

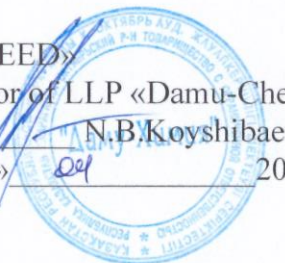
MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN  
KARAGANDA UNIVERSITY OF THE NAME OF ACADEMICIAN E.A.BUKETOV

«AGREED»

Director of LLP «Damu-Chemistry»

N.B.Koyshibaev

« 24 » 09 2021



«AGREED»

Director of LLP «KhimKo»

G.E.Dzhanparova

« 24 » 09 2021



«APPROVED»

Chairman of the Board - Rector of  
Karaganda University of the name of  
academician E.A.Buketov

N.O. Dulatbekov

« 09 » 09 2021



**EDUCATIONAL PROGRAM**

**for**

**8D053-Physical and Chemical Sciences training direction**

*8D05308901-Chemistry degree program*

Level: Doctoral studies (PhD)

Degree: Doctor of Philosophy (PhD) on the 8D05308901-Chemistry educational program

Karaganda, 2021

- The Order of the Ministry of Education and Science of the Republic of Kazakhstan «On approval of the Rules for the organization of the educational process on credit technology» dated 2 October, 2018 No. 152 (with changes and additions from 12 October, 2018 No. 563);
- Classifier of training with higher and postgraduate education of 13 October, 2018 No. 569;
- Professional standard «Science (scientific, scientific and technical activity)», «Higher and postgraduate education (pedagogical and methodological activity)» (Approved by the Ministry of Health on the 10 July, 2015. No. 10-3-16 / 14215);
- Sectoral Qualifications Framework «Chemical Production» (Approved by Protocol No. 1 of the meetings of sectoral commissions on social partnership and the regulation of social and labor relations for the mining and metallurgical, chemical, construction industries and woodworking, light industry and mechanical engineering.

This educational program was recommended by the decision of the University Academic Council to enter into force from 1 September, 2020.

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## 1. The passport of the educational program

### 1.1 General information about the educational program

1. Field of education: 8D05 Science, Mathematics and Statistics
2. Training direction: 8D053 Physical and Chemical Sciences
3. Duration of training: 3 years
4. Language: Russian
5. Application to the state license to engage in educational activities: No 036 from 4 February, 2019
6. Accreditation of the educational program: IQAA agency, certified SA No. 0039 / 6 dated 27 December, 2014, valid until 26 December, 2019
7. Admission Requirements: the persons who have the degree of Master of Science on the educational program «Chemistry» and work experience at least one (1) year.
8. Type of educational program:
  - acting
9. Installed prerequisites for the development of the program:
  - in the case of coincidence of the profile of the educational program of doctoral program of postgraduate education - not required
  - in the case of not matching the profile of the educational program of doctoral program of postgraduate education: - «Theory and Problems of Physical Chemistry» - 3 ESTC
10. Data on foreign partners to implement the program: University of Wolverhampton, Great Britain; Norfolk State University, Norfolk, USA; Basque University, Spain; Charles University, Prague, Czech Republic; Szeged University, Seged, Hungary; Xinjiang University, Urumqi, China; Institute of Petrochemistry and Catalysis, Russian Academy of Sciences, Ufa, Russian Federation; Institute of Solid State Chemistry and Mechanical, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russian Federation; Altai State University, Barnaul, Russian Federation; Tomsk State University, Tomsk, Russian Federation.
12. The main base practices of the educational program:
  - Pedagogical: Physical and Analytical Chemistry Department, Inorganic and Technical Chemistry Department, Chemical Engineering and Environment Department, Organic Chemistry and Polymer Department: Chemical Faculty of the Academician Y.A. Buketov Karaganda State University;
  - Research: LLP «Institute of Organic Synthesis and Coal Chemistry of the Republic of Kazakhstan», LLP «Universal analytical expertise and certification center», LLP «Centrgeolanalit», JSC International Research and Production Holding «Phytochemistry», Chemical and Metallurgical Institute Abisheva, Laboratory of Engineering Profile «Physico-chemical research methods», Institute of Chemical Problems, technological incubator «Chemical materials science and nanochemistry».
13. The main scientific organization, the organization of relevant industries or areas of activity, including foreign ones, to conduct scientific training: Eindhoven University of Technology, Netherlands; Southwestern University «Neophyte Rilski», Blagoevgrad, Bulgaria; Charles University, Prague, Czech Republic; Wroclaw University of Technology, Wroclaw, Poland; Xinjiang University, Urumqi, China; Altai State University, Barnaul, Russian Federation; Tomsk State University, Tomsk, Russian Federation.
14. The basic scientific organizations, research institutes, centers for scientific research: LLP «Institute for the Study of Complex Mineral Development», LLP «Institute of Organic Synthesis and Coal Chemistry of the Republic of Kazakhstan»; JSC International Research and Production Holding «Phytochemistry»; Abishev Chemical and Metallurgical Institute; Institute of Chemical Problems.
15. Possibilities for further continuation of the study: postdoctoral programs in the field of chemistry and chemical engineering.

