sediments in water and electrolyte solutions.	1
20	Buffer solutions. Their properties. Buffer capacity. Calculation of the buffer capacity of the solution. Preparation of buffer solutions. Calculations. Universal buffer solutions.	1
21	Assessment of reliability of analytical data. Reproducibility and correctness of experimental data. Types of systematic errors. Individual and instrumental systematic errors.	1
22	Determination of systematic error and its influence on the results of the analysis. Random error. Basic concepts of classical statistics.	1
	Totally	**30**

6. Tools for assessing expected learn outcomes:

- Exam;
- Module test;
- Referates;
- Laboratory works;
- Abstracts.
- Presentation of laboratory works.

Teaching Methods

- Verbal methods (lecture, interview)
-Practical methods (Laboratory works)
- Visual methods(demonstration methods)
- Independent work (task performance)

7. Assessment methods

Forms of control:
-exam
-test
-control work
-module test
-laboratory work.

8. Distribution of points received by students

Distribution of points received by students. The student's knowledge is assessed on a 100-point scale and translated into national assessments according to the table. 1 "Regulations on examinations and assessments at NUBiP of Ukraine" (order on implementation dated 26.04.2023, protocol No. 10)

The assessment of students' knowledge and skills is conducted by means of a 100-point scale and is converted into national grades according to Table 1 of the current Exam and Credit Regulations at NULES of Ukraine.

8.1. Distribution of points by types of educational activities

Type of educational activity	Learning outcomes	Evaluation
Module 1. Theoretical foundations of inorganic chemistry. Basic laws of chemical transformations		
Lecture 1. Chemistry as a component of natural scientific disciplines	.	-
Laboratory class 1. General rules of work in a chemical laboratory. Techniques of laboratory works. A slice of chemistry knowledge. Study of chemical properties of various types of compounds.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory.	**10**
Lecture 2. Structure of atoms of chemical elements		-
Laboratory class 2. Rules for compiling electronic formulas of elements, determination of their possible valence and degrees of oxidation	Ability to communicate in a English language	**10**
Lecture 3. The periodicity of changes in the structure and properties of elements and their compound.		-
Laboratory class 3. The periodicity of changes in the structure and properties of elements and their compounds.	Use a thorough knowledge of chemistry and biology to the extent necessary to achieve other outcomes of the educational program	**10**
Lecture 4. Chemical bond and structure of molecules		-
Laboratory class 4.	Ability to	**10**

Qualitative assessment of types of chemical bonds and structure of molecules of acids, bases, salts, oxides.	communicate in a English language and to learn	
Self-study work 1	Ability to learn and master today and modern knowledge on topic Theoretical foundations of inorganic chemistry. Basic laws of chemical transfor-mations	**30**
Module control 1.	Ability to learn and master today and modern knowledge on topic Theoretical foundations of inorganic chemistry. Basic laws of chemical transfor-mations	**30**
∑ **Module 1**		**100**
Module 2. Basic laws of chemical transformations		
Lecture 5. Chemical kinetics and equilibrium		**-**
Laboratory class 5. Studying the rules for composing equations in electrolyte solutions	Ability to communicate in a English language and to learn	**10**
Lecture 6. Solutions and their properties. Electrolyte solutions and electrolytic dissociation.		**-**
Laboratory class 6. Studying the rules for compiling the equations of hydrolysis reactions and determining pH	Ability to communicate in a English language and to learn Studying the rules for compiling the equations of hydrolysis reactions and determining pH	**10**
Lecture 7. Salt hydrolysis reactions		**-**

