UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Inorganic Chemistry

2627-1-E3006Q003

Aims

The Inorganic Chemistry Course aims at providing to the students a wide basic knowledge of general chemistry, and get them to know the main inorganic systems of interests within the Optics and Optometry Course. This is relevant both to the general scienticic education, and to understand the relationship between chemical structure and properties of some classes of materials relevants for optics: glass and solutions for contact lenses.
Knowledge and Understanding This teaching will permit to 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. Get insight on the microscopic structure of materials of frequent use in optics, such as glass or solutions for contact lenses.
Applying knowledge and understanding Apply the acquired knowledge to the solution of stoichiometry problems and balance chemical equations. Understand the concept of chemical equilibrium and its application to solubility, titrations and buffer solutions.
Making judgements The autonomous judgement in the context of chemistry will be stimulated by interacting with the teachers during classes and by means of self-evaluations tests made available on the Moddle page.
Communication skills At the end of the course, the students will be able to clearly expose the main elements of chemical sciences.
Learning skills By combining theoretical classes, lectures devoted to the solution of problems, and assignments in form of quiz and test, the students will be enabled to stimulate their capability of learnong basic scientific subjects.

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 exponentials and logarithms).

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

Teaching form

The course lasts forty-height hours. Forty hours are devoted to theoretical lectures (delivered teaching), while eight hours are devoted to the solution of stoichiometry problems (interactive teaching). All activities are carried out in presence.

Textbook and teaching resource

Notes, extra contents and exercises are shared via the e-learning platform.

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

Some examples of adequate 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 mandatory written exam at the end of the course. The exam is structured as follows:
• Six open questions (3 points each, to verify knowledge and understanding of the topics included in the program, and communication skills).
• Three exercises (4 points each, to apply knowledge and understanding of chemistry to stoichiometric problems)
There are three requisites to pass the exam: at least 18 total points, at least 9 points in the open questions, and at

least 6 points in the exercise part. The students may decide to undergo an optative oral examination to improve the mark of the written exam. The final mark will be comprised in the range -10%, +10% with respect to the mark of the written essay. The teacher may require the student to attend the oral colloquium in case few points are missing to pass the exam.
Grading criteria:
High (27-30): solid knowledge on all topics, good communication skills
Middle (23-26): solid knowledge on most of the topics, fair communication skills
Low (18-22): knowledge limited to basic aspects, communication not always effective
Not sufficient: relevant lacks of knowledge on fundamental aspects

Office hours

Please contact the teacher via email and arrange an appointment.

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | RESPONSIBLE CONSUMPTION AND PRODUCTION