## 16. Employers List:

No	The names of companies, enterprises, organizations	Contacts, phone, e-mail
1.	JSC International Research and Production Holding «Phytochemistry», Karaganda	8 (7212) 43-31-27 e-mail: <a href="mailto:arglabin@phyto.kz">arglabin@phyto.kz</a> , <a href="mailto:phyto_pio@mail.ru">phyto_pio@mail.ru</a> website: <a href="http://www.phyto.kz">http://www.phyto.kz</a>
2.	LLP «Institute of Organic Synthesis and Coal Chemistry of the Republic of Kazakhstan», Karaganda	8 (7212) 41-38-66, 41-13-29 e-mail: <a href="mailto:iosu@mail.ru">iosu@mail.ru</a> website: <a href="http://www.iosu.kz">http://www.iosu.kz</a>
3.	Karaganda Medical University, Karaganda	8 (7212) 51-34-79, 50-39-30, 51-89-31 e-mail: <a href="mailto:info@kgmu.kz">info@kgmu.kz</a> website: <a href="http://www.kgmu.kz/">http://www.kgmu.kz/</a>
4.	Karaganda State Technical University, Karaganda	8 (7212) 56-03-28, 56-75-98 e-mail: <a href="mailto:kargtu@kstu.kz">kargtu@kstu.kz</a> website: <a href="http://www.kstu.kz/">http://www.kstu.kz/</a>
5.	LLP «Institute for the Study of Complex Mineral Development», Karaganda	8 (7212) 41-45-20 e-mail: <a href="mailto:info@ipkon.kz">info@ipkon.kz</a> website: <a href="http://ipkon.kz">http://ipkon.kz</a>
6.	LLP «Centrgeolanalit», Karaganda	8 (7212) 42-60-76; 42-60-39 e-mail: <a href="mailto:corp@analit.kz">corp@analit.kz</a> website: <a href="https://analit.kz">https://analit.kz</a>
7.	LLP «Universal analytical expertise and certification center», Karaganda	8 (7212) 30-43-51, 30-43-52 e-mail: <a href="mailto:info@uacec.com">info@uacec.com</a> website: <a href="http://uacec.com">http://uacec.com</a>
8.	RSE «National Center on complex processing of mineral raw materials of the Republic of Kazakhstan», Almaty	8 (7272) 59-00-70; 59-00-75 e-mail: <a href="mailto:nc@cmrp.kz">nc@cmrp.kz</a> , <a href="mailto:cmrp@mail.ru">cmrp@mail.ru</a> website: <a href="http://www.cmrp.kz">www.cmrp.kz</a>
9.	Abishev Chemical and Metallurgical Institute, Karaganda	8 (7212) 43-31-61 e-mail: <a href="mailto:hmi2009@mail.ru">hmi2009@mail.ru</a> website: <a href="http://www.hmi.kz">www.hmi.kz</a>
10.	Karaganda State Industrial University, Temirtau	8 (7213) 91-56-26; 91-16-59; 91-42-66. e-mail: <a href="mailto:info@kgiu.kz">info@kgiu.kz</a> website: <a href="http://www.kgiu.kz">www.kgiu.kz</a> .
11.	Ualihanov Kokshetau State University, Kokshetau	8 (7162) 25-55-97; 25-56-26; 25-51-69 e-mail: <a href="mailto:mail@kgu.kz">mail@kgu.kz</a> , <a href="mailto:mailkgukz@gmail.com">mailkgukz@gmail.com</a> website: <a href="http://www.kgu.kz">www.kgu.kz</a>

