Universitat Autònoma de Barcelona

2020/2021

Chemistry of Elements

Code: 102505
ECTS Credits: 12

Degree	Type	Year	Semester
2502444 Chemistry	OB	2	A

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

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Prerequisites

Prerequisites: ***Fonaments de Química***.

To take Química dels Elements (Chemistry of the elements), it is a prerequisite to have passed the subject Fonaments de Química.

Objectives and Contextualisation

"Química dels Elements" (Chemistry of the elements) is a second year course in which the student must acquire a first set of fundamental contents of the area of knowledge of Inorganic Chemistry. The essential objective is that, based on the general knowledge of chemistry acquired in the subject "Fonaments de Química" (Fundamentals of Chemistry), the student reaches a basic knowledge of how is the chemistry of the different elements of the periodic table, with special emphasis on the elements of the main groups. Its natural continuation is found in the third year course "Química de Coordinació i Organometal·lica" (Coordination and Organometallic Chemistry), in which the chemistry of the transition elements is dealt with more thoroughly. Also, the contents of this subject are essential to be able to take "Ciència de Materials" (Materials Science) in the third course.

Objectives of the subject:
1) Remember and expand basic concepts of bonding, structure and periodic properties studied in the first course.
2) Learn the general aspects of the structures of inorganic solids, especially metals and ionic solids.
3) Expand the acid-base concepts studied in the first year to understand aspects such as the influence of the solvent, the properties of the oxides or the hydrolysis of cations.
4) Expand knowledge of redox reactions. Understand and learn how to use the Latimer, Frost, Pourbaix and Ellingham diagrams.
5) Acquire general knowledge about coordination chemistry.
6) Obtain general knowledge about the structure, reactivity and applications of the elements of the main groups and their compounds.
7) Acquire basic knowledge about the structure, reactivity and applications of transition elements and their compounds.
8) To obtain security in the interpretation of data and in the resolution of problems in the field of the subject.
9) Acquire skills in the fundamental techniques and procedures ofan inorganic synthesis and characterization laboratory.

Competences

- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Communicate orally and in writing in ones own language.
- Develop synthesis and analyses studies in chemistry from previously established procedures.
- Handle chemical products safely.
- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- Have numerical calculation skills.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Reason in a critical manner
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Apply knowledge of abundance, natural state and reactivity of chemical elements to their method / s of production and / or purification.
2. Apply the different bond theories and models of inorganic chemistry to predict the physical properties and, in particular, the reactivity of elements and compounds.
3. Assess the involvement of inorganic chemistry in the development of new materials, pollution, decontamination, new energy sources, etc.
4. Communicate orally and in writing in ones own language.
5. Determining the yield of a synthesis reaction
6. Develop the habits and skills of a laboratory.
7. Evaluate risks in the use of chemicals and laboratory procedures.
8. Have numerical calculation skills.
9. Highlight the unique behavior of the first member of a group.
10. Identify the main scale inorganic compounds of industrial interest and their synthesis.
11. Identify the oxidation states and coordination numbers major, of transition metals.

12. Interpret the data from observations and measurements in the laboratory in terms of their meaning and of the theories sustaining the same.
13. Learn autonomously.
14. Manage the organisation and planning of tasks.
15. Manage, analyse and synthesise information.
16. Observe the physical and chemical properties of different substances.
17. Obtain information, including by digital means.
18. Performing qualitative and / or quantitative analysis of the reaction products
19. Reason in a critical manner
20. Recognise potentially dangerous reagents and dissolvents.
21. Recognize the most common chemical terms in inorganic chemistry in English
22. Relate the characteristics of the elements and their position in the periodic table.
23. Resolve problems and make decisions.
24. Resolve qualitative and/or quantitative problems in accordance with previously developed models.
25. Safely dispose of waste from chemical reactions.
26. Safely handle inflammable, toxic and/or corrosive reagents.
27. Set reactivity trends and general behavior of the elements of the blocks s, p, d and f.
28. Show sensitivity for environmental issues.
29. Synthesise and purify a compound chemical.
30. Synthesize an article of inorganic chemistry in English
31. Understanding the natural state in which are the elements based on their physicochemical properties.
32. Use IT to treat and present information.
33. Use data processors to produce reports.
34. Use graphic design programs to draw chemical formulas and their reactions.
35. Use knowledge of Inorganic Chemistry to communicate professionally.
36. Use spectroscopy devices to confirm experimental results.
37. Use the periodic table with ease and place each element in its correct position.
38. Work in a team and show concern for interpersonal relations at work.
39. Work safely in the laboratory while following the adequate procedure.

