# COURSE DATA

| Data Subject | |
|---|---|
| **Code** | 34185 |
| **Name** | Chemistry laboratory I |
| **Cycle** | Grade |
| **ECTS Credits** | 6.0 |
| **Academic year** | 2022 - 2023 |

**Study (s)**

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 1110 - Degree in Chemistry | Faculty of Chemistry | 1 | First term |

**Subject-matter**

| Degree | Subject-matter | Character |
|---|---|---|
| 1110 - Degree in Chemistry | 1 - Chemistry | Basic Training |

**Coordination**

| Name | Department |
|---|---|
| MARTINEZ BISBAL, MARIA CARMEN | 315 - Physical Chemistry |

# SUMMARY

This subject is compulsory and of basic character, is taught in the first semester of the first year of the Degree in Chemistry, with a volume of 6 credits. Together with the "Laboratory of Chemistry II" (also obligatory of basic character, but taught in the second semester), it is intended, essentially, that the student learn the operation and the basic work techniques that will be developed in a laboratory chemical; and the preparation, recording, analysis and presentation of results of an experimental work. In this way, the essential foundations will be established so that the experiences of the different branches that make up the discipline can subsequently be successfully addressed.

In this specific subject, the security, analysis and interpretation of data necessary for the development of any chemical experience, as well as the management and treatment of data developed in any chemical laboratory will be addressed. To this end, experiments will be carried out in which different basic techniques must be used, so that later they can be applied to more complex tests.

It is assumed that students know and use, in a basic but clear way, the concepts taught in the last year of High School Chemistry. However, all the scripts include a theoretical introduction and, whenever necessary, additional teaching material will be provided to cover those deficiencies that are detected.

## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

### Other requirements

Students are expected to know and to be able to clearly apply the concepts taught on their last High School Chemistry course, albeit at a basic level. However, all scripts will include a theoretical introduction and, when required, extra teaching materials will be provided.

## COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

### 1108 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.

- Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Evaluate, interpret and synthesise chemical data and information.
- Handle chemicals safely.
- Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems.
- Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.
- Evaluate the risks in the use of chemicals and laboratory procedures.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

## LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the subject Chemistry Laboratory I that allow to acquire both specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Chemistry Laboratory I related to the competences of the degree in Chemistry.

| **SPECIFIC KNOWLEDGE OF CHEMISTRY** | |
|---|---|
| **The learning process should allow the degree graduates to demonstrate:** | |
| | **Competences of the subject Chemistry Laboratory I that contemplate the learning outcomes EUROBACHELOR®** |
| Major aspects of chemical terminology, nomenclature, conventions and units. | Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units..(CE1) |
| The major types of chemical reaction and the main characteristics associated with them. | Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4) |
| The principles and procedures used in chemical analysis and the characterisation of chemical compounds. | Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8)<br><br>Show knowledge of the metrology of chemical processes including quality management..(CE10)<br><br>Handle the instrumentation used in the different areas of chemistry.(CE19).<br><br>Understand the qualitative and quantitative aspects of chemical problems..(CE24).<br><br>Develop sustainable and environmentally friendly methods.(CE25) |
| The characteristics of the different states of matter and the theories used to describe them. | Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them..(CE3). |

| HABILITIES AND COGNITIVE COMPETENCES | |
|---|---|
| **The learning process should allow the degree graduates to demonstrate:** | |
| | **Competences of the subject Chemistry Laboratory I that contemplate the learning outcomes EUROBACHELOR®** |
| Ability to recognize and implement science and the practice of measurement. | **C1:** Demonstrate that you know the metrology of chemical processes including quality management. (CE10)<br><br>**C2:** Interpret the data from observations and measurements in the laboratory in terms of its significance and the theories that support it (CE20) |
| Ability to calculate and process data, related to information and chemistry data. | **C1:** Solve qualitative and quantitative problems according to previously developed models (CE14).<br><br>**C2:** Recognize and analyse new problems and plan strategies to solve them (CE15). |