## **2. Qualification characteristics of doctoral graduates**

### **2.1 List of qualifications and positions**

Doctoral graduate is awarded the «**Doctor of Philosophy (PhD)**» degree on the 8D05308901-Chemistry educational program. **The list of positions includes:** Engineer, Head of Laboratory, Production Manager, Principal Researcher; Leading Researcher; Senior Researcher; Researcher; laboratory assistant; engineer; Senior Assistant; Junior Researcher; Professor; docent; Senior Lecturer; Advisor teacher (assistant); methodologist of the structural unit.

### **2.2 Scope of professional activities**

The sphere of professional activity of «8D05308901-Chemistry" educational program graduates are the branches of chemical, metallurgical, petrochemical and pharmaceutical industries; education, science and ecology.

### **2.3 Objects of professional activity**

The objects of «8D05308901-Chemistry» educational program doctors professional activity are:

- institutions of higher education;
- governments in the field of education, the chemical industry;
- the establishment of control and analytical services, standardization and certification centers;
- natural resource agencies and environmental protection.

### **2.4 Subject of professional activity**

The subject of professional activity of graduates of the educational program «8D05308901-Chemistry" is the study of the laws and regularities of chemical reactions, processes and technologies; environmental objects; teaching activities.

### **2.5 Types of professional activities:**

- educational and pedagogical: work as teachers of chemistry at the universities public and private sector;
- organizational and management: working as heads of departments and services in different scientific organizations, research institutes, as well as various departments and departments of chemical, pharmaceutical, metallurgical industries, and environmental services;
- production and technology: work in institutions of chemical, environmental, metallurgical, pharmaceutical, petrochemical, gas and coal Profile .;
- Research and experimental research: work as professionals and researchers in the laboratory of chemical, environmental, metallurgical, pharmaceutical, petrochemical, gas and coal profile.

### **2.5 Functions of professional activity:**

- implementation of the organization of production and technological processes in the chemical industries, and industry;
- implementation of development methodologies, organizing and conducting a variety of chemical analyzes, research chemicals and the characteristics of their composition;
- planning and organization of research programs;
- Manual industrial, scientific and teaching staff, laboratory;
- planning and organization of educational work in the field of education.

### **2.6 Typical tasks of professional activity:**

*in the field of organizational and technological activities:*

- statement and organization of the conditions for chemical processes;
- production solution of technological problems;
- etc.;

*in the field of research activities:*

- work with the scientific literature;
  - implementation of scientific programs;
  - experimental production;
  - summary and analysis of experimental data;
- etc.;

*in the field of production and management activities:*

- Guide the conditions for carrying out chemical processes;
  - Guide a certain research group, laboratory;
- etc.;

*in the field of educational activity:*

- conducting laboratory and practical classes;
- preparation of laboratory work;
- management of scientific circles, groups.

## **2.7 The content of professional activity**

Doctoral student of this area should be able to:

- plan, design, implement and coordinate the process of scientific research;
- purposefully carry out scientific research in accordance with modern requirements of the experiment and summarize the resulting experimental material;
- critically analyze, evaluate and compare new and complex ideas; communicate their knowledge and achievements to colleagues and the scientific community; contribute their own original solutions, research, expanding the boundaries of the scientific field;
- to use the acquired knowledge for priority research areas for the economic growth of the Republic of Kazakhstan;
- to use scientific knowledge to create an economically and environmentally beneficial new technologies in the field of waste-free processing of mineral raw materials of Kazakhstan;
- Administer the academic and teaching departments, research units, laboratories, departments;
- to present and justify the experimental material

## **3. The purpose of the educational program**

The aim of the «8D05308901-Chemistry» educational program is to prepare competitive qualified scientific and pedagogical staff with high spiritual and moral qualities, capable of independent thinking and providing a progressive science and technology, socio-economic and cultural development of society, possessing fundamental knowledge, innovative approaches, research skills for scientific, educational, professional and practical work in the field of chemistry and related scientific fields.

