COURSE DESCRIPTION CARD - SYLLABUS

Course name
Chemistry [S1MiTPM1>CHEM]

Course

Field of study
Materials and technologies for automotive industry

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

Student: W1) Has theoretical knowledge at high school level in the field of general and inorganic chemistry, in particular: knows the basic laws, concepts and chemical quantities as well as the names and symbols of chemical elements. W2) Has knowledge at high school level in the field of physics and, in particular, knows the basics of the structure of matter and identifies the components of the atomic nucleus and atom. W3) Has knowledge at high school level in mathematics, especially regarding proportions and using them in simple calculations. Student: U1) Writes summary formulas for simple inorganic compounds U2) Writes simple chemical reactions involving inorganic reagents U3) Performs basic chemical calculations and, in particular, can calculate and recalculate the percentage and molar concentrations of solutions; can make other calculations based on the skill of stacking proportions (percentage composition of chemical compound, purity and degree of reacting substrates, yield of reaction products). Student: K1) Is determined to acquire knowledge in chemistry as an exact subject being the basis for thorough education in many engineering professions. K2) Demonstrates interest in ways of carrying out useful chemical processes on an industrial scale, and, at the same time, understands environmental protection problems, including mainly problems of minimizing chemical pollution.

Course objective

To show chemistry as a science in constant dynamic development. Expanding and enhancing the ability to perform calculations in the field of solution concentrations and stoichiometry as well as basic thermodynamic calculations. Expanding knowledge of general and inorganic chemistry and its systematization based on the types of chemical reactions and the law of periodicity. Showing the relationship between the properties of compounds and the type of chemical bonds in their molecules. Systematization of theoretical knowledge in the field of chemistry and the effects associated with the characteristic reactions of cations and anions. Understanding the chemistry of major inorganic processes of technological importance. Acquaintance with global environmental effects.

Course-related learning outcomes

Knowledge:
1. Student has extended knowledge regarding the structure of matter; identifies the components of matter and characterizes the interactions between them; knows the structure of atoms and the genesis of their creation; defines and explains the laws governing the interaction of matter components at both the nuclear and atomic levels.
2. Indicates the properties of elements resulting from the electronic configuration of their atoms and their position in the periodic table and, in particular, knows and explains the relationship between the electronic configuration of atoms and the reactivity of elements.
3. Lists reactions involving inorganic compounds of great practical industrial importance. Describes, explains and characterizes their chemistry (course and associated effects).
4. Lists and describes the most important harmful effects of some elements and inorganic compounds on the environment, and identifies the most important sources from which they are emitted to the environment.

Skills:
1. Student analyzes and interprets the content of computational tasks and performs chemical calculations (mainly in the field of concentration conversion, stoichiometry and basics of thermodynamics of chemical reactions).
2. Uses the periodic table of elements and is able to use it as a basic source of information about the physicochemical properties of elements and their compounds.
3. Uses the current nomenclature of inorganic compounds and is especially able to combine the correct name of the compound with its correct summary (stoichiometric) formula, which can correctly write, and on this basis prepare its structural formula.
4. Writes and correctly balances chemical reactions between inorganic reagents (also with the participation of simple organic compounds); predicts the direction of any type of chemical reactions (including oxidation and reduction reactions) and is able to quantify the steady state of the reaction (can calculate the equilibrium constant of a chemical reaction).

Social competences:
1. The student is aware of the continuous, rapid increase in knowledge in the field of inorganic chemistry and, as a result - the level of his knowledge in this field, which causes him to further study and assimilate new knowledge on his own initiative, with determination and an active attitude.
2. Is aware that knowledge regarding inorganic chemistry is widely used in industry and the economy; understands and reckons with the necessity of practical use of acquired knowledge and skills in the future; is aware of the responsibility associated with this.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Control of progress regarding the acquisition of knowledge from lectures and exercises is carried out on an ongoing basis in the form of written tests. After completing a specific batch of material, the instructor organizes - in predetermined dates - a minimum of two big, written colloquia tests. Each test consists of 5-7 tasks with different points. The threshold is 50% of the points. In addition, the student has the opportunity to earn additional points during each class. The final form of checking progress in the acquisition of knowledge is a written exam.