Content

Theoretical Contents

1. Introduction.
Abundance of the elements in the universe and in the earth's crust. Oxidation states in blocks s and p. The size of atoms and ions in blocks s, p and d. The importance of bonding energy and electronegativity. Polarizability and polarizing ability: Fajans rules.

2 .- The structure of solids.
Description of the structure of solids. The elementary cell. Compact packing of spheres, holes in compact packaging. Structure and bonding in metals and alloys. Ionic solids. Characteristics of the structures and their rationalization. Energetic aspects in the ionic bond. Electronic structure of solids.

3 .- Acids and bases.
Brönsted acids. Characteristics of Brönsted acids. Lewis acids and bases. Examples and general characteristics of Lewis acids. Reactions and properties of Lewis acids and bases. Hydrolysis of the cations.

4 .- Oxidation and reduction.
Reduction potentials. Trends in standard potentials. Reactions in water. Oxidation by atmospheric oxygen. Latimer diagrams. Frost diagrams. Pourbaix diagrams. Chemical extraction of the elements: chemical reduction, chemical oxidation, electrochemical extraction.

5 .- Introduction to coordination compounds.
Constitution, coordination numbers and geometry of coordination compounds. Representative ligands. Isomerism and chirality: square, tetrahedral and octahedral geometry.

6 .- Hydrogen.

Nuclear properties. Atoms of hydrogen and ions. Properties and reactions of elemental hydrogen. Molecular, saline and metallic hydrides. Stability, synthesis and reactions. Applications.

7 .- The alkaline elements.
Generalities of the group. Simple compounds: hydrides, halides, oxides and related compounds. Hydroxides and carbonates. Solubility and hydration. Coordination and organometallic compounds. Applications.

8 .- The alkaline earth elements.
Generalities ofthe group. Simple compounds: hydrides, halides, oxides, carbides and others. Hydroxides and carbonates. Solubility and hydration. Coordination and organometallic compounds. Applications.

9.- General aspects of block *p* elements

General aspects: electronic configurations, metallic character, electronegativity and radii. The *d* block contraction. Oxidation states and inert pair effect. General trends in the properties of oxides: structures and acid-base character. General trends in the behavior of halides: structures and reactivity.

10 .- The elements of group 13.
Generalities of the group. Boron compounds: hydrides and halides. Boron-oxygen and boron-nitrogen compounds. Boron clusters. Aluminum compounds: hydrides, halides and oxo compounds. Compounds of gallium, indium and thallium. Coordination and organometallic compounds. Applications.

11 .- The elements of group 14.
Generalities of the group. The elemental carbon. Simple carbon compounds: hydrides, halides and oxides. Other carbon compounds Silicon compounds: silicon oxide, silicates and aluminosilicates. Compounds of germanium, tin and lead. Coordination and organometallic compounds. Applications.

12 .- The elements of group 15.
Generalities of the group. Nitrogen compounds Ammonia and other hydrides. Nitrogen oxides. Nitrous and nitric acids. Nitrites and nitrates. Other nitrogen compounds Phosphorus and its allotropic forms. Binary phosphorus compounds. Oxo acids of phosphorus and phosphates. Arsenic, antimony and bismuth compounds. Coordination and organometallic compounds. Applications.

13 .- The elements of group 16.
Generalities of the group. The Oxigen. The bond in the oxygen compounds. Water and hydrogen peroxide. Sulfur and its allotropic forms. Sulfur compounds: sulfides, oxides, oxo acids and oxosols. Other compounds Selenium, tellurium and polonium compounds. Applications.

14 .- The elements of group 17.
General aspects of the group: fluorine,chlorine, bromine and iodine. Hydrochloric acid. Haluros. Oxides of halogens. Oxoacids and oxoanions. Interhalogenic and pseudohalogenic compounds. Applications.

15 .- The elements of group 18.
Generalities of the group. The elements and their compounds. Synthesis, structure and reactions of xenon fluorides. Xenon-oxygen compounds and other compounds ofgroup 18 gases.

16 .- The metals of block d.
General properties, classification of transition elements. Abundance. Energy of the orbitals. Electronic configurations Variation of the oxidation states. Magnetic properties Noble character Representative compounds: oxides, halides and sulfides. Oxocations, oxoanions and polyoxometalates. Important applications of the elements of the block d.

