# . . - General Chemistry and Physical Chemistry

## Prof. Gabriele Rocchetti, Prof. Terenzio Bertuzzi

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

# General Chemistry Module

## Prof. Gabriele Rocchetti

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The course aims to teach students the structure of matter, its possible chemical and chemical-physical transformations and the principles that govern its behaviour; the course will also include the solving of stoichiometry exercises covering the concepts addressed.

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 competences:

* 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;
* 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 |
| Structure of the atom and molecules |  |
| Atomic theory and quantitative laws; atomic and orbital models  Atomic structure and chemical characteristics. Parameters of a wave and electromagnetic spectrum. Absorption and emission spectra. | 1.0 |
| The chemical bond. Covalent, ionic and dative bonds. Electronegativity. Valence bond (VB) and molecular orbital (MO) theories. Intermolecular bonds. | 1.0 |
| Compounds, nomenclature and stoichiometric coefficients. Moles. Acid-base, oxidation-reduction and precipitation reactions. Stoichiometry. | 1.0 |
| Chemical reactions |  |
| Chemical equilibrium: equilibrium constant and Le Chatelier's principle. Ionic dissociation equilibrium: ionic product of water. pH. Acid and base behaviour and dissociation constant. Indicators. Hydrolysis. Buffer solutions. Handerson-Hasselbach equation. Solubility balance. Acid-base titration curves. | 1.5 |
| States of matter |  |
| Gaseous state: gas law, perfect gas equation. Dalton's law.  Liquid state: diffusion, vapour pressure, boiling. State diagram. Solutions. Raoult's law and azeotropes. Colligative properties. | 1.5 |
| Classroom practical activities | 0.5 |
| Laboratory practical activities | 0.5 |

READING LIST

Whitten, Davis, Peck, Stanley, *Chimica*, Piccin, 10th Ed, 2014.

Atkins, Jones, Lavermann, *Principi di chimica,* Zanichelli, 4th Ed, 2018.

Other recommended teaching materials: Periodic table of the elements.

TEACHING METHOD

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

1. Theoretical 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 the blackboard.
2. Frontal practical activities in class during which exercises and problems are carried out using the methods presented in lectures (6 hours; 0.5 ECTS) and practical activities.
3. Laboratory practical activities carried out in groups of 2-3 students, in which practical activities related to the theoretical aspects dealt with in lectures are proposed. Specifically, practical activities 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 practical activities (14 h) will be dealt with in an accurate, detailed and simplified manner.

ASSESSMENT METHOD AND CRITERIA

For the General Chemistry module, an interim test is scheduled on the program covered in the first part of the course (about 24 hours) while a second test at the end of the module will cover the contents of the second part of the course. Both tests will be based on 5-6 open questions covering the theoretical concepts addressed plus 4 stoichiometry exercises. For each test, the two parts (theory and exercises) may be addressed separately by the student. The questions will be of equal weight and marked out of thirty; the final mark of the test will be the arithmetic average of the marks obtained across all of the questions. The interim tests, lasting 2 hours, are optional and are not required to pass the exam.

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

NOTES AND PREREQUISITES

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

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 be able to autonomously carry out theoretical and practical exercises related to the topics covered, and will be able to analyse and explain the aspects addressed by demonstrating their 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.

COURSE CONTENT

|  |  |
| --- | --- |
|  | ECTS |
| Thermodynamics |  |
| Heat Capacity. Enthalpy. Entropy. Gibbs free energy. | 1.0 |
| Chemical kinetics |  |
| Chemical reaction rate. Reaction order and molecularity. Collision theory. Activated complex theory. The Arrhenius equation. Catalysis. | 1.0 |
| Electrochemistry |  |
| Electrochemical potential. Oxidation-reduction reactions. Nernst equation. | 0.5 |
| Practical activities | 0.5 |

READING LIST

Whitten, Davis, Peck, Stanley, *Chimica*, Piccin, 10th Ed, 2014.

Atkins, Jones, Lavermann, *Principi di chimica,* Zanichelli, 4th Ed, 2018.

Other recommended teaching materials: Periodic table of the elements.

TEACHING METHOD

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

1. Theoretical 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). Lectures will be held with the aid of slides and/or the blackboard.
2. Laboratory practical activities 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, at 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 practical activities, attendance of which will be registered. Prior to these practical activities, 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/.