

**AL-FARABI KAZAKH NATIONAL UNIVERSITY**  
**Faculty of Chemistry and Chemical Technology**  
**Department of Physical Chemistry, Catalysis and Petrochemistry**

**Program of the final exam in the discipline**

**FH 2211 «Physical chemistry, part I»**

Educational program “6B05301 – Chemistry (NIS)”

Almaty, 2021

Program of the final exam in the discipline was compiled by the lecturer of the Department of Physical Chemistry, Catalysis and Petrochemistry Supiyeva Zh.A.

It was considered and recommended at the meeting of the Department of Physical Chemistry, Catalysis and Petrochemistry at «15» November 2021, Protocol No 5.

Head of the Department \_\_\_\_\_ Ye.A. Aubakirov

## Introduction

**Exam format:** synchronous, i.e. the student takes the exam in real time "here and now".

**Exam form:** testing.

**Exam platform:** LMS Moodle.

**Control of passing testing:** automatic proctoring system

## Exam rules

### *Test duration and number of test questions*

The exam will be held in accordance with the schedule, strictly according to the schedule. Students who, for technical reasons, cannot write during the exam can write it within the next 48 hours. For each student, the system will automatically generate 25 questions (of five different types). To answer these questions, the student will be given 1 attempt, and the test duration will be 60 minutes

## Test check and scoring

In LMS MOODLE - the score is reflected in the system immediately after testing, and the points will be set in the certification within 48 hours.

**Important!!!** In order for the testing session to be successful, the following steps must be taken immediately before the test:

1. provide good lighting in the room,
2. check the availability and speed of your internet connection,
3. check that the camera and microphone are turned on and the camera lens is not covered with a cap,
4. prepare a document for personal identification,
5. turn on the laptop to the mains (battery power may reduce the performance of the device),
6. reboot your computer for maximum performance,
7. turn off all unnecessary programs and tabs in the browser (use the Windows Task Manager, which is invoked by the Ctrl + Shift + Esc keyboard shortcut; the program is closed by the End task button),
8. remove headphones, books and notes (unless they are allowed by the exam rules),
9. disable duplicate monitors (if any).

Instructions for students to take the test:

1. Go to the LMS Moodle <https://dl.kaznu.kz/>.

2. In the window that opens, enter your login password (which you use for the Univer system). Click Sign in.

3. Open the course you want (double-click on the course name).

4. On week zero, the prepared PDF file "Final Exam Program" will be uploaded, download and read the document.

Zero week is located at the very beginning of the course - until the first week.

5. In the form of an element "Test" there will be "Final exam *in Physical chemistry, part I*".

To open the test, you must click on the corresponding hyperlink. This will open a window containing 25 test questions. Testing will be possible only at the scheduled time, within 60 minutes.

The questions can be answered in any order. After answering all the questions, a page will open containing statistics of all answers. Submit your test by clicking: Submit All and End Test.

***The following types of questions in test tasks are found on the exam for this discipline:***

**Multiple choice** – the student chooses the answer to a question from several options offered to him, and the questions may involve one or several correct answers at once;

**True/False** – the student chooses between two options True or False;

**For correspondence** – each element of answers in the first group must be matched with an element of answers in the second group;

**Nested answers** are text directly inserted into which short answers, numeric answers, or multiple choice answers are inserted, as in «workbook»;

**Numeric** – the same as the short answer, only for performing computational operations, the numeric answer can have a specified range of maximum allowed error deviations from the correct value.

***Topics on which test assignments will be compiled:***

1. Physical chemistry, methods of its research, basic concepts and concepts. The first law of thermodynamics, its definitions, analytical formula. Hess's law, its consequences.

2. Heat capacity, its dependence on various factors. Mayer's equation. Temperature dependence of the thermal effect of a chemical reaction, Kirchhoff's equation.

3. Application of the first law of thermodynamics to various processes involving ideal gases.

4. The second law of thermodynamics, its concepts. Carnot cycle and Carnot's principle. Efficiency of an ideal heat engine. Entropy.

5. Entropy is a criterion for the direction of the process (constructive condition). Equations for calculating the change in entropy in various processes. Planck's postulate.

6. Thermodynamic potentials. Characteristic functions and their natural variables. Comparative characteristics of thermodynamic functions ( $\Delta U$ ,  $\Delta H$ ,  $\Delta S$ ,  $\Delta F$ ,  $\Delta G$ ) as a criterion for the direction of the process.

7. Chemical potential, its relationship with thermodynamic functions and composition of the system. Chemical potential of a component in ideal and real solutions. Activity, activity coefficient.

8. Homogeneous equilibrium, its features and conditions. Isothermal equations of chemical reactions and directions of processes for various homogeneous systems. The law of mass interaction and the equilibrium constant of a chemical reaction.

9. Temperature dependence of the equilibrium constant. Isobaric and isochoric Van't Hoff equations.

10. Phase, components, constituent. Heterogeneous chemical systems, equilibrium conditions in them. Gibbs Phase Rule. Clapeyron-Clausius equation. Description of the state of the water diagram by the Clapeyron-Clausius equation and the Gibbs phase rule. Phase transitions of types 1 and 2, their features.

11. Melting diagram of a two-component system: one-eutectic systems, systems in which components interact chemically (forming compounds with congruent and incongruent melting points). Solid solutions, their formation by penetration and displacement. Melting diagram of solid solutions. Gibbs-Rosebohm Rules I and II.

12. Solubility of two and three liquids in each other. Methods for displaying the composition of a three-component system. Tarasenkov's rule. Crisis melting points. Extraction.

13. Thermodynamic properties of ideal liquid solutions. Real solutions. Raoult's law. Thermodynamic substantiation of the linear dependence of the total and partial vapor pressure on the composition of the system for ideal systems.

14. Boiling point (vapor pressure) - composition ( $t$ ,  $P - x$ ) diagrams. Gibbs-Konovalov laws I and II.

15. Ebulliometry. Cryometry. Determination of the molecular weight and molecular state of the solute from cryometric or ebulliometric data. Isotonic Van't Hoff coefficient.

### ***Grading policy***

Each correct answer is graded 4 points.

The maximum score for 25 correct answers is 100 points.

***Recommended Reading Sources for Preparing for the Exam***

1. Elements of Physical Chemistry: 6th Edition / P. Peter. Atkins. - Oxford: Oxford University Press, 2013. - 591 p.
2. Physical chemistry: a modern introduction: second Edition / updated and revised by W.M.Davis. - USA: CRC Press, 2012. - 501 p.
3. David W. Ball. Physical Chemistry. USA, Thomson Learning, 2011. 840 p.
4. Peter Atkins, Julio de Paula. *Physical Chemistry*, Eighth Edition. Oxford University Press, 2006. 1050 p.
5. Robert J. Silbey, Robert A. Alberty, Mounqi G. Bawendi. Physical Chemistry. Hamilton Printing, 2005. 944 p.
6. Стромберг А.Г., Семченко Д.П. Физическая химия. М.: Высшая школа, - 2003, 527 с.
7. Краснов Г.С., Воробьев Н.К., Годнев И.Н. и др. Физическая химия: в 2-х книгах. М.: Высш.шк., 1995. Кн.1,2.
8. Ira N. Levine. Physical Chemistry. Sixth Edition. *New York*: McGraw-Hill, 2009. 995 p.
9. Еремин В.В., Каргов С.И., Успенская И.А. и др. Задачи по физической химии. М.: Экзамен, 2005, 318 с.