17 .- The metals of the block f
General features. Elements of group 3 and the lanthanides: properties of the elements, oxidation states and important compounds. Actinides, oxidation states and important compounds.

Experimental Contents

The following laboratory experiments will be carried out:

- Preparation of some lead salts
- Preparation of sodium thiosulfate
- Preparation of chromium compounds
- Synthesis and reactivity of copper compounds
- Preparation of tin (II) chloride and tin iodide (IV)
- Preparation of potassium iodate and potassium iodide

Methodology

Description of the methodology

Face-to-face and virtual classes

Teaching will be given through theory sessions, problem sessions and seminars, as well as follow-up tests. All these activiries can be face-to-face or virtual depending on the requirements of the current health situation.

Laboratory Practices:

The lab internship program is designed to achieve a dual goal. On the one hand, transfer the learning of the concepts elaborated during the theoretical lessons and discussed during the problem sessions to selected experiments that allow to consolidate the concepts. On the other hand, to provide the students with the necessary skills in the synthesis and characterization of inorganic products through the use of the most common techniques of a synthesis laboratory. Due to the nature of this training, this part of the teaching will be face-to-face, as long as the legal regulations allow it.

About class attendance

As a semi-face-to-face subject, it is compulsory for students to attend the face-to-face allocated theory and problem sessions or face-to-face laboratory sessions. As a result, follow-up tests may be conducted during any of these sessions without prior notice to students.

SAFETY WARNING IN THE LABORATORY

The student who is involved in an incident that may have serious safety consequences may be expelled from the laboratory and suspend the subject.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Type: directed	12	0.48	1, 2, 3, 31, 4, 27, 11, 10, 12, 19, 22, 24, 8, 35
Type: directed	53	2.12	1, 2, 3, 31, 27, 11, 10, 22, 35
Type: directed	60	2.4	13, 4, 6, 5, 25, 14, 12, 26, 28, 16, 19, 18, 20, 21, 23, 24, 29, 8, 39, 38, 35, 7
Type: Supervised			
Type: supervised	8	0.32	13, 3, 28, 19, 30, 38, 35
Type: supervised	18	0.72	1, 2, 3, 31, 4, 27, 15, 11, 10, 28, 17, 19, 22, 23, 30, 8, 35, 32

Type: Autonomous			
Type: Autonomous	139	5.56	1, 2, 13, 3, 31, 4, 27, 14, 15, 11, 10, 28, 17, 19, 22, 23, 24, 30, 8, 38, 35, 32, 34, 33

Assessment

Subject Assessment

The continuous evaluation of the subject has the following fundamental objectives:

1) Monitor the teaching-learning process, allowing both the students and the teacher to know the degree of achievement of the skills and correct, if possible, the deviations that occur.

2) Encourage the continued effort of the students.

3) Verify that the students have achieved the competencies determined in the curriculum.

Blocks: For evaluation purposes, the subject can be considered divided into four blocks (B1-B4). The laboratory practice block (B4), has a special treatment because its special nature. It will be discussed below. Theory blocks B1-B3 will be evaluated with a partial exam (P1-P3) and by means of the follow-up tests that are carried out during the teaching period corresponding to each block, giving rise to marks S1-S3.

Exams: Throughout the course there will be three partial exams (P1-P3), corresponding to the three blocks of theory (B1-B3). All exams will be scored with a grade between 0 and 10.

Follow-up work: A series of follow-up tests will be carried out throughout the course. The set of tests for each block is summarized in a note between 0 and 10 (S1-S3) for the first three blocks.

Laboratory Practices: The grade for the practice block (B4) will be obtained during the laboratory sessions. The exam mark of the practice block (P4) will be between 0 and 10 and will be the weighted average of the marks of the exams taken during the internship period. This grade corresponds to 60% of the grade of B4. The face-to-face laboratory generates a non-recoverable laboratory follow-up grade between 0 and 10 (S4), which corresponds to 40% of the B4 grade. The laboratory is especially face-to-face: it is up to the responsible teacher to decide whether a fault is justified or not. Students who do not assist to all the laboratory days or who have unjustified absences may be assigned the grade failed in the subject.

Students who have taken the subject once and have not passed it, will be able to maintain, if they wish, their mark of examination of practices (P4) and his note of block (B4), without repeating the practices, if the mark B4 is higher than or equal to 5. In this case they will not be allow to retake exam of the laboratory practices.

