GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemistry II, PG_00027572		
Field of study	Nanotechnology		
Date of commencement of studies	October 2021	Academic year of realisation of subject	2021/2022
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	1	Language of instruction	Polish
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Elżbieta Luboch	
	Teachers	prof. dr hab. Anna Lisowska-Oleksiak prof. dr hab. inż. Elżbieta Luboch	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	0.0	0.0	0.0	45
	E-learning hours included: 0.0						
	Adresy na platformie eNauczanie:						

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	50.0	100

Subject objectives	Strengthening the knowledge that is the subject of general chemistry with a particular focus on the following issue: the structure and properties of chemical substances.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W05	Student explains chemical formulae and defines fundamental laws of chemistry. Student characterises chemical bonds. Student names inorganic compounds and discusses their general properties. Student builds formulae from names and names from chemical compound formulae and evaluates organic compound reactivity. Student evaluates the structure of biologically important macromolecules. Student explains which elements of the polymer structure influence on their properties. Student explains the role of the knowledge of energy effects associated with chemical changes. Student analyses properties of electrolyte solutions.	[SW1] Assessment of factual knowledge
K6_U04	Student is able to draw conclusions and formulate opinions. Student is able to analyze the obtained results.	[SU2] Assessment of ability to analyse information
K6_U01	Student can individually in the textbooks or other literature search for relevant information.	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
K6_W01	Student discusses relations between substance properties and types of underlying bonds. Student is also able to bind the properties of materials with the possibility of their use.	[SW1] Assessment of factual knowledge

Subject contents

LECTURE: Periodic table of elements. Periodic changes in certain quantities: ionisation energy of elements, electron affinity, electronegativity of elements. Atomic and ionic radii. Chemical bonds: main types of bonds. Covalent bond: description of electrons in molecules based on the electron theory of chemical bonds and theory of molecular orbitals. Bonding and anti-bonding orbitals. Shapes of molecular orbital areas: σ and π molecular orbitals. Electronic configuration of molecules. Hybridisation of orbitals. Explanation of shapes of molecules based on hybridisation. Delocalised bonds. Aromatic compounds: properties, examples. Explanation of molecule shapes: VSEPR method. Polarisation of chemical bonds. Inter-molecular interactions. Hydrogen bond and its effects on chemical compound physical properties. General characteristics of states of matter. Solid: crystal systems, types of unit cells, ionic, covalent, molecular and metallic crystals. Crystal structure and substance physical properties. Types of chemical reactions. Oxidation and reduction reactions. Oxidation state. Nomenclature of inorganic compounds. General characteristics of the individual blocks of the periodic table of elements. Coordination bond. Complex compounds: notion of the central atom and the ligand, examples of complex compounds and their names; properties of complex compounds and their role. Complex compounds: crystal field theory. Organic compounds: classification, nomenclature. Organic compounds: properties, reactivity. Mechanisms of organic compound reactions. Laboratory techniques in organic chemistry. Methods of identification of organic substances. Macromolecules: methods of polymer synthesis, polymer structure and its properties. Biologically important molecules: the structure of proteins, lipids, sugars, and nucleic acids. Chemical thermodynamics: basic terms, first law. Enthalpy of physical changes and chemical reactions. Second law of thermodynamics: entropy, free energy, free energy of reaction, spontaneous processes, equilibrium reactions. Equilibrium in aqueous solutions. Electrolyte solutions. Ionic and proton theory of acids and bases. pH. Weak electrolytes. Hydrolysis. Buffer solutions. Electron theory of acids and bases, HSAB theory. Strong electrolytes, ionic activity and strength. TUTORIALS: Basic concepts and laws of chemistry. The stoichiometry of chemical formulas. The stoichiometry of the chemical equations and reaction types. Solutions, the types of solutions, the concentration of solutions. The stoichiometry of the reactions in solutions. Oxidation and reduction reactions. Chemical equilibrium. Equilibria in aqueous solutions, electrolytes, weak electrolytes, pH calculation. Strong electrolytes. Debye-Hückel theory, ionic strength, the effect of salt. The electronic structure of molecules (MO theory). The theory of Valence Shell Electron Pair Repulsion (VSEPR). Complexes. Basic of electrochemistry: cells. Basic of electrochemistry: electrolysis.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture: two written colloquia	50.0%	65.0%
Tutorials: two written tests	50.0%	35.0%

