COURSE DESCRIPTION CARD - SYLLABUS

Course name

Physical chemistry

Course

Field of study

Chemical and process engineering

Area of study (specialization)

Level of study

First-cycle studies

Form of study

full-time

Year/Semester

2/4

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

Number of hours

Lecture

15

Laboratory classes

45

Other (e.g. online)

0

Tutorials

0

Projects/seminars

0

Number of credit points

5

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).

are able to prepare solutions of specific concentrations.

are aware of further development of their competences.

Course objective

To familiarise students with basic problems in physical chemistry and electrochemistry at the academic level in the field of: chemical kinetics, simple and complex reactions, homo- and heterogeneous catalysis and electrolysis, type of half-cells and type of cells.

Course-related learning outcomes

Knowledge

Students will be able to define and explain the basic principles, theories in the field of chemical kinetics, such as: rate of chemical reaction, order and molecularity, half-life, activation energy, collision and activated-complex theory. K_W03, K_W10

Students will be able to define and explain the basic principles, theories in the field of electrochemistry, such as: types of half-cells, types of cells, the concept of electrolysis or corrosion. K_W03, K_W10

Students will be able to characterise, list and identify simple and complex reactions, define hommo- and heterogeneous catalysis, define the causes of corrosion, give examples and practical application. K_W03, K_W10

Skills

Students will be able to obtain information from literature, databases and other sources and interpret it. K_U01

Students will be able to plan and carry out measurements of basic physicochemical parameters. K_U08

Students will have the self-study skills in the subject. K_U05

Students will be able to elaborate, describe and present results of an experiment or theoretical calculations. K_U09

Social competences

Students will be aware of the responsibility for collaborative tasks related to teamwork. K_K04

Students will be able to properly prioritise the task. K_K03

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: exam

Laboratory classes: final assessment based on points obtained for: response, planning and conducting subsequent experiments and preparation of the report. Passing exercises from: 56%

Programme content

Lecture:

1 Chemical kinetics - basic concepts

General Concepts of Kinetics. Collision Theory. Mechanisms of the Chemical Reactions – unimolecular, bimolecular and termolecular reactions. Rate of chemical reaction. Rate constant. Half-life. Order of the Chemical Reaction. Zero, first, second, and third-order rate equations. Pseudo-first-order reactions. Temperature dependence of the rate constant - Arrhenius formula. Activation Energy.

2 The reaction product is formed directly not from the substrates but from the active complex

Activated-Complex Theory. Temperature dependence of the rate constant – Arrhenius and Eyring's equations. Enthalpy and entropy of activation. The relationship between the parameters of the Arrhenius equation and Eyring. Two barriers to the course of the reaction: energetic and structural (energy and entropy of activation). Influence of pressure on the rate of gas reactions.

3 Complex reactions

Reversible reactions - equations for equilibrium concentrations. The equilibrium constant results from kinetics. Efficiency of reversible reactions. Parallel reactions, kinetic equations, under given conditions we observe a product that is formed in the fastest reaction. The speed of individual parallel reactions can be adjusted using: temperature changes, concentration changes or using a selective catalyst. Consecutive reactions. Intermediate product.

4 Chain reactions

Straight and branched chain. Initiating chain reactions. Examples of chain reactions. Establishment of steady state. The slowest reaction rate determines the speed of the whole process. Examples of kinetic methods for solving the reaction mechanism. Activation energy of consecutive processes.

5 Homogenous Catalysis in solution

Mechanism of catalyst operation. Reaction inducer. Heterogeneous and Homogenous Catalysis. Types of homogeneous catalysts in liquid solution. The dependence of rate of catalysis on the amount of catalyst. Acid-base catalysis. Enzymes.

6 Heterogeneous Catalysis

The principle of operation of heterogeneous solid catalysts. Catalyst, catalyst supports (powder and monolithic). Influence of diffusion and adsorption on the rate of catalytic reaction. Examples of different mechanisms of contact catalysis. Diffusion as the rate determining step. TON and TOF coefficients.

7 Explosive reactions

Explosions. Blast power. Detonation, deflagration. Propelling and crushing materials. Initiators. Mathematical description of radical reaction with branched chain - balance of radicals, acceleration factor. Oxygen balance. Explosive composites. Cumulation phenomenon, Monroe effect.

Laboratory classes:

CHEMICAL KINETICS

General Concepts of Kinetics. Collision Theory, Activated-Complex Theory. Mechanisms of the Chemical Reactions – unimolecular, bimolecular and termolecular reactions. Rate of chemical reaction. Rate constant. Order of the Chemical Reaction. Zero, first, second, and third-order rate equations. Temperature dependence of the rate constant. Activation Energy. Complex Reactions: reversible, parallel, competitive, consecutive. Inductive. Catalysis. Heterogeneous and Homogenous Catalysis. Oscillatory Reactions. Ionic strength of an electrolyte. Influence of the ionic strength on the chemical reaction rate. Spectrophotometer construction. Principles of the spectrophotometric measurements. Lambert-Beer law.

ELECTROCHEMISTRY

Chemical and electrochemical depositions of metal coating. Corrosion. Protection from Corrosion. Electrolysis, Faraday's laws. Chemical and electrochemical corrosion (examples). Types of half-cells. Methods of EMF (electromotive force) determination. Types of the galvanic cells. Primary and Secondary Cells. Deposition potential. Overpotential varieties. Hydrogen overpotential. Ion mobility. Transfer number. Electric Double-Layer. Electrokinetic phenomena. Diffusion potential. Concentration cells.

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. Cooling curves. Thermal analysis.

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.

Teaching methods

Lecture: multimedia presentation

Laboratory classes: practical method. Planning, execution and analysis of the results of physicochemical experiment.

Bibliography

Basic

1. K. Pigoń, Z. Ruziewicz, Chemia Fizyczna, PWN Warszawa 2013

2. P. Atkins, Chemia Fizyczna, PWN, Warszawa 2005

3. A. Molski, Wprowadzenie do kinetyki chemicznej, WNT warszawa 2000

4. L. Sobczyk, Eksperymentalna Chemia Fizyczna, PWN Warszawa 1982

Additional

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

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

3. J. Minczewski, Chemia analityczna, PWN Warszawa 2005

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

5. Instrukcje do ćwiczeń laboratoryjnych z chemii fizycznej

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	65	2,6
Student's own work (literature studies, preparation for laboratory classes, preparation for exam, preparation of report) [1]	60	2,4

[1] delete or add other activities as appropriate