COURSE DESCRIPTION CARD - SYLLABUS

Course name
Termodynamika chemiczna i procesowa

Course

Field of study
Technologia Chemiczna (Chemical Technology)

Year/Semester
III/5

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
30

Other (e.g. online)
0

Tutorials
20

Projects/seminars
0

Number of credit points

8

Lecturers

Responsible for the course/lecturer:

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Wydział Technologii Chemicznej

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Responsible for the course/lecturer:

Prerequisites

Students:

have knowledge in general chemistry (writing chemical reactions, converting concentrations, knowledge of laboratory glassware and basic laboratory equipment).

have knowledge in mathematics and physics enabling the introduction of problems in physical chemistry (basic laws of physics, differential calculus).

can apply the learned mathematical apparatus and knowledge in physics to physicochemical calculations.

Course objective

To familiarise students with basic problems in thermodynamics at the academic level in the field of: thermodynamic functions (the first and second laws of thermodynamics, the Gibbs free energy, thermochemistry,the thermodynamic equation of state), phase equilibrium – one-component and multi-component systems and chemical equilibrium .

Course-related learning outcomes

Knowledge

K_W03 The graduate has the necessary knowledge of chemistry to understand chemical phenomena and processes.

K_W08 The graduate has a systematzed, general theoretical knowledge of basic annd inorganic chemistry, organic physical and analytial chemistry.

Skills

K_U01 The graduate can obtain necessary information from literature, databases and other sources related to chemical sciences, interpret them properly, draw conclusions, formulate and justify opinions.

K_U05 The graduate can implement the process of self-learning.

K_U09 The graduate can perceive the systemic and non-technical aspects of taks when formulating and solving them.

K_U19 The graduate can characterize various states of matter, the structure of chemical compounds using the theories used to describe them and experimental methods / techniques.

K_U23 The graduate can apply the principles of thermodynamics in the implementation of chemical processes.

K_U24 The graduate can predict the reactivity of chemical compounds based on their structure, and estimate the thermodynamic and kinetic effects of chemical processes.

Social competences

K_K02 The graduate is aware of the importance and understanding non-technical aspects and results of the engineer's job, including its environmental impact and the resulting responsibility for all decisions made.

K_K03 The graduate can cooperate and work on a team, inspire and integrate engineering environments.

K_K04 The graduate can appropriately determine the priorities for accomplishing the assigned task.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: exame

Exercises: written test, passing the test above 75%

Laboratory: The course passing is based on points received for the individual exercise description

Programme content

LECTURE

The first law of thermodynamics: The effect of the energy of a chemical reaction. The concept of internal energy. The energy balance of the reaction (process) - the balance of internal energy. The difference of the energy contained in the products and substrates exchanged with the environment. Thermodynamic definition of work, its kinds. Working volume. How the internal energy is stored. Thermal energy. The average thermal energy of the molecules. Temperature, its various scales. Thermodynamic temperature scale.

The second law of thermodynamics. The system aims to maximize the chaos - a state most likely. Simple examples. The concept of entropy as a measure of chaos. The total entropy can grow, but can not reduce (the second law of thermodynamics). Zero (the third) law of thermodynamics.

The driving force processes - thermodynamic potentials. Work and heat depend on the conduct of the process. Why do not we use in thermodynamics size we're used to (heat, work). The concept of state function, its mathematical expression. Process at constant volume. Isobaric process. Adiabatic processes. The concept of free energy. Enthalpy. The entropy and enthalpy as a state function. When I use the function (p = const) or (v = const).

Thermochemistry. Heat capacity. Definition of heat capacity at constant volume and at constant pressure. Measurement of heat - calorimeter. The dependence of the temperature of the heat capacity. The difference between Cp and Cv and Qp and Qv. Thermochemical equations. The Helmholtz and Gibbs energies. Properties of the Gibbs energy(the variation of the Gibbs energy with temperature and pressure).

Conditions ((p= 1 atm, T = 298 K). Procedure for calculating the standard heat of reaction. Procedure for calculating the standard enthalpy of reaction. Procedure for calculating the standard Gibbs energy of reaction.

The concept of perfect gas. Real gases. Viral coefficients. Wiral equation of state. Description of real gas using the van der Vaals'a equation. Critical parameters.

Phase diagrams. The phase rule. The location of phase boundaries. Clapeyron equation. The solid-liquid Bondary. The liquid-vapour Bondary. The solid-vapour Bondary. Supercritical fluid.

