

## UNIVERSITA' DEGLI STUDI MEDITERRANEA DI REGGIO CALABRIA

**Subject Code** 56T002  
**Subject Name** CHEMISTRY  
**Professor** Maria Grazia Musolino

**Department:** DICEAM  
**Degree course:** CIVIL AND ENVIRONMENTAL ENGINEERING  
**Class:** L-7  
**Type of educational activity:** Basic  
**Disciplinary Area:** Physical and Chemistry  
**Scientific-Disciplinary Sector:** CHIM\07

**Compulsory preliminary exams:** None  
**Course Year:** 1°  
**Semester:** 1°  
**ECTS:** 9  
**Hours:** 72

### **Synthetic description**

The course aims to provide the student with a general knowledge on chemical and physical processes, on the structure and the transformations of the matter. Further learning objective is the numerical and experimental application of the fundamental principles of chemistry.

### **Acquisition of knowledge on:**

By the end of the programme, student will have:

a comprehensive understanding of the fundamental principles that govern the physico-chemical transformations related to the structural changes of matter;

a thorough knowledge of organic compounds, that now constitute a very important part from which to get the new high-tech materials used for the construction of the various devices;

an ability to use an appropriate technical and scientific language.

### **Evaluation method**

Written and oral examination.

### **Student's independent work**

Individual study of the discipline, implementation of the subjects of discipline and resolution of basic chemical problems.

### **Detailed course program**

#### *ATOM*

The states of matter (gaseous, liquid and solid) and their properties. Mixtures (heterogeneous, homogeneous) and pure substances. Elements and compounds. The atomic theory of matter. Subatomic particles. Experience of Rutherford. Atomic number, mass number, isotopes. Mole, Avogadro's number, relative atomic mass. The corpuscular-

ondulatory nature of light. Atomic spectra. Bohr model of the atom. De Broglie's postulate. Heisenberg's uncertainty principle. The quantum mechanical model. The atomic orbitals. Quantum numbers for electrons in atoms. Multi-electron atoms. Electron spin. Electronic configuration of the elements. Aufbau principle. The periodic table and the periodic properties of the elements. Atomic radius. Ionization energy. Electronic affinity.

### *CHEMICAL BONDING - CHEMICAL REACTIONS*

Lewis structure. Bond energy. Covalent bond. Valence bond theory. Electronegativity. Resonance. Hybridization and molecular geometry. VSEPR theory. Ionic bond. Lattice energy. Principles of molecular orbital theory. Metallic bond. Band theory. Semiconductors. Weak bonding interactions. Hydrogen bond.

Valence. Oxidation number. Nomenclature of inorganic compounds. Oxidation-reduction reactions: balancing. Amounts of substances in a chemical reaction. Equivalent weight. Stoichiometry.

### *STATES OF MATTER*

Gaseous state. Gas properties. Ideal gas. Gas laws. Ideal gas equation. Kinetic theory, of an ideal gas: Maxwell's speed distribution. Theorem of equipartition of energy. Diffusion and effusion. Real gas. Van der Waals equation. Critical temperature. Gas liquefaction: Andrews diagram.

Liquid state. Properties of liquids. Surface tension. Evaporation. Vapour pressure. Boiling. Solide state. Properties of solids. Determining crystal structure by X-ray diffraction. Ionic, covalent, molecular, metallic solids.

### *SOLUTIONS*

Phase transitions. Phase diagrams. Solubility. Henry's law. Solutions concentrations. i Ideal solutions. Raoult's law. Non-ideal solutions. Colligative properties. Electrolyte solutions Conductivity. Equivalent conductivity. Equivalent conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel theory of electrolytes.

### *THERMODYNAMICS*

Heat. Work. First law of thermodynamics. Internal energy. Enthalpy. Endothermic and exothermic processes. Molar specific heats of gases. Thermochemistry Hess's law. di Born-Haber cycle. Second law of thermodynamics. Entropy. Third law of thermodynamics. Gibbs free energy and spontaneity. Free energy and useful work. Clausius-Clayperon equation, phase transitions.

### *CHEMICAL EQUILIBRIUM AND CHEMICAL KINETICS*

Homogeneous equilibrium. Dynamic equilibrium. Law of mass action. Free energy and equilibrium. Dissociation degree. Equilibrium position: Le Chatelier's principle. Van't Hoff equation. Heterogeneous equilibria.

Solutions in equilibrium. Acids and bases. The Arrhenius and Bronsted-Lowry concept. Lewis acids and bases. Strengths of acids and bases. Ion product of water. pH. Buffer solutions. Indicators. Hydrolysis. Titration acid-base. Solubility equilibrium. Solubility product. Common ion effect.

Reaction rate. Reaction mechanisms. Elementary reactions and molecularity. Activation energy. Reaction order. Arrhenius law. Catalysts and catalysis.

### *ELECTROCHEMISTRY*

Galvanic cells. Cell potentials and thermodynamics. Nernst equation. Standard cell potential and standard electrode potentials. Reference electrodes. Standard hydrogen electrode. Calomel electrode. Concentration cells. Primary battery. Electrolysis. Decomposition potential. Overpotential. Faraday's laws. Electrolysis of molten salts. Electrolysis of water. Secondary batteries: lead-acid cell. Corrosion of iron and control of corrosion.

### *STRUCTURE AND PROPERTIES OF ORGANIC COMPOUNDS*

Hydrocarbons. Naming hydrocarbons. Alkanes. Alkenes. Addition reactions. Markovnikov rule. Polymerization. Dienes. Alkynes. Alcohols. Alkyl halides. Aldehydes and ketones. Synthetic preparation of aldehydes and ketones. Reactions of aldehydes and ketones. Ethers. Carboxylic acids. Acid halides and anhydrides. Optical isomerism. Esters. Amines. Amides. Amino acids. Aromatic hydrocarbons: electrophilic substitution. Heterocyclic compounds.

### **Resources and main references**

Material provided during the lectures by the teacher.

.P. Finocchiaro, R. Pietropaolo "LEZIONI DI CHIMICA"  
Schonenfeld & Ziegler.

A.M. Manotti Lanfredi, A. Tripicchio "FONDAMENTI DI CHIMICA "  
Casa Editrice Ambrosiana.

A. Clerici, S. Morocchi "ESERCITAZIONI DI CHIMICA"