Qualifications:

To pass the subject per course one must obtain a final course grade (FCG) greater than or equal to 5.0 and achieve a grade greater than or equal to 4.0 of each of the blocks.

1) FCG is calculated according to:

FCG = a1 B1 + a2 B2 + a3 B3 + 0,25 B4

where coefficients a1, a2 and a3 are the fractions of the hours dedicated to each block in the schedule of the subject, with respect to the total scheduled hours, normalized to 0,75. The value of the coefficients will be established and inform to students as soon as the final schedule of the academic year is known.

2) The mark of each block is the average between the mark of the examination P and that of the follow-up tests S corresponding to the period of each block.

Students who do not pass the subject per course (continuous assessment) and students who want to improve the course grade

Students who do not pass the subject per course, in accordance with the previous continuous assessment scheme, or who want to improve their grade, may take a maximum of three exams to recover the partial ones (P1-P4). The exams that the students take must be those for which the grade or grades of the corresponding block (B1-B4) are the lowest. Students who have all the blocks with a grade lower than 4,0 will not be able to participate in the retake exam and will have the qualification of failed.

When the student carries out a retake exam, the P mark of the block will be that of the retake exam, if this is higher than that obtained in the corresponding exam during the course. If the mark obtained in the retake exam is lower than that obtained during the course, the P mark of the block will be the average of the mark of the retake exam and the exam taken during the course. The mark of block B will be the average between the mark P of the exam calculated in the way indicated above and the mark of the follow-up tests S corresponding to the block carried out during the course. S-tracking notes are not recoverable.

To pass the subject after taking the retake exam the students must meet the same requirements needed to pass the subject per course.

Final grades

Students who take at least one P1-P3 midterm exam or one of the laboratory practices exams will be graded as "Suspès" (failed), "Aprovat" (passed), "Notable" (notable), "Excel·lent" (excellent) or "Matrícula d'honor" (honors degree). Students who do not meet the above requirements will be classified as "No avaluable" (non-assessable).

The final marks of the students who pass the subject may be distributed between 5 and, if applicable, 10, always maintaining the order of the students in accordance with the FCG mark obtained, in order to achieve the distribution between "aprovats", "notables", "excel·lents" and "MHs" that teachers consider ideal.

Students who do not pass the subject because they do not pass at least one block, that is, who obtain less than 4,0 in one block, regardless of their overall average, will obtain a maximum final grade of FCG of 4,5.

Students must act honestly throughout the course. Dishonest attitudes (copying, allowing copying or any action aimed at distorting an assessment) in any follow-up test or exam will be grounds for a grade of failed with a final grade of 0 in the subject for all students involved, regardless of the rest of grades obtained. In particular, during the written tests, mobile phones or any other telecommunication devices must be disconnected and stored in bags or backpacks, which must be left on the class platform. In the event that a student wearing an unauthorized device during the exam and /or follow-up test is detected, the student will be expelled from the classroom and will have a grade of failed in the subject.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Block 1	25	2.5	0.1	1, 2, 13, 31, 4, 27, 11, 19, 22, 23, 24, 8, 35
Block 2	25	2.5	0.1	1, 2, 13, 3, 9, 31, 4, 27, 14, 15, 11, 37, 28, 17, 19, 21, 22, 23, 30, 8, 38, 35, 32
Block 3	25	2.5	0.1	1, 2, 3, 31, 27, 11, 10, 22, 35
Block 4	25	2.5	0.1	4, 6, 5, 25, 15, 12, 26, 28, 16, 19, 18, 20, 21, 29, 8, 39, 38, 36, 35, 34, 33, 7

Bibliography

Textbooks:
"Inorganic Chemistry" Shriver & Atkins, McGraw Hill, 4th Ed, 2008. In Spanish. ISBN-13: 978-970-10-6531-0
There is the corresponding original version: "Inorganic Chemistry" Shriver & Atkins, Oxford UP, 4th Ed, 2006. In English. ISBN-13: 978-019-92-6463-6

Basic descriptive chemistry of the elements:
"Descriptive Inorganic Chemistry" G. Rayner-Canham, Freeman. In English.
"Descriptive Inorganic Chemistry" G. Rayner-Canham, Prentice-Hall. In Spanish.

General reference reference:

"Química Inorgánica" (2a ed.) C.H. Housecroft, A.G. Sharpe, Pearson Educación, 2006.

"Chemistry of the Elements" by N.N. Greenwood & A. Earnshaw, Pergamon, 1984.

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