Chemistry

Academic Year: (2024 / 2025) **Review date: 23-04-2024**

Department assigned to the subject: Materials Science and Engineering and Chemical Engineering Department

Coordinating teacher: TORRES CARRASCO, MANUEL

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

High school chemistry

SKILLS AND LEARNING OUTCOMES

RA1: Acquire knowledge and understanding of the basic general fundamentals of engineering and biomedical sciences.
RA2: Be able to solve basic engineering and biomedical science problems through a process of analysis, identifying the problem, establishing different methods of resolution, selecting the most appropriate one and its correct implementation.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Adequate knowledge and skills to analyse and synthesise basic problems related to engineering and biomedical sciences, solve them and communicate them efficiently.
CG3: Knowledge of basic scientific and technical subjects that enables them to learn new methods and technologies, as well as providing them with great versatility to adapt to new situations.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
ECRT3: Ability to solve basic chemistry problems that may arise in engineering and biomedicine. Ability to apply knowledge of: Chemical elements and bonding. Thermochemistry and chemical kinetics. Ideal gases. Chemical equilibrium. Electrochemistry. Applied organic and inorganic chemistry. Instrumental analysis.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.

OBJECTIVES

To understand the fundamental principles of chemistry: structure of matter, chemical thermodynamics, kinetics and chemical equilibrium
To know the reactivity of the principal organic chemical groups
To know the structure and properties of the principal macromolecules of biological interest.
To be able to handle simple analytical instruments as well as to interpret experimental results

During the course students will work on the following capabilities:
- Capability to solve complex problems
- Capability to find, understand and discriminate the relevant information to make a proper decission
- Capability to apply multidisciplinary knowledge to solve a given problem

- Capability for team work: to accept tasks and to distribute tasks among classmates to face complex problems

A collaborative attitude will be developed along the course to obtain from other agents skills and knowledge necessary for specific objectives.

DESCRIPTION OF CONTENTS: PROGRAMME

0. Preliminary concepts. What is chemistry? Definitions. Units. Standard conditions. Atoms. Molecules. Mole. Molecular mass. Chemical equations. Reactions in aqueous media: acids and bases, redox reactions
1. Atoms. Ancient ideas about atoms. Bohr¿s model. Experiments and concepts that led to Bohr¿s model. Foundations of quantum theory. Hydrogen atom: quantum numbers, electronic configuration, atomic orbitals, energy of hydrogen atom. Multielectronic atoms. Periodic table and periodic properties
2. Molecules. Preliminaries on covalent bonding theory: Lewis structures, molecular geometry, bond parameters, ionic character of bonds. Introduction to the theory of molecular orbitals. Visualization of molecular orbitals from valence bond theory. Simple energy diagrams. Hybridization. Coordination compounds. Intermolecular forces: coulombic and polarization forces. Hydrogen bonding. The structure of water.
3. States of matter. Aggregation states: long and short range order. Solids: ionic, metals, covalent, molecular. Gases: kinetic theory of gases, equation of state. Real gases: liquefaction. Liquids: viscosity, surface tension. Liquid crystals: membranes. Liquid vapor equilibrium: Clausius equation, equilibrium phase diagrams. Solutions: solubility, colligative properties of electrolytes and non-electrolytes.
4. Thermochemistry. Definitions: system, state variable, state function, heat and work, reversible process. First law of thermodynamics: enthalpy, heat capacity, reaction enthalpy, temperature dependence of reaction enthalpy. Second law of thermodynamics: entropy, reaction entropy, temperature dependence of reaction entropy. Third law of thermodynamics. Gibbs free energy: spontaneity, standard free energy of formation, relation between free energy and chemical equilibrium for ideal gas mixtures.
5. Equilibrium reactions. Gases: equilibrium constant, heterogeneous equilibria, factors affecting chemical equilibrium(pressure, temperature, concentration, inert gases, temperature). Arrhenius, Brönsted-Lowry and Lewis theories of acids and bases. Water self-ionization. Strength of acids and bases. Conjugate acids and bases. Hydrolysis. Buffers. Titration. Solubility. Electrochemical reactions: reducing and oxidizing agents. Balance of redox reactions. Electrochemical cells: conventions, galvanic potential, standard electrode potential, free energy and electrode potential. Electrolytic cells: Faraday¿s laws.
6. Chemical kinetics. Reaction rate law. Differential and integrated reaction rates. Reaction mechanism: elemental process, molecularity, limiting reactant, reaction intermediate. Rate constants and equilibrium constants. Collision theory. Transition state theory. Catalysis: homogeneous and heterogeneous. Enzymatic catalysis: Michaelis-Menten kinetics.
7. Introduction to organic chemistry. Naming organic compounds. Empirical, molecular and structural formula. Conformational isomerism. Stereoisomerism: optical activity. Fisher projections. Molecular structure and intermolecular forces. Electronic shifts on ¿ and ¿ bonds. Aromaticity. Substitution effects in ¿ systems. Intermediates: radicals, carbocations, carbanions. Intermediate stability: induction, resonance, hyperconjugation. Organic reactions: classification and definitions. Substitution. Addition. Elimination. Transposition. Condensation.
8. Alkanes: reactivity. Cycloalkanes: synthesis. Alkenes: isomerism, terpenes, addition reactions (Markovnikov), oxidation and autoxidation reactions. Alkynes: electrophilic addition reactions. Aromatic hydrocarbons: addition reactions and stability, electrophilic substitution. Benzene derivatives. Alcohols and phenols: acidity, electrophilic substitution, oxidation, stability of phenoxy radicals. Ethers: reactivity and synthesis. Thiols: reactivity and synthesis. Carbonyl compounds: resonance, oxidation and reduction, nucleophilic addition, synthesis. Carboxylic acids: stability of carboxylate anion, acidity, nuclephilic substitution, synthesis. Derivatives of carboxylic compounds, acyl chlorides, esters, anhydrides, amides: nucleophilic substitution. Amines: basicity, synthesis, reactivity.

LEARNING ACTIVITIES AND METHODOLOGY

Face-to-Face lectures, collective tutorials, individual tutorials and homework; oriented to attainment of theoretical knowledge.
Problem solving lectures in small groups, laboratory practicals, individual tutorials and home work; oriented to attainment of practical knowledge and skills related with the syllabus

ASSESSMENT SYSTEM

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Continous assesment:

30% Quizzes in small groups (2 partial exams)
10% Laboratory practicals (4 laboratory sessions)

Final exam: 60% global mark. It is necessary to obtain 4 as a minimum grade in the final exam to average with continuous assesment.

BASIC BIBLIOGRAPHY

- B.M MAHAN, R.J. MYERS Química. Curso Universitario, Addison-Wesley Iberoamericana.

- Bettelheim, Brown, Campbell, Farrell Introduction to General, Organic and Biochemistry, Brooks/Cole, 2010

- J. FISHER, J.R.P. ARNOLD Chemistry for Biologists, Taylor & Francis, 2004

- P. ATKINS, L. JONES Chemical Principles, W.H Freeman and Company, 2010

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