GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physical chemistry, PG_00057673		
Field of study	Green Technologies		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
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	Polish
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. Dorota Warmińska	
	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 familarize the student 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 teachnig him/her effective and safe 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.	knows the terminology related to the course, can explain it, and understands how the terms relate to one another.	[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	can verbally formulate laws expressed through physical equations; can also express relevant correlations precisely enough to formulate a physical equation; analyzes simple physicochemical problems and can devise an algorithm to solve them.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

Fundamentals of chemical thermodynamics and their application to the description of physicochemical processes relevant to green technologies. Thermochemistry, Hess's law, Kirchhoff's law, and state functions. The first law of thermodynamics, energy balances, and thermodynamic cycles. The second law of thermodynamics, entropy, Helmholtz free energy, and Gibbs free energy. The third law of thermodynamics. Criteria of spontaneity and equilibrium and their significance for evaluating the direction and energy efficiency of technological processes. Thermodynamics of open systems: partial molar quantities and chemical potential. Chemical equilibrium: standard Gibbs free energy change of reaction, reaction quotient, definitions and interrelations of equilibrium constants. Le Chatelier's principle, the van't Hoff equation, and the Gibbs–Helmholtz equation. Effects of temperature, pressure, and composition on chemical equilibrium in the context of designing energy- and resource-efficient chemical processes. Phase equilibria: general conditions for phase equilibrium, the Clausius–Clapeyron equation, Gibbs phase rule, and the Gibbs–Duhem equation. Selected equilibria in one- and two-component systems and interpretation of phase diagrams. Liquid–vapour equilibrium, simple and fractional distillation, and the thermodynamic basis of separation processes used in chemical and environmental technologies.

Solutions and their physicochemical properties. Colligative properties of solutions and their dependence on system composition. Application of thermodynamic principles and concepts of chemical and phase equilibria to the analysis and optimization of processes aimed at reducing energy and raw-material consumption, selecting appropriate solvents, separating components, and designing processes consistent with the principles of sustainable development and green chemistry.

Course content – exercises

Calculations involving the ideal gas equation of state, the Clapeyron equation, and ideal gas transformations. Application of the laws of thermodynamics to the calculation of work, heat, and changes in internal energy, enthalpy, and entropy for reversible and irreversible processes. Calculation of entropy changes associated with mixing, heating, cooling, and phase transitions. Calculation of heat effects of chemical reactions under constant-volume and constant-pressure conditions, as well as their dependence on temperature. Determination of changes in internal energy, enthalpy, entropy, and Gibbs free energy accompanying chemical reactions. Calculations related to phase equilibria in one-component and multicomponent systems, including liquid–vapour equilibrium, compositions of phases at equilibrium, and the compositions of the distillate and residual liquid. Calculation of colligative properties of solutions, including freezing-point depression and boiling-point elevation. Application of the relationship between the standard Gibbs free energy change and the equilibrium constant. Calculations of chemical equilibria in the gas phase, including the determination of equilibrium composition, degree of dissociation, and extent of reaction.

Course content – laboratory

Completion of six laboratory experiments covering selected topics in calorimetry, thermochemistry, UV-Vis spectroscopy, phase equilibria, and colligative properties of solutions. Determination of the heat of neutralization of an acid with a base and the specific heat capacity of a liquid. Determination of the enthalpy of dissolution from the temperature dependence of solubility. Determination of the stoichiometric composition of a complex based on electronic absorption spectra. Measurement of the saturated vapour pressure of solvents. Experimental determination of the liquid–vapour phase diagram for a binary system. Experimental investigation of selected colligative properties of solutions.

Prerequisites and co-requisites

completed courses in mathematics, physics i inorganic chemistry

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lab - performance and reports	100.0%	16.0%
Lab - written/oral tests	50.0%	16.0%
Exercises: 2 written tests	50.0%	28.0%
Lecture: written/oral exam	50.0%	40.0%

Recommended reading

Basic literature	1. K. Pigoń i Z. Ruziewicz, Chemia fizyczna, PWN 2006. 2. P. W. Atkins, Chemia fizyczna, PWN 2001. 3. H. Strzelecki, W.Grzybkowski (red.), Chemia fizyczna, ćwiczenia laboratoryjne, PG, Gdańsk 2004. 4. M. Pilarczyk, Zadania z chemii fizycznej, PG, Gdańsk 1996.
Supplementary literature	1. H. Buchowski i W. Ufnalski, Podstawy termodynamiki (poz. 1-6 z serii Wykłady z chemii fizycznej, WNT, Warszawa) 2. W Libuś, Chemia Fizyczna, część I, PG, Gdańsk 1970. 3. W. Grzybkowski, Chemia fizyczna w przykładach, PG, Gdańsk 2014
eResources addresses	

Example issues/ example questions/ tasks being completed

1. Derive the equation linking the first and second laws of thermodynamics.

2. Draw the dependence of the heat capacity of an ideal diatomic gas under constant pressure on temperature.

3. Why is the melting curve of the water negative?

4. Define the pressure equilibrium constant for a specific chemical reaction, then discuss the influence of temperature and pressure on the reaction yield.

Practical activites within the subject	Not applicable

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