UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Chemistry

2627-4-G8501R046-G8501R073M

Course title

Chemistry

Topics and course structure

The course presents the basic concepts of modern chemistry applied to concrete experiences in relation to the more general themes reported in the 2025 National Indications and chemistry in ecology and environmental education, also in connection with the topics of the other module of the same course.
The course aims to foster environmentally responsible behaviour by helping students understand the importance of respecting nature and encouraging them to adopt proactive practices for environmental protection in their everyday lives.
Know and understand the effects of climate change, with particular emphasis on the environment.

Objectives

With this course, and through consistent and active participation in the lessons, the following educational objectives are pursued, as outlined in the regulations and the curriculum framework:

KNOWLEDGE AND COMPREHENSION SKILLS

1. Knowledge of fundamental scientific concepts, selected based on their relevance and accessibility in the context of early childhood and primary education.
2. Knowledge of formalized languages and their use to represent and construct models of relationships between objects and events.

3. Knowledge of scientific methods for the observation, understanding, and study of natural phenomena and their interdependent relationships.
4. Knowledge of the biotic and abiotic elements of the natural environment, their mutual interaction, and their transformations, including reference to the biological, chemical, and physical environmental impact of human society on the Earth's ecosystem.
5. Basic knowledge and understanding of some chemical, physical, and biological aspects in everyday life.
6. Understanding the phenomena that characterize the relationship between humans and their environment, as well as knowledge of territorial and demographic evolutionary dynamics related to cultural and productive systems.
7. Ability to critically read historical texts, particularly by grasping the value of historical perspective and knowledge for understanding the world we live in.
8. Knowledge of the principles of education for the respect and conservation of cultural (and environmental) heritage.

APPLICATIVE SKILLS

1. The ability to communicate and work with formalized meanings and languages. The ability to use these languages to represent and construct models of relationships between objects and events.
2. The ability to apply scientific practices for studying and understanding natural phenomena: observing, experimenting, collecting data, imagining, constructing interpretive models, predicting, revising.
3. The ability to design educational activities and pathways through an interconnected vision of scientific disciplines, in order to interpret phenomena and events in a systemic manner.
4. Knowing how to use the analytical tools of mathematics and physics for the scientific description of the world and to tackle problems in everyday life.

JUDGMENT AUTONOMY

These attitudes are developed through group discussions, teaching internship activities focused on reworking educational experiences, simulation practices, critical content presentation, and activation of reflection and problem-solving based on case discussions. The assessment of judgment autonomy is conducted through specific sections of written and oral exams, as well as the final report presented at the end of each internship year. In the evaluation of the internship, thesis, and final report, consideration will be given to the future teacher's ability to independently and reflectively elaborate. Upon completion of the educational path, the graduate will possess the following attitudes:

- Ability to self-assess their professional preparation and the effectiveness of their teaching practice.
- Willingness to renew teaching practices through openness to research, experimentation, and innovation.

COMMUNICATIVE SKILLS

The acquisition of these learning outcomes is supported by transversal paths throughout all formative activities. The assessment of these results, which may include the presentation of written papers, oral presentations, projects, and educational products, is conducted through basic and specialized training activities, laboratory and internship pathways, and within the context of understanding texts and lectures in English. Upon completion of the educational path, the graduate will possess the following skills:

- Verbal and non-verbal ability to modulate classroom communication for different purposes: to present, prepare experiences, explain concepts and theories, motivate learning, support students in difficulty, and stimulate peer interaction.
- Ability to present the objectives and nature of the teaching intervention in an organized manner, through educational and didactic planning.

LEARNING ABILITIES

The acquisition of these learning outcomes is pursued through all formative activities that allow for independent research by the student and free access to useful information for developing a cultural attitude aimed at self-formation. The monitoring and assessment of these results occurs through various types of ongoing assessments throughout the different educational activities. Upon completion of the educational path, the graduate will have

developed the following attitudes and approaches in terms of learning abilities, in the perspective of lifelong learning:

- Interest in the teaching profession and the desire to improve its knowledge and practice.
- Willingness to expand basic psycho-pedagogical and methodological-didactic culture, also in relation to advancements in scientific research.
- Motivation to deepen the content and study methods of school knowledge, with ongoing updates to disciplinary repertoires.
- Openness to exploring perspectives of educational, methodological, technological, and media research conducted both nationally and internationally, with a focus on pedagogy and special education.
- Ability to self-sustain and self-regulate learning through independent bibliographic research and active participation in professional development and training opportunities.

Methodologies

a) 14 two-hour lectures, in person, Delivered Didactics

b) Type: lectures

Online and offline teaching materials

Languace of lectures: italian
Books
Additional material discussed in class
Slides shown in class
Use of websites for further information

Students who wish to spread the exam over two years must agree with the instructor on a new, updated bibliography to take the exam.

The teacher provides the following additional and alternative materials to support non-traditional students in their study and exam preparation:

- Full recording of in-person lectures;
- Copy of the slides containing material not included in the mandatory textbooks.