### **3.1 The overall goal of the educational program is:**

Training of qualified specialists for the development of economy, industry, education and science of the Republic of Kazakhstan, creation of conditions for full-fledged education, professional competence in the field of chemistry and chemical technology.

**3.2 The purpose of the basic disciplines of the cycle is the** provision of basic knowledge in the field of chemistry and chemical sciences, natural and scientific, general technical and economic nature, such as vocational education foundation.

**3.3 The purpose of the cycle majors is the** provision of professional knowledge and practical skills in the field of chemistry and related scientific fields. According to the cycle of majors, the graduate of this profile must meet the requirements that determine competence in the field of:

- theoretical and practical problems of the main areas of chemistry;
- professional research and innovation activities;
- carrying out research of theoretical and experimental studies;
- legal and / or educational documents regulating educational, technological or scientific process;
- interpersonal and intercultural communication, to interact in a team, have leadership skills, be proactive and responsible in their professional activities;
- information activities, constant updating of professional knowledge;
- matters of specialty and philosophical questions of natural science;
- management of chemical technology; in the principles of construction of flowsheets chemical production;
- organizational and economic foundations of chemical industries;
- questions of ownership colloquial and scientific terminology in a foreign language; reading and discussion of scientific articles and achievement, as well as participate in the conversation.

**3.4 The purpose of the research** / experimental and research work is the study the latest theoretical, methodological and technological achievements of domestic and foreign science, as well as the consolidation of practical skills of application of modern methods of scientific research, processing and interpretation of experimental data in this thesis.

**3.5 The purpose of the final certification is the** assessment of scientific and theoretical and analytical research and doctoral level, formed of professional and managerial skills, readiness for self-fulfillment of professional goals and its compliance with the requirements of the professional standard of training and education of doctoral programs.

#### 4. Key competences graduate

competence code	Description of competence
<b>Personal Competences</b>	
<b>PC1</b>	The ability to independently carry out research and development in the relevant professional field with the use of modern methods of research and information and communication technologies
<b>PC2</b>	Ready for teaching basic educational in the field of chemistry and chemical engineering programs of higher education
<b>PC3</b>	Capacity for critical analysis and evaluation of modern scientific achievements, generating new ideas in solving the research and practical problems, including interdisciplinary fields
<b>PC4</b>	Willingness to use modern methods and technologies for research and teaching communication in the native and foreign languages in the field of professional activity at a level to carry out research and to implement the teaching of special disciplines in universities
<b>PC5</b>	Ability to plan and solve problems of their own professional and personal development
<b>Specialized Competence</b>	
<b>SC1</b>	Demonstrates possession of conceptual knowledge of fundamental mathematics, natural sciences and technical disciplines that contribute to the formation of a highly educated person with a broad outlook and culture of thinking
<b>SC2</b>	Demonstrates understanding of the principles of work and ability to work on modern scientific equipment for research
<b>SC3</b>	It demonstrates the ability to use the normative documents on metrology, quality standards in practice; ability to apply safety rules, occupational health, fire and safety regulations
<b>SC4</b>	shows the ability to choose the technology of scientific research, to evaluate the costs and organize its implementation; the ability to perform analysis of the results of a scientific experiment with the use of appropriate methods and processing tools; present the results of research work in the documentary form, decorated in accordance with your requirements, using appropriate tools, processing and reporting



<b>SC5</b>	Demonstrates the ability to critically analyze current problems of innovation in the field of chemistry, to set goals and develop a program of research, interpret, represent and apply the results
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### 5. Key learning outcomes