Recommended reading	Basic literature	1. L. Jones, P. Atkins "Chemia ogólna. Cząsteczki, materia, reakcje" PWN 2009. 2. A. Bielański „Podstawy chemii nieorganicznej” PWN 2002 3. F.A. Cotton, G. Wilkinson, P.L. Gaus „Chemia nieorganiczna. Podstawy” PWN 2002 4. M.J. Sienko, R.A. Plane „Chemia. Podstawy i zastosowania” WNT 20024. 5. L. Pajdowski „Chemia ogólna” PWN 1999 6. P.W. Atkins „Podstawy chemii fizycznej” PWN 1999 7. E. Białecka-Floriańczyk, J. Włostowska "Chemia organiczna" WNT, Warszawa 2007 8. J. McMurry „Chemia organiczna” PWN 2005 9. red. E. Luboch, M. Bocheńska, J.F. Biernat „Chemia ogólna. Ćwiczenia laboratoryjne” Wyd. PG 2003 10. W. Gorzelany, H. Słaby, A. Śliwa "Obliczenia chemiczne: Zbiór zadań z chemii ogólnej i analityki nieorganicznej" PWN 1987 11. K.M. Pazdro, A. Rola-Noworyta "Akademicki zbiór zadań z chemii ogólnej", Oficyna Edukacyjna*Krzysztof Pazdro, 2013.
	Supplementary literature	1. W. Kołos, J. Sadlej „Atom i cząsteczka” WNT 2007 2. P.W. Atkins „Przewodnik po chemii fizycznej” PWN 1997 3. P.W. Atkins „Chemia fizyczna” PWN 2007 4. P. Mastalerz „Chemia organiczna” Wyd. Chemiczne 2002 5. A. Cygański „Metody elektroanalityczne” WNT 1995
	eResources addresses	
Example issues/ example questions/ tasks being completed	*Possible topics to pass the lecture.* Ionization energy of elements: definition, changes in the periodic table. Electronegativity of elements: Pauling electronegativity scale and Allred and Rochow scale. MO Theory - characterize the molecular orbitals, bonding and anti-bonding orbitals and illustrate the example, eg. hydrogen molecule. Typical examples of hybridization of atomic orbitals and their characteristic angles between bonds. Multiple bonds: CO_2 boils at -78 °C and SiO_2 at a temperature of approx. 2500 °C. Please explain the difference. Delocalised bonds: aromatic compounds and their general characteristics. Please draw at least three formulas of aromatic heterocyclic compounds, their names and meaning. Define hydrogen bond (hydrogen-bridge) and give examples of compounds which have: a) the intermolecular hydrogen bond (three examples) and b) an intramolecular hydrogen bond (one example). Examples of the influence of hydrogen bond on physical properties of the substance. Crystal structure: the general characteristics of molecular crystals; the crystal structure of fullerene C_{60}. General characteristics of covalent crystals; crystal structure of the diamond. Why diamond has excellent transparency? The crystal structure intermediate between molecular and covalent: the crystal structure of graphite. Please indicate the oxidation state of all elements in the given compounds, eg: K_2SO_4, K_2MnO_4, Cr_2O_3, K_2SO_3, $KMnO_4$, NaH, $K_2Cr_2O_7$, MnO_2, H_2O_2. Please indicate formulas of inorganic compounds with the following names, eg .: phosphoric(V) acid; ammonia, hydrogen chloride, chloric(VII) acid, sodium chlorate(VII), oxonium ion, sodium peroxide, sodium hydrogen sulfate(VI); potassium chromate(VI); rubidium superoxide. General characteristics of the s-block elements. Physical and chemical properties of alkali metals. General characteristics of p-block metals. General characteristics of non-metals p block. General characteristics of Group 18. General characteristics of d-block elements. The definition, structure and examples of complex compounds. Chelate complexes. Isomerism of coordination compounds; examples. The complexes: high-spin complexes and low-spin complexes. Isomerism of organic compounds. Constitutional isomerism: types, examples. What compounds correspond to the empirical formulas, eg .: C_2H_6O; C_3H_6O; $C_4H_8O_2$? Nomenclature of alkanes: please give formulas and names of the three constitutional isomers of heptane (other than *n*-heptane). Please give semi-structured formulas, with the full structure of the functional groups, the following organic compounds: methanol; propan-2-ol; isopropyl alcohol; diethyl ether; ethanal; acetaldehyde; propanone; acetone; ethanoic acid; acetic acid; benzoic acid; oxalic acid; lactic acid; ethylamine; triethylamine; aniline; ethyl acetate. Transformation of organic compounds: short characteristics of ionic and radical reactions. Transformation of organic compounds: substitution reactions, addition, elimination and rearrangement (general scheme and examples). Electronic effects of substituents: inductive effect and resonance effect. Influence of the electron effects of substituents on the reactivity of aromatic compounds. Techniques for the isolation and purification of organic compounds. For what purpose are used in organic chemistry spectroscopy: NMR, IR and MS? Addition polymerization of vinyl monomers - radical mechanism and coordination machanism. Examples of addition polymers (formula, name, abbreviation) eg.: polypropylene, polystyrene, polyvinyl chloride, teflon. Condensation polymers: Nylon 6-6, poly(ethylene terephthalate) (PET), Kevlar (PPTA) – chemical structure, preparation, application. Influence of the structure of macromolecules on its physical properties: the characteristics of the fibers. Protein amino acids: structure, configuration (optical isomers). Ion structure of amino acids and their properties. The primary structure of peptides and proteins. Typical secondary structures of proteins. Lipids: an example of triglyceride. What is the chemical structure of D-glucose - the most common organic compound on the planet? What is the chemical structure of ribose and 2-deoxyribose - a sugar component of nucleic acids? Nucleic acids: primary and secondary structure of DNA. What is the genetic code? Thermodynamics: Please explain the concept of "state function". The enthalpy of vaporization of the liquid: definition, comparison of the standard enthalpy of vaporization of water and methane, to justify the difference. Calculate the standard enthalpy of chemical reactions: what is the method of submission of chemical reactions? Task: Calculate the standard enthalpy of a given reaction, using the values (given) standard enthalpy of formation of the reactants of the reaction. Discuss the equation: $\Delta G = \Delta H - T\Delta S$. What is the role of catalysts for chemical and biochemical reactions? Acids and bases: Brønsted-Lowry theory. Brønsted acids and bases: the influence properties of the solvent for acid-base properties of the dissolved substances. Calculating the pH of the aqueous solutions of strong electrolytes. Structural factors determining the acid strength. Hydrolysis of the salt: hydrolysis of sodium acetate or sodium carbonate. Buffer solutions. Acetate buffer: illustrate the properties of this type of buffer solutions by analyzing the expression for the concentration of hydrogen ions. Acids and bases - Lewis theory. Pearson's theory - hard and soft acids and Lewis bases (HSAB). Solutions of strong electrolytes: define the concept of activity, activity coefficient and ionic strength.	
Work placement	Not applicable	