APPROVED
at a meeting of the Academic Council
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Protocol № 11 from 23.05.2025 y.

The program of the entrance exam for applicants to the PhD for the group of educational programs D097 – «Chemical engineering and processes»

1. General provisions.

1. The program was drawn up in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 600 “On Approval of the Model Rules for Admission to Education in Educational Organizations Implementing Educational Programs of Higher and Postgraduate Education” (hereinafter referred to as the Model Rules).

2. The entrance exam for doctoral studies consists of writing an essay, passing a test for readiness for doctoral studies (hereinafter referred to as TRDS), an exam in the profile of a group of educational programs and an interview.

Block	Points
1. Interview	30
2. Essay	20
3. Examination according to the profile of the group of the educational program	50
Total admission score	100/75

3. The duration of the entrance exam is 3 hours and 10 minutes, during which the applicant writes an essay and answers the electronic exam ticket. The interview is conducted at the university before the entrance exam.

2. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D097 – «Chemical engineering and processes» write a problematic / thematic essay. The volume of the essay is at least 250 words.

2. The electronic examination card consists of 3 questions.

Topics for exam preparation according to the profile of the group of the educational program.

1. General information about the entrance exam program

Answers to the exam questions of the entrance exam require knowledge from the main sections of the following disciplines studied at the bachelor's and partially master's level:

1. General chemical technology
2. Basic processes and devices of chemical technology
3. Physical chemistry
4. Analytical chemistry
5. Organic chemistry
6. Petrochemistry

The questions are aimed at identifying, first of all, functional and especially systemic competencies among applicants for doctoral studies, i.e. applicants must show the ability to solve proposed problems, analyze certain situations

Each exam card includes 3 questions; the content of each question can refer to any of the above disciplines, or a combination of the two disciplines.

Since the questions on the exam card cover a number of separate disciplines, they are characterized by some peculiarities. First, the questions (the overwhelming majority) are formulated in such a way that the answers to them require the applicant to understand the problem as a whole, and not to state secondary details and details. Many questions allow for several alternative answers (depending on the preferences of the applicant). For example, in the assignment, it is required to provide a schematic diagram of a phosphorus or nitrogen-containing fertilizer, and the choice of a specific fertilizer remains with the applicant. Or, it is required to give a schematic diagram of the production of a specific chemical product, while the choice of the production method entering the doctoral program can be chosen by himself.

A significant proportion of the questions are questions of a problem type. The applicant is invited to solve a specific problem in the field of chemical engineering, and it is possible to give several different correct answers to the question. For example, an applicant for doctoral studies must be offered ways to process (utilize) specific waste from the chemical or metallurgical industry. It is enough for the applicant to give one detailed and reasonable solution to get the highest score for the question. Another example, from the field of analytical chemistry: during the development of a new deposit of non-ferrous metal, it became necessary to determine this metal in different concentration ranges. The applicant must propose methods for determining the metal in the raw material, the most suitable for each concentration range.

About a quarter of all questions require from applicants a graphic representation of circuits, devices, processes, the construction of explanatory drawings.

It is very important that applicants know and understand the basic definitions of terms from each discipline included in the exam questions.

2. List of references.

Discipline **«General chemical technology»**

1. Basic definitions and concepts of chemical technology.
2. Classification of chemical technological processes.
3. Chemical raw materials and their sources.
4. Methods of mineral processing.
5. Sulfuric acid production.
6. Production of ammonia, nitric acid and nitrogen fertilizers.

7. Production of phosphate fertilizers.
8. Basics of mineral processing.
9. Electrochemical production (features, principles of implementation, examples).
10. Thermodynamics of the formation of superheated steam from cold water
11. Wastewater treatment (basic methods).
12. Liquid extraction in chemical technology.
13. Sorption processes in chemical technology.
14. Obtaining industrial gases.
15. Principles of Green Chemistry.
16. Technical and economic indicators of chemical production.
17. The structure of the cost of chemical production.
18. Ways to reduce the cost of chemical products.
19. Economic efficiency of the chemical-technological process.

Discipline **«Basic processes and devices of chemical technology»**

1. General principles of analysis and calculations of chemical devices.
2. Material balance of chemical production.
3. Heat balance of chemical production.
4. Hydrodynamic processes. Filtration. Centrifugation.
5. Mixing in chemical technology, mixing devices.
6. Mass transfer processes.
7. Heat exchange processes.
8. Intensification of chemical processes.

Discipline **«Physical chemistry»**

1. The first and second laws of thermodynamics.
2. The thermal effect of a chemical reaction.
3. Chemical equilibrium, principles of its displacement.
4. Phase transitions in chemical technology (general concepts).
5. Thermodynamic approach to the analysis of a chemical-technological process.
6. Kinetic approach to the analysis of a chemical-technological process.
7. Influence of the catalyst on the rate of chemical reaction. Requirements for industrial catalysts.

Discipline **«Organic Chemistry»**

1. Isomerism of organic compounds.
2. Reactions of electrophilic substitution.
3. Industrial organic synthesis (general approaches to implementation).
4. Reactions of substitution in organic chemistry.
5. Prospects for the production and use of polymers in Kazakhstan.

Discipline **«Analytical chemistry»**

1. The main stages and principles of analytical control.
2. Sampling for analytical control.
3. Features of analytical control in the field (out-of-laboratory) conditions.
4. Chemical methods of analysis (classification, examples).
5. Physical methods of research and analysis (X-ray analysis, electron probe methods).
6. Error of analytical control results.

7. Statistical processing of analytical control results (basic principles of implementation)

Discipline **«Petrochemistry»**

1. Modern trends in the development of petrochemistry and oil refining.
2. Modern oil refining complexes.
3. Primary oil refining.
4. Secondary oil refining.
5. The main directions of alkane processing.
6. The main directions of processing of aromatic hydrocarbons.
7. Processing of natural gas, associated petroleum gas and gas condensate into marketable products.
8. Utilization of waste from oil, gas and coal refining processes.
9. Obtaining and using synthesis gas.
10. Thermal processes in petrochemical production.
11. Steam concession of natural gas.
12. Coal gasification.

3. List of references.

Main:

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Additional:

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