

SYLLABUS
Fall semester 2021-2022 academic years
on the educational program «6B05301 – Chemistry (NIS)»

Discipline's code	Discipline's title	Independent work of students (IWS)	No. of hours per week			Number of credits	Independent work of student with teacher (IWST)
			Lectures (L)	Practical training (PT)	Laboratory (Lab)		
FH2211	Physical chemistry, part I	82	15	15	60	6	8
Academic course information							
Form of education	Type of course	Types of lectures		Types of practical training	Number of IWS	Form of final control	
Online/ blended	blended	problematic, review and analytical		To solve problems, carry out laboratory work	4	Testing in CDO Moodle	
Lecturer	Supiyeva Zhazira						
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Academic presentation of the course							
Aim of course is to form the student's ability to define the main thermodynamic functions of systems for predicting the possibility, direction, and control of the physical and chemical process.	Expected Learning Outcomes (LO) As a result of studying the discipline the undergraduate will be able to:			Indicators of LO achievement (IA)			
	LO1. explain the content of the main regularities and rules of chemical thermodynamics, ideal solutions, homogeneous and heterogeneous equilibriums;			IA 1.1 operates with definitions and terms of thermodynamics; IA 1.2 executes the classification of thermodynamic systems, processes and their characteristics; IA 1.3 formulates the main rules, regulations, and principles of chemical thermodynamics; IA 1.4 characterizes thermodynamic parameters and state functions of systems; IA 1.5 operates with basic formulas describing thermodynamic regularities.			
	LO 2. calculate thermodynamic parameters of physical and chemical processes			IA 2.1 defines the necessary data for calculating the specified thermodynamic parameter; IA 2.2 selects an equation and its form for calculating the specified thermodynamic parameter; IA 2.3 chooses the most appropriate method (analytical, graphical, least squares) for calculating the specified thermodynamic parameter; IA 2.4 substantiates the choice of the method for calculating the specified thermodynamic parameter; IA 2.5 properly expresses the dimensions of the initial and calculated values;			

	LO 3. describe the main thermodynamic regularities of physical and chemical processes	IA 3.1 evaluates the influence of various factors on the value of a particular thermodynamic parameter of the system; IA 3.2 describes the state diagrams of the system; IA 3.3 determines the nature of the influence of different factors on the equilibrium in the system.
	LO 4. predict the possibility, direction, and depth of a physical and chemical process on the basis of calculated thermodynamic parameters or system state diagrams;	IA 4.1 evaluates the thermodynamic probability and direction of a chemical reaction/phase transformation under specific conditions; IA 4.2 determines the depth of transformation of the initial substances under the specified conditions; IA 4.3 sets the conditions of chemical / phase equilibrium in the system and the factors that affect it;
	LO 5. independently perform a physical and chemical experiment (according to the elaborated methodic) with subsequent analysis and interpretation of obtained results and finalizes with conclusions.	IA 5.1 understands the basic safety rules for working in a chemical laboratory IA 5.2 performs a statistical assessment of the determined physical quantities; IA 5.3 defines a system/process parameter based on measurement data for physical values; IA 5.4 builds a diagram of the system state using experimental data and "expound" it; IA 5.5 analyzes and interprets experimental data based on the acquired knowledge of the main thermodynamic rules of physical and chemical processes.
Prerequisites	Physics, maths, chemistry	
Post requisites	Physical chemistry, part II, The basis of Physico – chemical Analysis, Modern concepts of the theory of solutions, general chemical technology	
Information resources	Literature: 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. <i>Physical Chemistry</i>, 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.:Высш.школа, 1995. Кн.1,2. 8. Ira N. Levine. Physical Chemistry. Sixth Edition. <i>New York</i>: 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.	
Academic policy of the course in the context of university moral and ethical values	Academic Behavior Rules: All students have to register at the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the discipline study schedule. ATTENTION! Non-compliance with deadlines leads to loss of points! The deadline of each task is indicated in the calendar (schedule) of implementation of the content of the curriculum, as well as in the MOOC. Academic values: - Practical trainings/laboratories, IWS should be independent, creative. - Plagiarism, forgery, cheating at all stages of control are unacceptable. - Students with disabilities can receive counseling at e-mail bakirovabota91@gmail.com.	

