

**COURSE DATA****Data Subject**

<b>Code</b>	36594
<b>Name</b>	Chemistry laboratory
<b>Cycle</b>	Grade
<b>ECTS Credits</b>	7.5
<b>Academic year</b>	2023 - 2024

**Study (s)**

<b>Degree</b>	<b>Center</b>	<b>Acad. year</b>	<b>Period</b>
1929 - D.D. in Physics-Chemistry	Double Degree Program Physics and Chemistry	1	First term

**Subject-matter**

<b>Degree</b>	<b>Subject-matter</b>	<b>Character</b>
1929 - D.D. in Physics-Chemistry	1 - Primer Curso (Obligatorio)	Obligatory

**Coordination**

<b>Name</b>	<b>Department</b>
MURCIA MASCAROS, M.SONIA	320 - Inorganic Chemistry

**SUMMARY**

This course is a compulsory basic course taught in the first semester of the first year of the Double Degree in Physics and Chemistry, with a volume of 7.5 credits. In it, it is essentially intended that the student learn the operation and basic work techniques that they will develop in a chemical laboratory, and the preparation, recording, analysis and presentation of results of an experimental work. In this way, the essential foundations will be established so that you can subsequently successfully tackle the experiences of the different branches that are part of Chemistry.

In this specific subject the security, analysis and interpretation of data necessary for the development of any chemical experience will be addressed, as well as the management and treatment of data obtained in any chemical laboratory. For this, experiments will be carried out in which different basic techniques must be used, so that they can then 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

No enrollment restrictions have been specified with other subjects in the curriculum.

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.

## OUTCOMES

### 1929 - D.D. in Physics-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.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.
- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.



- 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.
- 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 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.
- 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

In the Chemistry Laboratory subject, the competences corresponding to the Chemistry Laboratory I (34185) and Chemistry Laboratory II (34186) subjects are acquired.

At the end of the Chemistry Laboratory course, the student is able to:

- Distinguish and recognize the most frequently used standard laboratory equipment: glass (volumetric and non-volumetric), electrical equipment and assemblies (heating mantle, distillation, rotary evaporator, scales, melting point apparatus, etc.).
- Know the waste minimization protocols.
- Understand and distinguish the information on the labeling of laboratory products, especially that referring to Safety Standards, H and P phrases, pictograms, etc.
- Use common devices such as the Bunsen burner or the vacuum pump.
- Distinguish between the different types of filtration, depending on the objective pursued.



- Accurately prepare a conical filter and a pleated filter.
- Separate well-differentiated products based on their solubility, using processes such as decantation and choosing the appropriate solvent.
- Accurately manipulate the different types of filtration, both hot and cold.
- Estimate the amount of solute that can be dissolved in a solvent based on its solubility (obtained from the literature).
- Know the phase changes that can be caused in a compound when we are in the laboratory.
- Know the safety measures to take into account when handling and heating flammable liquids.
- Assemble a simple distillation equipment whose objective is to measure the boiling point of a liquid.
- Calculate the efficiency (performance) of the distillation process.
- Properly measure the melting point of a crystallized solid.
- Correctly manipulate the melting point apparatus and select the appropriate program as required.
- Know the liquid-liquid extraction technique.
- Know what characteristics an organic solvent must possess to use it in an extraction.
- Handle a sloping funnel with precision, taking into account the safety protocol.
- Know the procedure to isolate the aqueous phase and the organic phase of the extraction process.
- Know when and at what stage a desiccant (anhydrous salt) should be added.
- Correctly use the quantities and their units in the laboratory processes that involve measurements or quantitative calculations.
- Adequately estimate the errors made in the measurements (absolute, relative error, standard deviation, etc.).
- Correctly carry out 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 depending on the polarity of the compound to be identified.
- Adequately distinguish 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.
- Precisely calculate the amount of solid or liquid needed to prepare a solution of a certain concentration.