Laboratory class 7. Study of the rules of composition of equations of redox reactions. Study of types of redox reactions.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory.	**10**
Lecture 8. Oxidation-reduction reactions		**-**
Laboratory class 8. Rules for compiling formulas of coordination compounds and equations with their participation. Study of their properties	Ability to communicate in a English language and to learn rules for compiling formulas of coordination compound	**10**
Lecture 9. Complex (coordination) compounds		**-**
Laboratory class 9. Coordination compounds and equations with their participation.	Ability to communicate in a English language and to learn rules for compiling formulas of coordination compound	**10**
Self-study work 2	Ability to learn and master today and modern knowledge on topic Basic laws of chemical transformations	**20**
Module control 2.	Ability to learn and master today and modern knowledge on topic Basic laws of chemical transformations	**30**
∑ **Module 2**		**100**
Module 3. Chemistry of elements and qualitative analytical analysis		
Lecture 10. Subject, task, meaning of analytical chemistry. Analytical research technique in natural sciences.		**-**
Laboratory class 10. Theoretical foundations of	Ability to communicate in a	**10**

measurement and processing of results in chemical analysis. The essence and task of quantitative measurements and calculations	English language and to learn Analytical research technique in natural sciences.	
Lecture 11. Chemical-analytical properties of cations on the example of s-elements of I-A and II-A groups, p-elements of III-A and IV-A groups and d-elements of periods 4 and 5		**-**
Laboratory class 11. Subject and task of analytical chemistry. Qualitative analysis. The technique of performing qualitative analytical reactions.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory.	**10**
Laboratory class 12. Study of chemical and analytical properties of s-cations Na, K, Mg, Ca, Sr, Ba.	Ability to communicate in a English language and to learn analytical properties of s-cations Na, K, Mg, Ca, Sr, Ba.	**10**
Lecture 12. Chemical-analytical properties of anions on the example of p-elements VII-A, VI-A, V-A and IV-A groups. Qualitative analysis of an unknown substance (salt, acid, base, oxide).		**-**
Laboratory class 13. Study of chemical-analytical properties of p-cations Al, Pb. Study of chemical and analytical properties of d-cations Zn, Cu, Mn, Fe, Ag.	Ability to communicate in a English language and to learn and study of chemical and analytical properties of d-cations Zn, Cu, Mn, Fe, Ag .	**10**

Lecture 13. Equilibrium in heterogeneous and homogeneous systems. Reactions of precipitation and dissolution of sediments and their significance for analysis.		**-**
Laboratory class 14. Study of the chemical-analytical properties of anions on the example of p-elements VII-A, VI-A, V-A, IV-A and III-A groups B, C, Si, N, P, O, S, Cl, Br, I. Analytical classification of cations. Study of qualitative reactions of the opening of cations of groups I-IV and their separation according to the ammonia-phosphate classification.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory	**10**
Self-study work 3	Ability to learn and master today and modern knowledge on topic Chemistry of elements and qualitative analytical analysis	**20**
Module control 3.	Ability to learn and master today and modern knowledge on topic Chemistry of elements and qualitative analytical analysis	**30**
∑ **Module 3**		**100**
Module 4. Theoretical and experimental foundations of quantitative chemical analysis.		
Lecture 14. Theoretical foundations of measurement and processing of results in chemical analysis. The essence and task of		**-**

quantitative measurements and calculations.		
Laboratory class 15. Analysis of an unknown substance. Two experimental control tasks for the analysis of chemical compounds.	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory and calculations in chemical and volumetric analysis	**10**
Lecture 15. The essence of equilibrium in titrimetry. The practice of measuring by the method of neutralization.		**-**
Laboratory class 16. Techniques of work in quantitative analysis: weighing, measuring vessels, filtering. Volumetric analysis. Calculations in volumetric analysis. Method of neutralization. Preparation of working solutions. Experimental control tasks on the definition of: - alkali solution concentration;	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory and calculations in volumetric analysis	**10**
Lecture 16. Measurement by redoxmetry methods**.**		**-**
Laboratory class 17. Measurement by redoxmetry methods. Preparation of working solutions for permanganatometry and iodometry. A control task for determining the percentage of iron in Mohr's salt by the permanganatometry method and the percentage of copper in copper sulfate	Ability to learn and master today and modern knowledge rules of work in a chemical laboratory and preparation of working solutions for permanganatometry and iodometry.	**10**

by the iodometry method.		
Lecture 17. Measurement by the method of complexometry.		**-**
Laboratory class 18. Complexonometry method. Preparation of working solutions.	The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of the subject area	**10**
Laboratory class 19. Control problems by definition: - general water hardness; - calcium content in the solution	The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of the history and patterns of development of the subject area	**10**
Self-study work 4	Ability to learn and master today and modern knowledge on Theoretical and experimental foundations of quantitative chemical analysis.	**20**
Module control 4.	Ability to learn and master today and modern knowledge on Theoretical and experimental foundations of quantitative chemical analysis.	**30**
∑ Module 4		**100**
Study work		**(M1 + M2 +M3 + M4)/4*0,7 ≤ 70**
Exam		**30**
Course		**(Study work +exam) ≤ 100**