For **Erasmus students**, any chemistry textbook in English at the high school level, as well as texts in other languages related to the topics covered by the program and mandatory books, may be used (to be brought on the day of the exam).

Programme and references

Indicatively, the lesson blocks will follow this scheme:

First part (18-20 hours)

- Chemistry as a bridge between different scientific disciplines
- The macroscopic and microscopic worlds
- Measurements and physical quantities
- Substances and mixtures and their properties
- States of matter and changes of state
- Chemical transformations (at the phenomenological and macroscopic levels)
- From chemical transformations to atomic theory; the periodic table of the elements
- The kinetic molecular theory
- The mole concept
- The atom: particles and structure
- The chemistry of water and chemical bonding

Second part (4-6 hours)

- the evolution of chemical thought in history: the great discoveries and the great chemists of the past

Third part (4-6 hours)

- chemistry in the ecological transition to accelerate the energy transition towards complete climate neutrality and sustainable development with respect for resources and people, mitigate the effects of climate change and move to an energy system with lower greenhouse gas emissions and production and more sustainable energy consumption
- green chemistry and use of reagents and solvents that respect humans and the environment

The course is structured in frontal lessons.

Mandatory bibliography (an integral part of the examination syllabus)

1. Giuseppe Valitutti, Patriza Amadio, Marco Falasca, "Chimica. Concetti e modelli. Dalla materia all'elettrochimica. Terza Edizione, Zanichelli, 2023.
2. Alessandro Abbotto, "Il genio quotidiano. Raccolta di racconti del quotidiano di grandi scienziati chimici e delle loro scoperte, Edises, 2023.
3. Alessandro Abbotto, Vito Capriati, “La nuova chimica del XXI secolo. Rivoluzione verde e transizione ecologica”, Edizioni Dedalo, 2023.
4. Alessandro Abbotto, "Il labirinto delle molecole", romanzo per alunni della scuola primaria, Scienza Express, 2026

Other recommended bibliography (non mandatory for exam preparation):
5) Alessandro Abbotto," Idrogeno. Tutti i colori dell’energia”, Edizioni Dedalo, 2021.
6) Primo Levi, “Il sistema periodico”, edizione per le scuole, a cura di Roberta Mori, Maria Vittoria Barbarulo, Einaudi Scuola, 2022 (ISBN 8828625678)
7) Vincenzo Balzani, Margherita Venturi, “Chimica!”, Scienza Express
8) Sara Moraca, Elisa Palazzi, "Siamo tutti Greta", Edizioni Dedalo, 2022
9) Gianfranco Pacchioni, “W la CO2”, Il Mulino
10) Eleonora Polo, “L’isola che non c’è”, Edizioni Dedalo
11) Laura Cipolla, “I quaderni della didattica. Metodi e strumenti per l’insegnamento e l’apprendimento della chimica”, EDISES.
12) Alessandro Abbotto, "La mobilità elettrica. Storia, tecnologia, futuro", Carocci Editore, 2022.
13) Alessandro Abbotto, "Perchè l'auto elettrica", Scienza Express, 2024.
14) Alessandro Abbotto, "Ammoniaca. La molecola che può salvare. Una seconda volta", Scienza Express, 2026.
15) Testo di chimica generale a livello del primo anno di università per corsi di laurea non chimici (a lezione saranno indicati alcuni testi)

Teaching materials provided by the instructor (including lecture slides, lecture recordings, supplementary documents, and any additional materials made available through the e-learning platform) are intended

solely as study aids. Unless explicitly stated otherwise by the instructor, they do not replace the mandatory textbooks, which remain the primary reference for examination preparation.

Assessment methods

Written and Oral Examination

The examination covers the **entire course syllabus**, with particular reference to the **mandatory textbooks** listed in the previous section, **which constitute an integral and essential part of the course**.

All topics included in the mandatory textbooks may be examined, regardless of whether they have been covered in detail during the lectures.

The primary purpose of the lectures is to provide further explanations, clarifications, and examples related to the contents of the mandatory textbooks. The lectures do not, in any way, replace the need for a thorough study of the required bibliography.

Therefore, passing the examination requires knowledge of the **entire contents of the mandatory textbooks**.

The written examination consists of a **multiple-choice test** designed to assess students' knowledge of the topics included in the course syllabus. Each question presents several possible answers, **only one of which is correct**.

The number of questions and the duration of the examination may vary depending on the organization of the examination sessions, taking into account the timetable established by the Degree Programme Board, the time available between the end of the teaching module and the end of the semester, and the availability of computer laboratories. **These factors may require multiple examination sessions and, consequently, adjustments to both the duration of the examination and the number of questions.**

As a guideline, the written examination consists of **15 questions to be completed in 45 minutes**; however, these values may be adjusted to meet the organizational requirements described above.