- Accurately handle volumetric material in the process of preparing a solution.
- Determine qualitatively and quantitatively the expected pH value for prepared solutions (both acids and solid salts).
- Use the pH-meter accurately in the process of measuring the pH of a solution.
- Know the standardization procedure of a solution and the volumetric material necessary for it.
- Properly manipulate a burette to make an assessment.
- Know what an indicator is and what are the conditions in which its use is useful: in which interval it changes and for what type of valuations it is suitable.
- Know the use of primary patterns and their characteristics.
- Determine the concentration of a solution from a valuation process, calculating the errors made, the standard deviation, etc.
- Precisely prepare solutions by dilution, from a stock solution.
- Make stoichiometric calculations applied to a reaction where there is a limiting reagent.
- Determine the molar mass of  $\text{CaCO}_3$  by two methods: gravimetric and volumetric.
- Estimate  $\text{CaCO}_3$  richness by weight in a test sample.
- Analyze the effect of  $\text{H}^+$  ion concentration on the chromate ion-dichromate ion balance.
- Deduct and check the effect of the common ion in simple aqueous solution equilibria (acetic acid, ammonia, etc.)
- Analyze the redissolution of precipitates of metal hydroxides due to the effect of various factors (addition of an acid, formation of a complex, etc.)
- Confirm the existence of reversible and irreversible reactions.
- Analyze the influence of temperature on complex ion equilibria.
- Prepare the assembly to perform a potentiometric evaluation (burette, pH meter, etc.).
- Interpret the behavior of some metals against an HCl solution, according to their reducing power. Check the reaction products by means of specific reactions of the same.
- Obtain a metal from a solution of one of its salts making it react with another more reducing metal.
- Study the influence of some factors on redox reactions, such as pH or complex formation.
- Build galvanic cells with the appropriate mounting (electrodes, salt bridge, voltmeter, etc.) and predict the theoretical voltage that the system should give based on the reduction potentials.



- Prepare an assembly with a U-tube, to provoke an electrolysis reaction, specifically of a potassium iodide solution. Identify the products formed on the electrodes with specific reactions.
- Prepare the appropriate assembly to analyze the migration of metal ions as an example of an electrochemical process in solving environmental problems.
- Determine the hardness of a water sample by means of a complexometric evaluation, using EDTA as titrant and NET as indicator.
- Prepare the appropriate assembly to perform a softening process of a sample of problem water by exchanging the divalent Ca and Mg ions for the Na<sup>+</sup> ion.
- Carry out a process of deionization of a sample of test water, by exchanging cations for H<sup>+</sup> and anions for OH<sup>-</sup>.
- Carry out the pertinent verifications through different tests to interpret whether the softening and deionization processes have been correct (measurement of ionic conductivity, pH, or test for the presence of chlorides).
- Experimentally determine the rate constant and the order of a reaction using a photolorimetric technique.
- Use the UV-visible spectrophotometer to experimentally measure the absorbance variation of the crystal violet discoloration reaction in basic medium.
- Obtain the graph of the variation of concentration versus time in the kinetics of discoloration of crystal violet
- Calculate the partial reaction orders and the absolute speed constant in the crystal violet discoloration reaction.
- Analyze Transparent Tin-Doped Indium Oxide (ITO) Electrodes Preparation of thin layers of nano-structured semiconductors based on TiO<sub>2</sub> Insertion of a natural dye and iodine/iodide electrolyte Construction of a photovoltaic cell and determine its efficiency.
- Introduction to thin film coating methods, molecular assemblies, some basic properties of inorganic materials, elemental redox and solid state chemistry. Introduction on the interaction of physical and chemical processes involved in the absorption of light, the conduction of charge and the interaction between them.
- Acquire a special awareness for the sustainable management of raw materials and for sustainable development compatible with the environment (SDGs 11, 12, 13, 14 and 15).
- Design, select and/or develop efficient chemical products and processes (SDG 7) that minimize their impact on the environment (SDG 14 and 15), take advantage of alternative raw materials and generate less waste (SDG 11).

In addition, the student must have acquired the competences contained in the document VERIFICA relative to the subjects of the Degree in Chemistry " Chemistry Laboratory I" and " Chemistry Laboratory II".



