COURSE DESCRIPTION CARD - SYLLABUS

Course name
Chemistry [S1ETI1>Chem]

Course

Field of study
Education in Technology and Informatics

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
20

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

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Prerequisites

Basic knowledge of chemistry and mathematics (core curriculum for secondary schools, basic level). Ability to solve elementary problems in chemistry based on your knowledge (eg: preparation of solutions at given concentrations, handling of weights, application of a known mathematical apparatus and chemistry problems for physicochemical calculations), ability to obtain information from indicated sources. Understanding the need for further education; readiness to cooperate within the team.

Course objective

1. Passing knowledge of chemistry to students, to the extent specified by the curriculum relevant to the field of study. 2. Developing students" ability to solve simple problems and perform simple experiments and analysis of results based on the acquired knowledge. 3. Shaping teamwork skills in students

Course-related learning outcomes

Knowledge:
1.the student can formulate and explain basic chemical laws in the area covered by the curriculum relevant to the field of study [k1_w03]
2. student can determine the basic limitations and scope of applicability of laws of chemistry and electrochemistry and give examples of their application to the description of phenomena in the surrounding world [k1_w03]

Skills:
1. the student can perform standard measurements of basic physicochemical quantities, estimate the time needed for their implementation and follow the schedule[k1_u04]
2. the student cano make a qualitative and quantitative analysis of the results of simple chemical experiments[k1_u04]
3. the student can formulate conclusions based on the obtained results of calculations and measurements made [k1_u04]
4. the student can use the understanding from the indicated sources of knowledge (list of basic literature) and gain knowledge from other sources [k1_u01]

Social competences:
1. the student can cooperate within the team, fulfill the responsibilities entrusted within the division of work in a team [k1_k01]
2. the student can actively engage in solving set tasks, set priorities for the implementation of a specific task [k1_k02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Autcome Form Assesment criteria
W01, W02, W03 written test 50.1%-70.0% (3)
70.1%-90.0% (4)
od 90.1% (5)
U01, U02 preparation of the report 50.1%-70.0% (3)
oral answer 70.1%-90.0% (4)
od 90.1% (5)
K01, K02 performing a given experiment 50.1%-70.0% (3)
activity 70.1%-90.0% (4)
od 90.1% (5)

Programme content

• Elements of Atomic Structure: structure of the atom, atomic theories, quantum numbers and orbitals, Aufbau principle of electron shells, natural and artificial atomic transformations, periodic table of elements, electron configurations of elements, periodicity of chemical and physical properties.
• Solutions: structure, types, preparation, and properties of acids, bases, and salts, electrolytic dissociation, ionic product of water, pH and pOH, methods of pH measurement, acid-base indicators, acid-base titration (alkalimetry), buffer solutions, water hardness and its removal.
• First Law of Thermodynamics: law of energy conservation, internal energy, energy balance of reactions, law of energy conservation ($\Delta U = Q - W$), thermodynamic definition of work.
• Second Law of Thermodynamics, Thermochemistry: concept of entropy, second law of thermodynamics, third law of thermodynamics, isobaric and isochoric processes, enthalpy and heat capacity, calorimetry.
• Phase Equilibria – Single Component Systems: Gibbs' phase rule, phase transitions (melting, evaporation, sublimation), Clausius-Clapeyron equation, phase equilibrium diagrams for liquid-gas, liquid-solid, and solid-gas, supercritical fluid.
• Phase Equilibria – Multicomponent Systems: thermal analysis, phase diagrams, azeotropy, distillation and rectification, eutectic systems.
• Chemical Reaction Equilibrium, Physical Chemistry of Solutions: equilibrium constant of reactions, van’t Hoff isotherm, temperature dependence of equilibrium, osmosis and reverse osmosis, Nernst distribution law.
• Chemical Kinetics: rate of chemical reactions, molecularity and order of reactions, kinetic equations, half-life period, Arrhenius equation.

• Electrochemistry: electroplating and electroless plating, corrosion prevention, electrolysis and laws of electrolysis, types of electrodes, galvanic cells and batteries, deposition potential and overvoltage.
• Adsorption on Solids: physical and chemical adsorption, Langmuir and Freundlich isotherms, structure of adsorbents (micro-, meso-, macropores), BET isotherm, applications of adsorbents.