Programme content

The course will cover basic topics in general and inorganic chemistry, including types of chemical reactions, the periodic law, the relationship between the properties of compounds and the types of chemical bonds in their molecules, the chemistry of major inorganic processes of technological importance, and the principles of performing calculations related to solution concentrations, stoichiometry, and basic thermodynamic calculations.

Course topics

Lecture: 1. Chemical calculations. Different types of concentrations. Percentage. Mole and molar concentration. Weight equivalent and normal concentration. Conversion of concentrations. Stoichiometric calculations. 2. Structure of matter. Big bang. Nucleons and primary nucleosynthesis. Isotopes. Chemical processes in stars. Artificial nuclear reactions. Elemental distribution. Atom. Quantum numbers. Electron configurations of elements. Periodic table and periodicity of changes in physicochemical properties of elements. Regularities of the periodic table. 3. Chemical bonds. Electronegativity. Ion bond. Atomic bond - Lewis structures. Dipole moment - polarization of the atomic bond. Coordination atomic bond. Metallic bond. Van der Waals forces. Hydrogen bond. Chemical bonds and the properties of compounds. 4. Thermodynamics and reaction kinetics. Thermal effects of the reaction. Entropy and enthalpy. Gibbs energy. The effect of temperature and pressure on the reaction balance. Properties of gases and mixtures thereof. Liquid thermodynamics, chemical potential, nonelectrolyte solutions, gas-liquid and liquid-solid equilibria (phase diagrams). Solid state thermodynamics. Kinetics of chemical reactions. First and second order reactions, single and double molecule reactions. Theory of active complex, Arrhenius and Eyring equations. Reversible, parallel and sequential reactions. Chain reactions. Combustion and explosive reactions. Photochemical reactions. Hetero- and homogeneous catalysis - catalysts. 5. Acids and bases. Electrolytic dissociation. Strong and weak electrolytes. Concentration and activity - activity coefficients, ionic strength. Theories of acids and bases. Ionic product of water and the pH scale. The power of acids and bases. Acid-base indicators. Degree and acid constant. Buffer solutions. Ampholyts. Acid-base titration. The reaction of aqueous solutions of acids, bases and salts. Hydrolysis. pH measurement. 6. Precipitation. Structure of compounds and solubility. Solubility product. Solubility. Common ion effect. Salt effect. The effect of pH on dissolution and selective precipitation. Solubility of compounds and their toxicity. Water hardness - removal of hardness. 7. Qualitative analysis. Division of anions and cations into analytical groups - group reagents. Characteristic reactions of selected cations and anions. 8. Complex compounds - structure and types. Equilibria in complex solutions - gradual formation of complexes. Complex durability and impermanence. Influence of pH on complexation reactions. Sediment solubility and complex formation. The use of complexes in analytics. 9. Oxidation and reduction (redox) reactions. Basic concepts. Half-reaction, redox reaction equilibrium constant, Nernst equation, normal potential, balancing redox reactions. Influence of pH on redox reactions. Redox imaging - potential-pH graphs (Pourbaix)). Determining the direction of reaction based on Pourbaix charts. Thermodynamic water stability. Strong oxidizers and reducing agents in aqueous solutions. Discussion regarding the chemical properties of basic elements based on the potential-pH graph. Mechanisms of iron corrosion and protection technologies. 10. Chemical properties of elements and their compounds. Characteristics of the "s" (lithium, beryllium), "p" (borohydrides, hydrocarbons, nitrites, oxides, halogen and helium), d- and f-electron block elements. Non-metals and their relationships. Hydrogen. Oxygen. Chlorine and halogens. Sulfur. Nitrogen. Phosphorus. Silicates. Aluminum silicates. Metals. Oxides, hydroxides and sulphides of metals. Review of metals using potential-pH charts. Obtaining the most important metals. Organometallic compounds. Preparation and applications of the most important inorganic compounds. 11. Inorganic compounds and the environment. Emission of pollutants into the atmosphere. Acid rain. The greenhouse effect. Ozone - the ozone hole. Water and soil pollution - heavy metals in the environment.
Exercises: 1. Exercises based on the periodic table (names and symbols of elements, electronic configurations, summary and structural formulas of compounds, inorganic nomenclature); 2. Conversion of concentrations (types of concentration, percentage and molar concentration, solution density and molar/molecular mass in the calculation); 3. Stoichiometric calculations (summary formula and compound percentage, product yield, substrate purity, obtaining reaction data); 4. Electrolyte solutions (writing of dissociation and hydrolysis reactions, reactions of cations as acids and anions as bases, water as solvent - ionic product of water and pH scale, calculation of the pH of aqueous solutions of acids, bases, salts and buffer solutions, acid dissociation constant and degree of dissociation); 5. Calculations using reaction heat (enthalpy, entropy, thermodynamic potential, equilibrium constant and reaction rate constant); 6. Sediments (relationship between solubility product and solubility - calculation of compound, cation and anion solubility); 7. Complex compounds (construction of complexes - summary