Evaluation and attestation policy	Criteria-based evaluation: assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams). Summative evaluation: assessment of work activity in an audience (at a webinar); assessment of the completed task.
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CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:

week s	Topic name	LO	IA	amount of hours	Maximum score	Form of Knowledge Assessment	The Form of the lesson / platform
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Module 1

1	L.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.	LO 1	IA 1.1.; IA 1.3	1			Video lecture in MS Teams/ synchronously https://teams.microsoft.com/l/team/19%3aAwWYdSfDpgHTz3RSRGSaH9Elcxqmv2KP3vDv_7Exmkg1%40thread.tacv2/conversations?groupId=f1fa0bb2-f217-4e6c-a18d-b2b6827eec65&tenantId=b0ab71a5-75b1-4d65-81f7-f479b4978d7b
1	PT Internal energy, heat, work, their physical and thermodynamic values, their relationship (showing differences in properties A, Q, ΔU , δQ , δA), solving problems.	LO 1	IA 1.1. IA 1.4	1	5	Solve problems	Webinar in MS Teams/ synchronously https://teams.microsoft.com/l/team/19%3aAwWYdSfDpgHTz3RSRGSaH9Elcxqmv2KP3vDv_7Exmkg1%40thread.tacv2/conversations?groupId=f1fa0bb2-f217-4e6c-a18d-b2b6827eec65&tenantId=b0ab71a5-75b1-4d65-81f7-f479b4978d7b
	LL 1 Introductory lesson. Introduction to the academic policy of the course. The procedure for conducting a laboratory classes. Basic safety in a chemical laboratory. Tasks of laboratory work No. 1	LO 5	IA 5.1, IA 5.2	4	5	Self-test questions	Offline / Webinar in MS Teams/ synchronously https://teams.microsoft.com/l/team/19%3aAwWYdSfDpgHTz3RSRGSaH9Elcxqmv2KP3vDv_7Exmkg1%40thread.tacv2/conversations?groupId=f1fa0bb2-f217-4e6c-a18d-b2b6827eec65&tenantId=b0ab71a5-75b1-4d65-81f7-f479b4978d7b

