

**al – Farabi Kazakh national University**  
**Faculty of chemistry and chemical technology**  
**Department of physical chemistry, catalysis and petrochemistry**

**Program of final exam on discipline**

**FH 2213 «Physical chemistry, 2»**  
**6B05301 – Chemistry**

**Almaty 2023 y.**

The program of final exam is composed by senior lecturer of the department of physical chemistry, catalysis and petrochemistry Supiyeva Zh.A.

Reviewed and recommended at the meeting of the department of physical chemistry, catalysis and petrochemistry

«25» January 2023 y., protocol № 7

Head of department \_\_\_\_\_ Ye.A.Aubakirov

## Introduction

**The form of the exam:** standard, written

**Exam platform:** UC “Univer”

**Type of exam** - offline

**Exam control** - video cameras in the classroom and a teacher

**Duration:** 3 hours to answer the questions.

## Topics for which assignments will be compiled

1. Basic concepts of chemical kinetics. The chemical reaction rate, the influence of various factors on the rate. The basic postulate of chemical kinetics. Average and instant rates. Rate constant, its physical meaning. The mechanism of a chemical reaction, elementary stages, an elementary act of a chemical reaction. Molecularity and order of reaction.
2. Kinetic analysis of simple irreversible reactions of the first, second, n-th (with equal concentrations of reactants) and zero orders. Half-life. Dimension of the different orders reactions rate constants.
3. Integral and differential methods for determining the reaction order and the rate constant of formal-simple reactions in closed systems.
4. The dependence of the reaction rate on temperature. Van't Hoff's rule, temperature coefficient. Arrhenius's law. Activation energy, physical meaning, empirical and true activation energy. Methods for determining the activation energy.
5. The postulates of the independence of the flow of elementary reactions, detailed equilibrium and the limiting stage. Kinetic analysis of a reversible and parallel first-order reaction.
6. Kinetic analysis of consequent reactions. Analysis of kinetic dependences in sequential reactions. Approximate methods of chemical kinetics. Bodenstein's principle of quasi-stationary concentrations.
7. Homogeneous catalysis. Basic properties of the catalyst. Catalytic activity and selectivity. Kinetics of homogeneous catalytic reactions.
8. Heterogeneous catalysis. Adsorption on the catalyst surface. The main stages of a heterogeneous catalytic reaction. Kinetics of heterogeneous catalytic reactions, Langmuir's adsorption theory.
9. Basic characteristics of electrochemical reactions. Causes of electrostatic dissociation. Positive and negative sides of Arrhenius' theory of electrostatic dissociation. Solvation and hydration in electrolyte solutions.
10. Thermodynamic theory of electrolyte solutions. Activity and activity coefficient. Ionic strength of solution, Lewis Randall rule. Debye-Gückel theory of strong electrolytes. Basic concepts of the electrostatic theory of electrolyte solutions. Equations for activity coefficients in the first, second and third approximations, concentration limits of their application.

11. Electrical conductivity of electrolyte solutions. Specific and molar electrical conductivity. Dependence of the electrical conductivity of weak and strong electrolytes on their concentration. Kohlrausch, Debye-Onsager laws. Electrophoretic and relaxation effects of inhibition. Effects of Wine, Falkenhagen.

12. Mobility and transfer numbers, methods of their determination. Electrolysis. Electrolysis laws. Hittorff method. Moving border method.

13. The appearance of a potential jump at the interface. Electromotive force of a galvanic cell (EMF). Nernst equation. Equilibrium and standard electrode potentials. Types of electrodes. Electrodes of the first and second kind. Redox electrodes. Luther's rule. Amalgam and gas electrodes.

14. Types of electrochemical cells. Chemical chains. Thermodynamics of an electrochemical cell. Determination of standard thermodynamic functions and equilibrium constants of electrochemical reactions by the EMF method.

15. Concentration chains with and without charge transfer. Diffusion potential.

### **Rules of Exam**

The student needs to come to the classroom 20 minutes before the start of the exam and prepare, to sign the attendance sheet and sit in the seat indicated on the attendance sheet. You must have an identity card or ID card, a pen, a pencil with you.

### **During the exam forbidden:**

1. Take and open a ticket without the teacher's permission.
2. To carry unauthorized aids during the exam (cheat sheets, cell phones (turned on or off), smart watches, headphones, other electronic devices, etc.).
3. Make noise, talk, get up and leave the room.
4. Seek help from third parties.
5. Unauthorized use of books, drawings, calculators without the permission of the teacher.

### **Instruction for the student**

#### **Important!**

1. A student who has committed a violation of any of the above requirements, which was recorded by the act, is graded "F" ("unsatisfactory") in the discipline.
2. Opening unauthorized educational materials, electronic means of communication with the student during the exam, as well as violation of these Rules is the basis for a decision to cancel the assessment results and give an "unsatisfactory" grade, regardless of whether they were used in the exam or not.

## **Important!**

### **Assessment policy:**

The case – tasks consist of 2 steps and they evaluate by toughly level.

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|----------------------------|-----------------------------|
| First question – 50 points | Second question – 50 points |
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### **Recommended literature sources for exam preparation**

#### **Educational literature: basic:**

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, Mounji 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.: Вышш.школа, 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.

#### **Internet resources:**

1. <http://elibrary.kaznu.kz/ru>
2. <https://www.coursera.org/learn/physical-chemistry>
3. <https://teach-in.ru/lecture/09-02-Korobov>