## DESCRIPTION OF CONTENTS

### 1. Prevention Session

Fire prevention and action in teaching-university buildings.

### 2. Seminar 1: Presentation

Management and organization of laboratory work. Preparation of the experimental work. Elaboration of a laboratory report. Objectives, index and theoretical introduction. Treatment and discussion of results. Formal aspects. Presentation of tables and figures. Bibliography.

### 3. Practice 1: Safety and Laboratory Material.

Safety rules. Simplified compound worksheets. Pictograms. Phrases H and P. Laboratory equipment (glassware, electrical equipment, assemblies, lighter, vacuum pump, etc.). Types of filtration. Use of the scale. Direct weighing and tare. Waste. Waste minimization program.

### 4. Practice 2: Dissolution, precipitation and crystallization.

Dissolution and Solubility. Precipitation and Crystallization. Solid-liquid separations: decantation and filtration.

### 5. Practice 3: Characterization of liquids and solids.

Distillation. Determination of the boiling point. Melting point determination.

### 6. Practice 4: liquid-liquid extraction

Separation and isolation of unknown organic compounds. Solvents extraction. Aqueous phase and organic phase.

### 7. Practice 5: Crystallization and identification of samples.

Session A: Purification (crystallization) and identification of an organic acid.

Session B: Purification (crystallization) and identification of a neutral compound.

Characterization and identification by melting point.

Thin layer chromatography.



## 8. Seminar 2: Presentation of results.

Presentation of results.

Physical magnitudes. System of units.

Measurement and experimental error.

Accuracy and precision. Significant figures.

## 9. Practice 6: Preparation of solutions and measurement of pH.

Acidity, basicity, balance and pH. Preparation of solutions of different concentrations. Solutions from solid salts. Use of the pH-meter and pH measurements.

## 10. Practice 7: Acid-base assessment and potentiometric assessment.

Stoichiometry and neutralization of acid-base reactions Indicators in acid-base assessments. Use of primary patterns. Valuation curves. Determination of the autoprotolysis constant of water ( $K_w$ ). Determination of the acidity constant of acetic acid.

## 11. Seminar 3

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

## 12. Practice 8: Absorbance spectrum of solutions.

Aqueous solutions of  $\text{CuSO}_4$  by dilution. Preparation and utility of a white solution. Using the visible spectrophotometer and recording the spectrum. Absorbance measurements of copper sulfate solutions. Data processing.

## 13. Practice 9: Distillation of mixtures of miscible liquids.

Acetone-acetic acid distillation. Simple distillation and fractionation column. Efficiency of both processes. Density of a mixture by weighing.

## 14. Practice 10: Stoichiometric calculations.

Reaction between calcium carbonate and hydrochloric acid.

Determination of the molar mass of  $\text{CaCO}_3$ .

Richness in weight of a sample problem.

Gravimetric method and volumetric method.



#### **15. Practice 11: Chemical balance.**

Chemical reactions in the test tube. Factors that influence a chemical balance. Reversible and irreversible reactions.

#### **16. Practice 12: Determination of water hardness.**

Determination of the hardness of a water sample by complexometric titration with EDTA. Ion exchange. Softening and deionization. Ionic conductivity and pH measurements. Chloride test.

#### **17. Practice 13: Electrochemistry.**

Behavior of some metals before a solution of HCl. Influence of pH and complex formation on redox reactions. Construction of galvanic cells. Electrolysis.

#### **18. Practice 14: Photovoltaic Energy, chemical and physical aspects related to the design of efficient solar cells.**

Basic knowledge of a photovoltaic cell. Construction of an organic photovoltaic cell and determination of its efficiency.

#### **19. Practice 15: Kinetics.**

Decoloration kinetics of violet crystal. Instant speed. Experimental determination of rate constant and the reaction order. Photocolorimetric technique. Apparent rate constants and absolute constant.

#### **20. Seminar 4**

Oral presentation of the practice assigned to each student.

#### **21. Evaluation**

Final evaluation session.