Course topics

Lecture:
1. Periodic table
Basic laws and concepts. Atom (structure, theories, quantum numbers, orbitals, the principle of expansion of electron shells). Natural and artificial atomic transformations The law of periodicity. Construction of the modern periodic table. Electronic configurations of elements and the law of periodicity. Periodicity of chemical and physical properties of elements.
2. Solutions
Acids, bases, salts - structure, types, preparation, properties. Electrolytic dissociation of acids, bases and salts, constant and degree of dissociation. Ion product of water. pH and pOH. Methods of pH measurement. Acid-base indicators. Acid-base titration, PK (end point) titration. Buffer solutions. Water hardness and its types. Removal of water hardness.
3.First law of thermodynamics
Internal energy – total energy of a system. Energy balance of the reaction (process) - internal energy balance. The difference of energy contained in products and substrates exchanged with the environment. Varieties of work: electrical, surface expansion, volumetric. How internal energy is stored. Thermal energy. Average thermal energy of particles. Maxwell-Boltzman distribution. Temperature, its various scales. Thermodynamic temperature scale.
4. Second law of thermodynamics
The concept of entropy as a measure of chaos. Total entropy may increase but cannot decrease. Total entropy change as the sum of entropy system and environment changes. Zero (third) law of thermodynamics.
5. Phase equilibrium – one component system
Gibbs phase rule. Melting, evaporation, sublimation. Phase diagrams: liquid – vapour. Temperature dependence of vapour pressure, Clausius-Clapeyron equation. Liquid heating curves. Boiling phenomenon - boiling point. Dependence of boiling point on pressure. Heat of evaporation, heat of condensation. Cooling by evaporation of water. Cavitation. Liquid - solid transformation. Dependence of melting point on pressure. Solid state –vapour transition: sublimation. Dependence of the vapor pressure over a solid on temperature.
6. Phase equilibrium -multi component systems
Thermal analysis. Phase diagram. Liquid-gas phase equilibria for multi component systems. Distillation, fractional distillation. Aseotropes. Crude oil distillation, agricultural alcohol distillation. Liquid-solid phase equilibria for multi component systems. Crystallization, purification. Simple eutectic mixture. Eutectics of solid solutions, phase diagram. Eutectic mixture with a chemical connection between the components. Peritectic mixture. Structure of eutectic alloys. Metal alloys, examples.
7. Chemical equlibrium
The equilibrium constant for reaction K. Dependence of the equilibrium constant for reaction K on temperature - van"t Hoff"s isotherm. Dependence of equilibrium position on temperature, isobar and isochor van’t Hoff. Pressure dependence of the equilibrium position, van Laar"s isotherm.
8. Chemical kinetics - basic concepts
General Concepts of Kinetics. Collision Theory. Mechanisms of the Chemical Reactions – unimolecular, bimolecular and termolecular reactions. Rate of chemical reaction. Rate constant. Half-life. Order of the Chemical Reaction. Zero, first, second, and third-order rate equations. Pseudo-first-order reactions. Temperature dependence of the rate constant - Arrhenius formula. Activation Energy.
9. Electrochemistry
Chemical and electrochemical depositions of metal coating. Corrosion. Protection from Corrosion. Electrolysis, Faraday’s laws. Chemical and electrochemical corrosion (examples). Types of half-cells. Methods of EMF (electromotive force) determination. Types of the galvanic cells. Primary and Secondary Cells. Deposition potential. Overpotential varieties. Hydrogen overpotential. Ion mobility. Transfer number. Electric Double-Layer. Electrokinetic phenomena. Diffusion potential. Concentration cells.
10. Solid -liquid adsorption
Solid-liquid adsorption. Physical and Chemical Adsorption. Heat of adsorption. Single- and multilayer adsorption. Identical adsorption centers. Isotherms of adsorption: Linear, Freundlich, Langmuir, BET

equations. Adsorbents – properties. The structure of adsorbents, micro-, meso and macro-pores. Activated carbons. Capillary gas condensation. Determination of the adsorbent specific surface area from the BET isotherm. Surface modification of solid adsorbents. The use of solid adsorbents. Adsorption at the interface: liquid - liquid, liquid - gas. Gibbsa adsorption isotherm. Surfactants.

Laboratory:
Phase Transitions: Gibbs' phase rule. Types of liquid-solid equilibrium in binary systems. Binary and multicomponent alloys. Phase diagrams for liquid-solid systems. Cooling curves. Thermal analysis.
Electrochemistry: Chemical and electrochemical corrosion (examples). Methods of corrosion protection. Electroplating and electroless plating. Electrolysis and laws of electrolysis. Types of electrodes and methods of measuring their potential. Standard potential. Construction and types of cells. Batteries.
Physical Chemistry of Water: Water hardness and its types. Removing water hardness - distillation, thermal method, chemical methods, demineralization of water. Ion exchangers. Water treatment for cooling and boiler purposes.
Acid-Base Reactions: Acids, bases, salts - structure, types, preparation, properties. Electrolytic dissociation of acids, bases, and salts, dissociation constant and degree. Ionic product of water. pH and pOH. Methods of pH measurement. Acid-base indicators. Acid-base titration, endpoint of titration. Buffer solutions.
Chemical Kinetics: Reaction rate, rate constant. Reaction order. First, second, and third order reactions. Rate equations for first and second order reactions. Half-life period. Temperature dependence of rate constant. Activation energy.
Chemical Equilibria: Temperature dependence of equilibrium constant. Heat of reaction and its temperature dependence. Concept of solubility product. Conductometry. Measurement of electrical conductivity of electrolyte solutions. Construction of a conductometric cell.

Teaching methods

Lecture: multimedia presentation
Laboratory classes: performing a given experiment as part of a laboratory exercise and preparation of the report.

Bibliography

Basic
1. L. Jones, P. Atkins, Chemia ogólna, PWN, W-wa 2006
2. L. Sobczyk, A. Kisza, Chemia fizyczna dla przyrodników PWN Warszawa 1977
3. A. Lewandowski, St. Magas, Wiadomości do ćwiczeń laboratoryjnych z chemii fizycznej, WPP, Poznań 1994 (skrypt nr 1765).
Additional
1. P. Atkins, Podstawy Chemii Fizycznej, PWN, Warszawa 1999
2. A.G. Whittaker, A.R. Mount, M.R. Heal, Krótkie wykłady. Chemia fizyczna, PWN, W-wa 2007
3. J. Minczewski, Chemia analityczna, PWN Warszawa 1975.

Breakdown of average student's workload

	Hours	ECTS
Total workload	105	4,00
Classes requiring direct contact with the teacher	73	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	52	2,00