Universitat Autònoma de Barcelona

2023/2024

Chemistry of Elements

Code: 103281
ECTS Credits: 8

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	OB	2	2

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Prerequisites

There are no prerequisites, but it is recommended to have passed the subjects 'Chemical link and structure of matter' and 'Chemical reactivity' of 1st year.

Objectives and Contextualisation

The subject Chemistry of the elements is taught in the second semester of the 2nd year of the Degree in Nanoscience and Nanotechnology and is a compulsory subject.

The training objectives are included in the following sections:

a) Predict the properties of the elements and their compounds by applying the different binding theories and models of Inorganic Chemistry.

b) Establish the reactivity and general tendencies of the elements according to their position in the periodic table.

c) Identify the main most representative inorganic compounds, their properties, synthesis and applications.

d) Introduction to the complexes of transition metals: classification of the type of ligands and isomerism.

e) Generalities of the binding theories of transition metal compounds: rule of 18 electrons, Valencia Link Theory, Molecular Orbital Theory and Crystalline Field Theory.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Apply the general standards for safety and operations in a laboratory and the specific regulations for the use of chemical and biological instruments, products and materials in consideration of their properties and the risks.
- Be ethically committed.
- Communicate orally and in writing in one's own language.
- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Show sensitivity for environmental issues.
- Work correctly with the formulas, chemical equations and magnitudes used in chemistry.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. Analyse situations and problems in the field of physics and chemistry, and propose experimental responses or studies using bibliographic sources.
2. Apply the acquired theoretical contents to the explanation of experimental phenomena.
3. Appreciate the danger and risks of using samples and reagents and apply the right safety precautions for each case (goggles and/or special gloves, extractor hood, gas mask, etc.)
4. Be ethically committed.
5. Classify and rationalise the most important reaction mechanisms of metal complexes.
6. Classify coordination ligands by their donor-acceptor characteristics and situate them in the chemical spectrum of ligands.
7. Classify organometallic compounds by metal ion and ligands.
8. Communicate orally and in writing in one's own language.
9. Correctly handle glass and another types of material usually found in a synthesis and characterisation laboratory.
10. Critically evaluate experimental results and deduce their meaning.
11. Deduce the most likely structure of a compound using the 18 electrons rule.
12. Design simple experiments for the study of simple chemical and physical systems.
13. Determine and represent isomers of coordination compounds
14. Draw Lewis's structures of inorganic and organic molecules, and describe, from them, their geometry and polarity.
15. Employ information and communication technology in the documentation of cases and problems.
16. Establish the reactivity and general trends of the elements by their position in the periodic table.
17. Identify and situate safety equipment in the laboratory.
18. Identify the most important inorganic compounds of industrial interest.

19. Identify the most representative inorganic compounds, their properties, their synthesis and their applications.
20. Interpret basic chemistry texts and bibliographies in English.
21. Justify the results obtained in the laboratory from chemical compound synthesis, separation, purification and characterisation processes on the basis of knowledge of their structure and properties.
22. Learn autonomously.
23. Make adequate use of laboratory materials and instruments.
24. Manage the organisation and planning of tasks.
25. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
26. Perform basic synthesis, separation and purification procedures in a chemistry laboratory
27. Perform basic synthesis, separation and purification procedures in a synthesis and characterisation laboratory.
28. Perform calculations related with solubility equilibrium and equilibrium constants.
29. Perform thermodynamic calculations of chemical processes.
30. Predict the properties of the elements and their compounds by applying the different bond theories and models of inorganic chemistry.
31. Predict the reactivity of the most important organometallic compounds.
32. Predict the reactivity of the most representative elements and inorganic compounds
33. Propose creative ideas and solutions.
34. Reason in a critical manner
35. Recognise and analyse physical and chemical problems related with the structure of organic and inorganic compounds
36. Recognise the relationship between structure, bond characteristics, and properties of solids.
37. Recognise the terms relative to physics and materials.
38. Recognise the thermodynamic and kinetic parameters that affect the formation of coordination species and reaction mechanisms.
39. Relate experimental data with the physical and chemical properties and/or analysis of the systems that are the object of study.
40. Relate redox potentials with the reactivity of the elements and their inorganic compounds.
41. Relate the electronic configuration of metal ions with theory in the field of ligands and molecular orbitals, in the most common coordination environments.
42. Relate the optical properties of coordination compounds with their electronic configuration.
43. Resolve exercises and problems related with chemical separations using different bibliographic sources and simulation programs.
44. Resolve problems and make decisions.
45. Safely handle chemical and material reagents.
46. Safely handle gases, especially inflammable ones.
47. Show sensitivity for environmental issues.
48. Use basic instruments to characterise chemical and material compounds.
49. Use basic instruments to characterise inorganic and organic chemical compounds
50. Use suitable strategies for the safe elimination of reagents.
51. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

