



Code: CHIM/03

Credits: 9

Course: Chemistry

Main language of instruction: Italian

Other language of instruction: English

Teaching Staff

Head instructor

Prof. Marianna GALLO- marianna.gallo@unicusano.it

Introduction

1. Objective of the course :

The teaching of general chemistry aims to provide the student with an understanding of the fundamental chemistry that characterizes many of the processes with which we interface daily. The lectures and exercises are always contextualized, specifying a classic situation that more or less everyone experiences: cooking a dish of pasta, washing their hands, using a remote control to turn on any electronic device, etc. The 11 modules (and introductory module 0) that make up the course should be understood as connected to each other. The course can be seen as dissected into 3 macro-blocks: the first block is focused on atom composition and models for describing the shape of molecules; the second block considers interactions between species, whether these are atoms or molecules, condensed phases, and the introduction of thermodynamics; the last block focuses on the concept of chemical equilibrium applied to reactions of acids and of bases, dissolution of salts and stacks. The presence of Eivity associated with the various modules (or macro-blocks) will guide the student to develop the skills necessary to obtain the basic information related to chemical phenomena generics.

Objectives

2. Course Structure:

The Chemistry course has the following educational objectives:

1. To know the basics of Chemistry;
2. To explain Molecular Models and Chemical bonds;



3. Illustrate Gaseous state, Condensed states of aggregation and Thermodynamics;
4. Illustrate physical and chemical equilibria with particular attention to acids and bases solution;
5. Illustrate the Electrochemistry.

Competencies:

A. Knowledge and understanding:

The student upon completion of the course will be able to understand the properties of the main chemical species with which each of us comes into contact every day. The student will be able to understand the principles of operation, measurable quantities, potentials and limits of the main observable chemical-physical processes. Measurable quantities, the potentials and limits of the main observable chemical-physical processes.

B. Applying knowledge and understanding:

The student will be able to use fundamental knowledge of chemistry to discriminate independently when choosing a product to use or a procedure to implement. In addition, the student will be able to use the acquired knowledge for data processing and general chemistry problem solving.

C. Communication skills:

The student will be able to use correct and understandable technical language to express in clearly the fundamental knowledge of general chemistry acquired in the context of the topics proposed in the 11 modules.

Syllabus

3. Programme of the course:

Subject 1 – Introduction

- The scientific method
- Chemistry

Subject 2 – Atoms

- Weight laws (Lavoisier, Proust, Dalton)
- Evolution of atomic models



- Principles of quantum mechanics
- Quantum numbers
- Atomic orbitals
- Electronic configuration
- Periodic system
- Properties of the elements

Subject 3 - Chemical Nomenclature

- Valence
- Oxidation number
- Traditional and official (IUPAC) nomenclature
- Nomenclature of compounds binary and ternary compounds

Subject 4 – Chemical bonds

- Ionic bonds
- Covalent bonds (Lewis structures, resonance)
- Octet (doublet) rule
- Strength and length of covalent bonds
- Metallic bonds

Subject 5 – Molecular shape models

- VSEPR model
- Valence bond model (σ, π orbitals, hybridization)
- LCAO method (H_2 molecule)

Subject 6 – Gaseous state

- Observation of gases
- Pressure
- Empirical laws of the gaseous state
- Equation of state of ideal gases
- Mixtures gases (partial pressures and volumes)
- Real gases

Subject 7 – Condensed states of aggregation

- Intermolecular forces (ion-dipole, dipole-dipole, London dispersion, van der Waals, Hydrogen bonding)
- Viscosity
- Surface tension
- Structures of solids (metallic, ionic, molecular)



Subject 8 – Elements of Thermodynamics

- Definitions (open, closed, isolated systems)
- I principle (heat, work, internal energy, enthalpy, Hess's law)
- II principle (entropy, statistical interpretation)
- III principle (free energy, concept of spontaneity of a reaction)

Subject 9 – Physical equilibria

- Phases and transitions of state (vapor pressure, boiling, Clausius-Clapeyron equation)
- Diagram of state (water, triple point)
- Solubility (temperature, enthalpy, free energy)
- Colligative properties (molality, vapor pressure lowering, cryoscopic lowering, ebullioscopic raising)

Subject 10 – Chemical equilibria

- Equilibrium (reversibility of a reaction, law of mass action, equilibrium constants)
- Degree advancement of a reaction
- Direction of unfolding
- Equilibrium shift (addition/subtraction of reactants, pressure, temperature)

Subject 11 – Acids and bases, equilibria in solution

- Definitions (Arrhenius, Brønsted-Lowry, Lewis)
- Acid-base reactions
- Conjugate pairs
- Constants of acidity and basicity
- pH scale
- Buffers
- Self-protolysis of water
- Titrations (strong acid-strong base, strong acid/weak base/weak acid, weak acid-weak base)
- Indicators
- Solubility product

Subject 12 – Electrochemistry

- Oxidation-reduction reactions
- Standard reduction potential (E°)
- Galvanic cells (Daniell stack, construction of stacks)
- Nernst equation

- Electrolysis (Faraday's laws, applications)

Evaluation system and criteria

The examination consists of a written test. This includes:

- 5 open-ended questions (1 theoretical and 4 exercises).

In addition, 3 E-tivities, consisting of numerical problems, are compulsory. These need to be sent to the instructor in advance of the examination. E-tivity counts a total of 2 marks.

Bibliography and resources

4. Materials to consult

Notes written by the instructor are available in Italian.

5. Recommended bibliography

Suggested readings are:

- P. Silvestroni, "Fondamenti di Chimica", Ed. Veschi
- P. Atkins, L. Jones, "Principi di Chimica", Ed. Zanichelli
- Brain B. Laird, "Chimica generale", Ed. McGraw-Hill