



Subject card

Subject name and code	Thermodynamics, PG_00061912						
Field of study	Materials Engineering						
Date of commencement of studies	October 2023	Academic year of realisation of subject			2024/2025		
Education level	first-cycle studies	Subject group			Obligatory subject group 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			4.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Department of Physical Chemistry -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Dorota Warmińska					
	Teachers	dr hab. inż. Dorota Warmińska					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	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	60	5.0		35.0		100
Subject objectives	The aim of the subject is familiarizing the students with fundamentals of thermodynamic analysis of physico-chemical systems, esp. those including chemical equilibria and phase equilibria.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_K01] Understands the need to improve professional and personal competencies; is conscious of own limitations and knows when to turn to experts, properly establishes priorities helping to accomplish tasks defined by oneself or others.	The students understand the need expanding their knowledge and are aware of their own limitations.			[SK3] Assessment of ability to organize work [SK5] Assessment of ability to solve problems that arise in practice		
	[K6_U06] Can integrate obtained information, interpret it and draw conclusions, as well as formulate and justify opinions.	The student can describe and analyze physicochemical systems from thermodynamic point of view, especially chemical and phase equilibria.			[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information		
	[K6_W02] has knowledge of physics and chemistry, useful for formulating and solving simple problems within the scope of materials science	The student is able to use knowledge in mathematics, physics and chemistry for thermodynamic description.			[SW1] Assessment of factual knowledge		
Subject contents	First law of thermodynamics. State functions. Work and heat. Enthalpy. Molar heat capacities of ideal gases. Thermochemistry. Hess's law. The effect of temperature on the energetic effects of physicochemical processes. Second law of thermodynamics. Entropy. Entropy change in reversible and irreversible processes. Third law of thermodynamics. Helmholtz free energy and Gibbs free enthalpy. Dependence of Gibbs free enthalpy on pressure and temperature. Thermodynamic potential and chemical potential. Gibbs-Duhem equation. Thermodynamic equilibrium. Gibbs phase rule. Equilibrium in single-component systems. Clausius-Clapeyron equation. Selected equilibria in single-, two- and ternary systems (Gibbs triangle) interpretation and use of diagrams. Chemical equilibrium. The effect of temperature and pressure on chemical equilibrium. Real systems. Real gases. Compressibility coefficient. Volatility.						
Prerequisites and co-requisites	Knowledge of mathematics, physics and chemistry at BSc level.						

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written exam	50.0%	50.0%
	performing 5 experiments and delivering the reports	100.0%	50.0%
Recommended reading	Basic literature	1. Chemia fizyczna. P.W.Atkins, PWN 2. Chemia fizyczna. 1.Podstawy fenomenologiczne. K.Pigoń i Z.Ruziewicz, PWN 3. Chemia fizyczna. Ćwiczenia laboratoryjne. Red.: H.Strzelecki i W.Grzybowski, Wydawnictwo PG	
	Supplementary literature	1. Wykłady z chemii fizycznej (praca zbiorowa). Wydawnictwo NT 2. Chemia fizyczna. 2.Fizykochemia molekularna. K.Pigoń i Z.Ruziewicz, PWN 3.Eksperymentalna chemia fizyczna.Red.: H.Strzelecki, Wydawnictwo PG 4. Podstawy termodynamiki. H. Buchowski, W. Ufnalski, Wydawnictwo NT 5. Gazy, ciecze, płyny. H. Buchowski, W. Ufnalski, Wydawnictwo NT	
	eResources addresses	Adresy na platformie eNauczanie: Termodynamika dla studentów kierunku Inżynieria Materiałowa_2024/2025 - Moodle ID: 44178 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=44178	
Example issues/ example questions/ tasks being completed	Define and discuss the concept of thermodynamic equilibrium. Discuss the concepts of specific heat at constant volume and constant pressure. Derive a general relationship between them and give its physical meaning. Apply the results obtained to perfect gas. Discuss the relationships between thermodynamic potentials $U(V, S)$, $H(S, p)$, $F(V, T)$, $G(p, T)$. Formulate, derive and discuss the Gibbs phase rule.		
Work placement	Not applicable		

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