UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Inorganic Chemistry

2122-1-E3002Q027-E3002Q030M

Aims

The Chemistry course (E3002Q027, 12 ECTs) is splitted in two modules: INORGANIC CHEMISTRY (E3002Q030M, 6 ECTS, first semesters) and ORGANIC CHEMISTRY (E3002Q031M, 6 ECTS, second semester). The course aims at providing a wide basic knowledge on both main areas of chemistry. This is relevant both to the general scientific culture and to the comprehension of the structure/properties relationship in all the main classes of materials for Optics: glasses and solutions for contact lenses (illustrated in the Inorganic chemistry module) and plastic materials for contact lenses (organic chemistry module).

There will be a separated exam for each module, in written form for Inorganic Chemistry and oral form for Organic Chemistry. The final mark is recorded as an average of the written and oral essays, once both exams have been passed.

Incoming Erasmus students have also the possibility to include only one module in their plan.

Inorganic Chemistry Module

Acquire fundamental concepts and definitions for the study of chemistry. Get to know the fundamental physical and chemical properties of matter in its gaseous, liquid or solid state. Understand the atomic structure and its link to the chemical reactivity. Read analytically the periodic table of elements. Manage and solve stoichiometry problems and balance chemical equations. Understand the concept of chemical equilibrium and its application to solubility, titrations and buffer solutions. Get insight on the microscopic structure of materials of frequent use in optics, such as glass or solutions for contact lenses.

Contents

General definitions and preparatory tools to study chemistry. Stoichiometry. Balancing chemical equations. Gas theory and thermochemistry. Quantum theory, atomic structure and electronic configuration. Chemical bond. Molecular structure. Covalent bond theory. Intermolecular forces. Properties of solutions. Chemical kinetics and thermodynamics. Chemical equilibrium and pH. Reduction-oxidation reactions in basic and and acid environment. Materials chemistry for optics.

Detailed program

1. General definitions and preparatory tools to study chemistry.
Physical and chemical properties and transformations. Significant digits and roundoff. Atomic theory. Formulas and nomenclature of inorganic compounds.
2. Stoichiometry.

Molecular mass and formula mass. Molar mass and Avogadro's number. Problems and exercises. Reaction's yield and limiting reactant. Stoichiometry in solutions: concentration and molarity.

3. Balancing chemical equations.
Dissolution and precipitation of ionic compounds. Acid base reactions. Oxidoreductions.
4. Gas theory and thermochemistry.
The laws of gases. State equation of perfect gases. Stoichiometry and perfect gases. Kinetic theory of gases. Real gases. Exchange of energy, heat and work in chemical reactions. Enthalpy and specific heat.
5. Quantum theory, atomic structure and electronic configuration.
Wave-particle dualism of light. Quantization of energy. Bohr's model for the hydrogen atom. Quantistic atomic model, quantum numbers and orbitals. Electronic configuration of atoms and ions. Chemical periodicity: atomic/ionic radius, ionization energy, electron affinity.

6. The chemical bond.

Metallic, ionic and covalent bond: main properties and periodic trends in bond energy and distance. Electronegativity and polarity in bonds. Periodic trends in chemical reactivity.
7. Molecular structure.
Lewis formula, VSEPR theory, polarity in molecules.
8. The covalent bond theory.

Valence bond theory and hybridization of orbitals. Molecular orbital theory. Bonding and antibonding theory. Bond order. Electronic delocalization.
9. Intermolecular forces.

Quantitative aspects of phase transitions. Vapour pressure. Phase diagram. Intermolecular forces. Liquid state: surface tension, capillarity, viscosity. Solid state: crystal lattice and unit cell. Amorphous and crystalline solids. Chemical bond in solids and electric conductivity.
10. Properties of solutions

Intermolecular forces in solutions. Energetic and thermal aspects of solubility. Sature solutions. Colligative properties.
11. Chemical kinetics and thermodynamics.

Reaction rate. Kinetic laws and reaction's order. Collisions theory. Transition state. Catalysis. Entropy. Gibb's free energy and spontaneity of reactions.

12. Chemical equilibrium.

Reaction's coefficient and equilibrium constant. Direction of a reaction and Le Châtelier's principle. Acid-base equilibrium. Ionization's equilibrium. Buffer solutions. Problems and exercises.
13. Oxidoreductions in acid and basic environment. The semireactions method.

14. Materials chemistry for Optics.

Glass: chemical structure and physical properties. Main components of common glasses and optical glasses. Coloured glasses and photocromism. Solutions for contact lenses: types and functions, physico-chemical parameters, solutions for hydrogel lenses.

Prerequisites

Basic prerequisites of mathematics (fundamental operations, basic concepts in functions study, properties of logarithms).

Basic prerequisites of physics (scalar and vector quantities, laws of thermodynamics, Coulomb's law).

Teaching form

This course consists mainly of theory's lectures. A few hours are devoted to exercises and tutotials.

Textbook and teaching resource

The slides shown during the lectures are only partially shared with the students, Extra contents and exercises are shared via the e-learning platform.

It is strongly recommended to recurr to a valid textbook to prepare the exam.

Some textbooks (in English):

M. S. Silberberg, CHEMISTRY - The molecular nature of matter and change, Sixth edition (McGraw-Hill)

W. L. Masterton, C. N. Hurley, Neth. Chemistry: principles and reactions (Brooks/Cole,)

Semester

First semester

Assessment method

The assessment is based on a single written exam at the end of the course. The exam is structured as follows:

• Five open questions (4 points each).
• Three exercises (5 points each)

Overall, there are 35 available points. At least 18 points are required to pass the exam. The final mark is not registered. A global mark averaging inorganic chemistry and organic chemistry is registered once both exams are passed.

The exam can be done, upon request, in English in oral form.

Office hours

Wednesday from 9 to 10 am.

It is preferrable to get in touch to the teacher and arrange an appointment.