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2	L.2 Heat capacity, its dependence on various factors. Mayer's equation. Temperature dependence of the thermal effect of a chemical reaction, Kirchhoff's equation.	LO 1	IA 1.1.; IA 1.3; IA1.4	1			Video lecture in MS Teams/ synchronously
2	PT 2 Temperature dependence of the heat capacity of chemicals. Methods for calculating the thermal effect of a chemical reaction.	LO 1, LO 2	IA 1.3; IA 1.4 IA 2.1 IA 2.2 IA 2.5	1	5	Anal ysis/ typic al tasks	Webinar in MS Teams/ synchronously
	LL 2 The task of the theoretical part of the laboratory work No. 1 «The study of the temperature dependence of the vapor elasticity of an individual substance by the dynamic method»	LO 5	IA 5.1 IA 5.3	4	10	Self-contr ol quest ions	Offline
	ISWT 1: Consultation on IWS #1 task «Calculation of thermal effect of chemical processes and analysis of temperature effect»			1			Webinar in MS Teams
3	L 3 Application of the first law of thermodynamics to various processes involving ideal gases.	LO 1	IA 1.3, IA 1.4	1			Video lecture In MS Teams / synchronously
3	PT 3 Calculation of thermal effects of chemical reactions and phase transitions at different temperatures. The increase in the enthalpy of an individual substance depends on temperature. Work to increase the ideal gas in different conditions.	LO 1 LO 2 LO 3	IA 1.3; IA 1.4; IA 2.1 IA 2.2 IA 2.5	1	5	Anal ysis / typic al tasks	Webinar in MS Teams/ synchronously
	LL 3 Performance of laboratory work No. 1. «The study of the temperature dependence of the vapor elasticity of an individual substance by the dynamic method» Tasks of laboratory work No. 2 «Equilibrium liquid vapor in binary solutions»	LO 2 LO 5	IA 2.2 IA 2.5 IA 5.1 IA 5.3 IA 5.5	4	10	Self-contr ol quest ions	Offline
Module 2							
4	L4 The second law of thermodynamics, its concepts. Carnot cycle and Carnot's principle. Efficiency of an ideal heat engine. Entropy.	LO 1	IA 1.1 IA 1.2 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
4	PT 4 Calculation of changes in the internal energy and enthalpy of a substance in various temperature ranges under conditions of constant pressure and volume.	LO 2 LO 3	IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	5	Anal ysis/ typic al tasks	Webinar in MS Teams/ synchronously
	LL 4 Defense of laboratory work No. 1, Delivery of the theoretical part of the laboratory work No. 2 «Equilibrium liquid vapor in binary solutions»	LO1 LO5	IA 1.3 IA 1.4 IA 5.1 IA 5.3	4	10	Self-contr ol quest ions	Offline
	ISWT 2: Completion of IWS #1 task «Calculation of thermal effect of chemical processes and analysis of temperature effect». Deadline – until 23: 00 pm the current week	LO 1 LO 2 LO 3	IA 1.1 IA 1.4 IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	20		“Univer” System
5	L.5 Entropy is a criterion for the direction of the process (constructive condition). Equations for	LO 1	IA 1.2 IA 1.4	1			Video lecture in MS Teams/

	calculating the change in entropy in various processes. Planck's postulate.						synchronously
5	PT Calculation of the change in the entropy of a chemical reaction at various temperatures based on the standard absolute entropy of substances and the temperature dependence of the heat capacity.	LO 2 LO 3 LO 4	IA 2.1 IA 2.2 IA 2.5 IA 3.1 IA 4.1 IA 4.2	1	5	Anal ysis/ typic al tasks	Webinar in MS Teams / synchronously
	LL 5 Examination and colloquium based on the materials of lectures 1-5.	LO 2 LO 5	IA 2.2 IA 2.3 IA 2.5 IA 5.1 IA 5.2 IA 5.3 IA 5.5	4	20	Self- contr ol quest ions	Offline
5	MC 1 (Midterm control)				100		
6	L6 Thermodynamic potentials. Characteristic functions and their natural variables. Comparative characteristics of thermodynamic functions (ΔU , ΔH , ΔS , ΔF , ΔG) as a criterion for the direction of the process.	LO 1	IA 1.1 IA 1.2 IA 1.4	1			Video lecture in MS Teams / synchronously
6	PT 6 Calculation of the change in entropy of various processes in the presence of ideal gases and standard absolute entropy of matter.	LO 2 LO 3 LO 4	IA 2.1. IA 2.2 IA 2.5 IA 3.1 IA 4.1 IA 4.2	1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 6 Performance of laboratory work No. 2 «Equilibrium liquid vapor in binary solutions»	LO 1 LO 3 LO 5	IA 1.1 IA 1.3 IA 3.2 IA 5.1 IA 5.3	4	10	Self- contr ol quest ions	Offline
	ISWT 3: Consultation on IWS #2 task «Calculation of the effect of temperature on the direction of a chemical reaction»			1			Webinar in MS Teams
Module 3							
7	L7 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.	LO 1	IA 1.2 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
7	PT7 Calculation of changes in Gibbs and Helmholtz energies at different temperatures for thermodynamic processes and chemical reactions.	LO 2 LO 3	IA 2.1. IA 2.2 IA 2.5 IA 3.1 IA 3.3	1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 7 Defense of laboratory work No. 2 «Equilibrium liquid vapor in binary solutions»	LO 2 LO 5	IA 2.2 IA 2.3 IA 2.5 IA 5.1 IA 5.3 IA 5.4 IA 5.5	4	10	Self- contr ol quest ions	Offline
	ISWT 4: Completion of IWS #2 task «Calculation of the effect of temperature on the direction of a chemical reaction» Deadline – until 23: 00 pm the current week	LO 1 LO 2 LO 3	IA 1.1 IA 1.4 IA 2.1 IA 2.2 IA 2.5	1	10		“Univer” System