Phase equilibria - multiple systems. Thermal analysis of multi-component system. Phase diagram. Phase equilibria liquid - gas for multi-component systems. Azeotrope. Distillation. Vacuum distillation. For example, crude oil distillation, distillation of alcohol of agricultural. Phase equilibria liquid- solid for multi-component systems. Crystallization, purification. Simple eutectic system. Phase diagram.

Parameters eutectic. Eutectic solid solutions, phase diagram. Eutectic system with a combination of the chemical between components. Examples.

Balance the chemical reaction . The equilibrium constant of the reaction. The van't Hoff equation. The dependence of the equilibrium constant on the temperature.

Thermodynamic description of solutions. The mixture and a solution. Changes in volume when mixing liquid - no additivity. The partial molar volume. Overall: partial molar volume. Relation Gibbs-Duhem'a. The chemical potential, its dependence on the quantities of ingredients and the temperature. The condition of equilibrium in multi-component systems.

Exercices and laboratory:

The second law of thermodynamics. The system aims to maximize the chaos - a state most likely. Simple examples. The concept of entropy as a measure of chaos. The total entropy can grow, but can not reduce (the second law of thermodynamics). Zero (the third) law of thermodynamics.

The driving force processes - thermodynamic potentials. Work and heat depend on the conduct of the process. Why do not we use in thermodynamics size we're used to (heat, work). The concept of state function, its mathematical expression. Process at constant volume. Isobaric process. Adiabatic processes. The concept of free energy. Enthalpy. The entropy and enthalpy as a state function. When I use the function (p = const) or (v = const).

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PHASE EQUILIBRIUM

Liquid – Vapour transition. Temperature dependence of vapour pressure, Clausius-Clapeyron equation. Raoult’s law and Henry's law. Phase diagrams: liquid – vapour. Distillation, fractional distillation. Aseotropes. Gibbs phase rule. Phase diagrams: liquid - solid for the two component systems. Two and multi component systems. Thermal analysis. Cooling curves.

SURFACE EQUILIBRIUM

Physical and Chemical Adsorption. Isotherms of adsorption: Linear, Freundlich, Langmuir, BET equations. Adsorbents – properties. Spectrophotometer construction. Principles of the spectrophotometric measurements. Lambert-Beer law. Surface tension and measurement methods. Gibbsa adsorption isotherm. Flotation. Surfactants. Foams and emulsions.

CHEMICAL EQULIBRIUM

Chemical equilibrium and thermodynamics functions. Thermal dependency of chemical equilibrium. Heat reaction and temperature dependence. Solubility equilibrium. Conductometry. Conductivity measurements of the electrolytes. Measurement cell construction. Heat reaction and determination. General principles of thermodynamics. Laws of thermodynamics. Internal energy and enthalpy. Molar enthalpy of formation, combustion, dissolution dilution. Calorimetry. Construction and types of calorimeters. Cells and cell types. Methods for measuring the electromotive force of a cell.

Teaching methods

Lecture - presentation

Classes with discussion. Deductive method. The exercises involve solving partial tasks and solving detailed problems.

Laboratory - practical method - laboratory exercises. Planning, execution and analysis of the results of physicochemical experiment.

Bibliography

Basic

1. K. Pigoń, Z. Ruziewicz, Chemia Fizyczna, PWN Warszawa 2005

2. P. Atkins, Chemia Fizyczna, PWN, Warszawa 2001

Additional

1. P. Atkins, Podstawy Chemii Fizycznej, PWN, Warszawa 1999

2. L. Sobczyk, A. Kisza, Chemia fizyczna dla przyrodników PWN Warszawa 1977

3. H. Buchnowski, W. Ufnalski Wykłady z chemii fizycznej WNT Warszawa 1998

4. P.W. Atkins, C.A Trapp, M.P.Cady, C.Giunta Chemia fizyczna. Zbiór zadań z rozwiązaniami

5. J. Demichowicz-Pigoniowa Obliczenia fizykochemiczne, Wydawnictwo Politechniki Wrocławskiej Wrocław 1997.

6. W.Ufnalski. Obliczenia fizykochemiczne. Wydawnictwo Politechniki Warszawskiej 1995

Breakdown of average student's workload

	Hours	ECTS
Total workload	200	8,0
Classes requiring direct contact with the teacher	90	3,6
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	110	4,4

[1] delete or add other activities as appropriate