UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

General and Inorganic Chemistry

2021-1-E0201Q004

Aims

The course aims to provide students with:
• an introduction to language and scientific methodology with particular regard to chemical phenomena
• an in-depth knowledge of the behavior of aqueous solutions and chemical equilibria in solution with the aim of acquiring the necessary bases to face the study of biological systems.

Knowledge and understanding. At the end of the course, students will learn the fundamental chemical properties of matter (compounds and molecules, be they pure, or combined - especially in solution, given the importance that this state has on a biological level), above all being able to derive the 'origin of the reactivity of substances by the type of atoms (with their specific chemical-physical characteristics) which constitute the substances themselves.
Ability to apply knowledge and understanding. At the end of the course, students will be able to apply the acquired knowledge to problems of practical interest, often attributable both to basic research and to processes of industrial interest.
Autonomy of judgment. Students will be able to work out what they have learned and to recognize "real" case studies and specific problems.
Communication skills. At the end of the course students will be able to appropriately communicate general chemistry issues with the proper vocabulary.
Learning skills. At the end of the course, students will be able to analyze and apply their knowledge in the field of general chemistry and will integrate it with the issues of other scientific disciplines, such as organic chemistry, biochemistry, molecular biology ...

Contents

The course is focussed on qualitative and quantitative aspects of chemistry:
- Structure of matter (atoms, molecules, compounds ...)
- Stoichiometry and rules for balancing reactions
- States of matter (with particular reference to solution)

- Control of chemical reactions (kinetics and chemical thermodynamics)
- Chemistry of aqueous solutions (acids and bases)
- Electrochemistry (outline)
- Inorganic chemistry (outline)

Detailed program

The course is focussed on qualitative and quantitative aspects of chemistry.
Structure of matter
Atomic Structure. Subatomic particles. Electromagnetic radiation and the atomic spectrum. Bohr atom. Quantum mechanical description of the atom and wave functions.
Electronic Configuration of atoms. Quantum numbers and orbitals. Pauli's principle and Hund's rule. Electronic configuration of the elements and periodic table. Periodic properties: size of atoms and ions, ionization energy and electron affinity.
Chemical bond and molecular structure. Electron distribution. Ionic and covalent bond. Symbols and structure by Lewis. Octet Rule. Resonance. Electronegativity. Dipolar moment and polarity of molecules. Form of molecules (VSEPR theory). Valence bond theory. Hybrid orbitals. Bonds and bond strength. Multiple bonds. Some structures of inorganic and organic molecules. Molecular orbitals theory. Weak intermolecular forces. Hydrogen bond.

Stoichiometry
Stoichiometry of chemical reactions. Chemical reactions. Chemical equations and their balance. Stoichiometric calculations. Percentage composition and elementary analysis. Yield of reactions and limiting agent. Reactions in aqueous solution. Net ionic equations. Expressions of concentration. Dilution. Oxidation reductions and their balancing.

States of aggregation of the matter
Gas: outline of the kinetic theory of gases.
Liquids. State transition and phase equilibria. Vapor pressure. Surface tension. Viscosity. State diagrams of water and carbon dioxide. Water properties.
Solids. Ionic, covalent, molecular and metallic solids. Crystal lattices.
Solutions. Types of solutions. Dissolution process. Concentration unit. Raoult's law. Colligative properties. Osmosis. Solubility. Colloids and colloidal dispersions.

Control of chemical reactions
Chemical kinetics. Chemical reaction rate. Reaction mechanism. Activation energy. Catalysis.
Chemical thermodynamics. General concepts. First law of thermodynamics. Second law of thermodynamics. Entropy. Gibbs free energy and spontaneity criteria.
Chemical equilibrium. Mass action law. Balance constant. Reaction quotient. Principle of Le Chatelier.
Chemistry of aqueous solutions
Chemistry of acids and bases
Ionic product of water, pH, pOH and pKw. Strong and weak electrolytes. Acids and bases according to Arrhenius and Brönsted-Lowry. Conjugated pairs of acid-base. Strength of acids and bases. Aqueous solutions of strong and weak acids and bases. Degree of ionization. Polyprotic acids. Common ion effect. Acids and bases according to Lewis. Dative covalent bonds and complex ions. Reactions between acids and bases. Hydrolysis of salts. Buffer solutions.
Outline of coordination chemistry

Electrochemistry
Electrochemical cells and electrolytic cells. Standard reduction potentials. Electromotive force of a battery. Free energy and f.e.m. Voltaic cells in non-standard condition: Nernst equation. EMF and equilibrium constant.

Inorganic chemistry
Outline of the inorganic chemistry of elements of biological relevance.

Prerequisites

Background: none
Prerequisites: none

Teaching form

Classroom lectures supported by slides, exercises to consolidate the quantitative and numerical aspects of chemistry.

Teaching is in Italian

In the emergency period Covid-19 classes will take place in mixed mode: partial attendance and videorecorded asynchronous/synchronous lessonsing language: italian.

Textbook and teaching resource

Learning material (slides) is available at the e-learning platform of the course.

Recommended textbook:
- Chemistry. Kotz, Treichel, Townsend. Ed. EdiSES

Semester

First semester

Assessment method

Oral examination, with short exercises/problems.
Students are asked to describe theory, chemical models and, above all, their practical applications, which are relevant course issues. This kind of knowledge will be assessed through various typologies of exercises (eg: stoichiometric balances, Lewis structures of compounds, problems on concentrations of ionic species in solution, problems on chemical balance, problems on pH etc).

Office hours

Contact: on demand, upon request by mail to lecturer