Universitat Autònoma de Barcelona

2022/2023

Chemical Bonding and Structure of Matter

Code: 103293
ECTS Credits: 7

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	FB	1	1

Contact

Name: Laura Masgrau Fontanet
Email: laura.masgrau@uab.cat

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

Nuria Marco Garcia
Xavier Solans Monfort
Francesc Xavier Muñoz Berbel
José Emilio Sanchez Aparicio

Prerequisites

There are no official prerequisites but it is recommended that the student review the basic knowledge of Chemistry, Physics (Electricity and Electromagnetic Waves) and Calculation of Integral and Derivatives (High School level).

Objectives and Contextualisation

The general objective of the subject is that the student knows how to apply the concepts, principles and theories on the structure of the atom and the matter; their structures determine their properties. Understanding the foundations of chemical bonding, intermolecular forces and states of matter is essential in order to manipulate and design chemical entities and their reactions / interactions. This is a basic knowledge for Nanoscience and Nanotechnology.

The student work his ability to identify, analyze and solve chemical, physical and biological problems in the field of Nanoscience and Nanotechnology. They will also develope critical reasoning, autonomous work (individual and / or group) and will use computer and bibliographic resources.

In addition, the student will also be introduced in the basic operations of the chemical laboratory, as well as in the safety regulations and the correct laboratory practices.

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.
- 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 on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. Apply the acquired chemistry theory to the explanation of experimental phenomena.
2. Be ethically committed.
3. Communicate orally and in writing in one's own language.
4. Correctly apply Valence bond theory and molecular orbital theory to simple molecules.
5. Correctly handle commonly used materials in a chemistry laboratory.
6. Correctly perform calculations in relation to chemical reactions (performance, limiting reagent, etc.)
7. Correctly use the protocols for manipulating reagents and chemical waste.
8. Correctly use the terminology of chemical compounds.
9. Critically evaluate experimental chemistry results and deduce their meaning
10. Describe the concept of chemical equilibrium and the factors that can modify it.
11. Describe the structure of the atom and bond theories.
12. Determine the electronic configurations of the elements and, from these, the properties of the elements.
13. Draw Lewis structures of molecules and use them to describe geometry and polarity.
14. Learn autonomously.
15. Manage the organisation and planning of tasks.
16. Name and formulate simple chemical compounds.
17. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
18. Perform the basic synthesis, separation and analyses procedures of a chemistry laboratory.
19. Rationalise the results obtained in the laboratory in processes of synthesis, separation and analysis of chemical compounds on the basis of knowledge of their structure and properties.
20. Reason in a critical manner
21. Resolve problems and make decisions.
22. Show sensitivity for environmental issues.
23. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

The main sections of the subject are:

- Atomic nature of matter.

- Atomic structure: quantum mechanics and electronic configuration of atoms.

- The periodic table of the elements.

- Chemical Bond.

- Intermolecular forces and states of the matter.

- Introduction to crystalline solids.

- Introduction to the basic techniques of the chemical laboratory, learning the use of its material and safety regulations and measures.

Methodology

Students will learn by working by themselves. They will have to learn how to find knowledge, to work individualy and as a part of a team, to face and solve problems.

Theory classes: they will be carried out by combining the use of computer material (e.g. power point slides) along with the board. It is recommended to take notes and complete them by consulting the recommended books in the bibliography. Students will be encouraged to participate during the classes. The professor will solve some practical cases in order to exemplify the theory.

Classes of problems: they are essential for the correct understanding of the subject and for the application of the concepts studied. Students will have a collection of problems that must be resolved; they will be corrected throughout the course in the problem classes. Under the professor requirement they must deliver solved problems.

Laboratory practices: laboratory practices will be carried out so students will learn basic operations of a chemical laboratory. Whenever possible, the practices will be carried out individually. Practices in the computer classroom are also included.

