GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	PHYSICAL CHEMISTRY, PG_00049195					
Field of study	Chemistry					
Date of commencement of studies	October 2022		Academic year of realisation of subject		2023/2024	
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		7.0	
Learning profile	general academic profile		Assessment form		assessment	
Conducting unit	Department of Physical Chemistry -> Faculty of Chemistry					
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Piotr Bruździak				
	Teachers					

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	15.0	105
	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	105	5.0	65.0	175

Subject objectives	The course's objectives are to familiarize students with: - the idea of a model in chemistry, its use in real systems, and its practical application;- fundamental laws of reactions and physicochemical processes; - basic concepts of chemical thermodynamics; - how energy and other thermodynamic processes, including intermolecular interactions, affect organic and inorganic reactions; - the idea of chemical and phase equilibrium, how thermodynamics helps determine the direction of a chemical reaction, and how reaction conditions affect the efficiency and direction of the reaction.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	K6_U07	Student defines and describes basic laws and phenomena of chemical thermodynamics. Student solves calculation problems in ideal gas thermodynamics, thermochemistry, chemical equilibria and phase equilibria. Student explains theoretical background of physicochemical experiments in phenomenological thermodynamics. Student applies knowledge of phenomenological thermodynamics in practical laboratory experiments. Student elaborates and interprets results of self-conducted physicochemical experiments.	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
	K6_W03	Student presents a chosen physicochemical problem on the basis of self study of the subject literature.	[SW2] Assessment of knowledge contained in presentation

Subject contents	LLECTURE: A lecture test follows the lecture. The student is exempt from the final exam with the average of the tests from this and the following semester. In the winter semester, failing the lecture test does not automatically result in failing the entire course. 1. The concept of a model in physical chemistry on the example of the ideal gas model: expansion of the model to real gases. 2. Basics of chemical thermodynamics: - basic concepts: heat, work, thermodynamic functions, heat capacity, system, reversibility of reactions and processes; - basic thermodynamic functions: internal energy, enthalpy, entropy, free enthalpy and their relationship with chemical reaction; - principles of thermodynamics applied to chemical reactions and processes; - laws of Hess and Kirchhoff in planning chemical reactions; - thermodynamics of real systems: chemical potential, chemical affinity, activities, activity coefficient; - chemical equilibria in gas, liquid and solid phases; - thermodynamic principles of chemical reaction/process control: the influence of environmental conditions on the thermodynamic functions of the reaction and the position of the equilibrium state. 3. Phase transitions and equilibria: - basic relationships regulating phase transitions in ideal and real systems; - influence of external factors on phase transformations; - relationship of thermodynamics with phase transitions; - phase equilibria in one- and two-component systems; 4. Reactions in solutions:- basic concepts of solutions; - basic calculations of chemical equilibria in solutions; - reaction thermodynamics calculated using quantum mechanics methods; - thermodynamics of dissolution and crystallization processes. 5. Fundamentals of thermodynamics of reactions and irreversible processes: - local thermodynamic description; - sources of entropy of irreversible processes;

- process couplings, cross-effects and stationary states.

EXERCISES

Students in practice use the knowledge gained in lectures by solving computational tasks.

1. (2h) Thermodynamics of gas transformations;

2. (2h) Thermochemistry - Hess's law, Kirchhoff's law;

3. (2h) Entropy, Gibbs energy, and chemical potential;

4. (3h) phase transitions of pure substances and two-component mixtures;

5. (4h) chemical equilibria - reaction constant, reactions in solutions.

Additionally, two 1h tests.

LAB

During the semester, students perform six practical exercises and then take six tests on the subject of the exercises (the theoretical basics of the exercise, the course, and the interpretation of the results).

1. Molar enthalpy of acid neutralization/Thermal capacity of salt solutions

2. Enthalpy of dissolution of oxalic acid in aqueous solution

3. Ionic equilibria in solutions

4. Enthalpy of vaporization of a liquid

5. Determination of the molar mass of a substance using colligative quantities

6. Liquid-vapour phase diagram

SEMINARY:

Groups of 2-3 students receive an extensive task or problem closely related to the subject of the lectures,

	which they develop with the help of the teacher, and present the results in the form of a report (pdf format) and an oral presentation. Schedule of seminar classes: (1h) Initial meeting to present the principles of group work, define the project's goals and divide tasks between group members. (2h) Introduction to scientific spelling and text formatting, including a discussion of the basic rules for the structure of a scientific article. (2h) The use of LaTeX, Overleaf and library databases of publications as tools to develop a scientific report. (6h) Development (in the form of a report) of a given problem related to the thermodynamics of chemical reactions and processes, containing the following main elements: - physicochemical basis of the problem; - presentation of the method of processing the received data; - discussion of the results in a descriptive and graphical form; - discussing the problems that arose during the work on the project. (4h) Presentation of the results of the work in the form of a 15-minute presentation (+10-minute discussion) and a joint discussion of the most important problems that arose during the work on the problems.
Prerequisites and co-requisites	Preceding subjects: mathematics (including calculus), physics, general chemistry.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
6 tests and reports (laboratory)	60.0%	30.0%
2 tests (exercises)	60.0%	40.0%
final report and presentation (seminars)	60.0%	30.0%
1 final lecture test (lecture)	60.0%	0.0%

Recommended reading

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. Grzybkowski, Wydawnictwo PG.
	Supplementary literature	1. Chemia fizyczna, Część I, W. Libuś, Wydawnictwo PG. 2. Chemia fizyczna. Zbiór zadań z rozwiązaniami, P.W. Atkins, C.A. Trapp, M.P. Cady, C. Giunta, PWN. 3. Chemia fizyczna. Laboratorium fizykochemiczne, L. Komorowski, A. Olszowski, PWN. and a list of scientific papers forming the basis of the seminar project.

	eResources addresses	
Example issues/ example questions/ tasks being completed	LECTURE: 1. The entropy change of the water freezing process is negative. Doesn't this fact contradict the second law of thermodynamics? Justify your answer. 2. Hess's law is a consequence of some general thermodynamic laws. State what the rules are. 3. The phase equilibrium line between phase a and phase b in the p-T system has a negative and steep slope. List and justify all possible reasons for this fact. EXERCISES: 1. Hess's law and Kirchhoff's law - determination of thermal effects of reactions. 2. Phase transitions in one- and two-component systems. 3. Reaction equilibrium constant - relationship with reaction thermodynamics and dependence on temperature. 4. Example task: Calculate Q, W, U, and H in the adiabatic process of expanding 1 mole of a monatomic ideal gas with an initial temperature of 25oC and a volume of 2 dm3 to a final volume of 3 dm3: a) reversibly, b) against a constant external pressure of 4.5 bars. LAB: 1. How can the vapor pressure of a pure substance be measured using an isoteniscope? 2. Methods of determining the heat capacity of a calorimeter. 3. Suggest a method for determining the heat of dissolution of a substance. SEMINAR: 1. The Benesi-Hildebrand equation in determining the equilibrium constant of a reaction. 2. Determination of thermodynamic functions and verification of hypotheses regarding the chemical reaction mechanism using DSC differential calorimetry. 3. Colligative quantities in studies of macromolecular compounds.	
Work placement	Not applicable	