8.2. Higher education student knowledge assessment scale

Student's rating, points	National grading of exams and credits	
	exams	credits
90-100	excellent	pass
74-89	good	
60-73	satisfactorily	
0-59	unsatisfactorily	fail

To determine a student's rating in the discipline $\mathbf{R_{DIS}}$ (upto100points), the received assessment rating $\mathbf{R_A}$ (upto30points) is added to the academic performance raiting $\mathbf{R_{AP}}$ (up to 70 points): $\mathbf{R_{DIS}} = \mathbf{R_{AP}} + \mathbf{R_A}$.

8.3. Evaluation Policy

Deadline and resubmission policy	EXAMPLE: Works submitted after the deadline without a valid reason will be graded lower. Modules can be re-assigned with the permission of the lecturer if there is a valid reason (e.g. sick leave).
Academic Integrity Policy	EXAMPLE: Cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct text references to the literature used
Visitation Policy	EXAMPLE: Attendance at classes is mandatory. For objective reasons (e.g. illness, international internship), studies may be conducted individually (online upon agreement with the dean of the faculty).

9. Technology and methodological requirements

1. Voytenko L., Kopilevich V., Prokopchuk. Inorganic Chemistry. Manual. N. - Kyiv: NUBiP of Ukraine., 2020. - 148 p.
2. Voytenko L., Kopilevich V., Prokopchuk N. Workbook on Inorganic Chemistry. - Kyiv: NUBiP of Ukraine., 2019. - 85 p.
3. Voytenko L., Kopilevich V., Prokopchuk N. Laboratory manual on general and inorganic chemistry for bachelors students specialty 162 – "Biotechnology and bioeingeneering- Kyiv: NUBiP of Ukraine., 2024. - 203 p.
4. Lavrik R.V. Inorganic and analytical chemistry Inorganic Chemistry. https://elearn.nubip.edu.ua/course/view.php?id=1201

10. Recommended sources of information

1. Morris Hein, Leo R. Best, Scott Pattison and Susan Arena. Introduction in General, Organic and Biochemistry, 7th Edition, by Brooks/Cole Publishing Co., 2020, 872 pp.
2. D. F. Shriver, P. W. Atkins, and C.H. Langford; W. H. Freeman. Inorganican analytical Chemistry, secondedition.NewYork, 2023, 913 pp.
3. https://elearn.nubip.edu.ua/course/view.php?id=1201
4. Diclofenac and Omeprazole Electrochemical Determination on Cobalt (III) Oxyhydroxide-Modified Electrode. A Theoretical Study 2024, Letters in Applied Nano-BioScience, Q4, Vol. №13, Issue 2.p.98 -103. Volodymyr V. Tkach, Marta V. Kushnir, Ruslan V. Lavrik https://doi.org/10.33263/LIANBS132.098
5. TheTheoretical Description for Electrochemical Hydroxyquinol and Phloroglucinol Electrochemical Detection Over CoO(OH)-Modified Electrode 2024Letters in Applied Nano-BioScience, Q4, Vol. №13, Issue 3.p.133-136. Volodymyr V. Tkach, Marta V. Kushnir, Ruslan V.Lavrik https://doi.org/10.33263/LIANBS133.136
6. Theoretical Description for Lugduname and Perillartin Electrochemical Determination by Cathodic Route 2024Letters in Applied Nano-BioScience, Q4, Vol. №13, Issue 4.p.162 -167. Volodymyr V. Tkach, Tetiana V. Morozova, Ruslan V. Lavrik . https://doi.org/10.33263/LIANBS134.162