VNIVERSITAT DE VALÈNCIA

Course Guide
34201 Inorganic Chemistry Laboratory I

COURSE DATA

Data Subject	
Code	34201
Name	Inorganic Chemistry Laboratory I
Cycle	Grade
ECTS Credits	6.0
Academic year	2024 - 2025

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	2	First term
1929 - Double Degree Program in Physics and Chemistry	Double Degree Program Physics and Chemistry	3	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	8 - Inorganic Chemistry	Obligatory
1929 - Double Degree Program in Physics and Chemistry	3 - Tercer Curso (Obligatorio)	Obligatory

Coordination

Name	Department
SANAU TORRECILLA, MERCEDES	320 - Inorganic Chemistry

SUMMARY

Students will learn the basic skills and laboratory techniques of inorganic chemistry in an experimental laboratory. They will become familiar with the materials, instrumentation, and basic operations of inorganic chemistry by performing experiments related to the reactivity and chemical properties of the elements of the representative groups and their inorganic compounds, and the synthesis of some inorganic compounds.

The subject is organised so that students make a basic theoretical study of the chemical behaviour of the elements or compounds before each experiment. This study is followed by an experimental part that employs specific laboratory techniques. Subsequently, a series of complementary experiments enables a study of the reactivity and properties of the synthesised substances (always following rules and safety recommendations). Laboratory work simultaneously reinforces and enhances an understanding of the theoretical concepts used in inorganic chemistry.

This subject stresses the need for a laboratory journal to be kept and students are taught how to report on experimental work in chemical language so that the experiments can be reproduced.

Results are analysed and, where appropriate, discrepancies between expected and observed results are discussed by analysing possible causes. A critical review is made of the steps taken to discover errors that might explain discrepancies.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

1929 - Double Degree Program in Physics and Chemistry :

1110 - Degree in Chemistry :

R5-OBLIGATION TO PURSUE THE COURSE SIMULTANEOUSLY

36452 - Inorganic Chemistry I

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Other requirements

All students enrolled in this course must have previously completed Chemistry Laboratory I and Chemistry Laboratory II, and therefore understand common chemistry laboratory operations. In addition, although the objectives of the course are essentially practical and experimental, students must have studied the contents of General Chemistry I and General Chemistry II.

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.
- Solve problems effectively.
- 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.
- Learn autonomously.
- Demonstrate the ability to adapt to new situations.

- 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 main types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.
- Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.
- 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.
- Recognise and analyse new problems and plan strategies to solve them.
- 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.
- Handle the instrumentation used in the different areas of chemistry.
- 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.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Develop sustainable and environmentally friendly methods.
- 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 matter Inorganic Chemistry Laboratory I that allow to acquire 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 Inorganic 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 Inorganic 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) Handle the instrumentation used in the different areas of chemistry.(CE19).

	Understand the qualitative and quantitative aspects of chemical problems..(CE24). 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).
The principles of thermodynamics and their applications to chemistry	Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6).
The characteristic properties of elements and their compounds, including group relationships and trends within the Periodic Table	Interpret the variation of the characteristic properties of chemical elements according to the periodic table..(CE2). Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7).
The structural features of chemical elements and their compounds, including stereochemistry.	Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7). Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.CE11). Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes..(CE12).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Inorganic Chemistry

	Laboratory I that contemplate the learning outcomes EUROBACHELOR®
Ability to demonstrate knowledge and understanding of the facts, concepts, principles and fundamental theories related to the topics mentioned above.	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry..(CE13).
Ability to apply this knowledge and understanding to the solution of common qualitative and quantitative problems.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Competences for the evaluation, interpretation and synthesis of information and chemical data.	Evaluate, interpret and synthesise chemical data and information..(CE16). Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).

COMPETENCES AND COGNITIVE SKILLS RELATED TO THE PRACTICE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Inorganic 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). Evaluate the risks in the use of

	chemicals and laboratory procedures..(CE21).
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). Relate theory and experimentation..(CE22). 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). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). 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). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).

	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). Develop sustainable and environmentally friendly methods.(CE25). 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 Inorganic 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). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).

Ability to analyse materials and synthesize concepts.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). 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..(CB3).
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). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).
Competences in oral and written communication, in one of the main European languages, in addition to the language of the country of origin.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community. (CT1). Students must be able to communicate information, ideas, problems and solutions to both

	expert and lay audiences..(CB4). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Study skills necessary for professional development. These will include the ability to work autonomously.	Learn autonomously.(CG8). Demonstrate the ability to adapt to new situations..(CG9). Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.(CB5).
Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf	Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.(CG10). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). 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. (CB3).