THEORY

General Perspective of the Periodic Table
redox reactivity
Hydrogen
Alkaline and alkaline earth metals
Group elements 13
Elements of group 14
Group 15 elements
Group 16 elements

halogens
Noble gases
Elements of transition
The metals of the block
Introduction to coordination and organometallic compounds

PROBLEMS

The content of this section, which will be delivered in the form of a dossier, consists of a certain number of statements of problems related to the topics developed in theory.

LABORATORY PRACTICES

There will be four laboratory sessions of four hours each.

Practice 1 (2 sessions): Synthesis of Pb (II) nitrate and Pb (II) chloride.

Practice 2 (2 sessions): Synthesis of sodium thiosulfate.

Methodology

The training activities are divided into three sections: theory classes, problem classes and laboratory practices, each with its specific methodology. These activities will be complemented by 2h of tutoring.

Theory classes

The teacher will explain the content of the syllabus. These expository sessions will be the most important part of the theory section.

In the hands of the teacher and through communication through the Virtual Campus, the knowledge of some selected parts of the syllabus should be sought and studied through autonomous learning by the students. To facilitate this task, information on locations in textbooks, web pages, etc. will be provided.

Also to reinforce learning, cooperative activities to be carried out in a group within the classroom will be proposed. These will be directed by the teacher, as in some kind of theory as in some of problems, and will consist in the discussion and sharing of the knowledge acquired by each member of the group.

Classes of problems

The theory group will be divided into two subgroups of problems. Students will attend the sessions scheduled by their subgroup of problems.

At the beginning of the semester will be delivered through the Virtual Campus a dossier of statements of problems of the subject that will be resolved throughout the sessions. In these sessions distributed throughout the semester, the problem teacher will expose the experimental and calculation principles necessary to work on the problems, explaining the guidelines for the resolution and reinforcing at the same time the knowledge of different parts of the Mata of the classes of theory.

Laboratory practices

The group will be subdivided into two subgroups. It is necessary to appear to the practices with laboratory coat, the protocol of practices (available in the Virtual Campus) printed, and previously read. There will also be a notebook to record the observations made and the data obtained.

On the days established in the calendar, the students will be summoned in the Chemistry of the Elements laboratory to carry out basic experiences. The practices will be carried out in pairs and will be evaluated individually. At the end of the internship, the internship booklet must be submitted in order to evaluate the comprehension of the practices and to have the experimental results of each one of the practices. Attendance at practices is mandatory.

Material available in the Virtual Campus of the subject

Teaching guide

Presentations used by teachers to theory classes

Dossier of problem classes

Protocols of practical classes

Links to educational web addresses

Calendar of teaching activities (classroom classes, laboratory classes, evaluations).

15 minutes of a class will be allocated to answer the UAB institutional surveys.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	16	0.64	22, 8, 26, 27, 15, 24, 17, 21, 46, 9, 45, 4, 47, 25, 33, 34, 39, 44, 51, 23, 50
Lectures	37	1.48	7, 6, 11, 13, 16, 18, 19, 32, 30, 38, 37, 36, 41, 42
Problems	17	0.68	1, 22, 10, 8, 13, 14, 15, 20, 25, 32, 33, 34, 28, 29, 37, 35, 40, 44, 51
Type: Supervised			
Tutorial	2	0.08	8, 33, 34, 37
Type: Autonomous			
Problem resolution	39	1.56	1, 22, 10, 8, 13, 14, 15, 25, 32, 33, 34, 28, 29, 37, 35, 40, 44, 51
Study	78.5	3.14	7, 6, 11, 13, 16, 18, 19, 20, 32, 30, 38, 36, 41, 42

Assessment

Exams

For evaluation purposes, the subject can be considered divided into two parts.

Throughout the semester two partial exams will be carried out, one of each part (ExP1 and ExP2), an exam of practices and a global examination of recovery (ExG), all of them with a grade between 0 and 10.

