UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

General and Inorganic Chemistry of Materials

2627-1-ESM02Q002

Aims

General Objectives

The course of General and Inorganic Chemistry (6 CFU) is devoted to the students enrolled to Materials Science university course. The aim of the course is to present the basic concepts of the chemistry in order to realize the macroscopic properties of the pure substances and compounds and of the materials.

Knowledge and understanding.

Students, by the end of the course, will learn the basic principles of stoichiometry and of the chemical reactions of inorganic compounds. Moreover, students will learn to know and exploit general chemistry lab equipment and glassware as well as the basic safety rules.

Applying knowledge and understanding.

By the end of the course, students will be able to solve simple problems of stoichiometry and to perform simple chemistry lab experiments.

Making judgments.

By the end of the course, students will become able to choose the methodology to study the chemistry of a selected system and to individuate proper compounds and techniques to carry out simple chemical reactions.

Communication skills.

By the end of the course, students will be able to describe the arguments of the course and to participate in stimulating discussions.

Learning skills.

By the end of the course, students will have developed the ability to solve and face with more complex exercises, arguments and experiments.

Contents

The course aims to provide in-depth knowledge of general chemistry, necessary for understanding the structure and properties of the most relevant chemical compounds, as well as chemical phenomena (chemical reactions, chemical equilibria, pH, colligative properties). The course includes stoichiometry exercises closely coordinated with the course "Introduction to Basic Laboratory Operations" and designed to complement and reinforce the concepts learned by the student in the theoretical part of the course.

Detailed program

Atoms, Electronic Configuration of Elements, and Periodic Properties.
Structure of the atom, subatomic particles, dimensions. Elements and their isotopes. Concept of the mole and Avogadro number, atomic masses. Stable and unstable isotopes. Electron motion, wave functions. Atomic orbitals, their energies, shapes, and sizes for hydrogen and multi-electron atoms. Electronic configurations of the elements, their characteristics, and periodic properties. Atomic volumes and radii, ionization potentials, and electron affinities. Hybrid orbitals of types “sp,” “sp^2,” and “sp^3.”

Molecules, Compounds, Stoichiometric Relationships, Chemical Bonds, and Molecular Interactions.
Molecules and chemical formulas, molecular weights, number of moles. Stoichiometric reactions, their balancing, and mass calculations in the conversion of reactants into products. Ionic bond theory, lattice energy, crystal structures, and ionic radii. Valence bond theory, covalent, polar, and coordinate bonds. Multiple bonds. Electronegativity. Oxidation numbers. Structural formulas of polyatomic molecules. Biatomic molecules and molecular orbitals. Intermolecular interactions.

States of Matter and Phase Transitions.
Systems, number of phases, components, and degrees of freedom. Phases and their transitions. Ideal gas model, vapor. Solids. Amorphous and crystalline systems, crystalline structures, and unit cells. Liquid phase. Phase equilibria. Phase diagram of water. Binary mixtures. Methods for measuring concentration. Colligative properties.

Introduction to Thermodynamics and Chemical Kinetics, Chemical Equilibrium.
Brief overview of results from the study of thermodynamics and chemical kinetics. Energy balance and spontaneous direction of chemical reactions. Equilibrium conditions of chemical reactions, equilibrium constants.

Dissolution Reactions of Solid Molecular and Ionic Solutes in Liquid Solvents, Definition of Solubility and Solubility Product of Salts.

Hydrolysis Reactions. Acids and Bases.
Proton transfer reactions. Strength of acids and bases and related dissociation constants. Self-ionization of water. Definition of pH and pOH and their applicable ranges in dilute aqueous solutions. Calculation of the pH of monoprotic acid and base solutions.

Electron Transfer Reactions and Introduction to Electrochemistry.
Oxidized and reduced species, half-reactions of oxidation and reduction. Electrode potential difference and Nernst equation. Standard reduction potentials. Types of chemical electrodes. Galvanic cells and their electromotive force.

Inorganic Chemistry of Elements.

Main characteristics of naturally occurring elements. Elements of industrial importance. Case studies relevant to Materials Science.

Prerequisites

The basic knowledge concerning the numerical, algebra and analytical geometry calculations are required, such as typically given in the high school.

Teaching form

The course (6 CFU) correspond to 48 hours of lessons.
All lectures are delivered as in-presence delivered lessons
The lesons are recorded and put at students disposal on the e-learning platform.
The lessons are delivered in Italian language by the teacher which presents the syllabus arguments by slides or on the blackboard. The slides of the lessons will be supplied to the students on the e-learning platform. Besides the theoretical aspects representative examples and exercises will be shown in order to practice. The student can verify its learning through other exercise texts and written questions, which will be proposed as didactical material during the cycle of lessons. The regular attendance of the lessons is recommended for an easier learning, although it is not more compulsory.

Textbook and teaching resource

Chimica - Kotz, Treichel, Weaver - Edises
Martin S. Silberberg, Chimica, la natura molecolare della materia e delle sue trasformazioni, Mc Graw Hill

Slides of the lessons on the e-learning website

Semester

first semester

Assessment method

Oral interview (grade from 18/30 to 30/30) aimed at verifying at assessing the knowledge of the main aspects of general and inorganic chemistry.
No in-itinere tests are provided.
The oral exam consists in open questions on the main topics of the general chemistry program regarding the comprehension of the properties and structure of substances and compounds and of the chemical reactions and transformations. The capacity of solving quantitative problems related to the topic of the program is also evaluated.

The evaluation will take into account the ability to present knowledge clearly and with appropriate language, to answer the examiner’s questions, and to engage in a discussion
The final evaluation will be communicated in detail, specifying strengths and weaknesses.
The grading scale will be as follows:
• Failing grade: the minimum level of preparation was not achieved
• Passing grade (18–21): the minimum level of preparation was achieved, with several gaps
• Fair grade (22–25): a satisfactory level of preparation was achieved, with some gaps
• Good grade (26–28): a good level of preparation was achieved, with few gaps
• Excellent grade (29–30 with honors): an excellent level of preparation was achieved, with no gaps

Office hours

upon request

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | DECENT WORK AND ECONOMIC GROWTH | SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION