Universitat Autònoma de Barcelona

2019/2020

Chemistry of Elements

Code: 102505
ECTS Credits: 12

Degree	Type	Year	Semester
2502444 Chemistry	OB	2	A

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 .- 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.

10 .- 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.

11 .- 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.

12 .- 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.

13 .- 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.

14 .- 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.

15 .- 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.

16 .- 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

Methodology

Theory Classes - Lectures:

The student acquires the knowledge of the subject by attending master classes and complementing them with personal study of the topics explained. The master classes are the activities in which less interactivity is required of the student: they are conceived as a fundamentally unidirectional method of transmitting the teacher's knowledge to the student.

Problems and exercises:

The knowledge acquired in the theory classes and in the personal study, are applied to the resolution of problems and exercises in the form of practical cases or theoretical assumptions.

Laboratory practices:

The laboratory program is designed to achieve a double objective. On the one hand, to transfer the learning of the concepts elaborated in the theoretical classes and discussed in the class of problems to selected experiments that allow to consolidate the concepts. On the other hand, provide the student with the necessary skills in the synthesis and characterization of inorganic products through the use of the most common techniques of a synthesis laboratory.

About class attendance

As a *presential* course, attendance at theory classes, problems or in laboratory sessions is mandatory. Consequently, follow-up tests may be conducted during any of these classes 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

Evaluation of the Subject

The continuous evaluation of the subject has the following fundamental objectives:
1) Monitor the teaching-learning process, allowing both the student and the teacher to know the degree of achievement of the skills and correct, if possible, the deviations that occur.
2) Encourage the student's continued effort
3) Verify that the student has achieved the competences determined in the curriculum.

Blocks: For evaluation purposes, the subject can be considered divided into four blocks (B1-B4). The block of laboratory practices (B4) -by its nature- has a special treatment (discussed below). The theory blocks B1-B3 will evaluate with a partial exam (P1-P3), to which the points of the approved follow-up work (S1-S3) will be added for a value of 10% + (maximum one point), if the average mark of the follow-up work is 5 or bigger than 5. On the contrary, the mark of the Block will be the mark of the corresponding partial exam.

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

Follow-up work: Throughout the course a series of follow-up tests will be carried out: problems (or other assignments) made at home will be collected, tests or problems will be made in the classroom, oral questions will be evaluated in the classroom, etc. which will be considered evidences of the personal work of follow-up of the course on the part of the student. The evidence of personal work, summarized in a note between 0 and 10, (S1-S3) for the first three blocks, will have a value of 10% + in each block and are not recoverable, the value of these notes, if it is greater than 5, will be added (previously divided by ten) to the exam score.

Laboratory practices: The note of the block of practices (B4) will be obtained during the laboratory sessions. The exam score of the practice block P4, will be between 0 and 10 and will be the weighted average of the marks of the exams. This grade corresponds to 60% of the B4 grade. The on-site laboratorygenerates a laboratory follow-up note between 0 and 10 (S4), not recoverable, which corresponds to 40% of the B4 grade. The laboratory is especially *presential*: it is up to the instructor to decide if a fault is justified or not. The student who does not do all the laboratory days or who has unexcused absences may be assigned a grade of "fail" in the subject.
Students who have completed the subject once and have not passed it, will be able to maintain, if they wish, their practical exam note (P4) and their block mark (B4) of the previous course, without repeating the practices, if the Note B4 is greater than or equal to 5, but in this case they will not be able to take the exam to recover the practice exam.

Grades

In order to pass the subject per course, a final course grade (NFC) greater than or equal to 5.0 must be obtained and the four blocks of the subject must also be passed.
1) The NFC is calculated according to:

$$NFC = 0.25\ B1 + 0,25\ B2 + 0,25\ B3 + 0,25\ B4$$

2) To be able to overcome a block (B1-4), and to make average with the rest of the blocks of the subject, it will be necessary that the exam note of the exam of the corresponding block (P) is greater than or equal to 3.5.

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, according to the previous continuous assessment scheme, or who want to improve their grade, may be submitted to a maximum of three partial exams (P1-P4). The examinations to which the student presents mustbe those for which the note or notes of the corresponding block (B1-B4) are the lowest. The time available for the recovery exams for blocks will be assigned by the faculty, being impossible to give more time, regardless of the number of recoverable blocks. Students who have all blocks suspended may not appear for the recovery and will have the "Fail" grade.

When the student is presented for a recovery exam, the P grade of the block will be that of the recovery exam, if this is greater than that obtained in the corresponding exam during the course. If the grade obtained in the recovery exam is lower than that obtained during the course, the P grade of the block will be the average of the grade of the exam of recovery and of the exam made during the course. The mark of the Block will be calculated from the mark of the exam as previuosly described. This will be modify by the follow-up mark in the same way as it was during the regular academic year.
To overcome the subject with the recovery, the student must meet the same requirements as to pass the subject per course.

Final grades

Students who complete at least a partial P1-P3 exam or one of the internship exams will have a grade of "Suspended," "Approved," "Remarkable," "Excellent," or "Honor Roll." Students who do not meet the above requirements will be classified as "Not evaluable".
The final grades of the approved students can be normalized from 0 to 10 (the maximum mark must be 10, respecting the order, and the mark can be increased up to 1.5 points) in order to achieve the distribution among approved, notable, excellent and MHs that the professors consider suitable.
Students who do not pass the course because they do not exceed any of the blocks, regardless of their overall average, will obtain a final grade of 4.5.
Students must act honestly throughout the course. Dishonest attitudes (copying, copying or any action aimed at distorting an evaluation) in any follow-up or exam test will be grounds for a "Suspended" grade witha final grade of 0 in the subject, regardless of the rest of the grades obtained by student. In particular, during written tests, mobile phones or any other telecommunication device must be disconnected and stored in bags or backpacks that must be on the platform. In the event that a student is found to be carrying an unauthorized device during the exam and / or follow-up test, the student will be expelled from the classroom and will have a "Suspended" grade 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:
"Chemistry of the Elements" by N.N. Greenwood & A. Earnshaw, Pergamon, 1984.

WEB References:
https://cv2008.uab.cat

http://www.webelements.com/

http://tablaperiodica.analesdequimica.es/