



## Subject card

Subject name and code	, PG_00058861						
Field of study	Nanotechnology						
Date of commencement of studies	October 2022		Academic year of realisation of subject		2022/2023		
Education level	second-cycle studies		Subject group		Optional subject group 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	1		Language of instruction		English		
Semester of study	1		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Zakład fizyki układów nieuporządkowanych -> Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Maciej Bobrowski				
	Teachers		dr hab. Maciej Bobrowski  dr inż. Marta Przeźniak-Welenc				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	E-learning hours included: 0.0						
	Additional information: Classroom instructions (face to face teaching). If necessary, the classes could be moved to internet , for online teaching.						
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	45		5.0		25.0	75
Subject objectives	The goal of this course is to teach general chemistry and connection of this knowledge with synthesis' methods and analysis of nanostructures. An emphasis is laid on an analysis of electronic structure of molecules and prediction of resulting properties and reasons of onsequent behaviour in chemical reactions.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	K7_U02	Student has knowledge on the OSH: Occupational Safety and Health in chemistry laboratory. Student knows on how to analyze mixture of dissolved cations and anions, qualitatively determining the chemical content of the analyte. Student can do the titration and to determine quantitatively the content of acid/ base samples. Student can predict the course of redox reaction under distinct environment and on this basis -- analyze qualitative and quantitative redox samples. Student can apply knowledge on electrochemical series and on this basis can do experiments with given samples containing redox compounds.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
	K7_W04	Student has deep knowledge on practical methods of calculations of chemical concentrations, can balance redox reactions, calculate redox potential, identify and explain the direction of redox reaction, determine the strength of acids and bases, can identify and name chemical compounds, orientates in chemical synthesis of nanoparticles and tiny layers as well as in their properties and applications.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	K7_W07	student distinguishes different types of chemical substances, defines the relationship between the chemical composition and the harmfulness of the compound.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
Subject contents	Introduction, chemical bonds (weak and strong), hybridization, electron configuration, atomic and molecular bonds, reactive oxygen species, concentrations, calculus in chemistry, redox reactions, balancing of redox reactions, electrochemical cells, electrochemical series, Nernst equation, batteries, electrolysis, corrosion, acids and bases, strength of acids and bases, pH, pOH, titration, oxygens. Introduction to organic chemistry and biochemistry.		
Prerequisites and co-requisites	Fundamentals of chemistry, mathematics and physics.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	positively reviewed all reports from all laboratories.	51.0%	50.0%
	final exam	51.0%	50.0%
Recommended reading	Basic literature	1. Timberlake, Karen C. Chemistry: An Introduction to General, Organic, and Biological Chemistry, Global Edition, Boston : Pearson. 2015 2. Atkins, P. W. Chemistry: A Very Short Introduction, Oxford : OUP Oxford. 2014 3. General chemistry; principles, patterns, and applications. ( <a href="http://www.saylor.org/books">http://www.saylor.org/books</a> )	
	Supplementary literature	1. Robert J. Ouellette and J. David Rawn. Organic Chemistry. Structure, Mechanism, and Synthesis, Elsevier, 2014. 2. Chemistry Dictionary: <a href="http://www.chemistry-dictionary.com/definition/d-orbitals.php">http://www.chemistry-dictionary.com/definition/d-orbitals.php</a> 3. Dahm, Donald J. Calculations in chemistry: an introduction, New York: Norton, 2013	
	eResources addresses	Uzupełniające Adresy na platformie eNauczanie: Chemistry and Nanochemistry 2022. - Moodle ID: 25952 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25952">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=25952</a>	

Example issues/ example questions/ tasks being completed	<ul style="list-style-type: none"> <li>• Covalent bonds: understanding, distinguishing, examples, types of covalent bonds, radical orbitals (singly occupied molecular orbitals (SOMOs)), spin of molecules, types of critical points on energy hypersurface: minimas, saddle points. Reactive oxygen species, energy levels of oxygen molecule's molecular orbitals.</li> <li>• Ionic bonds, differences between ionic bonds and covalent bonds, examples, zwitterions, ionic liquids, application of ionic liquids.</li> <li>• Coordinate and metallic bonds, -interactions, hydrogen bonds, Van der Waals bonds. Examples of systems, differences, delocalization of electrons.</li> <li>• Concentrations: only problems: (given reactions, concentrations, calculate different concentration, also by using metric prefixes).</li> <li>• Redox reactions: half reactions, disproportionation, basic and acidic media, oxidation states,</li> <li>• Typical oxidizers, reductors, construction of voltaic and electrochemical cells (redox reactions occurring there): zinc-copper, cadmium-silver</li> <li>• Redox potentials, galvanic series, standard conditions, directionality of a reaction, construction and chemical reactions of following electrodes: SHE, calomel, silver.</li> <li>• Equilibrium constants, description (charging and discharging redox reactions) of zinc-carbon dry-cell battery, lead-storage battery, lithium-ion batteries.</li> <li>• Acids and bases: Arrhenius definition, Bronsted-Lowry definition, Lewis theory. <math>K_a</math>, <math>K_b</math>, <math>pK_a</math>, <math>pK_b</math>, pH, pOH. Amphoterism.</li> <li>• Strength of acids and bases. Titration.</li> <li>• Metals: occurrence, periodic trends in metallic properties. Metal oxides: acidic, basic, amphoteric, neutral, peroxides, trends in acid-base behaviour. In all cases - the reactions!</li> <li>• Metal oxides nanoparticles' synthesis: Hydrothermal/solvothermal, sol-gel, chemical precipitation, CVD, PVD. Ferrofluids.</li> <li>• Hydrocarbons: saturated, unsaturated. Functional organic groups: alkane, alkene, alkyne, phenyl, amine, alcohol, ether, alkyl halides, thiol, aldehyde, ketone, ester, carboxylic acid, amide.</li> <li>• Nutrients, macromolecules: carbohydrates, lipids, proteins, nucleic acids.</li> </ul>
Work placement	Not applicable