



# UNIVERSITÀ DEGLI STUDI DI PALERMO

|                              |   |             |                  |
|------------------------------|---|-------------|------------------|
| DEPARTMENT                   | Scienze della Terra e del Mare  |             |                  |
| ACADEMIC YEAR                | 2023/2024   |             |                  |
| BACHELOR'S DEGREE (BSC)      | NATURAL AND ENVIRONMENTAL SCIENCES  |             |                  |
| SUBJECT                      | PRINCIPLES OF CHEMISTRY FOR NATURE AND ENVIRONMENT                                |             |                  |
| TYPE OF EDUCATIONAL ACTIVITY | B   |             |                  |
| AMBIT                        | 50172-Discipline agrarie, chimiche, fisiche, giuridiche, economiche e di contesto |             |                  |
| CODE                         | 19286   |             |                  |
| SCIENTIFIC SECTOR(S)         | CHIM/12   |             |                  |
| HEAD PROFESSOR(S)            | MACCOTTA ANTONELLA  | Ricercatore | Univ. di PALERMO |
| OTHER PROFESSOR(S)           |   |             |                  |
| CREDITS                      | 6   |             |                  |
| INDIVIDUAL STUDY (Hrs)       | 98  |             |                  |
| COURSE ACTIVITY (Hrs)        | 52  |             |                  |
| PROPAEDEUTICAL SUBJECTS      |   |             |                  |
| MUTUALIZATION                |   |             |                  |
| YEAR                         | 1   |             |                  |
| TERM (SEMESTER)              | 2° semester   |             |                  |
| ATTENDANCE                   | Not mandatory   |             |                  |
| EVALUATION                   | Out of 30   |             |                  |
| TEACHER OFFICE HOURS         | MACCOTTA ANTONELLA<br>Tuesday 13:30 15:30 Via Archirafi, 20 - V piano             |             |                  |

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| <b>PREREQUISITES</b>          | Entering student is expected to have a working knowledge of high school maths, in particular: algebra, logarithms, and scientific notation.   |
| <b>LEARNING OUTCOMES</b>      | <p>Knowledge and understanding:<br/>The successful student in this course will demonstrate mastery of basic chemical concepts: atomic structure of matter, electronic structure and periodic table, chemical bond, molecular shapes, intermolecular forces, states of matter, phase diagrams, chemical reactions and stoichiometry, chemical equilibrium and kinetics, thermodynamics, acid/base and precipitation equilibria, electrochemistry.</p> <p>Applying knowledge and understanding:<br/>The successful student will be able to: interpret and illustrate the chemical behavior of the molecules based on the nature of the present chemical bond and the molecular shape, predict the course of a reaction and the conditions that make it more favorable according to the principles of thermodynamics, solve problems relative to chemical reactions (acid-base, solubility, redox), analyze phase diagrams, recognize the principal chemical reactions in environmental field.</p> <p>Making judgments:<br/>The student will be able to interpret and use data from text or other scientific sources, also presented through drawings, patterns, diagrams, tabulates. It will also be able to read and critically evaluate journal papers in the chemical field.</p> <p>Communication skills:<br/>The student should be able to communicate and express basic chemistry issues both in oral and written form demonstrating mastery of language, accessible to an unknowable public.</p> <p>Learning skills:<br/>The student will acquire the ability to schematize and rework the obtained knowledge. This will enable him/her to apply these concepts autonomously and critically to the natural and environmental sciences.</p>  |
| <b>ASSESSMENT METHODS</b>     | <p>A midterm test, consisting of some exercises, takes place for an evaluation of student's learning. This test does not contribute to the final result. The final exam consists of a written and an oral test. The written test lasts up to two and half hours and consists of six exercises to verify the ability to solve chemistry problems. Consulting textbooks or notes is not permitted. Each exercise will be marked with a grade between 0 (missing or completely wrong answer) and 5 (correct answer). To pass the written test with a grade of 15/30 at least is a prerequisite for the admission to the oral test that aims for a further verification of the knowledge gained and for the evaluation of the student's exhibiting and processing skills. Access to this final test does not guarantee passing the exam.</p> <p>The final examination aims at assessing whether the student has knowledge and understanding of the subjects, has acquired interpretative competence and autonomy in judging concrete cases.</p> <p>The threshold of sufficiency will be achieved when the student shows the knowledge and understanding of the topics at least in the general guidelines and has minimal application skills; he/she must equally have exhibits and arguments that enable him to convey his/her knowledge to the examiner. Below this threshold, the examination will be insufficient. Instead, the student manages to interact with the examiner with his/her argumentative and exhibition skills, and the more his/her knowledge and application skills go into detail of the discipline being tested, the more the evaluation will be positive. The final exam score will be done in thirtieth.</p> <p>Excellent (30-30 cum laude). Excellent knowledge of the topics, excellent language skills, good analytical skills, the student is able to apply the knowledge to solve the proposed problems.</p> <p>Very good (26-29). Good mastery of the topics, full property of language. The student is able to apply his/her knowledge to solve proposed problems.</p> <p>Good (24-25). The student reached a basic knowledge of the main topics, discrete properties of language, with limited ability to independently apply the his/her knowledge to the solution of the proposed problems.</p> <p>Satisfactory (21-23). The student does not have full mastery of the main topics of teaching, but it possesses the knowledge, satisfactory property language, poor ability to independently apply the acquired knowledge.</p> <p>Sufficient (18-20). The student has a minimum basic knowledge of the main topics and technical language issues, very little or no ability to independently apply the acquired knowledge.</p> <p>Insufficient - The student does not have an acceptable knowledge of the contents of the topics covered in the course.</p> |
| <b>EDUCATIONAL OBJECTIVES</b> | The course aims to provide the student with the tools to understand the chemical transformations occurring in nature and in the different environmental compartments. He must know the basic principles relative to: atomic structure of matter, chemical bond, chemical reactions, kinetics and chemical balance, intermolecular forces.   |

