COURSE DESCRIPTION CARD - SYLLABUS

Course name
Chemistry [S1ETI2>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
30

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

Lecturers

Prerequisites

Basic knowledge of chemistry and mathematics (core curriculum for secondary schools, basic level). Ability to solve elementary chemical problems based on existing knowledge (e.g. preparing of solutions of given concentrations, operating balances, using of familiar laboratory equipment, applying mathematics and chemistry to physico-chemical calculations), ability to obtain information from specified sources. Understanding of the need for further learning; willingness to cooperate as part of a team.

Course objective

1. To provide students with knowledge of chemistry, within the scope defined by the framework of the curriculum content specific to the field of study. 2. To develop in students the ability to solve simple problems, carry out simple experiments, and analyse the results based on the knowledge gained. 3. To develop in students the ability to work in a team.

Course-related learning outcomes

Knowledge:
As a result of the course, the student is able to:
1. define basic chemical terms and quantities within the scope covered by the curricular content specific to the field of study and give simple examples of their application in the surrounding world.
2. formulate and explain the basic chemical laws in the scope covered by the curricular content

appropriate to the field of study, determine the basic limits and scope of their application, and give examples of their use to describe phenomena in the surrounding world.

Skills:
As a result of the course, the student should be able to:
1. carry out standard measurements of basic physicochemical quantities, identifying and assessing the importance of basic factors interfering with the measurement.
2. analyse qualitatively and quantitatively the results of simple chemical experiments.
3. formulate conclusions on the basis of obtained results of calculations and measurements.
4. use with understanding the indicated sources of knowledge (list of basic literature) and acquire knowledge from other sources.

Social competences:
1. the student cooperates as part of a team, fulfils his/her duties assigned within the division of labour in the team.
2. is actively involved in solving assigned tasks, is responsible for the reliability of the results of his/her work.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Outcomes Form of assessment Assessment criteria
W01, W02, W03 colloquium 50.1%-70.0% (3)
70.1%-90.0% (4)
from 90.1% (5)
U01, U02 Laboratory exercise report, 50.1%-70.0% (3)
viva 70.1%-90.0% (4)
from 90.1% (5)
K01, K02 Evaluation of the laboratory exercise 50.1%-70.0% (3)
Assessment of activity in laboratory exercises. 70.1%-90.0% (4)
from 90.1% (5)

Programme content

Atomic Structure and Periodic Table: Atom, theories, quantum numbers, orbitals, Aufbau principle, natural and artificial nuclear transformations, periodic law, electronic configurations of elements, periodicity of chemical and physical properties.
Solutions: Acids, bases, salts - structure, types, preparation, properties, electrolytic dissociation, ionic product of water, pH, pOH, acid-base indicators, acid-base titration, buffer solutions, water hardness - types and removal methods.
Thermodynamics: First law of thermodynamics, internal energy, energy balance, thermodynamic work, temperature scales. Second law of thermodynamics, entropy, isobaric and isochoric processes, enthalpy, heat capacity, calorimetry. Zeroth law of thermodynamics.
Phase Equilibria: Single-component systems - melting, evaporation, sublimation, Gibbs phase rule, Clausius-Clapeyron equation. Multicomponent systems - azeotropy, distillation, eutectic systems, phase diagrams.
Chemical Reaction Equilibria and Solution Physical Chemistry: Equilibrium constant, free enthalpy, van't Hoff equation, distribution equilibrium, Nernst partition law, osmosis, reverse osmosis, membranes, water purification.
Chemical Kinetics: Reaction rate, molecularity, reaction order, rate constant, half-life, Arrhenius equation, activation energy.
Electrochemistry: Electrolysis, Faraday's laws, chemical and electrochemical corrosion, types of cells, batteries, electrode potentials, hydrogen overpotential, ion mobility, double electric layer, diffusion potential, concentration cells.
Adsorption on Solids: Physical and chemical adsorption, heat of adsorption, Langmuir and Freundlich isotherms, porous structure of adsorbents, capillary condensation, BET isotherm, specific surface area, applications of adsorbents, surfactants.