| COMPETENCES AND SKILLS RELATED TO THE PRACTICE OF CHEMISTRY | |
|---|---|
| **The learning process should allow the degree graduates to demonstrate:** | |
| | **Competences of the subject Chemistry Laboratory I that contemplate the learning outcomes EUROBACHELOR®** |
| Capacities to handle chemical products safely, taking into account their physical and chemical properties, including any risk associated with their use. | Handle chemicals safely..(CE17).<br><br>Evaluate the risks in the use of chemicals and laboratory procedures..(CE21). |

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| Capabilities necessary to perform standard laboratory procedures as well as to use instrumentation in synthetic and analytical works, in both cases in relation to both organic and inorganic systems. | Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems..(CE18).<br><br>Relate theory and experimentation..(CE22).<br><br>Understand the qualitative and quantitative aspects of chemical problems..(CE24). |
| Capacities to monitor, observe and measure the chemical properties, facts or changes, and perform their registration (collection) and documentation in a systematic and reliable way. | Handle the instrumentation used in the different areas of chemistry.(CE19).<br><br>Relate theory and experimentation..(CE22).<br><br>Recognise and evaluate chemical processes in daily life..(CE23).<br><br>Understand the qualitative and quantitative aspects of chemical problems..(CE24). |
| Ability to interpret data derived from observations and laboratory measurements in terms of their relevance, and relate them to the appropriate theory. | Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).<br><br>Relate theory and experimentation..(CE22).<br><br>Recognise and evaluate chemical processes in daily life..(CE23).<br><br>Understand the qualitative and quantitative aspects of chemical problems..(CE24).<br><br>Relate chemistry with other disciplines.(CE26). |
| Ability to perform risk assessments of the use of chemical substances and laboratory procedures. | Understand the qualitative and quantitative aspects of chemical problems..(CE24).<br><br>Develop sustainable and environmentally friendly methods.(CE25).<br><br>Evaluate the risks in the use of chemicals and laboratory procedures..(CE21). |
| **GENERAL COMPETENCES** | |

| The learning process should allow the degree graduates to demonstrate: | |
|---|---|
| | **Competences of the subject Chemistry Laboratory I that contemplate the learning outcomes EUROBACHELOR®** |
| Ability to apply practical knowledge to solve problems related to qualitative and quantitative information. | Solve problems effectively..(CG4).<br>Solve qualitative and quantitative problems following previously developed models..(CE14).<br>Relate theory and experimentation..(CE22).<br>Recognise and evaluate chemical processes in daily life..(CE23).<br>Understand the qualitative and quantitative aspects of chemical problems..(CE24). |
| Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units. | Develop capacity for analysis, synthesis and critical thinking.. (CG1).<br>Show inductive and deductive reasoning ability..(CG2).<br>Solve problems effectively..CG4). |
| Skills related to information technology such as word processing, spreadsheet, recording and storage of data, internet use related to the subjects. | Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6).<br>Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2). |
| Interpersonal skills to interact with other people and get involved in team work. | Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5).<br>Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7).<br>Demonstrate the ability to adapt to new situations..(CG9). |

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| Study skills necessary for professional development. These will include the ability to work autonomously. | Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3).<br><br>Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5).<br><br>Learn autonomously.(CG8).<br><br>Demonstrate the ability to adapt to new situations..(CG9).<br><br>Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.(CB5). |

At the end of the subject "Laboratory of Chemistry I", the student must be able to:

- Distinguish and recognize the most commonly used laboratory material: glass (volumetric and non-volumetric), electrical material and assemblies (heating mantle, distillation, rotary evaporator, scales, melting point apparatus, etc.).
- Know the waste minimization protocols.
- Understand and distinguish the labelling information of laboratory products, especially that referring to Safety Standards, H and P phrases, pictograms, etc.
- Use common appliances such as the Bunsen burner or the vacuum pump.
- Distinguish between the different types of filtration, depending on the objective pursued.
- Precisely prepare a conical filter and a pleat filter.
- Separate well differentiated products according to their solubility, using processes such as decanting and choosing the right solvent.
- Handle with precision the different types of filtering, both hot and cold.
- Estimate the amount of solute that can be dissolved in a solvent depending on its solubility (obtained from the literature).
- Know the phase changes that can occur in a compound when we are in the laboratory.
- Know the safety measures to take into account in the handling and heating of flammable liquids.
- Mount a simple distillation equipment whose objective is to measure the boiling point of a liquid.
- Calculate the efficiency (yield) of the distillation process.
- Properly measure the melting point of a crystallized solid.
- Handle the melting point apparatus correctly and select the appropriate program to the necessary extent.
- Know the liquid-liquid extraction technique.
- Know what characteristics an organic solvent must possess to use it in an extraction.
- Handle with precision a separating funnel, taking into account the safety protocol.
- Know the procedure to isolate the aqueous phase and the organic phase of the extraction process.
- Know at what time and to which phase a desiccant should be added (anhydrous salt).
- Use the magnitudes and their units correctly in the laboratory processes that involve measurements or quantitative calculations.

- Estimate adequately the errors made in the measurements (absolute error, relative error, standard deviation, etc.).
- Correctly perform the hot filtration process to achieve the most perfect crystallization possible.
- Use the thin layer chromatography technique to identify a previously purified compound.
- Choose the appropriate eluent according to the polarity of the compound to be identified.
- Distinguish adequately between the functions of the stationary phase and the eluent in the thin layer chromatography technique.
- Know which are the possible eluents to use and know how to order them by their polarity.
- Accurately calculate the amount of solid or liquid necessary to prepare a solution of determined concentration.
- Accurately handle the volumetric material in the process of preparing a solution.
- Qualitatively and quantitatively determine the expected pH value for prepared solutions (both acids and solid salts).
- Accurately use the pH meter in the process of measuring the pH of a solution.
- Know the procedure of standardization of a solution and the volumetric material necessary for it.
- Manipulate properly a burette to make an assessment.
- Know what an indicator is and what are the conditions in which its use is useful: in what interval it turns and for what type of valuations it is adequate.
- Know the use of primary standards and their characteristics.
- Determine the concentration of a solution from a valuation process, calculating the errors committed, the standard deviation, etc.
- Precisely prepare solutions by dilution, from a stock solution.
- Know what it is and how a white solution is used.
- Know the use of a simple spectrophotometer for the measurement of the absorbance spectrum of a coloured solution (such as $CuSO_4$).
- Determine the analytical wavelength for a problem solution.
- Apply the Law of Lambert-Beer to relate the absorbance with the concentration of a concrete solution.
- Draw accurately the calibration line that relates the absorbance to the concentration of a solution.
- Determine, from the calibration line, the concentration of a problem solution.
- Prepare an assembly to carry out a distillation, both simple and with fractionation column.
- Apply the protocol correctly to properly separate, by distillation, two miscible liquids.
- Calculate the concentration of acid in the distilled phase of a mixture with acetic acid and acetone; and express it in different habitual units (mol / L, g / L, mole fraction).
- Analyze the necessary parameters to compare the separation of two miscible liquids by simple and fractional distillation.
- Determine the density of a mixture of two known liquids by weighing.
- Know the use of a eudiometer as a precision glass material to collect the gas generated in a reaction, and how to prepare the assembly.
- Do stoichiometric calculations applied to a reaction where there is a limiting reagent.
- Determine the molar mass of $CaCO_3$ by two methods: gravimetric and volumetric.
- Estimate the weight gain of $CaCO_3$ in a problem sample.

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to know in this subject how to apply the knowledge learned to guarantee an inclusive, equitable, and quality education and promote learning opportunities for everyone (SDG 4), to acquire a special sensitivity for sustainable management of water (SDG 6), raw materials and energy sources (SDG 7), as well as for an environmentally friendly and sustainable development (SDGs 11 , 12, 13, 14 and 15), in addition to being able to design, select and/or develop efficient chemical products, processes and/or analytical

methodologies (SDG 7) that minimize their impact on the environment (SDGs 14 and 15), using alternative raw materials and reducing wastes (SDG 11).

## DESCRIPTION OF CONTENTS

### 0. Prevention Session

Prevention and fire performance in buildings for teaching-university use.

### 1. Seminar 1

Presentation.
Management and organisation of laboratory work.
Preparation of experimental work.

### 2. Practice 1. Safety and Laboratory Material.

Safety rules. Simplified sheets of compounds. Pictograms. H and P phrases. Laboratory material (glass material, electrical material, assemblies, lighter, vacuum pump, etc.). Types of filtration. Use of the balance. Direct weighing and tare. Waste. Waste minimization program.

### 3. Practice 2. Dissolution, precipitation and crystallization.

Dissolution and solubility. Precipitation and crystallization.
Solid-liquid separations: decantation and filtration.

### 4. Practice 3. Characterisation of Liquids and Solids.

Distillation. Boiling point determination.
Melting point determination.

### 5. Seminar 2

Presentation of results.
Physical magnitudes. Units system.
Measurement and experimental error.
Accuracy and precision. Significant figures.

## 6. Practice 4. Liquid-Liquid Extraction

Separation and isolation of organic unknown compounds.
Extracting solvents.
Aqueous phase and organic phase.

## 7. Practice 5. Crystallization and identification of compounds.

Session A: Purification (crystallization) and identification of an organic acid.
Session B: Purification (crystallization) and identification of a neutral compound.
Characterisation and identification by melting point.
Thin layer chromatography.

## 8. Seminar 3

Analysis and discussion of the results of practices P2 to P5.

## 9. Practice 6. Preparation of Solutions and Measurement of pH.

Acidity, alkalinity, equilibrium and pH.
Preparing solutions of different concentrations.
Solutions from commercial products (solid salts).
Use of the pH-meter and pH measurements.

## 10. Practice 7. Acid-Base Titration.

Stoichiometry and neutralisation of acid-base reactions.
Indicators in acid-base titrations.
Use of primary and secondary standards.

## 11. Practice 8. Absorbance spectrum of solutions.

Aqueous solutions of CuSO4 by dilution.
Preparation and utility of a blank solution.
Use of the visible spectrophotometer and spectrum plot.
Absorbance measurements of cupper sulphate solutions.
Data treatment.

### 12. Practice 9. Distillation of Mixtures of Miscible Liquids

Distillation acetone-acetic acid.
Simple distillation and distillation with a fractionating column. Effectiveness of both processes.
Mixture density by weighing.

### 13. Practice 10. Stoichiometric Calculations.

Reaction between calcium carbonate and hydrochloric acid.
Molar mass determination of CaCO3.
Percentage purity of an unknown sample.
Gravimetric and volumetric methods.

### 14. Seminar 4

Analysis and discussion of the results of practices P6 to P10.

### 15. Evaluation

Final evaluation session.

## WORKLOAD

| ACTIVITY | Hours | % To be attended |
|---|---|---|
| Laboratory practices | 48,00 | 100 |
| Tutorials | 12,00 | 100 |
| Development of individual work | 20,00 | 0 |
| Study and independent work | 50,00 | 0 |
| Preparation of evaluation activities | 10,00 | 0 |
| Preparation of practical classes and problem | 10,00 | 0 |
| **TOTAL** | **150,00** | |

## TEACHING METHODOLOGY

Among the training activities described for the subject "Chemistry" in the verification report of the Degree in Chemistry, in this subject two are used: practical laboratory classes and seminars.

