

Course Unit	General Chemistry I		Field of study	Chemistry	
Bachelor in	Chemical Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	1	Level	1-1
Type	Semestral	Semester	1	ECTS credits	6.0
Code	9125-755-1105-00-23				
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) Hélder Teixeira Gomes

#### Learning outcomes and competences

- At the end of the course unit the learner is expected to be able to:
1. Know the general classification, physical states, physical and chemical properties of matter.
  2. Define basic concepts on chemical reactions, writing and balance of chemical equations.
  3. Describe basic concepts on the gaseous state and respective properties.
  4. Know the basic concepts on thermodynamics.
  5. Comprehend and manipulate the basic concepts on kinetic chemistry.
  6. Operate the basic concepts on chemical equilibrium.
  7. Describe and use the basic concepts on electrochemistry.

#### Prerequisites

Before the course unit the learner is expected to be able to:  
None

#### Course contents

Chemistry: the Study of Change. Atoms, Molecules and Ions. Mass Relationships in Chemical Reactions. Reactions in Aqueous Solution. Gases. Thermochemistry. Physical Properties of Solutions. Chemical Kinetics. Chemical Equilibrium. Acids and Bases. Acid-Base Equilibria and Solubility Equilibria. Entropy, Free Energy and Equilibrium. Electrochemistry.

#### Course contents (extended version)

1. Chemistry: the Study of Change
  - The study of chemistry.
  - Classifications of matter.
  - The three states of matter.
  - Physical and chemical properties of matter.
  - Measurement.
  - Handling numbers.
  - The factor-label method of solving problems.
2. Atoms, Molecules and Ions
  - The atomic theory.
  - The structure of the atom.
  - Atomic number, mass number and isotopes.
  - The periodic table.
  - Molecules and ions.
  - Chemical formulas.
  - Naming compounds.
3. Mass Relationships in Chemical Reactions
  - Atomic mass.
  - Molar mass of an element and Avogadro's number.
  - Molecular mass.
  - Percent composition of compounds.
  - Experimental determination of empirical formulas.
  - Chemical reactions and chemical equations.
  - Amounts of reactants and products.
  - Limiting reagents.
  - Reaction yield.
4. Reactions in Aqueous Solution
  - General properties of aqueous solutions.
  - Precipitation reactions.
  - Acid-base reactions.
  - Oxidation-reduction reactions.
  - Concentration of solutions.
  - Gravimetric analysis.
  - Acid-base titrations.
5. Gases
  - Substances that exist as gases.
  - Pressure of a gas.
  - The gas laws.
  - The ideal gas equation.
  - Gas stoichiometry.
  - Dalton's law of partial pressures.
  - The kinetic molecular theory of gases.
  - Deviation from ideal behavior.
6. Thermochemistry
  - The nature of energy and types of energy.
  - Energy changes in chemical reactions.
  - Enthalpy.
  - Calorimetry.
  - Standard enthalpy of formation and reaction.
  - Heat of solution and dilution.
  - Introduction to thermodynamics.
7. Physical Properties of Solutions
  - Types of solutions.
  - A molecular view of the solution process.
  - Concentration units.

**Course contents (extended version)**

- The effect of temperature on solubility.
  - The effect of pressure on the solubility of gases.
  - Colligative properties of nonelectrolyte solutions.
  - Colligative properties of electrolyte solutions.
8. Chemical Kinetics
- The rate of a reaction.
  - The rate law.
  - The relation between reactant concentration and time.
  - Activation energy and temperature dependence of rate constants.
9. Chemical Equilibrium
- The concept of equilibrium and the equilibrium constant.
  - Writing equilibrium constant expressions.
  - The relationship between chemical kinetics and chemical equilibrium.
  - What does the equilibrium constant tell us?
  - Factors that affect chemical equilibrium.
10. Acids and Bases
- Bronsted acids and bases.
  - The acid-base properties of water.
  - pH - a measure of acidity.
  - Strength of acids and bases.
  - Weak acids and acid ionization constants.
  - Weak bases and base ionization constants.
  - The relationship between the ionization constants of acids and their conjugate bases.
11. Acid-Base Equilibria and Solubility Equilibria
- Homogeneous versus heterogeneous solution equilibria.
  - The common ion effect.
  - Buffer solutions.
  - Acid-base titrations.
  - Acid-base indicators.
  - Solubility equilibria.
  - The common ion effect and solubility.
12. Entropy, Free Energy and Equilibrium
- The three laws of thermodynamics.
  - Spontaneous processes and entropy.
  - The second law of thermodynamics.
  - Gibbs free energy.
  - Free energy and chemical equilibrium.
  - Thermodynamics in living systems.
13. Electrochemistry
- Redox reactions.
  - Electrochemical cells.
  - Standard electrode potentials.
  - Spontaneity of redox reactions.
  - Effect of concentration on cell emf.
  - Batteries.
  - Corrosion.
  - Electrolysis.

**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. P. Atkins, L. Jones, Chemistry: Molecules, Matter and Change, 4th edition, Freeman, 2000.
4. J. B. Russel, Química Geral, 2ª edição, McGraw-Hill, 1992.

**Teaching and learning methods**

Theory: Description of the theoretical concepts. Discussion of the exposed theory based on analysis of some practical examples. Practice: Resolution of some application exercises and clarification of possible doubts on the resolution of the proposed exercises for the non-presential period.

**Assessment methods**

1. Alternative 1 - (Regular, Student Worker) (Final)
  - Intermediate Written Test - 33%
  - Intermediate Written Test - 33%
  - Final Written Exam - 34%
2. Alternative 2 - (Regular, Student Worker) (Supplementary)
  - Final Written Exam - 100%
3. Alternative 3 - (Regular, Student Worker) (Special)
  - Final Written Exam - 100%

**Language of instruction**

English

**Electronic validation**

Hélder Teixeira Gomes	Simão Pedro de Almeida Pinho	Ramiro José Espinheira Martins	José Carlos Rufino Amaro
12-10-2023	25-10-2023	25-10-2023	31-10-2023