formulas, nomenclature, calculation of equilibrium in complex solutions - stability constant and instability of complexes); 8. Oxidation and reduction reactions (balancing redox reactions, predicting the direction of redox reactions based on oxidation-reduction potentials, drawing Pourbaix charts and discussing the properties of elements on their basis).
Laboratory: 1. pH scale 2. Acid-base reactions 3. Reaction of quaoues solutions of salts 4. Buffer solutions 5. Complexing reactions I (gradual complex formation, buffer solution of the complex compound) 6. Complexing reactions II (properties of complex compounds: complexes and acidity, stability of complex compounds) 7. Oxidation and reduction reactions I (reduction with metals, hydrogen ion as an oxidant, power of oxidants and reducers, the effect of temperature on the redox reaction) 8. Oxidation and reduction reactions II (effect of pH on redox reactions, disproportionation reactions) 9. Separation by precipitation 10. Separation by extraction 11. Validation of automatic pipettes 12. Qualitative analysis of cations (according to the division of Fresenius into five analytical groups) 13. Qualitative analysis of anions (according to the division of Aleksiejew into three analytical groups) 14. Qualitative analysis of salts

Teaching methods

1. Interactive lecture: multimedia presentation, illustrated with examples on the board and demonstrations of simple experiences often with the participation of students, discussion.
2. Exercises and laboratory: joint performance of tasks assigned by the teacher and proposed by students - practical exercises. Handing over tasks and issues for independent study. Computational problem tasks related to contemporary aspects of life

Bibliography

Basic:
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3. G. Charlot, Analiza nieorganiczna jakościowa, PWN, Warszawa 1976.
4. J.D. Lee, Zwięzła chemia nieorganiczna, PWN, Warszawa 1999.
5. A. Śliwa, Obliczenia chemiczne, PWN, Warszawa 1987.
6. K. M. Pazdro, Zbiór zadań z chemii, Oficyna Edukacyjna 2007.
7. L. Pajdowski, Chemia ogólna, PWN, Warszawa 1992.

Additional:
1. A. Ciszewski, M. Baraniak, Aktywność chemiczna i elektrochemiczna pierwiastków w środowisku wody, Wydawnictwo PP, Poznań 2006.
2. F.A. Cotton, G. Wilkinson, C. Murillo, M. Bochmann, Chemia nieorganiczna. Podstawy, PWN, Warszawa 1995.
3. L. Kolditz, Chemia nieorganiczna, PWN, Warszawa 1994.
4. M.J. Sienko, R.A. Plane, Chemia. Podstawy i zastosowania, WNT, Warszawa 2002.
5. W. Ufnalski, Podstawy obliczeń chemicznych z programami komputerowymi, WNT, W-wa 1999.
6. G.W. van Loon, S. J. Duffy, Chemia środowiska, PWN, Warszawa 2008.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50