<b>competence code</b>	<b>Code learning outcome</b>	<b>Result</b>
<b>PC1</b>	<i>LO1</i>	Demonstrates knowledge of the theoretical and methodological fundamentals of the chosen field of research; history and development of major scientific schools; current issues and trends of development of the scientific field and the field of professional activity; existing interdisciplinary relationships and the possibility of using economic tools in research on the intersection of science; techniques, methods and forms of scientific debate, basis for effective scientific and professional communication, rhetoric, laws and requirements for public speaking
	<i>LO2</i>	It demonstrates the ability to develop their point of view in professional matters and to defend it during a discussion with specialists and non-specialists; abstracted the scientific literature, including foreign languages, subject to scientific ethics and copyright
	<i>LO3</i>	It owns modern information and communication technologies
<b>PC2</b>	<i>LO4</i>	Demonstrates knowledge of legal documents governing the organization and content of the educational process, the basic principles of educational programs, including taking into account international experience
	<i>LO5</i>	He knows how to develop educational programs on the basis of competence-based approach, the modular principle, the credit system; carry out the selection and use of optimal methods of teaching and assessment of students achievement
	<i>LO6</i>	It owns the technology of designing of the educational process at higher education level; methods and technologies of teaching and assessment of students achievement
<b>PC3</b>	<i>LO7</i>	Demonstrates knowledge of the methods of critical analysis and evaluation of modern scientific achievements, as well as methods for generating new ideas in solving the research and practical problems, including interdisciplinary fields
	<i>LO8</i>	It is able to analyze alternative solutions research and practical problems and assess the potential of these options, in the solution of practical problems of research and generate new ideas, measurable operationalization based on available resources and constraints
	<i>LO9</i>	He has the skills to analyze the methodological problems that arise in dealing with research and practical-for cottages; skills of critical analysis and evaluation of modern scientific achievements and results of research and to address practical problems, including interdisciplinary fields
<b>PC4</b>	<i>LO10</i>	Demonstrates knowledge of methods and techniques of scientific communication; stylistic peculiarities of presentation of the results of scientific activity in oral and written form in the native and foreign languages
	<i>LO11</i>	She is able to follow the basic norms accepted in the scientific communication in the native and foreign languages
	<i>LO12</i>	He owns a scientific text analysis skills; a variety of methods, technologies and types of communications in the exercise of professional activity in the native and foreign languages
<b>PC5</b>	<i>LO13</i>	Demonstrates knowledge of the content of the process of goal-setting professional and personal development, its features and how to implement in solving professional problems based on the stages of career and labor market requirements.
	<i>LO14</i>	Is able to formulate goals for personal and professional development and conditions for their achievement, based on the trends of development of the field of professional activities, career stages, individually-personal features; to exercise personal choice in a





				LO10, LO11, LO12, LO25, LO26, LO27	PC4, PC4
PD / UC		MFRI7104	Methods of Fast Reactions Investigation (in English)	LO1, LO2, LO3, LO4, LO5, LO6, LO7, LO8, LO9	SC1, SC2, SC3
				LO16, LO17, LO18, LO19, LO20, LO21, LO22, LO23, LO24	PC1, PC2, PC3
				LO10, LO11, LO12, LO28, LO29, LO30	SC4, SC5
PD / CC	Nanochemistry	IN7205	Inorganic Nanomaterials	LO1, LO2, LO3, LO4, LO5, LO6, LO7, LO8, LO9	LK1, LK2, LK3
				LO16, LO17, LO18, LO19, LO20, LO21, LO22, LO23, LO24	SC1, SC2, SC3
PD / CC		MN7206	Modern Nanotechnology	LO1, LO2, LO3, LO4, LO5, LO6, LO7, LO8, LO9	LK1, LK2, LK3
				LO16, LO17, LO18, LO19, LO20, LO21, LO22, LO23, LO24	SC1, SC2, SC3
PD / CC		CN7207	Computer Nanochemistry	LO1, LO2, LO3, LO4, LO5, LO6, LO7, LO8, LO9	LK1, LK2, LK3
				LO16, LO17, LO18, LO19, LO20, LO21, LO22, LO23, LO24	SC1, SC2, SC3