The written examination does **not** include open-ended questions, in order to ensure rapid marking and the timely publication of results, allowing students to receive their grades in sufficient time to register for the examination sessions scheduled at the end of the teaching period (January).

The oral examination (provided that the written examination has been passed) is optional, **at the student's request (in accordance with the University's Academic Regulations)** or at the request of the instructor. The optional oral examination consists of discussing any weaknesses identified in the written examination and, where appropriate, further assessing the student's knowledge of the topics included in the course syllabus and the mandatory textbooks.

The oral examination may confirm, increase, or decrease the grade obtained in the written examination, **including resulting in failure of the examination**.

The final course grade is the average of the grades obtained in the two course modules. The grade may be officially recorded only if the final average is **18/30 or higher**.

If the student rejects the final grade or does not pass the oral examination, the **entire examination**, including the written examination, must be repeated, even if the written examination had previously been passed.

During the course, **optional mid-term written tests** are offered.

The mid-term tests held during the course are subject to additional rules, which are explained during the lectures and published on the e-learning platform.

Erasmus students may request to take the oral examination in English.

The following grading criteria are applied according to the following learning outcomes:

1. Conceptual knowledge and understanding
2. Ability to apply knowledge and understanding
3. Communication and argumentation skills
4. Learning skills, self-assessment, and self-regulation

Grade: 14–17

Knowledge and Understanding
The student demonstrates only a partial understanding of the concepts. Connections between concepts are fragmented and supported by limited theoretical knowledge.

Ability to Apply Knowledge and Understanding
The student identifies only some relevant aspects of a phenomenon and is unable to integrate them into a coherent analysis.

Communication and Argumentation Skills
During the oral examination, the student presents a basic argument lacking logical organization and characterized by numerous inaccuracies.

Learning Skills, Self-assessment, and Self-regulation
The student is able to reconstruct only some aspects of their own learning and professional development.

Grade: 18–22

Knowledge and Understanding
The student recognizes and explains most conceptual features and provides a generally coherent explanation, although with some inaccuracies. Theoretical references are present but not always used rigorously.

Ability to Apply Knowledge and Understanding
The student is able to identify a significant number of relevant aspects and provide a partial explanation, although some shortcomings remain in the analysis.

Communication and Argumentation Skills
During the oral examination, the student presents a basic argument with a minimal logical structure, although some inaccuracies remain.

Learning Skills, Self-assessment, and Self-regulation
The student demonstrates a basic awareness of their own learning process and is able to establish essential connections among learning experiences, although with some inaccuracies.

Grade: 23–27

Knowledge and Understanding
The student demonstrates a thorough understanding of the concepts. During the oral examination, explanations are well organized and supported by appropriate theoretical references.

Ability to Apply Knowledge and Understanding
The student accurately identifies the essential aspects of a phenomenon. Knowledge is applied with

methodological rigor, although not always consistently.

Communication and Argumentation Skills
During the oral examination, the student develops a coherent and well-organized argument, demonstrating good command of scientific language and solid logical reasoning. Communication is clear and effective.

Learning Skills, Self-assessment, and Self-regulation
The student analyzes their own learning process clearly and systematically, identifying meaningful connections among different stages of learning and demonstrating good critical reflection.

Grade: 28–30

Knowledge and Understanding
The student demonstrates complete mastery of the concepts, establishing complex connections and providing comprehensive explanations. Theoretical references are used appropriately and rigorously.

Ability to Apply Knowledge and Understanding
The student demonstrates an advanced ability to analyze a phenomenon, identifying and interpreting all relevant aspects thoroughly. Knowledge is applied with methodological rigor and supported by well-developed and coherent reasoning.

Communication and Argumentation Skills
During the oral examination, the student presents a well-structured and rigorous argument characterized by a high degree of logical coherence. Communication is fluent, clear, and well organized.

Learning Skills, Self-assessment, and Self-regulation
The student demonstrates advanced reflective skills by providing a thorough and well-structured analysis of their own learning and professional development. Connections between learning experiences and theoretical concepts are clear, coherent, and rigorous.

To ensure transparency in assessment, the criteria adopted and shared with students for evaluating the examination are reported below.

Written examination: proportion of questions answered correctly; grading on a **30-point scale**.

Oral examination: discussion of the questions and concepts addressed in the written examination and assessment of knowledge of related concepts; **duration: 30–60 minutes**.

The **final grade**, expressed on a **30-point scale**, takes both components into account.

Office hours

Monday-Friday 9 am - 6 pm (by appointment via email)

Programme validity

One academic year

Course tutors and assistants

Sustainable Development Goals

ZERO HUNGER | GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | GENDER EQUALITY | CLEAN WATER AND SANITATION | AFFORDABLE AND CLEAN ENERGY | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE | SUSTAINABLE CITIES AND COMMUNITIES | RESPONSIBLE CONSUMPTION AND PRODUCTION | CLIMATE ACTION | LIFE BELOW WATER | LIFE ON LAND