

Subject card

Subject name and code	Physical chemistry, PG_00081922						
Field of study	Chemistry						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2026/2027		
Education level	Bachelor's studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	2		Language of instruction		Polish		
Semester of study	4		ECTS credits		2.0		
Learning profile	academic		Assessment form		credit		
Conducting unit	Faculty of Chemistry -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Janusz Rak				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	30.0	0.0	0.0	0.0	30
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	30		5.0		15.0	50
Subject objectives	Acquainting students with the description of irreversible processes and the functioning of nature based on thermodynamics, with the phenomenological description of chemical changes over time based on chemical kinetics, with the description and applications of catalytic phenomena, and with the description and utilization of electrochemical processes. Acquiring the skills to understand and quantitatively describe physical transformations, chemical reactions, and to use physicochemical data in preparation for studying other subjects.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[CHEML3_U06] Uses basic application software packages to solve problems from the field of science.	Plans and conducts simple experimental research or observations and analyzes the results using available IT tools.	[SU4] test/exam - oral or written
	[CHEML3_K05] Observes established procedures in laboratory work and is responsible for the safety of her/his and others' work.	Plans and conducts simple experimental studies or observations and analyzes the results using available IT tools.	[SK4] test/exam - oral or written
	[CHEML3_W10] Enumerates and describes the basic aspects of the construction, operation and use of measuring apparatus and equipment used in experimental works in the field of chemistry and related sciences.	Identifies the scientific research equipment he encountered during his studies and explains the principles of its operation.	[SW4] test/exam - oral or written
	[CHEML3_W06] Chooses higher mathematics techniques to the extent necessary to understand and describe the physical processes important for understanding chemistry.	Understands and explains descriptions of regularities, phenomena, and processes using the language of mathematics, and in particular, can independently reproduce basic laws and theorems.	[SW4] test/exam - oral or written
	[CHEML3_W03] Explains the relationship between the structure of matter and its observed properties.	Capable of analyzing problems and finding their solutions based on known laws and methods.	[SW4] test/exam - oral or written
	[CHEML3_U04] Plans and performs simple chemical experiments and analyses the results obtained.	Able to plan and conduct simple experimental studies or observations and analyze the results.	[SU4] test/exam - oral or written
	[CHEML3_W01] Enumerates basic laws and theories in chemistry, physics, mathematics and biology.	Has general knowledge of the basic concepts, principles, and theories in the field of physical chemistry.	[SW4] test/exam - oral or written
	[CHEML3_K02] Works individually demonstrating initiative and independence of activity and cooperates in a team fulfilling various roles in it.		
Subject contents	Calculations of changes in internal energy, heat, and work for physical processes and chemical reactions. Calculations of changes in entropy, free energy, and free enthalpy of physical transformations and chemical reactions. Determination of the chemical equilibrium constant, calculation of free enthalpy based on the chemical equilibrium constant, van't Hoff isotherm. Calculation of critical temperature, melting temperature, activity, and activity coefficients. Phase equilibria, Gibbs phase rule. Identifying the order of reactions, deriving kinetic equations based on reaction mechanisms, determining the kinetics of complex reactions, deriving and using integrated forms of kinetic equations, calculations using the Arrhenius equation, collision theory, and transition state theory. Calculation of specific and equivalent conductivity, mobility, and speed of ion movement in solution, determination of ion transference numbers using the Hittorf method and the moving boundary method, determination of the hydrodynamic radius of ions. Using standard potentials to determine chemical equilibrium constants, calculations using the Nernst equation, determination of the EMF of a working cell and ion activity coefficients, calculation of thermodynamic functions of reactions occurring in cells, calculations of the temperature coefficients of cells.		
Prerequisites and co-requisites	The necessity to complete courses in: general chemistry, basics of advanced mathematics, and fundamentals of physics. Knowledge of general chemistry at the undergraduate level, familiarity with basic concepts and principles of mathematics and physics.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	test	51.0%	100.0%
Recommended reading	Basic literature	P.W. Atkins, C.A. Trapp, M.P. Cady, C. Giunta, Chemia fizyczna. Zbiór zadań z rozwiązaniami, PWN Warszawa 2001.	
	Supplementary literature	A. W. Adamson, Zadania z chemii fizycznej, PWN, Warszawa 1978.	
	eResources addresses		

Example issues/ example questions/ tasks being completed	- Before it was discovered that Freon-12 (CF_2Cl_2) is harmful to the Earth's ozone layer, it was often used as a dispersing agent in deodorants and hair sprays. Its enthalpy of vaporization at the normal boiling point of -29.9°C is $20.25 \text{ kJ mol}^{-1}$. Calculate the pressure that a container holding Freon-12 must withstand at a temperature of 40°C (the temperature of the container exposed to sunlight), assuming that H_{vap} is constant for this temperature range and equal to the value at -29.9°C. - The ion mobilities of K^+, Cu^{2+}, and Br^- in a field strength of 1.0 V cm^{-1} are respectively: 0.00076276, 0.0005699, and $0.0008093 \text{ cm s}^{-1}$. Calculate the equivalent conductivities of KBr and CuBr_2. Also, calculate the transference number of the Cu^{2+} ion in a solution that is simultaneously 0.1 M with respect to KBr and 0.01 M with respect to CuBr_2. - For the cell: $\text{Pt} \mid \text{H}_2 (10^5 \text{ N/m}^2) \mid \text{H}_2\text{SO}_4 (0.01 \text{ M}) \mid \text{PbSO}_4(\text{s}) \mid \text{Pb}$, $E^\circ_{298} = -0.355 \text{ V}$. a) Calculate E_{298} assuming that the limiting Debye-Hückel law is satisfied ($A = 0.5$), b) Calculate the solubility product of PbSO_4, knowing that $E^\circ_{298} (\text{Pb}/\text{Pb}^{2+}) = -0.126 \text{ V}$.
Work placement	Not applicable

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