GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Kinetics and electrochemistry, PG_00060861		
Field of study	Kinetyka i elektrochemia		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2025/2026
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	4	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Physical Chemistry -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Joanna Krakowiak	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	30.0	0.0	0.0	75

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 1822 Kinetyka i elektrochemia
https://enauczanie.pg.edu.pl/2025/course/view.php?id=1822

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	75	10.0	95.0	180

Subject objectives

The aim of the course is to provide students with a fundamental understanding of chemical kinetics, including formal kinetics, reaction mechanisms, and theories of reaction rates, as well as the core concepts of electrochemistry, such as ionics, electrode processes, and electrochemical kinetics. The course also aims to develop students ability to perform basic calculations in both chemical kinetics and electrochemistry, thereby preparing them for more advanced studies and practical applications in these fields.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_U03] is able to apply knowledge of inorganic, organic, physical and analytical chemistry and identify appropriate sources of information to design and synthesize simple chemical compounds, carry out basic physicochemical and analytical measurements	The student is able to perform quantitative analysis using conductometric and potentiometric measurements. They select the appropriate measurement technique to track the kinetics of a chemical reaction in selected systems	[SU1] Ocena realizacji zadania [SU2] Ocena umiejętności analizy informacji [SU4] Ocena umiejętności korzystania z metod i narzędzi
	[K6_U11] individually plans and implements his/her own learning	As part of the course, lectures, calculation exercises, and laboratory classes are conducted according to a set schedule. The student plans and achieves defined educational goals, with the greatest amount of independent work dedicated to laboratory classes, where theoretical and practical knowledge, as well as the ability to analyze experimental data, are required	[SU1] Ocena realizacji zadania
	[K6_U02] is able to operate typical laboratory apparatus and conduct analyses related to materials testing	The student is able to perform conductometric and potentiometric measurements and use them to determine selected physicochemical quantities. They become familiar with various methods of tracking the kinetics of a chemical reaction and apply one of them during laboratory classes.	[SU1] Ocena realizacji zadania [SU2] Ocena umiejętności analizy informacji [SU4] Ocena umiejętności korzystania z metod i narzędzi [SU5] Ocena umiejętności zaprezentowania wyników realizacji zadania
	[K6_W02] has knowledge of inorganic, organic, physical and analytical chemistry useful for obtaining selected groups of compounds, determining their physical and chemical properties allowing for their quantitative and qualitative analysis, making measurements and determining the parameters of chemical reactions, phenomena and processes occurring in chemical technology	The student learns about the application of conductometric and potentiometric measurements in both laboratory and industrial settings. They are aware of the impact of key parameters on the rate of chemical reactions, including those of industrial significance.	[SW1] Ocena wiedzy faktograficznej

Subject contents

Course content – lecture

Chemical kinetics:
Basic concepts of formal kinetics: order and molecularity of reactions, definition of reaction rate, derivation of basic kinetic equations (differential and integrated forms). Kinetics and mechanisms of complex reactions (parallel, consecutive, reversible, and chain reactions). Steady-state approximation. Temperature dependence of reaction rates. Collision theory and transition state theory. Basic concepts of chemical catalysis in homogeneous and heterogeneous systems. Kinetics of electrode reactions.

Electrochemistry:

1. **Ionics.** Electrolyte solutions, strength of electrolytes. Mean ionic activity coefficients. Electrical conductivity of electrolyte solutions (fundamental relations, measurement methods, conductometric titrations, molar conductivities). Transport numbers definition and methods of determination.

2. **Electrode processes.** Classification of half-cells and electrochemical cells, electrode reactions. Electrode potential and electromotive force of a cell the Nernst equation. Electrochemical series. Applications of potentiometry. Thermodynamic characterization. Electrode polarization and overpotential. Electrolysis electrode reactions. Electrochemical energy storage systems.

Course content – exercises
Chemical kinetics: Calculation of the reaction rate and the extent of reaction. Determination of reaction order. Kinetics of reversible reactions composed of elementary first-order steps.

Electrochemistry: Application of Faradays first law in electrochemical calculations. Determination of transport numbers and conductivity using conductometric methods. Application of the Nernst equation to calculate electrode potentials and the electromotive force (EMF) of different types of cells. Determination of thermodynamic functions (ΔH, ΔS, ΔG) for cell reactions. Estimation of activity coefficients of electrolytes.

Course content – laboratory

Execution of five of the following experiments and analysis of the experimental results:

1. **Kinetics of the iodination of aniline (titrimetric analysis)** determination of the reaction rate constant using potentiometric titration to monitor changes in reagent concentration.
2. **Determination of ion transport numbers** application of Hittorfs method and the moving boundary method.
3. **Conductometry** performance of several conductometric titrations followed by data analysis.
4. **Determination of activity coefficients** based on EMF measurements.
5. **Determination of ΔG, ΔH and ΔS for a cell reaction** using the dependence of EMF on temperature.
6. **Solidliquid adsorption determination of the equations of two adsorption isotherms**

Prerequisites and co-requisites

Completed courses in mathematics, physics, general and inorganic chemistry. Knowledge of organic chemistry at the high school level (extended).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
preparatory tests for the lab	50.0%	12.5%
final exam (written/oral)	50.0%	50.0%
carrying out the measurements and delivery of reports	100.0%	12.5%
2 written tests in problem solving	50.0%	25.0%

Recommended reading

Basic literature	1. P. W. Atkins, Chemia fizyczna, PWN 2001. 2. W. Libuś i Z. Libuś, Elektrochemia, PWN 1987. 3. I Uruska (red.), Zbiór zadań z chemii fizycznej, PG, Gdańsk 1997. 4. H. Strzelecki, W.Grzybkowski (red.), Chemia fizyczna, ćwiczenia laboratoryjne, PG, Gdańsk 2004.
Supplementary literature	1. A. Molski, Wprowadzenie do kinetyki chemicznej (poz. 1-3. z serii Wykłady z chemii fizycznej, WNT, Warszawa) 2. A. Kisza, Elektrochemia. Jonika 3. A. Kisza, Elektrochemia. Elektrodyka 5. M. Pilarczyk, Zadania z chemii fizycznej, PG, Gdańsk 1996. 6. I Uruska, Zbiór zadań testowych z chemii fizycznej, PG, Gdańsk 1997. 7. P. W. Atkins, Podstawy chemii fizycznej, PWN 1999. 8. P. W. Atkins, Przewodnik po chemii fizycznej, PWN 1997. 9. K. Pigoń i Z. Ruziewicz, Chemia fizyczna, PWN 2006.
eResources addresses	

Example issues/ example questions/ tasks being completed	Kinetics In a first-order elementary reaction carried out at **27 °C**, the reactant concentration decreases to one half after **5000 s**. At **37 °C**, the concentration halves after **1000 s**. Compute: a) the rate constant at **27 °C**, b) the activation energy of the reaction. Electrochemistry **1.**Calculate the EMF at 20 °C for the cell: CuCdCdCl2(aq,0.1M)AgCl(s)Ag(s) Given standard reduction potentials: $E(Cd^{2+}/Cd)=0.40$ V,E(AgCl(s)/Ag,Cl)=+0.22 V.E. **2.** Draw the conductometric titration curve for an aqueous solution of **KOH** titrated with aqueous **HCl**. Clearly explain the changes in conductivity during the titration and write the relevant chemical reactions.
Practical activites within the subject	Not applicable

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