VNIVERSITAT DE VALÈNCIA

Course Guide
34202 Inorganic Chemistry Laboratory II

COURSE DATA

Data Subject	
Code	34202
Name	Inorganic Chemistry Laboratory II
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	3	Second term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	8 - Inorganic Chemistry	Obligatory

Coordination

Name	Department
ORTIZ BARBERA, ROSA M	320 - Inorganic Chemistry

SUMMARY

Students will learn specific inorganic chemistry techniques in an experimental laboratory and be given the knowledge and tools to design and reproduce experiments at an elementary level.

These objectives are achieved through the synthesis of a series of coordinated inorganic compounds. Various experimental procedures are required for producing these compounds, and then studying their reactivity and chemical properties. Assays of these compounds are also required to familiarise students with techniques commonly used in an inorganic chemistry laboratory.

In parallel to the experimental work and the practical observation of inorganic chemistry concepts, students must keep a laboratory journal that describes the principles of chemistry explored and the observations made in each experiment. As in all practical subjects, students must produce a final report on a set of experiments.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

1934 - Double Degree Program in Chemistry-Chemical Engineering :

1110 - Degree in Chemistry :

1108 - Degree in Chemistry :

1929 - Double Degree Program in Physics and Chemistry :

R5-OBLIGATION TO PURSUE THE COURSE SIMULTANEOUSLY

34200 - Inorganic Chemistry III

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Other requirements

All students enrolled in this course should have completed and passed the subjects previously Chemistry Laboratory I, Chemistry II Laboratory, and Laboratory of Inorganic Chemistry I and therefore, know the typical operations that are performed and some of the characterization techniques that are used in a laboratory of Inorganic Chemistry.
In addition, although the objectives of the course is essentially practical and experimental, the students should have consolidated the contents of the subjects General

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

1110 - 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.
- 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 contained 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 II 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 II **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 characteristic properties of elements and their compounds,	Interpret the variation of the characteristic properties of chemical elements according to

including group relationships and trends within the Periodic Table	the periodic table..(CE2). Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7).
COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Inorganic Chemistry Laboratory II **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 II **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).
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 II 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. (CG6) 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.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context. (CG5). 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. (CG6) 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:

- Know the chemical behavior of the elements of the representative groups and their compounds.
- To distinguish the types of reactions (acid-base, redox, precipitation) of the elements of “s” “p” and “d” blocks and their compounds and the factors that influence them.
- The procedures of synthesis of a selection of some of their compounds.
- Know design stages to be followed to obtain a particular compound: choice of reagents of departure, of the reaction medium, of the conditions of reaction (temperature, pH, time, etc.).
- Methods of isolation and purification of the obtained compounds.
- Know how to choose the technique most appropriate characterization in each case.
- Know the factors that to may possible to optimize the performance of a reaction and apply them.

DESCRIPTION OF CONTENTS

1. Lab 1 (one session) Comparative study of the chemical behaviour of metallic ions of the first transition series.

Stability of different oxidation states. Solution behaviour and reactivity.

2. Lab 2 (one session) Vanadium.

Study of the chemical behaviour of vanadium.

3. Lab 3 (one session) reactions in the absence of air.

Cr(II) acetate. Synthesis and reactivity.

4. Lab 4 (one session) Copper.

Synthesis of copper(I) and copper(II) compounds. Spectrochemistry series.

5. Lab 5 (one session) Preparation of oxalatocomplejos of Fe (II) and Fe (III).

Synthesis and characterization of oxalatocomplexes with formulas [Fe(C2O4)(H2O)2] and K3[Fe(C2O4)3].3H2O. Study of their reactivity.

6. Lab 6 (one session) Dioxygen fixation.

Reversible absorption of dioxygen by a Co(II) complex.

7. Lab 7 (two sessions) Preparation of organometallic compounds.

Acetilferrocene, [Fe(C5H5)(C5H4COCH3)]. Preparation and purification. Ferrocinium preparation.

8. Lab 8 (two sessions) Preparation and resolution of enantiomers.

Preparation and resolution of the enantiomers of the cation [Co(en)3]3+.

9. Lab 9 (two sessions) Co(III) complexes.

Synthesis and characterization of the complexes [CoCl(NH3)5]Cl2 and [Co(NH3)6]Cl3. Synthesis and characterization of bond isomers [Co(ONO)(NH3)5]Cl2 and [Co(NO2)(NH3)5]Cl2 and study of the interconversion of isomers.

