Subject card

Subject name and code	Experimental methods for studying chemical equilibria in aqueous solutions, PG_00050885		
Field of study	Chemical Business, Chemistry, Environmental Protection		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	Master's studies	Subject group	Optional subject group
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	English
Semester of study	3	ECTS credits	4.0
Learning profile	academic	Assessment form	credit
Conducting unit	Laboratory of Physicochemistry of Coordination Complexes -> Department of General and Inorganic Chemistry -> Faculty of Chemistry -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Dariusz Wyrzykowski	
	Teachers		

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	30.0	0.0	0.0	30
	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	30	5.0	65.0	100

Subject objectives	presenting basic issues in solution chemistry presenting the basis of chemical calculations familiarize students with the basic and more advanced aspects of chemical equilibria in aqueous solutions familiarize students with the commonly used experimental methods and data processing

<table>
<tr><td rowspan="7">Learning outcomes</td><td>Course outcome</td><td>Subject outcome</td><td>Method of verification</td></tr>
<tr><td>[CHEMMU2_U02] Critically assesses the results of conducted, performed observations and theoretical calculations and discusses errors.</td><td>K_U02

critically assesses the results of conducted, performed observations and theoretical calculations and discusses errors</td><td>[SU5] implementation of a problem task</td></tr>
<tr><td>[CHEMMU2_U01] Plans and implements chemical experiments of medium complexity.</td><td>K_U01

plans and implements chemical experiments of extended complexity</td><td>[SU5] implementation of a problem task</td></tr>
<tr><td>[CHEMMU2_U04] Applies acquired knowledge of chemistry and related scientific disciplines.</td><td>K_U04

applies acquired knowledge of chemistry and related scientific disciplines</td><td>[SU2] presentation/project/paper/report</td></tr>
<tr><td>[CHEMMU2_W10] Uses knowledge of the principles of operation of the basic scientific and research apparatus used in chemistry.</td><td>K_W10

uses knowledge of the principles of operation of the scientific and research apparatus used in chemistry</td><td>[SW1] oral statement/conversation/discussion
[SW5] implementation of a problem task</td></tr>
<tr><td>[CHEMMU2_W03] Demonstrates extended knowledge in the field of modern measuring techniques used in chemical analysis.</td><td>K_W03

demonstrates in-depth knowledge in the field of modern measuring techniques used in chemical analysis

K_W03

applies mathematics to the extent necessary to understand, describe and model chemical processes of extended complexity</td><td>[SW2] presentation/project/paper/report
[SW5] implementation of a problem task</td></tr>
<tr><td>[CHEMMU2_W06] Applies mathematics to the extent necessary to understand, describe and model chemical processes of medium complexity.</td><td>K_W06

applies mathematics to the extent necessary to understand, describe and model chemical processes of extended complexity</td><td>[SW2] presentation/project/paper/report</td></tr>
<tr><td>Subject contents</td><td colspan="3">The set of physico-chemical experiments includes 10 laboratory classes thematically related to chemical equilibria in aqueous solutions. The course is intended to familiarize students with the commonly used experimental methods, namely potentiometry and conductometry as well as an advanced method, namely isothermal titration chemistry for studying chemical equilibria, designing experiments, calculations as well as presentation of the obtained results.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="3"></td></tr>
<tr><td rowspan="2">Assessment methods and criteria</td><td>Subject passing criteria</td><td>Passing threshold</td><td>Percentage of the final grade</td></tr>
<tr><td>lab</td><td>51.0%</td><td>100.0%</td></tr>
<tr><td>Recommended reading</td><td>Basic literature</td><td colspan="2">lack</td></tr>
</table>

	Supplementary literature	a) L. S. Lanka K. Fernando, L. Hasini R. Perera, *Graphical Application to Assist Students Understand the Basic Concepts in AcidBase Titrations*, J. Chem. Educ., 2022, 99, 15471552 b) P. Gans, B. OSullivan, *GLEE, a new computer program for glass electrode calibration, Talanta*, 2000, 51, 3337 [Download the installation file: Install_GLEE.EXE: http://www.hyperquad.co.uk/glee.htm] c) L. Alderighi, P. Gans, A. Ienco, D. Peters, A. Sabatini, A. Vacca, *Hyperquad simulation and speciation (HySS): a utility program for the investigation of equilibria involving soluble and partially soluble species*, Coord. Chem. Rev., 1999, 184, 311-318 [Download the installation: Install HySS2009.EXE: http://www.hyperquad.co.uk/hyss.htm] d) K. C. Smith, E. Edionwe, B. Michel, *Conductimetric Titrations: A Predict-Observe-Explain Activity for General Chemistry*, J. Chem. Educ., 2010, 87, 12171221 e) A. Kraft, *The Determination of the pKa of Multiprotic, Weak Acids by Analyzing Potentiometric AcidBase Titration Data with Difference Plots*, J. Chem. Educ. 2003, 80, 554559 f) B. Sarac, S. Hadzi, *Analysis of Protonation Equilibria of Amino Acids in Aqueous Solutions Using Microsoft Excel*, J. Chem. Educ. 2021, 98, 10011007 g) E. Klotz, R. Doyle, E. Gross, B. Mattson, *The Equilibrium Constant for Bromothymol Blue: A General Chemistry Laboratory Experiment Using Spectroscopy*, J. Chem. Educ. 2011, 88, 637639 h) G. S. Patterson, *A Simplified Method for Finding the pKa of an AcidBase Indicator by Spectrophotometry*, J. Chem. Educ., 1999, 76, 395398 i) A. S. Kooser, J. L. Jenkins, L. E. Welch, *AcidBase Indicators: A New Look at an Old Topic*, J. Chem. Educ., 2001, 78, 15041506 j) A. Domínguez, A. Fernández, N. González, E. Iglesias, L. Montenegro, *Determination of Critical Micelle Concentration of Some Surfactants by Three Techniques*, J. Chem. Educ. 1997, 74, 12771231 k) J. Goronja, N. Pejic, A. Janosevic Lezaic, D. Stanisavljev, A. Malenovic, *Using a Combination of Experimental and Mathematical Method To Explore Critical Micelle Concentration of a Cationic Surfactant*, J. Chem. Educ. 2016, 93, 12771281 l) M. M. Mabrouk, N. A. Hamed, F. R. Mansour, *Simple Spectrophotometric Method to Measure Surfactant CMC by Employing the Optical Properties of Curcumins Tautomers*, J. Chem. Educ., 2021, 98, 26032609
	eResources addresses	

Example issues/ example questions/ tasks being completed	1) What information can be found from species distribution diagrams? 2) In which of the following acid / base titrations, we can NOT determine the equivalence point using a visual indicator in an accurate manner? (1) strong acid / strong base (2) strong acid / weak base (3) weak acid / strong base (4) weak acid / weak base (5) none of the above 3) Consider the titrations of the pairs of aqueous acids and bases listed on the left. For which pair is the pH at the equivalence point stated incorrectly? Acid-Base Pair pH at Equivalence Point (1) $HCl + NH_3$ less than 7 (2) $HNO_3 + Ca(OH)_2$ equal to 7 (3) $HClO_4 + NaOH$ equal to 7 (4) $CH_3COOH + NaOH$ less than 7 (5) $CH_3COOH + KOH$ greater than 7
Work placement	Not applicable

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