UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

# Chimica Generale ed Inorganica

**2526-1-E3202Q006**

## 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. Understand the different models of chemical bonds. Understand the fundamentals of thermodynamics, kinetics, and chemical equilibria.
Apply the acquired competences to read analitically the periodic table of elements, understanding the reactivity of the various groups and classes of compounds. Solve stoichiometry problems and balance chemical reactions. Apply the concept of chemical equilibrium to solubility, titrations, buffers, and electrochemistry. Apply the fundamental aspects of chemical sciences to the interdisciplinary frame of sustainability.
Develop autonomous learning skills in the frame of chemical sciences.
Develop communication skills on basic chemistry

## 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 of:
-24 theoretical lectures (2 hours each) in presence, delivered teaching
-8 sessions (2 hours each) of interactive teaching in presence, devoted to the solution of stoichiometry problems
-4 hours of interactive remote activities delivered asinchronically in Moodle environment and also dedicated to stoichiometry exercises. Two extra-points on the exam mark are granted to those students who deliver on time and correctly solve the assigned problems.

## Textbook and teaching resource

Notes, 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 (mandatory), followed by an oral colloquium (elective).

Written test: six questions (two stoichiometry problems, to apply knowledge and understanding of chemistry to stoichiometric problems, and four open-ended questions to verify knowledge and understanding of the topics included in the program and communication skills)
The students who aim at improving their mark (up to 10% maximum) are invited to an oral colloquium
Two extra points are assigned to those students who solve correctly and deliver timely the exercizes aligned via moodle at the end of the course.

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

Wednesday from 9 to 10 am.

Please contact the teacher and arrange an appointment.

## Sustainable Development Goals

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