COURSE DESCRIPTION CARD - SYLLABUS

Course name
General and inorganic chemistry

Course

Field of study
Chemical and Process Engineering
Year/Semester
1/1
Area of study (specialization)
-
Profile of study
general academic
Level of study
First-cycle studies
Course offered in
Polish
Form of study
full-time
Requirements
compulsory

Number of hours

Lecture
30
Laboratory classes
0
Other (e.g. online)
0
Tutorials
30
Projects/seminars
0

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
dr hab. eng. Grzegorz Milczarek, associate prof.

e-mail: Grzegorz.Milczarek@put.poznan.pl

Faculty of Chemical Technology

street: Berdychowo 4, 60-965 Poznań

phone: (61) 665 3015

Responsible for the course/lecturer:

Prerequisites

Knowledge:

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

Skills:

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)

Social competences:

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 how to implement useful chemical processes on an industrial scale

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

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 (K_W02)

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 (K_W03)

3. Lists reactions involving inorganic compounds of great practical industrial importance. Describes, explains and characterizes their chemistry (course and associated effects) (K_W03, K_W09)

4. Lists and generally characterizes the basic types of inorganic construction materials and indicates their general applications (K_W05)

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) (K_U01, K_U06)

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 (K_U01)

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 (K_U01)

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) (K_U01, K_U06)

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 (K_K01)

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 (K_K02, K_K06)

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: the final exam is carried out in the form of a stationary or remote test (depending on the method of conducting classes). The test may contain approximately 25-40 questions, open and closed. The threshold of pass the exam: 50% of the total points. Based on the number of points obtained, the final grade is issued, according to the rating scale in force at Poznan University of Technology.

Exercises: after completing a given batch of material, the teacher organizes, in predetermined dates, two partial tests (stationary or remote tests, depending on the form of conducting classes), consisting of variously scored questions. Both tests must be completed successfully, i.e. with the score at least 50% of

the points. Based on the sum of points from both tests, the final grade for exercises is given, according to the scale of grades in force at the Poznan University of Technology.

Programme content

1. Chemical calculations. Different types of concentrations. Percent concentration. The mole concept and molar concentration. Equivalent weight 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. Distribution of elements in the Universe. Atom. Quantum numbers. Electron configurations of elements. Periodic table and periodicity of physicochemical properties of elements

3.Chemical bonds. Electronegativity. Ionic bond - the Haber-Born cycle. Atomic bond - Lewis structures. The dipole moment - the polarization of the atomic bond. Coordination-covalent bond. Metallic bond. Van der Waals forces. Hydrogen bond. Chemical bonds and properties of compounds

4. Thermodynamics and kinetics of reactions. Thermal effect of reaction. Entropy and enthalpy. Gibbs energy. The influence of temperature and pressure on the reaction equilibrium. Properties of gases and their mixtures. Thermodynamics of liquids, chemical potential, solutions of nonelectrolytes, gas-liquid and liquid-solid equilibria (phase diagrams). Thermodynamics of a solid. Kinetics of chemical reactions. 1st and 2nd order reactions, single- and two-molecule reactions. Activated complex theory, equations of Arrhenius and Eyring. Reversible, parallel and consecutive 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. Theories of acids and bases. The power of acids and bases. The ionic product of water and the pH scale. Buffer solutions. Ampholytes. Acid-base titration. The pH of aqueous solutions of acids, bases and salts. Hydrolysis. pH measurement

6. Sediments. Compounds structure and their solubility. The solubility product constant. Solubility. Factors affecting solubulity - the effect of a common ion; the salt effect and complexation. Influence of pH on dissolution and selective precipitation of substances. Water hardness - hardness removal

7. The complexes (coordination compounds). Structure. Gradual complex formation - charge inversion. Equilibria in solutions of complexes. Influence of pH on complexation reactions. Sediment solubility and complex formation. Aquacomplexes - metal cations as acids. Hydroxocomplexes - amphotericity of hydroxides

