# . – Chemistry

## Prof. Luigi Sangaletti

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

This course entails studying matter and its transformations and applying the main laws of chemistry. It aims to: teach students the correlation between electronic structure, the spatial configuration of molecules and properties of matter; provide criteria for the spontaneity of reactions and for studying the rate of chemical transformations; and use the periodicity of chemical properties to analyse the characteristics and behaviour of various elements and compounds systematically.

At the end of the course, students will know the electronic structure of chemical elements, be able to distinguish and discuss the different chemical bonds, and know covalent bonds, hybridisation and its formulation via the Lewis law, and valence bond theory with its implications for molecular geometry; they will also know the states of matter and their transformations, as well as the stoichiometric, energetic and kinetic aspects of chemical reactions (including equilibrium), with particular reference to problems in the gas phase and in solution.

***COURSE CONTENT***

Matter and substance, homogeneous and heterogeneous systems, elements and compounds, law of definite proportion, law of constant composition, law of conservation of matter, atomic number, isotopes, atomic weight, mole and chemical nomenclature.

Rutherford's model, Bohr's model, quantization, Schrödinger equation, hydrogenic atoms, quantum numbers, s, p, d and f orbitals, electron configuration (Aufbau principle), Pauli exclusion principle, Hund's rule, ionization energy, electron affinity, electronegativity, periodic table and periodic properties of elements.

Ionic bond, covalent bond, valence-bond theory, resonance formulas, hybridization, valence shell electron pair repulsion (VSEPR) theory, molecular orbital theory, homonuclear molecules (H2, N2, O2, etc.) and heteronuclear molecules (CO and NO), polyatomic molecules (NH3, H2O, CH4, etc.), Lewis acids and bases, metals, semiconductors and insulators.

States of matter, covalent solids, crystalline solids, ionic solids, Madelung constant, molecular solids, Van der Waals forces, hydrogen bond, liquids, properties of liquids, gases, formulas, molarity, normality, oxidation number and types of chemical reactions.

Ideal and real gases, first law of thermodynamics, enthalpy, endothermic and exothermic processes, thermochemistry, heat capacity, dependence of enthalpy on temperature, bond energy, entropy, second law of thermodynamics, Gibbs free energy, dynamic equilibrium in chemical reactions, equilibrium constant and van't Hoff equation.

Gas-state reactions, Le Châtelier's principle, equilibrium constant calculation, autoprotolysis of water, pH, strength of acids and bases, acid-base reactions, polybasic acids, acid-base titrations, buffer effect, acid-base indicators, heterogeneous equilibria, slightly soluble salts, precipitation reactions, solubility product constant and simultaneous equilibria.

Phase diagrams for pure substances (H2O, CO2 and S), properties of solutions, ideal solutions, Raoult's law, Henry's law, ideal solutions of nonvolatile solutes, colligative properties, phase diagrams for two-component systems, phase rule, lever rule, mixtures of volatile liquids, azeotropic mixtures and mixtures of partially mixable liquids.

Oxidation-reduction reactions, Nernst equation, standard reduction potentials, types of electrodes, examples of cells of practical use, corrosion and electrolysis.

Rate of reaction, kinetic law, kinetic constant, reaction order, half-life, temperature-dependence of the kinetic constant, Arrhenius equation and catalysts.

Chemistry and reactivity of the main classes of inorganic compounds consisting of typical and transition elements. Coordination and metal-organic compounds.

***READING LIST***

1.Ralph H. Petrucci – F. Geoffrey Herring - Jeffry D. Madura – Carey Bissonette, *Chimica Generale,* Terza edizione italiana, Piccin, Padua, 2013.

***TEACHING METHOD***

Lectures.

***ASSESSMENT METHOD AND CRITERIA***

Oral exam. The oral exam is aimed at ascertaining how well students have assimilated the concepts, results and methods illustrated in class, the presentation and discussion of a number of points covered in the programme.

The assessment of the oral exam will take into account students’ accuracy in the procedures illustrated, and efficacy and accuracy of their presentation; their ability to assimilate concepts and personally rework them will be particularly valued.

***NOTES AND PREREQUISITES***

The course is aimed at students on the PHYSICS curriculum of the three-year Mathematics degree, but is also recommended for students taking the MATHEMATICS curriculum of the three-year Mathematics degree who are interested in acquiring Chemistry ECTS for the teaching of secondary school Mathematics and Sciences.

*Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.*