

Course Unit	Chemistry	Field of study	Physics/Chemistry
Bachelor in	Renewable Energy Engineering	School	School of Technology and Management
Academic Year	2022/2023	Year of study	1
Type	Semestral	Semester	1
Level	1-1	ECTS credits	6.0
Code	9910-743-1105-00-22		
Workload (hours)	162	Contact hours	T 30 TP - PL 30 TC - S - E - OT - O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Ana Maria Alves Queiroz da Silva, Hélder Teixeira Gomes

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. know to determine chemical formulas and apply the naming rules of inorganic compounds.
2. solve problems involving basic concepts of chemical reactions: writing and balancing chemical equations, stoichiometric calculations.
3. analyse and apply the laws of gases and make calculations involving those laws.
4. apply basic concepts of thermochemistry and make calculations involving those concepts.
5. apply basic concepts about chemical kinetics and chemical equilibrium and make calculations involving those concepts.
6. apply basic concepts about acid-base reactions: quantify the relative strength of acids and bases, effect calculations of pH and involving acid-base titrations.
7. apply basic concepts about chemical bond.

Prerequisites

Before the course unit the learner is expected to be able to:
Apply basic concepts of chemistry and mathematics.

Course contents

Atoms, molecules and ions. Stoichiometry. Reactions in aqueous solutions. Gases. Thermochemistry. Chemical kinetics. Chemical equilibrium. Acids and bases. Chemical bond.

Course contents (extended version)

1. Introduction.
 - Classification of matter.
 - Physical and chemical properties of matter.
 - The periodic table.
 - Measurement. Units. Mass and weight. Volume. Density. Temperature.
 - Scientific notation. Using significant figures.
2. Atoms, molecules and ions.
 - The atomic theory. The structure of the atom.
 - Atomic number. Mass number. Isotopes.
 - Chemical formulas. Molecular formulas. Empirical formulas.
 - Percent composition of compounds.
 - Naming inorganic compounds.
3. Stoichiometry.
 - Atomic mass. Molecular mass. Molar mass. Avogadro's number.
 - Chemical reactions and chemical equations. Writing and balancing chemical equations.
 - Amounts of reactants and products.
 - Limiting reagents and yields of reactions.
 - Stoichiometric calculations.
4. Reactions in aqueous solutions.
 - General properties of aqueous solutions. Electrolytes and nonelectrolytes.
 - Concentration of solutions. Dilution of solutions.
 - Precipitation reactions. Solubility. Molecular equation, ionic equation and effective ionic equation.
 - Acid-base reactions. General properties of acids and bases.
 - Oxidation-reduction reactions. Oxidation number.
5. Gases.
 - Substances that exist as gases.
 - Pressure of a gas. Units of pressure. Atmospheric pressure.
 - The gas laws: Boyle's law, Charles' and Gay-Lussac's law, Avogadro's law.
 - The ideal gas equation.
 - Dalton's law of partial pressures.
 - Graham's laws.
 - The kinetic molecular theory of gases.
 - Deviation from ideal behavior.
6. Thermochemistry.
 - Energy. Energy changes in chemical reactions.
 - Enthalpy. Thermochemical equations.
 - Calorimetry. Specific heat. Constant volume calorimetry. Constant pressure calorimetry.
 - Standard enthalpy of formation and reaction.
 - The first law of thermodynamics. Work. Heat.
 - Enthalpy and the first law of thermodynamics.
7. Chemical kinetics.
 - The rate of a reaction. The rate laws.
 - Experimental determination of rate laws.
 - Relation between reactant concentration and time. First order reactions. Second order reactions.
 - Activation energy and temperature dependence of rate constants. The Arrhenius equation.
8. Chemical equilibrium.
 - Concept of equilibrium. Equilibrium constants.
 - Homogeneous equilibria. Heterogeneous equilibria.
 - The form of K and the equilibrium equation.
 - Predicting the direction of a reaction. Calculating equilibrium concentrations.
 - Factors that affect chemical equilibrium. Le Chatelier's principle.
 - Relations between chemical kinetics and chemical equilibrium.
 - Gibbs free energy. Free energy and chemical equilibrium.
9. Acids and bases.
 - Acids and bases. Conjugate acid-base pairs.
 - The acid-base properties of water. The ionic product of water.

Course contents (extended version)

- pH - a measure of acidity.
- Strength of acids and bases. Weak acids. Weak bases. Ionization constants of weak acids and bases.
- Acid-base properties of salts.
- Acid-base titrations. Acid-base indicators.
- 10. Chemical bond.
 - Atomic orbital.
 - Electronic configuration.
 - Lewis' symbols.
 - Ionic and covalent bond.
 - Properties of ionic and covalent compounds.
 - Electronegativity.
 - Lewis' structures.
 - Bond energy.

Recommended reading

1. J. Overby, Raymond Chang, Chemistry, 14th edition, McGraw-Hill, 2017.
2. K. W. Whitten, R. E. Davis, L. Peck, G. G. Stanley, Chemistry, 10th edition, Brooks/Cole, 2013.
3. L. Jones, P. Atkins, Chemistry: Molecules, Matter and Change, 4th Edition, Freeman, 2000
4. L. J. Malone, T. O. Dolter, Basic Concepts of Chemistry, 9th Edition, John Wiley & Sons, Inc. , 2013
5. J. B. Russel, General Chemistry, McGraw-Hill, 1992

Teaching and learning methods

Theoretical lessons: Presentation of the theoretical concepts. Presentation, analysis and discussion of application examples. Practical lessons: guided resolution of application exercises and explanation of doubts related with exercises solved at the non-presential period. Non-presential period: study of the theoretical contents, resolution of exercises.

Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final)
 - Intermediate Written Test - 25% (Chapters 1 to 4)
 - Practical Work - 15% (Exercises solved at classroom)
 - Development Topics - 15% (Work about "Chemical bound" - mandatory)
 - Final Written Exam - 45% (All chapters. Minimum classification of 6)
2. Alternative 2 - (Regular, Student Worker) (Supplementary)
 - Final Written Exam - 85%
 - Development Topics - 15% (Work about "Chemical bound" - mandatory)
3. Alternative 3 - (Student Worker) (Final)
 - Final Written Exam - 85%
 - Development Topics - 15% (Work about "Chemical bound" - mandatory)
4. Alternative 4 - (Regular, Student Worker) (Special)
 - Final Written Exam - 100%

Language of instruction

Portuguese, with additional English support for foreign students.

Electronic validation

Ana Maria Alves Queiroz da Silva, Helder Teixeira Gomes	Simão Pedro de Almeida Pinho	Paulo Alexandre Vara Alves
22-10-2022	22-10-2022	24-10-2022