Follow-up work

Throughout the semester a certain number of tests of student follow-up will be collected (problems solved individually or in groups, short classroom tests, etc.). Each student will obtain, therefore, two follow-up notes (S1 and S2), which will be the averages of the grades obtained in the follow-up tests of each part of the subject.

Laboratory practices

The student will complete two compulsory laboratory practices throughout the course. These practices will be evaluated with an internship exam (EP) and laboratory follow-up (notebook, performance, attitude) (SL).

ratings:

Each part of the subject will have a grade (Not1, Not2, Not3) that will be:

Not1 = 0.85 x ExP1 + 0.15 x S1

Not2 = 0.85 x ExP2 + 0.15 x S2

Not3 = 0.60 x EP + 0.40 x SL

The final grade (NF) will be obtained in the following way:

NF = 0.85 x (Not1 + Not2) / 2 + 0.15 x Not3

To overcome the subject by partial, the following two conditions must be met:

1) The final grade for the subject (NF) must be $\geq$ 5.0

2) To be able to do media, ExP1, ExP2 and Not3 must be $\geq$ 4.5 and the practice test (EP) $\geq$ 4.0

In case the above requirement is not met, the student must take the global recovery exam, where he / she can recover one or both partial exams and/or the practical exam, since the subjects of each part will be separated and identified as such (ExR1, ExR2 and ExRP). The NF will be calculated by replacing the ExP1 and / or ExP2 and / or EP values with those obtained in the ExR1 and / or ExR2 and / or ExRP recovery exam.

In order to be able to take the globalrecovery exam, it is mandatory that the students have previously presented the exams of the 1st and 2nd partial.

To pass the subject in the global exam the following conditions must be met:

Precondition: Only students who have obtained a minimum grade in the average of the subject of a 3.5 will be able to submit to the final test.

Prerequisite: To participate in the recovery of students must have been previously evaluated in a set of activities the weight of which equals a minimum of two thirds of the total grade of the subject

1) The final grade of the subject must be $\geq$ 5.0

2) To be able to do media, ExP1 and ExP2 and EP (ExR1 and ExR2 and ExRP in case of recovery) must be $\geq$

4.5

Students who pass the course by partial but want to improve their qualification, may be submitted to the global exam but must do it fulfilled; that is, the two subtests corresponding to each partial. The note of the exam of recovery will replace the note that could have of the sets of both partial ones and, therefore, will have a weight of 85% (the note of the works of follow-up will not be able to be recovered). Students who apply to improve grades will not be eligible for enrollment.

Single Assessment

Students who have opted for the single assessment mode must take a final exam consisting of an examination of the entire subject syllabus to be taken on the day on which the students of the continuous assessment take the exam of the second partial. This grade will average with the grade of the laboratory practices.

The grade will be = Exam mark (85%) + Laboratory mark (15%).

If the final grade does not reach 5, the student has another opportunity to pass the subject by means of the recovery exam to be held on the date set by the coordination of the degree. This student's exam mark will replace the old one to obtain the grade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1st partial exam	36%	2	0.08	1, 5, 8, 14, 15, 16, 18, 19, 4, 32, 30, 34, 28, 29, 38, 37, 35, 36, 40
2nd partial exam	36%	2	0.08	7, 6, 11, 13, 14, 31, 32, 34, 28, 29, 38, 36, 40, 41, 42
Evidence of continuous evaluation	13%	4	0.16	22, 8, 24, 20, 4, 25, 33, 34, 37, 44, 51
Laboratory reports	6%	2	0.08	26, 27, 17, 21, 46, 9, 45, 34, 23, 48, 49, 50
Laboratory test	9%	0.5	0.02	1, 2, 10, 12, 47, 34, 35, 39, 43, 3

Bibliography

Libro de texto:

* Química Inorgánica Descriptiva - Geoff Rayner-Canham (2ª ed.) Ed. Pearson Prentice Hall (2000)

* Descriptive Inorganic Chemistry - Geoff Rayner-Canham, Ed. Freeman (1996)

Otros libros de consulta:

* Química Inorgánica - Shriver & Atkins (4ª ed.) Ed. McGraw-Hill (2006)

* Química Inorgánica - C.E. Housecroft, A.G. Sharpe (2ª ed.) Ed. Pearson Prentice Hall (2006)

Software

In case the lectures are online: Teams