GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00057772		
Field of study	Green Technologies		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
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 -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Maciej Śmiechowski	
	Teachers		

Lesson types

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						

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 students with fundamental physico-chemical laws in chemical thermodynamics, phase equilibria and chemical equilibria together with ability of solving relevant text problems involving calculations, as well as teaching them effective and safe ways of carrying out simple experiments/measurements of physico-chemical quantities and proper presentation and interpretation of their results.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[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.	has basic knowledge of physical chemistry, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment; measurements and determination of the parameters of these processes	[SW1] Assessment of factual knowledge
[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	is able to use known methods and mathematical-physical models to describe and explain phenomena and chemical processes	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task

Subject contents	Course content – lecture Chemical Thermodynamics: Thermochemistry, Hess's Law, and Kirchoff's Equation. State Functions. First Law of Thermodynamics. Thermodynamic Cycles. Second Law of Thermodynamics, Free Enthalpy and Free Energy. Third Law of Thermodynamics. Criteria for Spontaneity and Equilibrium of Processes. Open Systems – Partial Molar Quantities, Chemical Potential. Chemical Equilibrium: Standard Free Enthalpy of a Reaction. Reaction Quotient. Equilibrium Constants of Reactions (Definitions, Interrelationships). Le Chatelier's Principle. Van't Hoff Isobar. Gibbs-Helmholtz Equation. Phase Equilibria: General Conditions for Phase Equilibrium. Clausius-Clapeyron Equation. Gibbs Phase Rule. Gibbs-Duhem Equation. Selected Equilibria in One-, Two-, and Three-Component Systems (Gibbs' Triangle) – Interpretation and Use of Diagrams. Simple and fractional distillation. Nernst's partition law. Solutions: Colligative properties. Thermodynamic characteristics of ideal and perfectly dilute solutions. Thermodynamic definition of activity and activity coefficients. Excess functions.
	Course content – exercises Gas laws. Ideal gas transformations. Thermodynamic cycles. Thermochemistry. Calculations of ΔS and ΔG of reaction. Relation of ΔG^0 with equilibrium constant. Calculations of chemical equilibria in gaseous phase, equilibrium compositions and dissociation degree. Calculations of 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.
	Course content – laboratory Six experiments: 1. Vapor-liquid equilibrium of pure liquids. 2. Vapor-liquid equilibrium for a 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. Heat of dissolution 6. Determination of physicochemical constants of liquids.
Prerequisites and co-requisites	completed courses in mathematics, physics, inorganic chemistry, and computer science

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
written exam covering lecture topics	50.0%	40.0%
two written calculation tests covering tutorial material	50.0%	30.0%
six written final tests covering laboratory exercises	50.0%	30.0%

Recommended reading

Basic literature	1. P. W. Atkins, J. A. Beran, General Chemistry, Scientific American Books, 1992. 2. P. Atkins, J. de Paula, J. Keeler, Atkins' Physical Chemistry, Oxford University Press, 2018. 3. P. Atkins, J. de Paula, Physical chemistry for the life sciences, Oxford University Press, 2011.
Supplementary literature	1. M. J. Blandamer, J. C. R. Reis, A Notebook for Topics in Thermodynamics of Solutions and Liquid Mixtures, https://www.le.ac.uk/chemistry/thermodynamics/index.html 2. Chemistry LibreTexts, Physical & Theoretical Chemistry, https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps 3. H. DeVoe, Thermodynamics and Chemistry, http://www2.chem.umd.edu/thermobook 4. P. Atkins, Concepts in Physical Chemistry (free edition), https://books.rsc.org/books/monograph/2194/Concepts-in-Physical-Chemistry

	eResources addresses	Supplementary https://www.le.ac.uk/chemistry/thermodynamics/index.html - M. J. Blandamer, J. C. R. Reis, A Notebook for Topics in Thermodynamics of Solutions and Liquid Mixtures (accessed 03.07.2026) https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps - Chemistry LibreTexts, Physical & Theoretical Chemistry (accessed 03.07.2026) http://www2.chem.umd.edu/thermobook - H. DeVoe, Thermodynamics and Chemistry (accessed 03.07.2026) https://books.rsc.org/books/monograph/2194/Concepts-in-Physical-Chemistry - P. Atkins, Concepts in Physical Chemistry (accessed edition) (dostęp 03.07.2026)
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, 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.	
Practical activites within the subject	Not applicable	