In the practical laboratory sessions, an overview of the basic work of a chemistry laboratory will be offered. It is intended that students acquire skills in the execution of the basic techniques of laboratory work. They should become familiar with the mechanisms of safety and management, handling of material and equipment, treatment and presentation of data, decision making and choosing the most appropriate procedure, if applicable. A standard session will consist in the initial discussion of the previous questions that each practice has (that the student must bring resolved), and that will serve as a base to introduce the

theoretical concepts on which the practice is based and to discuss the possible doubts or special precautions that they are required. The important part of the session will be the work and handling of materials and products, depending on the objectives of the practice (most of the experimental procedure must be recorded by the student in his laboratory notebook). And at the end of the session, it is convenient to share the results achieved, an interpretation of these results and a reflection on whether the proposed objectives have been achieved.

Four additional seminars have been programmed. The seminar 1 which will be carried out joined to practical session 1, and the remaining three seminars will be independent of the laboratory sessions. These seminars will serve to reinforce the learning of the subject taught in the practical sessions, either treating monographic subjects (for example, treatment of magnitudes, units and calculation of errors), either to solve or analyze doubts that have arisen in the treatment and interpretation of the results of the practices.

Due to the current situation, Seminar 1/Practice 1, which constitute a single session, will be taught in the practice laboratory, where the presentation of the subject and the most important instructions for the development of the rest of the sessions will take place. Seminars 2, 3 and 4 will be taught online.

Since it is the first laboratory that first-year students have access to, two additional activities related to waste prevention and management are planned:

- Workshop on Prevention and extinction of fires, given by the chief prevention officer of the Valencia Provincial Fire Department Consortium.

- Conference on waste treatment in the laboratories of the Faculty of Chemistry, taught by a technician of the General Chemistry Laboratory, and whose objective is to make students aware of the process of minimization and correct waste management of a laboratory of these characteristics.

## EVALUATION

Attendance at practical laboratory classes is mandatory and these sessions will be face-to-face as long as the current situation does not change, and meetings and journeys are possible. Justified absence will be allowed for a maximum of two sessions (preferably, it should be suggested to be recovered in some other subgroup).

The assessment of student learning will be formative in nature and will be carried out by addressing different aspects that are part of two blocks with well differentiated characteristics:

a) Continuous evaluation

Those aspects that require a continuous evaluation of the progress and work developed throughout the course are part of this section. For this, the following will be taken into account: active participation in the seminars, the resolution of all those questions and problems that are proposed to them to work autonomously, and of course, the management in the laboratory, the monitoring of the security rules and the laboratory notebook.

Since the work in the laboratory, the preparation work of the experience and the preparation of the notebook involves a continuous evaluation process throughout the course, the grade obtained for these three sections, in the first call, will be maintained in the second one. The sections listed below, together with the percentage of the grade, can not be recovered, if necessary, in the second call. Only in the case of the Notebook will a partial recovery of those sections corresponding to the treatment and interpretation of the results be allowed.

- Preparation of experience and work in the laboratory (20%)
- Deliverables (previous, post, results) (30%)
- Laboratory notebook (20%)

In total, this section: 70% of the final grade

b) Evaluation of specific Activities

The acquired knowledge and skills will be evaluated through an exam at the end of the course. Any questionnaire or activity carried out in the seminar sessions is also part of this section.

Evaluation of exercise/s: 30% of the final grade.

To be able to pass the subject, a grade equal to or greater than 4 points is required in each of the two blocks that make up the evaluation, and the weighted sum of both will reach 5 points.

If the day of the exam a mandatory population confinement has been established, it is planned to carry out an online test of a similar nature to the one that would be done in person but adapted to the tools of the virtual classroom, and the percentages of each evaluable part will be maintained.

In any case, the evaluation system will be governed by the provisions of the Evaluation and Qualification Regulations of the University of Valencia for Degrees and Masters

(http://www.uv.es/graus/normatives/2017_108_Reglament_avaluacio_qualificacio.pdf)

## REFERENCES

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