This course will cover the following skills and outcomes related to inorganic chemistry in the degree course:

- Learn how to relate, distinguish, and recognise the behaviour of chemical elements and their compounds, as well as predict the properties, link type, structure, and possible reactivity of unspecified inorganic compounds on the basis of the relationship between groups and established variations.
- Assign and determine the structure of various types of inorganic compounds.
- Understand and use bibliographic and technical information relating to inorganic compounds.
- Explain in an understandable way, phenomena and processes related to inorganic

chemistry.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).
- Recognise and value chemical processes in everyday life.
- Make rigorous decisions.
- Solve problems rigorously.
- Effectively perform the tasks assigned as a member of a team (with a perspective on gender).
- Demonstrate skills in interpersonal relations (with a perspective on gender).
- Demonstrate an ability to use information and communication technologies.
- Demonstrate the ability to safely manipulate chemical reagents and inorgaic compounds.
- Plan and safely carry out simple experiments for synthesis of inorganic compounds.
- 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).
- Explain in understandable way experimental phenomena with the theories that support them.
- Rigorously develop laboratory practice reports.
- Demonstrate ethical commitment (with a gender perspective).
- Demonstrate creativity.
- Demonstrate independent learning.

By means of these learning outcomes, at the end of the course, the student will be able to:

- Establish the chemical behaviour of the elements of the representative groups and their compounds.
- Distinguish the types of reactions (acid-base, redox, precipitation) of the elements of the ‘s’ and ‘p’ blocks and their compounds and the factors that influence them.
- Explain the procedures of synthesis of a selection of compounds.
- Explain the design stages to be followed to obtain a particular compound: choice of starting reagents, the reaction medium, and reaction conditions (temperature, pH, time, etc.).
- Explain methods of isolation and purification of obtained compounds.
- Choose the most appropriate technique in each case.
- Identify the factors that may optimise the performance of a reaction and apply them.

DESCRIPTION OF CONTENTS

1. Synthesis of sodium bicarbonate and carbonate to the Solvay process.

Synthesis of sodium bicarbonate and sodium carbonate by means of the Solvay. process.

2. Boric acid and borates.

Obtention of boric acid. Acid-base properties of boric acid. Preparation of borates and ethoxide of boron.

3. Properties and reacctions of aluminium.

Properties and reactions of aluminum. Reactivity of aluminum with acids, alkalis and oxygen. Reducing properties of aluminum. Obtention and amphoteric behavior of aluminum hydroxide.

4. Silicon compounds.

Silicon compounds. Chemical garden, microesferes, silica gel, zeolites.

5. Nitrogen compounds.

Nitrogen compounds. Obtention and study of the chemical properties of the nitrogen monoxide and dioxide. Identification and reactivity of nitrite and nitrate.

6. Phosphoric acid and phosphates.

Phosphoric acid and phosphates. Potentiometric titration of a phosphoric acid solution. Preparation and use of a buffer solution.

7. Sulfur and its compounds.

Sulfur and its compounds. Allotropy. Preparation of sodium tetrathionate.

8. Obtention of sulphuric acid by the method of contact

Obtention of sulphuric acid by the method of contact. Mounting of the experimental device. Preparation of sulfuric acid. Determination of the purity of the product obtained. Reactivity of sulfuric acid.

9. Halogens (I).

Halogens (I). Reactivity and properties of halogens. Use of Frost diagrams.

10. Halogens (II).

Halogens (II). Synthesis of sodium metaperyodato. Determination of purity by redox titration.

11. Comparative study of the chemical behavior of metallic ions of the block "s".

Comparative study of the chemical behavior of metallic ions of the block "s".

12. Tin compounds

Preparation of several tin compounds and study of their properties according to the type of chemical bonding.

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	48,00	0
Preparation of practical classes and problem	22,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

Laboratory work by individual students (preferably) or teams (groups of two) is the core of this course. Attendance at laboratory sessions is compulsory.

All experimental works will be carried out under the supervision of a lecturer.

• Previous work. Before attending the laboratory, students must carefully read the notes for each session, review the theoretical concepts, resolve a number of questions, and prepare an outline of the experimental procedure.