WORKLOAD

ACTIVITY	Hours	% To be attended
Laboratory practices	48,00	100
Tutorials	12,00	100
Development of individual work	20,00	0
Preparation of evaluation activities	48,00	0
Preparation of practical classes and problem	22,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The core of this course is the assistance of the student to the laboratory and the individual realization (preferably) or team (couples) the proposed experiments, since the main objective that is intended is the training on laboratory work. Therefore, attendance at laboratory sessions is essential and compulsory.

All experimental works will be carried out under the eyes of the teacher.

• Previous work.- The student must prior to attending the lab, consisting of carefully reading the script of each practice, work reviewing the theoretical concepts involving the resolution of a number of previous questions and preparing an outline of the experimental procedure.

• Realization of practice. - During the lab session, the teacher made a brief explanation of the most important aspects of the experimental work to be performed, and the risks and safety measures to follow. Thereafter, assist the student during handling in any doubt that this error may have or may commit. During the lab session, the student shall be provided laboratory diary which consist previous work done, and which record all observations and significant events taking place throughout practice, will also include all data measurements (weight of reactants, pH, temperature, time, etc.). On the other hand, will emphasize that it is essential in laboratory work cleaning and order, the student will try minding that this is a habit that must acquire and that not doing so leads to bad habits difficult to remove later.

• Post work.- The student will analyze the observations and data in your notebook and record relevant findings. Will answer, if any, additional issues that the screenplay indicates. Also calculate and discuss the performance of the synthesis, where applicable, and will reflect on whether or not reached the objectives.

• Elaboration of a report, presentation or an alternative exercise. - The teacher could request to the student the elaboration of an report about a part of the experimental work previously performed, the presentation of it or an alternative exercise.

EVALUATION

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

• Prior to the laboratory work.- It will be assessed the degree of preparation of practices, through the preliminaries during the seminar prior to the practice and/or the daily review of the notebook, and it will contribute 20 % of the total grade.

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

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

• Memory or lab report, presentation or an alternative exercise.- The teacher may ask the student for the presentation, individually, of a memory or report on the experimental work done, the presentation of it or an alternative exercise. The teacher will indicate in advance, each student on experimental part should be and what it should be, as well as the date limit for delivery. This work will be valued at 20 % of the total grade.

• Exam.- All students must conduct a review at the end of the course, in which demonstrate their knowledge and/or skills acquired, through issues directly related to the operations carried out, with the material used, and the content developed during the lab sessions. The note of review will be 20 % of the total grade.

In any case, to overcome the subject it will be required to attend all sessions of laboratory and overcome all the items subjected to evaluation with a grade equal or greater than 5.0 out of 10.

In case of excused absence for serious reasons there must try to recover the practice unrealized.

Second evaluation: Previous work, laboratory work, laboratory notebook and laboratory report constitute a continuous evaluation process. Hence, the grade obtained in these four items, that was applied for the first examination session, will be maintained for the second session. It will be not possible to have a second opportunity for these items in the second examination session.

This second evaluation will be completed through a second examination in a written format and/or a practical examination at the laboratory.

REFERENCES

Basic

- Guión de prácticas, Laboratorio de Química Inorgánica II, aprobado por el Departamento de Química Inorgánica, Universidad de Valencia.
- Compromiso ético con el Código Europeo de conducta http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

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).
- 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.
- Kettle,S. F. A.; Physical Inorganic Chemistry: A Coordination Chemistry Approach, Ed. Oxford University Press, 2000. ISBN-13: 978-0198504047
- Ribas Gispert,J. Química de Coordinación, Edicions de la Universitat de Barcelona/Ediciones Omega, 2000. ISBN: 84-282-1210-4
- Miessler, G.L.; Tarr,D:A.; Inorganic Chemistry, 5ª Ed. Ed. Pearson Prentice Hall, 3ª ed., 2014. ISBN: 0321811054
- Angelici,R.J.; Técnica y Síntesis en Química Inorgánica, Ed. Reverté, 2ª ed., 1979. ISBN: 84-291-7018-9
- Inorganic Syntheses, 1939-1977, Ed. McGraw-Hill Inc., volumes 1 to 17; 1978-1995, Ed. John Wiley & Sons Inc., volumes 18-30. Volúmenes de síntesis de compuestos inorgánicos comprobadas.
- En el guión de cada práctica, hay al final una bibliografía complementaria específica para cada tema tratado.