GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00057772		
Field of study	Green Technologies		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2025/2026
Education level	first-cycle 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	English
Semester of study	3	ECTS credits	8.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Physical Chemistry -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Maciej Śmiechowski	
	Teachers	dr hab. inż. Maciej Śmiechowski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	45.0	0.0	0.0	90

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 1071 Physical chemistry GT 2025/2026 Winter
https://enauczanie.pg.edu.pl/2025/course/view.php?id=1071

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	90	15.0	95.0	200

Subject objectives

The aim of the subject is to familiarize the student with fundamental physicochemical laws in chemical thermodynamics, phase equilibria and chemical equilibria together with the ability to solve relevant text problems involving calculations, as well as teaching him/her effective and safe carrying out simple experiments/measurements of physicochemical quantities and proper presentation and interpretation of their results.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U03] is able to use information and communication technologies relevant to the common tasks of engineering, is able to use known methods and mathematical-physical models to describe and explain phenomena and chemical processes	Student is able to use known methods and mathematical-physical models to describe and explain phenomena and chemical processes	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K6_W02] has a basic knowledge of chemistry including general chemistry, inorganic, organic, physical, analytical, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment; measurement and the determination of the parameters of these processes.	Student has basic knowledge of physical chemistry, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment, as well as measurement and determination of the parameters of these processes	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents	LECTURES Chemical thermodynamics: Termochemistry, Hess law and kirchoff's equation. State functions. First principle of thermodynamics. Thermodynamic cycles, Second principle, Gibbs free anergy and Helmholtz free energy. Third principle. Criteria of spontaneity and equilibrium of reactions. Open systems, partial molar quantities, chemical potential. Chemical equilibrium. Standard molar Gibbs free energy and reaction quotient. Equilibrium constants. Le Chatelier principle and Van't Hoff isobar. Gibbs-Helholtz equation. General conditions of phase equilibria. Clausius-Clapeyron equation. Gibbs rule of phases. Gibbs-Duhem equation. Selected equilibria in one-, two, and three-component systems (Gibbs triangle) interpretation of phase diagrams. Simple and fractional distillation. Nernst law of partition. Solutions: Colligative properties. Thermodynamic characteristics of the perfect and perfectly diluted solutions. Thermodynamic definition of activity and activity coefficients. Excess functions. TUTORIALS: Calculations of heats of reaction at constant V or P. Calculations of ΔS and ΔG of reaction. Relation of ΔG^0 with equlibrium constants. Calculations of chemical equilibria in gaseous phase, equilibrium compositions and dissociation (reaction) degree. Calculations in phase equilibria in one-component systems. Calculation of composition of phases in gas-liquid systems, compositions of distillates and residuals. Calculations related to colligative properties. LABORATORY Performing 6 experiments from the list: 1. Vapor-liquid equilibrium of pure liquids. 2. Vapor-liquid equilibrium of two component systems. 3. Cryometry - Measurements of freezing point depression. 4. Calorimetry: a) measuring specific heat of liquids; b) measuring heat of acid-base neutralization. 5. Determination of heat of dissolution. 6. Determination of physicochemical constants of liquids.		
Prerequisites and co-requisites	suggested: completed courses in mathematics, physics, inorganic chemistry and computer science		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Lab - performance and reports	50.0%	30.0%
	written/oral exam	50.0%	40.0%
	tutorials: 2 written tests	50.0%	30.0%
Recommended reading	Basic literature	1. P. W. Atkins, J.A.Beran, General Chemistry, Oxford University Press, any edition above 2nd. 2. P. W. Atkins, Physical Chemistry, Oxford University Press, any edition above 5th.	
	Supplementary literature	1. P. W. Atkins, Przewodnik po chemii fizycznej, PWN 1997. 2. K. Pigoń i Z. Ruziewicz, Chemia fizyczna, PWN 2006. 3. H. Buchowski i W. Ufnalski, Podstawy termodynamiki (poz. 1-6 z serii Wykłady z chemii fizycznej, WNT, Warszawa) 4. H. Buchowski i W. Ufnalski, Fizykochemia gazów i cieczy 5. H. Buchowski i W. Ufnalski, Gazy, ciecze i płyny 6. H. Buchowski i W. Ufnalski, Roztwory 7. W. Ufnalski, Równowagi chemiczne 8. H. Buchowski, Elementy termodynamiki statystycznej 9. W Libuś, Chemia Fizyczna, część I, PG, Gdańsk 1970. 10. M. Pilarczyk, Zadania z chemii fizycznej, PG, Gdańsk 1996. 11. I Uruska, Zbiór zadań testowych z chemii fizycznej, PG, Gdańśk 1997	
	eResources addresses		

Example issues/ example questions/ tasks being completed	1. For a certain liquid A forming a real solution with liquid B the Henrys law constant is 25 kPa, while P_A^* = 60 kPa. What deviations (positive/negative) from ideality should be expected? 2. Sketch the phase diagram of a simple eutectic system. Then sketch the cooling curves of: (a) any of the pure components, (b) mixture with a eutectic composition, (c) mixture with any other chosen composition. Give the conditions for the existence of a temperature stop and a kink on the cooling curve. 3. On the provided Gibbs triangle mark the points corresponding to the given compositions. 4. Write the balanced equations of formation of the following compounds, including phases: NaNO3(s), KI(s), Cu(ClO4)2(s), LiOH(s). 5. The enthalpy of vaporization of ethanol at 298 K is 38.6 kJ/mol. The heat capacities of liquid and gaseous ethanol amount 112.4 and 78.3 J/(mol·K), respectively. Predict (without performing final numerical calculations), how the heat of vaporization of ethanol behaves with increasing temperature (increases/decreases) and why? 6. Explain the meaning of symbols in the van der Waals equation of state. 7. The diagram shows the cycle of reversible transformations of an ideal gas in the V=f(T) plane. On the basis of the diagram find (specify the start point and the end point) the transformation, for which: (a) q = U , (b) q = H , (c) p increases, (d) U = 0. 8. Can six phases be simultaneously in equilibrium in a 4-component system? Can a 3-component system possess five degrees of freedom? 9. Some of the phase diagrams of a single component system shown below are wrong. Indicate which ones and briefly explain why. 10. A certain M(IV) metal oxide decomposes to the M(II) metal oxide according to reaction: 2 MO2 (s) = 2 MO(s) + O2(g), for which the equilibrium constant is 0.1 at the temperature 100 °C. Write the equation defining the equilibrium constant and give the value of the equilibrium pressure of oxygen over the mixture of solid oxides.
Work placement	Not applicable