			IA 3.1				
8	L8 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.	LO 1	IA 1.1 IA 1.2 IA 1.4	1			Video lecture in MS Teams / synchronously
8	PT 8 Equations of equilibrium constants and their relationship, depending on various forms of the chemical reaction equation and various methods of expressing the composition of the reaction mixture, solving problems.	LO 2 LO 3 LO 4	IA 2.2 IA 2.3 IA 2.4 IA 2.5 IA 3.3 IA 4.2 IA 4.3	1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 8 Delivery of the theoretical part of the laboratory work No. 3 «Study of mutual solubility in a two -component system».	LO 1 LO 3 LO 5	IA 1.1 IA 1.3 IA 3.2 IA 5.1	4	10	Self- contr ol quest ions	Offline
8	ISWT 5 Consultation on the implementation of IWS 3 «Calculating the change in entropy of a chemical reaction»			1			Webinar in MS Teams / synchronously
9	L9 Temperature dependence of the equilibrium constant. Isobaric and isochoric Van't Hoff equations.	LO 1	IA 1.2 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
9	PT9 Le Chatelier-Brown principle of mobile equilibrium Analytical and graphical calculation of the equilibrium constant, heat effect and entropy of a chemical reaction.	LO 2 LO 3	IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 9 Performance of laboratory work No. 3 «Study of mutual solubility in a two -component system».	LO4	IA 4.1	4	10	Self- contr ol quest ions	Offline
Module 4							
10	L10 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.	LO 1	IA 1.1 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
10	PT 10 Influence of pressure on the melting point, evaporation and flash evaporation (sublimation) of a substance. Determination of triple point coordinates on the curves of flash evaporation (sublimation) and evaporation.	LO 2 LO 3 LO 4	IA 2.1 IA 2.2 IA 2.3 IA 2.4 IA 3.3 IA 4.2 IA 4.3	1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 10 Examination and colloquium based on the materials of lectures 6-9.	LO 3 LO 5	IA 3.2 IA 5.1 IA 5.3 IA 5.4 IA 5.5	4	20	Self- contr ol quest ions	Offline
10	IWSP 6 Completion of IWS #3 task «Calculating the change in entropy of a chemical reaction» Deadline – until 23: 00 pm the current week			1	10		“Univer” System