**WORKLOAD**

ACTIVITY	Hours	% To be attended
Laboratory practices	60,00	100
Tutorials	15,00	100
Development of individual work	25,00	0
Study and independent work	62,50	0
Preparation of evaluation activities	12,50	0
Preparation of practical classes and problem	12,50	0
<b>TOTAL</b>	<b>187,50</b>	

**TEACHING METHODOLOGY**

In this subject, you will take part in your training activities: the practical classes of laboratories and seminars.

In the laboratory practical sessions, there will be a global vision of the basic treball of a chemistry laboratory. It is intended that the students acquire a stress in the execution of the technical techniques of the treball d'un laboratori. They must familiarize themselves with the mechanisms of security and management, handling of material and equipment, handling and presentation of data, prey for decisions and choice of the most appropriate procedure, if applicable. A standard session will consist of the initial discussion of the questions that each practice has (which the student must carry out resolutions), and which will serve as the basis for introducing the theoretical concepts on which the practice is based and discussing the possible doubts or special precautions that is required. The important part of the session will be treball and handling of materials and products, depending on the object of the practice (the main part of the experimental procedure is to be registered for the student in the seu quadern de laboratori). And at the end of the session it is convenient to find an inn in common with the results advices, an interpretation of the results and a reflection regarding whether they have advised the object proposals.

S'han programat quatre seminaris adionales i independents de les sessions de laboratori, which will serve to reinforce the aprenentatge d'aquestes, bé tractant temes monogràfics (per exemple, tractament de magnitudes, unitats i càlcul d'errors), bé per a Resoldre or analyze dubtes that make sorgit in the tractament and interpretation of the results of the practices.

As this is the first laboratory to which the first-year students accessed, there are plans for additional activities related to prevention and management of residus:

- Workshop on Prevention and extinction of fire, taught by the official prevention chapter of the Provincial Consortium of bombers of Valencia.
- Lecture on tractament of residus in the laboratories of the Faculty of Chemistry, taught by a technician of the Laboratory of General Chemistry, and the objective of which is to make students aware of the minimization process and correct management of the residus d'un laboratori d'aquestes característiques.



## EVALUATION

Attendance at practical laboratory classes is mandatory. A maximum of two sessions will be allowed excused absence (preferably, their recovery should be suggested in some other subgroup).

The evaluation of student learning will be formative in nature and will be carried out 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 of the work developed throughout the course are part of this section. For this, the following will be taken into account: the active participation in the seminars, the resolution of all those questions and problems that are proposed to them so that they work independently, and of course, the handling in the laboratory, the monitoring of the rules of security and lab notebook.

Given that the work in the laboratory, the work of preparing the experience and the preparation of the notebook implies a continuous evaluation process throughout the course, the grade obtained for these three sections, in the first call, will be maintained in the second. The sections listed below, together with the percentage of the grade, cannot be recovered, if necessary, on the second call. Only in the case of the laboratory notebook will a partial recovery of those sections that correspond to the treatment and interpretation of the results be allowed.

1. Preparation of the experience (pre-questions 10%, phase diagram 10%): 20%
2. Laboratory work: 20%
3. Laboratory notebook (post-laboratory questions 10%, results 10%): 20%

### b) Evaluation of specific activities

The knowledge and skills acquired will be evaluated through tests throughout the course and / or an exam common to all subgroups of the subject that will be carried out at the end of the laboratory work, on an official call date. The oral and written presentation of a laboratory report is also part of this section.

4. Memory of a laboratory practice: 20%.
5. Assessment exercises (report 10%, oral presentation 10%): 20%

In order to pass the course, a grade equal to or greater than 4 points is required in each of the five sections that make up the evaluation, and the weighted sum of all of them reaches 5 points.

### Final warning

Copying or plagiarism of any assignment that is part of the evaluation will make it impossible to pass the course, and the student will be subject to the appropriate disciplinary procedures.



Please note that, according to Article 13 d) of the University Student Statute (RD 1791/2010, December 30), *"it is the duty of a student to refrain from using or cooperating in fraudulent procedures in evaluation tests, in the work performed or in official University documents"*.

## REFERENCES

### Basic

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### Additional

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