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| <b>TEACHING METHODS</b>       | Frontal lessons and exercises  |
| <b>SUGGESTED BIBLIOGRAPHY</b> | <p>Viaggio nella Chimica<br/>           Autori: A. Credi, A. Del Zotto, A. Gasparotto, F. Marchetti, D. Zuccaccia<br/>           Casa editrice: EdiSES, 2023<br/>           ISBN 978883623119<br/>           € 42,75<br/>           In alternativa:<br/>           Chimica generale<br/>           Autori: Julia Burdge, Jason Overby<br/>           Edra, seconda edizione, 2017<br/>           ISBN-10: 8821446999<br/>           ISBN-13: 978-8821446993<br/>           oppure<br/>           Fondamenti di chimica generale<br/>           Autori: Peter Atkins, Loretta Jones<br/>           Zanichelli, 2014<br/>           ISBN: 9788808636140<br/>           oppure<br/>           Chimica: materia, tecnologia, ambiente<br/>           Autori: Ivano Bertini, Claudio Luchinat, Fabrizio Mani<br/>           Casa Editrice Ambrosiana, prima edizione, 2016<br/>           ISBN-10: 8808182738,<br/>           ISBN-13: 978-8808182739<br/>           oppure<br/>           Chimica. Principi e reazioni<br/>           Autori: William L. Masterton, Cecile N. Hurley<br/>           Piccin, sesta edizione, 2010<br/>           ISBN: 978-8829920419</p> |

### SYLLABUS

| Hrs | Frontal teaching  |
|-----|---|
| 5   | Introduction to the course – The components of matter: elements, compounds, mixtures - Natural and artificial elements - Formulas - Nomenclature - The atom: atomic number, mass number, isotopes - Mole and molar mass.  |
| 4   | Electronic model of the atom - The wave-particle duality - Electromagnetic radiation - Quantization of energy and spectrum of atomic hydrogen – Electronic model of hydrogen atom, atomic numbers and atomic orbitals - Electronic configuration of polyelectronic atoms - Periodic table and periodic properties: ionization energy, electronic affinity, electronegativity, atomic sizes - Metals and non-metals. |
| 6   | The chemical bond: covalent bond, structural formulas, diatomic molecules, polyatomic molecules and molecular geometries, hybrid orbitals, resonance. Ionic bond, geometry of ionic compounds - Metallic bond: band model.  |
| 1   | Intermolecular forces - van der Waals forces - Hydrogen bonding – Aggregation states.   |
| 4   | Solid, gas, liquid state.   |
| 2   | Thermodynamics - Transitions and phase diagrams for one-component systems.  |
| 3   | Multicomponent systems - Solutions: gas solubility, colligative properties, electrical properties - Phase diagrams for binary systems - Solid solutions.  |
| 2   | Chemical reactions and stoichiometry: meaning of formulas, oxidation number, balance of chemical reactions (acid-base, precipitation and redox).  |
| 1   | Equilibrium and thermodynamics of gas-phase reactions.  |
| 4   | Acid-base equilibria: Brønsted-Lowry model, application of acid-base equilibria, Lewis acid-base - Solubility equilibria: solubility product, factors affecting solubility.   |
| 4   | Electrochemistry: redox reactions, voltaic cells, electrode potential, chemical equilibrium in electrochemical systems, concentration cells, electrochemical reactions relative to metals, prediction of the products of a reaction from potential standards, electrolysis, conductivity.   |
| 2   | Chemistry in the environment: molecules and reactions   |
| 2   | Outlines of spectroscopy and applications: greenhouse effect and ozone hole.  |
| Hrs | Practice  |
| 1   | Calculation of empirical and molecular formulas - Calculation of percent composition of compounds and calculation of moles.   |
| 1   | Balancing of reactions.   |
| 2   | Structure of molecules using Lewis, hybridization and VSEPR models.   |
| 2   | Calculation of concentrations, preparation of solutions of known concentration by weighing and by dilution.   |
| 1   | Applications of colligative properties  |
| 3   | Chemical equilibrium - pH of acids and bases (strong and weak) - Hydrolysis - Buffer solutions - Titration curves   |
| 1   | Solubility equilibria.  |
| 1   | Determination of the electromotive force of a cell.   |