10	MT (MidtermExam)				100		
11	L11 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.	LO 1	IA 1.1 IA 1.2 IA 1.4	1			Video lecture in MS Teams / synchronously
11	PT 11 The number of degrees of freedom in phase planes (parts) on the melting diagram, in phase planes (parts), on curves of phase transitions, in invariant (nonvariant) equilibria. Cooling curve, number of phase transitions and degrees of freedom of the cooling curve. Node, the rule of the lever.	LO 2 LO 3 LO 4	IA 2.1 IA 2.2 IA 2.5 IA 3.3 IA 4.2 IA 4.3	1	5	Analysis / typical tasks	Webinar in MS Teams / synchronously
	LL 11 Defense of laboratory work No. 3 «Study of mutual solubility in a two -component system», Tasks of the laboratory work No. 4 «Study of mutual solubility in a three -component system».	LO 2 LO 5	IA 2.2 IA 2.3 IA 2.4 IA 5.1	4	10	Self-control questions	Offline
12	L12 Solubility of two and three liquids in each other. Methods for displaying the composition of a three-component system. Tarasenkova's rule. Crisis melting points. Extraction.	LO 1	IA 1.1 IA 1.3 IA 1.4	1			Webinar in MS Teams / synchronously
12	PT 12 Comparative analysis of diagrams of two- and three-component systems consisting of poorly soluble liquids.	LO 2 LO 3	IA 2.1 IA 2.2 IA 2.5 IA 3.1 IA 3.3	1	5	Analysis / typical tasks	Webinar in MS Teams / synchronously
	LL 12 Delivery of the theoretical part of the laboratory work No. 4 «Study of mutual solubility in a three -component system».	LO 2 LO 5	IA 2.2 IA 2.3 IA 2.4 IA 5.1	4	10	Self-control questions	Offline
12	IWSP 7 Consultation on the implementation of IWS4 «Description of the equilibrium between phases in the system according to the state diagram»			1			Webinar in MS Teams
13	L13 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.	LO 1	IA 1.1 IA 1.2 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
13	PT 13 The equation of interaction of liquid and vapor phases in ideal systems, its consequences. Deviations from Raoult's Law and Reasons for Deviations.	LO 2 LO 3	IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	5	Analysis / typical tasks	Webinar in MS Teams / synchronously
	LL 13 Performance of the laboratory work No. 4. «Study of mutual solubility in a three -component system».	LO 1 LO 3 LO 5	IA 1.1 IA 1.3 IA 3.2 IA 5.1 IA 5.3	4	10	Self-control questions	Offline

14	L14 Boiling point (vapor pressure) - composition (t, P - x) diagrams. Gibbs-Konovalov laws I and II.	LO 1	IA 1.1 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
14	PT 14 Analysis of boiling diagrams. Boiling point (vapor pressure) is the ratio between the components of the liquid and vapor phases (y-x) in the composition diagrams.	LO 2 PO 3	IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	5	Anal ysis/ typic al tasks	Webinar in MS Teams / synchronously
	LL 14 Defense of the laboratory work No. 4. «Study of mutual solubility in a three -component system».	LO 1 LO 3 LO 5	IA 1.1 IA 1.3 IA 3.2 IA 5.1 IA 5.3	4	10	Self- contr ol quest ions	Offline
	IWSP 8 Completion of IWS #4 task «Description of the equilibrium between phases in the system according to the state diagram» Deadline – until 23: 00 pm the current week	LO 1 LO 2 LO 3	IA 1.1 IA 1.4 IA 2.1 IA 2.2 IA 2.5 IA 3.1	1	20		“Univer” System
15	L15 Ebulliometry. Cryometry. Determination of the molecular weight and molecular state of the solute from cryometric or ebulliometric data. Isotonic Van't Hoff coefficient.	LO 1	IA 1.1 IA 1.3 IA 1.4	1			Video lecture in MS Teams / synchronously
	PT 15 Features of the application of the Schroeder-Le Chatelier equation in cryometry and thermal analysis Osmosis.			1	5	Anal ysis / typic al tasks	Webinar in MS Teams / synchronously
	LL 15 Examination and colloquium based on the materials of lectures 11-14.	LO 2 LO 3 LO 5	IA 2.2 IA 2.3 IA 3.1 IA 5.3 IA 5.5	4	20	Anal ysis/ typic al tasks	Offline
	MC 2				100		

[Abbreviations: QS - questions for self-examination; TK - typical tasks; IT - individual tasks; CW - control work; MT - midterm.

Comments:

- Form of L and PT: webinar in MS Teams / Zoom (presentation of video materials for 10-15 minutes, then its discussion / consolidation in the form of a discussion / problem solving / ...)
- Form of carrying out the CW: webinar (at the end of the course, the students pass screenshots of the work to the monitor, he/she sends them to the teacher) / test in the Moodle DLS.
- All course materials (L, QS, TK, IT, etc.) see here (see Literature and Resources, p. 6).
- Tasks for the next week open after each deadline.
- CW assignments are given by the teacher at the beginning of the webinar.]

Dean

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