## 8. The content of the educational program

### 8.1 Map of the educational program

module code	Cycle and the component	The code discipline	form of control	Semester	ESTC	learning Outcomes
<b>1 Course</b>						
MPC 7101 Modern problems of chemistry	DB / BK	SPFH7101 Modern Problems of Physical Chemistry	Exam	<i>1</i>	<b>5</b>	<p><i>Knowledge:</i> Modern problems of physical chemistry and the different ways of solving them.</p> <p><i>Ability:</i> to use the modern information, analytical and experimental research methods in the field of physical chemistry.</p> <p><i>Skills:</i> possession of modern methods of analysis of the problems of physical chemistry and ways of solving them.</p> <p><i>Competencies:</i> PC1, PC2, PC3, PC5, SC1, SC2, SC3, SC5</p> <p><i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>- is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
SPH 7101 Modern chemistry problems	DB / HF	HTKR7102 Chemical Technology catalytic reactions	Exam	<i>one</i>	<b>5</b>	<p><i>Knowledge:</i> physical and chemical bases of catalytic processing of raw materials technology for the needs of the region; Modern methods of catalytic processing of fossil fuels, methods of manufacture of catalysts, adsorbents and carriers, selection of the best approaches to catalysts for processes of oil and gas technology.</p> <p><i>Ability:</i> using research methods properties of industrial catalysts; forecasting nature of the catalyst and its preparation technology to process hydrocarbon processing.</p> <p><i>Skills:</i> developing adequate kinetic description of processes with regard to the mechanism of the reactions occurring on the catalyst surface; search of heterogeneous catalysts technologies for hydrocarbon refining processes.</p>

						<p><i>Competencies:</i> LK1, LK2, LK3, LK5, SC1, SC2, SC3, SC5</p> <p><i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
SPH 7101 Modern chemistry problems	DB / HF	magnetic resonance SMR7103S pektroskopiya (English)	Exam	<i>one</i>	<b>5</b>	<p><i>Knowledge:</i> theoretical bases methods NMR and EPR spectroscopy; devices and circuits of modern devices in magnetic resonance spectroscopy</p> <p><i>Ability:</i> select the method for analyzing objects of various natures; the use of modern physical equipment for the appropriate method.</p> <p><i>Skills:</i> NMR data interpretation and the ESR of organic and inorganic compounds; deciphering the molecular structure of unknown compounds based on a set of spectroscopic data.</p> <p><i>Competencies:</i> LK1, LK2, LK3, LK4, SC1, SC2, SC3, SC4</p> <p><i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
SPH 7101 Modern chemistry problems	AP / BK	MIBR7104 Metody	Exam	<i>one</i>	<b>5</b>	<p><i>Knowledge:</i> Dynamic EPR and NMR spectroscopy; theoretical bases descriptions of spectral characteristics.</p>

		study of fast reactions (in English)				<p><i>Ability:</i> to interpret the spectra and dynamic extraction of kinetic information.  <i>Skills:</i> computer simulation study of molecular systems and their spectra.  <i>Competencies:</i> LK1, LK2, LK3, LK4, SC1, SC2, SC3, SC4  <i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
NN 7202 Nano-chemistry	PD / HF	NN7205 Inorganic Nanomaterials	Exam	2	5	<p><i>Knowledge:</i> the physical nature of the phenomena occurring in the materials in the conditions of application of nanostructures; their correlation with the properties of the resulting product; basic properties of inorganic nanomaterials.  <i>Ability:</i> to evaluate the behavior of nanoobjects when subjected to various operating factors; reasonably choose methods for modifying the properties of nano-modified inorganic materials.  <i>Skills:</i> selection of inorganic nanomaterials for various purposes, as well as with techniques that allow to define properties and evaluating characteristics of materials and structures.  <i>Competencies:</i> LK1, LK2, LK3, PC1, PC2, PC3  <i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> </ul>

