# . - General Chemistry and Physical Chemistry

## Prof. Lucrezia Lamastra; Prof. Terenzio Bertuzzi

***Text under revision. Not yet approved by academic staff.***

# General Chemistry Module

## Prof. Lucrezia Lamastra

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The course aims to provide the tools for knowing and understanding the structure of matter, its possible chemical and chemical-physical transformations, and the principles that govern its behaviour, with particular reference to chemical systems.

At the end of the course, students will be able to carry out in full autonomy theoretical and practical exercises related to the topics covered, and will be able to analyse and explain the chemical phenomena faced, demonstrating an ability to apply knowledge and understanding.

The aim of the course is to equip students with a simple language for expressing the evolution of a practical event clearly and with the necessary scientific rigour, and linking it to its relative theoretical concept.

In particular, at the end of the course students will possess the following knowledge and ability to understand:

* Basic knowledge of chemistry: main aspects of chemical terminology, nomenclature, conventions and units of measurement;
* Chemical reactions and their main characteristics;
* Structural characteristics of the elements and their compounds, including stereochemistry;
* Characteristics of the different states of matter;
* Chemical equilibria in an aqueous solution.

Furthermore, students will have developed the following skills:

* To interpret and evaluate data, perform laboratory procedures according to the indications provided and conduct simple experiments, solve problems and exercises related to the theoretical aspects covered in the course;
* To possess the ability to present their knowledge in a clear and orderly manner, with appropriate scientific language and using rigorous arguments;
* To work in small groups independently.

COURSE CONTENT

|  |  |
| --- | --- |
|  | ECTS |
| Concepts of chemistry |  |
| Inorganic compounds. Moles. Precipitation, acid-base and oxidation-reduction reactions. Stoichiometry. | 1.5 |
| Structure of the atom and molecules |  |
| Atomic orbitals. Electronic configuration of atoms. Atomic properties and the periodic table. | 1 |
| Bonds and molecular structure. Geometry and polarity of molecules. Valence bond (VB) and molecular orbital (MO) theories. | 0.5 |
| States of matter |  |
| Ideal gas law. Partial pressures. Solubility of gases. Diffusion and effusion. Intermolecular forces. Properties of liquids.  Changes of phase. Phase diagrams. | 1.0 |
| Chemical equilibria |  |
| The equilibrium constant. Le Chatelier's principle. Acids and bases according to Brønsted-Lowry. Water ionisation and the pH scale. Lewis acids and bases. | 1 |
| The pH of saline solutions. Buffer solutions. Titrations. Solubility. Colligative properties. | 0.75 |
| Introduction to thermodynamics |  |
| Fundamental principles of energy. Changes of State. The first law of thermodynamics. Enthalpy calculations. | 0.25 |
| Tutorials | 1.0 |

READING LIST

Kotz-Treichel-Townsend*, Chimica,* 7th ed., EdiSES, Naples, 2021.

BROWN, LEMAY, BURSTEN, MURPHY, WOODWARD, STOLTZFUS, *Fondamenti di chimica*, 4th ed., Edises, Naples, 2018.

Slides and other materials available on Blackboard.

***Recommended Reading***:

Periodic table of elements.

TEACHING METHOD

The course is run over the first four months. The teaching methods include:

1. Lectures accompanied by application examples, which present the theoretical principles and the methods for solving and calculating exercises and problems (48 hours; 6 ECTS). Lectures will be held with the aid of slides and/or Blackboard.
2. Frontal tutorials in class during which exercises and problems are carried out using the methods presented in lectures (6 hours; 0.5 ECTS) and tutorials.
3. Laboratory tutorials carried out in groups of 2-3 students, in which practical activities related to the theoretical aspects dealt with during the lectures are proposed. Specifically, tutorials on reactions in aqueous solutions, stoichiometry of reactions and titrations (6 hours; 0.5 ECTS) will be conducted.
4. Support lectures, during which the topics covered in class and in the practical and laboratory tutorials (28 h) will be dealt with in an accurate, detailed and simplified manner.