8. Oxidation and reduction reactions. Basic concepts. Half-reactions, redox reaction equilibrium constant, Nernst equation, redox system normal potential, redox reaction balancing. Influence of pH on redox reactions. Potential-pH graphs (Pourbaix diagrams). Determining the reaction direction based on the potential-pH graphs. Range of thermodynamic water stability. Strong oxidizers and reducing agents in aqueous solutions. Chemical properties of iron (potential-pH graph). Iron corrosion

9. Inorganic qualitative analysis. Division of anions and cations into analytical groups - group reagents. Characteristic reactions of selected cations and anions

10. Chemical properties of elements and their compounds. General characteristics of the s-, p-, d- and f-electron chemical elements. Non-metals and their relationships. Hydrogen. Oxygen. Chlorine and halogens. Sulfur. Nitrogen. Phosphorus. Silicates. Aluminosilicates - raw materials for the production of ceramics. Metals. Oxides, hydroxides and sulphides of metals. Overview of potential-pH graphs for metals. Methods of obtaining the most important metals. Organometallic compounds. Applications of the main inorganic compounds

Exercises:

1. Exercises based on the periodic table (names and symbols of elements, electron configurations, stoichiometric and structural formulas of compounds, inorganic nomenclature)

2. Conversion of concentrations (concentration types, percent and molar concentration, calculation with the use of solution density and molar/molecular weight of elements/compounds)

3. Stoichiometric calculations (stoichiometric formula and percentage composition of the compound, product yield, substrate purity, chemical reaction as a source of data)

4. Electrolyte solutions (writing dissociation and hydrolysis reactions, reactions of cations as acids and anions as bases, water as a solvent - ionic product of water and pH scale, pH calculation of aqueous solutions of acids, bases, salts and buffer solutions, acid dissociation constant and degree of dissociation)

5. Calculations with the use of reaction heat (enthalpy, entropy, thermodynamic potential, equilibrium constant and rate constant);

6. Sediments (relationship between the solubility product constant and solubility - calculation of solubility of compound, cation and anion)

7. Complex compounds (structure of complex - writing of stoichiometric formulas, nomenclature, equilibria calculation in solutions of complexes - stability constant and permanent instability constant of complex)

8. Oxidation and reduction (redox reactions balance, prediction of redox reaction direction based on oxidation-reduction potentials, Latimer diagrams, Frost diagrams, drawing Pourbaix diagrams and discussion of the properties of elements, on their base

Teaching methods

Lecture: based on multimedia presentations containing relevant examples; as a complement, additional examples with explanations, resulting from the current interest of the students.

Classes: short multimedia presentations with the theoretical foundations of the practiced subject; example calculations performed by the teacher; practical exercises - students solve problems or tasks indicated by the teacher (the solutions are regularly commented and interpreted by students with the help of the teacher).

Bibliography

Basic

1. A. Bielański, Podstawy chemii nieorganicznej, t.1-3, PWN, Warszawa 2005

2. L. Jones, P. Atkins, Chemia ogólna. Cząsteczki, materia, reakcje, tom 1 i 2, PWN, Warszawa 2009

3. L. Kolditz, Chemia nieorganiczna, PWN, Warszawa 1994

4. J.D. Lee, Zwięzła chemia nieorganiczna, PWN, Warszawa 1999

5. F. Domka, J. Jasiczak, Analiza jakościowa, Wydawnictwo AE, Poznań 2004

6. K. M. Pazdro, Zbiór zadań z chemii, Oficyna Edukacyjna 2007

7. L. Pajdowski, Chemia ogólna, PWN, Warszawa 1992

8. Praca zbiorowa (red. W. Bobrownicki), Technologia chemiczna nieorganiczna, WNT, W-wa 1965

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. G. Charlot, Analiza nieorganiczna jakościowa, PWN, Warszawa 1976

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

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	69	2,8
Student's own work (literature studies, preparation for exercises, preparation for colloquia, preparation for final exam) [1]	56	2,2

[1] delete or add other activities as appropriate