UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

General and Inorganic Chemistry

2223-1-E3201Q067

Aims

This course aims to provide to the students a wide, basic knowledge in the field of General and Inorganic Chemistry, in the specific frame of the bachelor in Science and Technologies for Environment. This matters both to the general scientific knowledge and to the development of specific skills to deal with environmentally relevant problems.
Aquire fundamental definitions and concepts to the study of chemistry. Get to know the fundamental chemical and physical properties of matter in gaseous, liquid and solid state. Understand the atomic structure and relate it to the chemical reactivity. Read analitically the periodic table of elements. Know the reactivity and natural abundance of the groups of elements. Solve stoichiometry problems and balance chemical reactions. Understand the concept of chemical equilibrium and its application to solubility, titrations, buffers and electrochemistry. Familiarize with the fundamental notions of thermodynamics and kinetics, at the base of the sustainability of the chemical processes.

Contents

General definitions and notions necessary to the study of chemistry. Stoichiometry. Chemical reactions and balancing. The theory of gas and thermochemistry. Quantum theory, atomic structure and electron configuration. The chemical bond. The shape of the molecules. Covalent bond theories. Intermolecular forces. Properties of solutions. Periodic trends in chemical bonds and reactivity. Fundamental aspects of kinetics and thermodynamics. Chemical equilibrium and pH scale. Oxidation/reduction reactions in acidic and basic environment. Electrochemistry. The chemical elements in nature: abundancy and requirement.

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. Periodic trends in chemical bonds and reactivity
Trends in reactivity and chemical behavior along the groups of the periodic tables.
12. Chemical kinetics and thermodynamics.
Reaction rate. Catalysis. Entropy. Gibb's free energy and spontaneity of reactions.
13. 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.
14. Oxidoreductions in acid and basic environment.
The semireactions method.
15. Electrochemistry
Electrochemical cells. Free energy and electrochemical work. Batteries. Electrolitic cells.
16. The elements in nature
Natural abundance of the elements. Basic aspects of carbon and nitrogen cycles. Critical requirements of some elements.

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

Second semester

Assessment method

The assesment is based exclusively on the final exam at the end of the course, consisting of a written test, followed by an oral colloquim.

• Written test: five questions (stoichiometry problems, nomenclature tests, structural formula, balance of chemical reactions)
• The students who passed the written test will be admitted to the oral part, consisting of a question on a topic chosen by the student, and further questions from the teacher on the other aspects of the program.

Office hours

Wednesday from 9 to 10 am.

Please contact the teacher and arrange an appointment.

Sustainable Development Goals

QUALITY EDUCATION