UNICUSANO ROME

Code: **CHIM/03** **Credits: 9**
Matter: Chemistry
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
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Introduction

1. *Objective of the course:*
   The course aims to make students acquire the knowledge of the chemical foundations that characterize many of the processes with which we interface every day. The lessons and exercises are always contextualized, specifying a classic situation that more or less everyone experiences: cooking a plate of pasta, washing your hands, using a remote control to turn on any electronic device, etc.

Objectives

2. *Course Structure:*
   - The atoms
   - Chemical bonds
   - Models of the molecular form
   - Chemical nomenclature
   - Gaseous state
   - Condensed states of aggregation
   - Elements of thermodynamics
   - Physical equilibria
   - Chemical equilibria
   - Acids and bases, equilibria in solution
   - Electrochemistry

   The 11 modules (and the introductory module 0) that make up the course must be understood as connected to each other. The course can be seen as

divided into 3 macro-blocks: the first block is focused on the composition of the atom and on the models to describe the shape of the molecules; the second block considers the interactions between species, whether these atoms or molecules, the condensed phases and the introduction of thermodynamics; the last block is focused on the concept of chemical equilibrium applied to the reactions of acids and bases, dissolution of salts and batteries. The presence of E-tivity associated with the various modules (or macro-blocks) will guide the student to develop the skills necessary to obtain basic information related to generic chemical phenomena.

Competencies:

A. Knowledge and understanding.

At the end of the course, the student will be able to understand the properties of the main chemical species with which he is in contact every day. The student will be able to understand the operating principles, the measurable quantities, the potentials and the limits of the main observable chemical-physical processes.

B. Applying knowledge and understanding.

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

C. Communication skills.

The student will be able to use a correct and understandable technical language that allows to clearly express 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: The atoms

Weight laws (Lavoisier, Proust, Dalton); evolution of atomic models; principles of quantum mechanics (quanta, photons, "wave-particle" dualism, De Broglie relation, uncertainty principle, wave functions); quantum numbers; atomic orbitals; electronic configuration (Pauli exclusion principle, Aufbau principle, Hund rule); definitions (atomic mass, isotopes, Avogadro's number, mole); periodic system and properties of the elements

Subject 2: Chemical bonds

Ionic bonds; covalent bonds (Lewis structures, resonance); octet rule (doublet); strength and length of covalent bonds; metallic bonds (hints).

Subject 3: Models of the molecular form

VSEPR model; valence bond model (σ, π orbitals, hybridization); LCAO method (H2 molecule).

Subject 4: Chemical nomenclature

Valence; oxidation number; traditional and official nomenclature (IUPAC); nomenclature of binary and ternary compounds.

Subject 5: Gaseous state

Gas observation; pressure; empirical laws of the gaseous state; equation of state of ideal gases; gaseous mixtures (partial pressures and volumes); real gases (hints).

Subject 6: Condensed states of aggregation

Intermolecular forces (ion-dipole, dipole-dipole, London dispersion, van der Waals, hydrogen bond); viscosity; surface tension; structures of solids (metallic, ionic, molecular); examples in kind.

Subject 7: Elements of thermodynamics

Intermolecular forces (ion-dipole, dipole-dipole, London dispersion, van der Waals, hydrogen bond); viscosity; surface tension; structures of solids (metallic, ionic, molecular); examples in kind.

Subject 8: Physical equilibria

Phases and state transitions (vapor pressure, boiling, Clausius-Clapeyron equation); state diagram (water, triple point); solubility (temperature, enthalpy, free energy); colligative properties (molality, vapor pressure lowering, cryoscopic lowering, ebullioscopic raising).

Subject 9: Chemical equilibria

Equilibrium (reversibility of a reaction, law of mass action, equilibrium constants); degree of progress of a reaction; direction of development; equilibrium shift (addition / subtraction of reagents, pressure, temperature)

Subject 10: Acids and bases, equilibria in solution

Definitions (Arrhenius, BrØnsted-Lowry, Lewis); acid-base reactions; constants of acidity and basicity; pH scale; tampons; water self-protolysis; titrations (strong acid-strong base, strong acid / base / weak acid, weak acid-weak base); indicators; solubility product.

Subject 11: Electrochemistry

Redox reactions; standard reduction potential (E °); galvanic cells (Daniell battery, battery construction); Nernst equation; electrolysis (Faraday's laws, applications).

E-tivity 1: Select any element from the periodic table and configure its electrons in the various orbitals. Subsequently, with the same element, constitute a molecule by defining the bonds that characterize it, define the oxidation number of the element (in that specific molecule) and define the nomenclature associated with the molecule under consideration.

E-tivity 2: Choose any compound, describe its state of aggregation and the molecular interactions present. Describe which compound is related and which is not related to the chosen compound, explaining why. Also, find a reaction in which the chosen compound is involved, whose enthalpy and entropy values are known (they can be found on the web or in textbooks), and describe the reaction from a thermodynamic point of view.

E-tivity 3: Describe an equilibrium reaction chosen between acid / base, dissolution of a salt, oxide / reduction. Specify all the boundary conditions (e.g. if you choose a dissolution equilibrium of a poorly soluble salt, in addition to calculating the solubility of the salt, you need to consider strategies to increase and decrease the solubility, justifying accurately).

Students who have to take the General Chemistry exam with a reduced number of CFUs, as they are partially recognized at the time of enrollment (so-called additions), are asked to contact me on the platform and send me the program of the exam already taken, so that I can evaluate the modules for taking the exam in a reduced form.

Evaluation system and criteria

The exam usually consists in carrying out a written test aimed at ascertaining the ability to analyze and rework the concepts acquired. The performance of the 3 Etivities can be assessed up to a total of 2 points (overall for the 3 Etivities): the assessment depends on the originality and accuracy with which the activities in question are carried out.
The written test includes 1 theory question and 4 numerical exercises to be performed in 90 minutes. Each of the 5 questions has a score of 6 points, for a total of 30 points. The assignment of honors depends on the method of explanation of the theoretical concepts and the method of resolution within each individual exam. The topics of the theory questions and numerical exercises can cover all the modules of the course. Only a calculator is allowed to take the exams (it is not allowed to use the calculator as an application in mobile phones and / or other electronic devices, eg tablets, PCs). The exams solved by the teacher, assigned in the previous sessions, are uploaded to the platform.

Bibliography and resources

4. *Materials to consult:*
   Notes written by the instructor

5. *Recommended bibliography:*

Suggested readings are:

Theory

i. Slide of the teacher
ii. P. Silvestroni, "Fondamenti di Chimica", Ed. Veschi
iii. P. Atkins, L. Jones, "Principi di Chimica", Ed.Zanichelli
iv. Brain B. Laird, "Chimica generale", Ed. McGraw-Hill

Exercises

i. Exercises of the teacher
ii. F. Cacace, M. Schiavello, "Stechiometria", Ed. Bulzon