Course topics

1.Elements of atomic structure. Periodic table
Basic laws and concepts. The atom (structure, theories, quantum numbers, orbitals, electron shell principle). Natural and artificial atomic transformations. Law of periodicity. Structure of the modern periodic system. Electronic configurations of the elements and the law of periodicity. Periodicity of the chemical and physical properties of the elements.
2. Solutions
Acids, hydroxides, salts - structure, types, formation, properties. Electrolytic dissociation of acids, hydroxides and salts, dissociation constant and degree. Ion product of water. pH and pOH. Methods of measuring pH. Acid-base indicators. Alkacimetric titration (acid-base), PK (end point) of titration. Buffer solutions. Water hardness and its types. Removal of water hardness.
3. First law of thermodynamics - conservation of energy principle.
The concept of internal energy. Energy balance of a reaction (process) - internal energy balance. The difference in energy contained in products and substrates exchanged with the environment. The principle of conservation of energy, its mathematical form (first principle of thermodynamics). Thermodynamic definition of work, its types. Temperature, its different scales.
4. The second law of thermodynamics, Thermochemistry.
A system tends towards maximum chaos - this is the most probable state. Simple examples. The concept of entropy as a measure of chaos. Total entropy can increase but cannot decrease (second law of thermodynamics). Zero (third) principle of thermodynamics. Isobaric and isochoric processes. The concept of enthalpy. Heat capacity. Measurement of heat - calorimeter.
5. Phase equilibria - single component systems.
Gibbs' rule of phases. Melting, evaporation, sublimation. Liquid-gas equilibrium. Temperature dependence of liquid vapour pressure: Clausis-Clapeyron equation. Liquid-solid transition. Pressure dependence of melting point. Solid-gas transition: sublimation. Pressure-temperature diagrams for liquid-gas, liquid-solid and solid-gas equilibria. Supercritical fluid. Supercritical CO2 - phase diagram, applications.
6. Phase equilibria - multicomponent systems.
Thermal analysis of a multicomponent system. Phase diagram. Liquid-gas phase equilibria for multicomponent systems. Azeotropy. Distillation. Rectification. Vacuum Distillation. Liquid-Solid Phase Equilibria for multicomponent systems. Eutectic system. Alloys of metals, examples.
7. Equilibrium of a chemical reaction, Physicochemistry of solutions.
The equilibrium constant of a reaction. Relationship of equilibrium constant to energy and free enthalpy: van't Hoff isotherm. Temperature dependence of the equilibrium position, van't Hoff's isobar and isochora. Calculation of equilibrium position and reaction yields from thermodynamic data. Equilibrium partitioning of a component between two liquid solutions, Nernst's partition law, extraction. Osmosis. Reverse osmosis, water purification. Membranes.
8. Chemical kinetics - basic concepts.
Definition of the rate of a chemical reaction. Molecularity of a reaction. Kinetic equations for simple one- and two-molecule reactions. Half-life of reactions. Rarity of a reaction. Rate constant. Pseudo-primary reactions. Temperature dependence of the rate constant - Arrhenius equation. Activation energy of a process.
9. Electrochemistry
Current and non-current deposition of metals. Methods of corrosion protection. Electrolysis, laws of electrolysis. Chemical and electrochemical corrosion (examples). Types of electrodes and methods of measuring their potential. Cells and methods of measuring the electromotive force of cells. Types of cells. Batteries. Separation potential. Overvoltage of discharge. Types of overvoltage (overpotential). Hydrogen evolution overvoltage. Ion mobility. Transfer numbers. Electric double layer. Electrokinetic phenomena. Diffusion potential. Concentration cells.
10. Adsorption on a solid.
Adsorption on a solid. Physical and chemical adsorption. Heat of adsorption. Single and multilayer adsorption. Active centres. Chemical adsorption, Langmuir isotherm. Freundlich isotherm. Structure of adsorbents, micro-, meso- and macropores. Activated carbons. Capillary condensation of gases. BET isotherm. Determination of the specific surface area of adsorbents from the BET isotherm. Use of solid adsorbents. Surfactants, their adsorption.

Teaching methods

Lecture: multimedia presentation
Laboratory exercises: carrying out a given experiment in a laboratory exercise and written elaboration of each laboratory exercise - practical exercise.

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	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00