ASSESSMENT METHOD AND CRITERIA

STUDENTS ATTENDING LECTURES

The assessment includes two interim learning assessments, particularly feasible for those attending on an ongoing basis and useful for periodically assessing how students are progressing. The interim assessments are multiple choice written tests and will contain 30 questions of the same weight. The questions will be both practical exercises and theoretical questions, and will focus on selected parts of the course programme. The duration of each interim assessment is 1 hour. The results of the written tests will be delivered through Blackboard. Those who achieve results above 15/30 for the formative assessments, may take the oral exam on the entire course programme. The overall result will be based on the weighted average of the three tests (2 interim written tests and the oral exam), with each of the tests being assigned an equal mark.

STUDENTS NOT ATTENDING LECTURES

The assessment includes a preliminary written test of 1 hour. The test will focus on all the topics covered in the course and will contain 30 practical and theoretical questions, each carrying the same mark. Those who pass the written test with a mark of at least 18/30, may take the oral exam on the entire course programme. The overall result will be based on the arithmetic average of the two tests.

NOTES AND PREREQUISITES

In September an 8-hour course will be held, with compulsory attendance. The aim of the course is to revise the basic concepts and skills needed to take the course.

Should the health situation relating to the Covid-19 pandemic not allow face-to-face teaching, remote teaching in synchronous or asynchronous mode will be guaranteed; this will be communicated in good time to students.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.

# Physical Chemistry Module

## Prof. Terenzio Bertuzzi

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The course aims to provide the tools for knowledge and understanding of the thermodynamic and kinetic aspects of chemical and chemical-physical transformations and the principles that govern their behaviour, with particular reference to chemical systems.

At the end of the course, students will possess the following knowledge and understanding:

* Basic knowledge of the electrochemical, thermodynamic and kinetic principles of chemical and physical reactions;
* Energy and entropic factors of chemical reactions;
* Aspects that affect the spontaneity and speed of reactions;
* Ability to carry out in full autonomy theoretical and practical exercises related to the topics covered.

Furthermore, students will have developed the following skills:

* To evaluate the principles of thermodynamics and their main applications;
* To know the principles of electrochemical reactions and their main uses;
* To evaluate the laws of reaction kinetics and their mechanisms.

COURSE CONTENT

|  |  |
| --- | --- |
|  | ECTS |
| Thermodynamics |  |
| First law of thermodynamics. Enthalpy. Thermal capacity and calorimetry. Entropy. Boltzmann's equation. Second law of thermodynamics. Gibbs free energy. | 1.0 |
| Chemical kinetics |  |
| Chemical reaction rate. Reaction order and integrated kinetic equations. Collision theory. Transition state and reaction mechanism. The Arrhenius equation. Catalysers. | 1.0 |
| Electrochemistry |  |
| Electrochemical potential. Voltaic cells and electrode potential. The Nernst equation. | 0.5 |
| Tutorials | 0.5 |

READING LIST

Atkins, de Paula, Elementi di Chimica Fisica, 4th ed., 2018.

Whitten, Davis, Peck, Stanley, Chimica, Piccin, 10th ed., 2015.

Kotz-Treichel-Townsend, Chimica, EdiSES, Naples, 5th ed., 2013.

TEACHING METHOD

The course is run over the second four-month period. The teaching methods include:

Lectures accompanied by application examples, which present the theoretical principles and the methods for solving and calculating exercises and problems (20 hours; 2.5 ECTS). Frontal lectures will be conducted with the support of PDF presentations. The presentations in PDF used during the course will be made available to students on the Blackboard platform.

Laboratory tutorials carried out in groups of 2-3 students, in which practical activities related to the theoretical aspects dealt with in lectures are proposed. In particular, exercises will be carried out on thermodynamics and kinetics (6 hours; 0.5 credits).

ASSESSMENT METHOD AND CRITERIA

For the Physical Chemistry module, there will be a single final written or oral test, of the student's choice. The written test will focus on 6 theory questions of equal weight and 2 exercises.

For those students who pass all the tests, the exam will be based on a brief discussion of the topics covered in the tests passed. The final mark will be the weighted average (based on the number of hours) of the marks obtained for the General Chemistry module and the Physical Chemistry module. For students who did not take or failed to pass the interim written tests, the oral exam will focus on the entire course programme with exercises to be solved in written form.

At the end of each module, at least one date is set aside for students to retake the tests.

NOTES AND PREREQUISITES

The course includes a cycle of laboratory tutorials at which attendance will be checked. Prior to these tutorials, students will have to take a short course, scheduled during the General Chemistry module, on the safety regulations to be observed.

Before taking the Physical Chemistry test, students must pass the General Chemistry module.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.