• Laboratory sessions. During the sessions, the lecturer will make a brief explanation of the most important aspects of the experimental work and the safety measures to be followed. Lecturers will then help students by answering questions or correcting errors. Students will bring their laboratory journals (with previous work done) to the lab sessions and record all observations and significant events – including data measurements (weight of reactants, pH, temperature, time, etc.). Tidiness and orderliness will be emphasised to prevent students acquiring bad habits.

• Post work. Students will analyse the observations and data in their journals and record relevant findings. They must answer any additional questions – as well as calculate and discuss the performance of the synthesis, where applicable, and reflect on whether or not the objectives were reached.

• Preparation of report, presentation, or alternative exercise. Lecturers may ask students to report on a part of the experimental work, or make a presentation, or prepare an alternative exercise.

EVALUATION

The global evaluation will be done according to the following criteria:

• Prior to the laboratory work.- The degree of preparation of lab sessions will be assessed through the preliminaries that take place during the seminar prior to the practicals and/or through the daily review of the notebook. It will contribute 10 % of the total grade.

• Work in the laboratory.- Because this is a highly experimental subject, the student work in the laboratory, i.e., interest, attitude, neatness, cleaning work and suitable work in the notebook will be highly valued aspects. Laboratory work will be evaluated continuously and it will contribute 20 % of the total grade.

• Laboratory diary.- A laboratory notebook must be used exclusively for this subject. The notebook must be available to the teacher at any time for review. It must include the pre-work, annotations during the lab session and later work, with the corresponding yield calculations, if any. This section will be valued at 20 % of the total grade.

• Memory or lab report, presentation or an alternative exercise.- The lecturer may ask students, individually, for the writing of a memory or report on the experimental work done, the presentation of it, or an alternative exercise. The lecturer will indicate, in advance, to each student the extent of the work and to which experimental part should be related, as well as the deadline for delivery. This work will be valued at 10 % of the total grade.

• Exam.- All students must take an exam at the end of the course, in which they demonstrate their knowledge and/or skills acquired, through issues directly related to the operations carried out, the material used, and the content developed during the lab sessions. The note of exam will be 40 % of the total grade.

In any case, in order to overcome the subject, it is required to pass all the items subjected to evaluation with a grade equal or greater than 5.0 out of 10.

Attendance to all laboratory sessions is mandatory. In case of absence, justified for serious reasons, the student must try to recover this missed lab session.

Resits will consist of a written exam and/or a practical examination in the laboratory.

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

- Guión de prácticas, Laboratorio de Química Inorgánica I, aprobado por el Departamento de Química Inorgánica, Universidad de Valencia.

Additional

- Housecroft, C. E.; Sharpe,A. G.; Inorganic Chemistry, ed. Pearson Prentice-Hall, 3ª edició, 2008. ISBN: 978-0-13-175553-6.
  (En format separat, s'ha publicat el manual de respostes als exercicis plantejats. Existeix una traducció a l'espanyol de la 2ª edició i del manual de respostes d'Ed. Pearson Prentice-Hall, 2006.)
- Atkins,P. W.; Overton,T. L.; Rourke, J.P.; Weller, M.T. y Armstrong, F. A.; Shriver & Atkins: Inorganic Chemistry, ed. Oxford, 5ª edición, 2010. ISBN: 978-0-19-923617-6.
  (Existe una traducción al español de la cuarta edición de Ed. McGraw-Hill, 2008).
- Rayner-Canham,G.; Overton,T.; Descriptive Inorganic Chemistry y Student solutions manual for descriptive inorganic chemistry, ed. W.H. Freeman, 4ª edición, 2006. ISBN 10: 1-4292-1814-2.
  (Existeix una traducció al espanyol de la 2ª edició de G. Rayner-Canham, Química Inorgánica Descriptiva, ed. Prentice Hall, 2000
- Cotton,F.A.; Wilkinson,G.; Murillo; C.A.; Bochmann, M.; Advanced Inorganic Chemistry, ed. Wiley-Interscience, 6ª edición, 1999. ISBN: 978-0-471-19957-1
  Existe una traducción al español de la 4ª edición, F.A. Cotton y G. Wilkinson, Química Inorgánica Avanzada, ed. Limusa, 1987.
- Greenwood, N. N.; Earnshaw, A.; Chemistry of the Elements, ed. Elsevier Science, 2ª edición, 1997 (corregida en 1998, con reimpresiones en 2001 y 2002). ISBN: 0-7506-3365-4.
- Malati,M. A.; Experimental Inorganic/Physical Chemistry, an investigative, integrated approach to practical project work, Horwood Publishing Limited, Horwood series in chemical science, 1999.

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