						<ul style="list-style-type: none"> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
NN 7202 Nano-chemistry	PD / HF	SN7206 Modern nanotechnology	Exam	2	5	<p><i>Knowledge:</i> theoretical foundations and terminology of nanotechnology; the main stages of solving the problem of implementation of the specific areas of nanotechnology in materials science; world experience of nanotechnologies.</p> <p><i>Ability:</i> to conduct communications between the structure, composition and properties of nanomaterials, using reference pictures in their structure and properties; use the methods of implementation of nanotechnology in materials science.</p> <p><i>Skills:</i> in the field of technologies for producing nanomaterials in the practice of professional activities.</p> <p><i>Competencies:</i> LK1, LK2, LK3, PC1, PC2, PC3</p> <p><i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> <li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li> <li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li> <li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li> <li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li> <li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li> </ul>
NN 7202 Nano-chemistry	PD / HF	KH7207 Computer Nanochemistry	Exam	2	5	<p><i>Knowledge:</i> basic capabilities and limitations of modern methods of computational chemistry to describe the structure and properties of nanosystems.</p> <p><i>Ability:</i> to plan quantum-chemical theoretical studies of the properties of nanosystems, the formulation of calculation tasks and the selection of appropriate methods to solve them.</p> <p><i>Skills:</i> possession of modern approaches to the analysis of structure and properties of nanosystems and modeling of their transformations within computational chemistry methods.</p> <p><i>Competencies:</i> LK1, LK2, LK3, PC1, PC2, PC3</p> <p><i>Criteria for evaluation:</i></p> <ul style="list-style-type: none"> <li>- systematic, deep and full knowledge of all areas of the discipline in the framework of basic and additional literature recommended curriculum subjects;</li> </ul>



						<ul style="list-style-type: none"><li>- the ability to navigate in the theories, concepts and directions for the study discipline and give them a critical evaluation, use the scientific achievements of other disciplines;</li><li>is the exact use of scientific terminology (including a foreign language), stylistically competent, logically correct statement of response to the questions;</li><li>- perfect possession of the tools of the discipline, his ability to be used effectively in the formulation and solution of scientific and professional tasks;</li><li>- independent creative work on practical, laboratory classes, active participation in group discussions, a high level of culture of execution of tasks;</li><li>- expressed the ability to independently and creatively solve complex problems in a precarious situation.</li></ul>
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## 8.2 Summary table for the volume of the educational program

Course of Study	Semester	The number of modules re-claimed	The num-ber of sub-jects stud-ied		Amount of ECTS credits						Total hours	amount		
			UC	CC	theoretical training	Ped. practice	Production Practice	Research practice	Scientific and re-search work of doctoral student (SRWD)	final examination		Total	Exam	Differential test
1	1	1	3	2	25				5		30	900	5	1
	2					10			20		30	900		2
2	3	1						10	20		30	900		2
	4							30		30	900		1	
3	5	2							30		30	900		1
	6							18	12	30	900		1	
<b>Total</b>		<b>4</b>	<b>2</b>	<b>5</b>	<b>25</b>	<b>10</b>		<b>10</b>	<b>123</b>	<b>12</b>	<b>180</b>	<b>5400</b>	<b>5</b>	<b>8</b>

### Compiled by:

Associate Professor of the Physical and Analytical Chemistry Department,  
Candidate of Chemical Sciences

Head of the Physical and Analytical Chemistry Department

### Agreed:

Chairman of methodical commission of the Chemical Faculty

### Note:

Educational program was reviewed and recommended at the Faculty Council from 04.04.2021 protocol number 10

Academic curriculum was considered at the meeting of the Scientific Methodical Council of the University and recommended for approval from «  » 04.05.2021 Protocol № 5.1


Educational program was considered and approved at the meeting of the Academic Council from 04.06.2021 Protocol № 13


Board member, Vice-rector for research

Board member, Prorector on Academic Affairs

Head of the postgraduate education department

Dean of the Chemical Faculty

  
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