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			
Lab practice	12	0.48	16, 1, 9, 3, 11, 10, 18, 15, 5, 2, 22, 17, 19, 20, 6, 21, 23, 7, 8
Problems class	18	0.72	16, 4, 1, 9, 3, 11, 10, 15, 2, 17, 19, 20, 6, 21, 23, 8
Theory class	33	1.32	16, 4, 1, 3, 11, 10, 15, 2, 17, 20, 6, 23, 8
Type: Supervised			
Support for doing problems and the assimilation of theoretical concepts	15	0.6	16, 4, 1, 9, 3, 11, 10, 15, 2, 17, 20, 6, 21, 23

Type: Autonomous			
Bibliographical work	10	0.4	16, 1, 14, 9, 17, 20
Completion of practical reports	15	0.6	16, 1, 14, 9, 3, 11, 10, 15, 2, 22, 17, 19, 20, 23, 8
Reading the practice scripts	2	0.08	16, 1, 14, 9, 10, 15, 5, 17, 23, 7, 8
Solving questions	25	1	16, 4, 1, 14, 9, 3, 11, 10, 15, 2, 17, 20, 6, 21, 23, 8
Studying	37	1.48	16, 1, 9, 11, 10, 15, 17, 19, 20, 8

Assessment

The evaluation will be carried out throughout the course and will be done through different items, each of them with the weight for the final qualification as indicated in the table. The evaluation will follow the rules from the Faculty

Partial exams: Two written tests will be made to evaluate the scientific-technical knowledge of the subject obtained by the student, as well as his capacity for analysis and synthesis, and of critical reasoning. The contents evaluated will be those of the classes of theory and problems.

The minimum mark requested for each partial is 4 out of 10. The average of the two tests must be greater than 5 to pass the subject.

Practices: The evaluation of the practices (reports, 60%, and proof, 40%) will represent 15% of the total mark. The average of the reports must be a minimum of 5 out of 10. Lab practices are mandatory. The student who is involved in an incident that may have serious consequences for the safety may be expelled from the laboratory and suspended the subject.

Delivered works: Eventually, the teacher will require that the students independently carry out problems/tests of the subject and / or bibliographical works, that will be delivered to be evaluated. It will represent a maximum of 15% of the total mark.

When minimum requiremets are not satisfied, students can take a second exam for each partial. This second exam can correspond to only one partial exam or to the total contents of the course. The score obtained in these exams will replace that obtained in the corresponding first attempt.

To have the right of being evaluated in these second exams, it is compulsory to have been previously evaluated in a set of evaluation activities whose weight equalsat least two thirds (66.6%) of the total grade ofthe course.

Non-presented: A student will be considered presented for evaluation if she/he performs any of the following activities: (a) a partial test or (b) realization of two practical sessions in the lab.

In all evaluation acts, any irregularity that can lead to a significant variation of the qualification will be qualified with 0. The student may suspend the subject.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation of practical lab	15%	1	0.04	16, 1, 14, 9, 3, 10, 12, 13, 18, 15, 5, 2, 22, 17, 19, 20, 6, 23, 7, 8

Home work	N% (15% at the most)	1	0.04	16, 4, 1, 14, 9, 3, 11, 10, 12, 13, 15, 2, 17, 20, 21, 8
Performing two partial tests	(85-N)%	6	0.24	16, 4, 1, 14, 9, 3, 11, 10, 12, 13, 15, 2, 17, 20, 6, 21, 23, 8

Bibliography

Bibliography includes books on General Chemistry and other more specialized on the Chemical Bond.

- R.H. Petrucci, F.G. Herring, J.D. Madura, C. Bissonnette: Química general: principios y aplicaciones modernas, 11ª edició, Ed. Pearson, 2017.
- R. Chang, K. Goldsby: *Química*, 12ª edició, Ed. McGraw-Hill, 2016.
- R. Chang: *Fundamentos de Química*, 1ª edició, Ed. McGraw-Hill, 2011.
- N.J. Tro. *Principles of Chemistry: a molecular approach*. Ed. Prentice Hall (Pearson), 2013.
- J.M.Costa, J.M.Lluch, J.J.Pérez*: Química. Estructura de la materia,* Biblioteca Universitària. Enciclopèdia Catalana, 1993.

Physical Chemistry General Books:

- T. Engel, P. Reid, *Química Física*, Addison Wesley, 2006.
- P.W. Atkins, *Physical Chemistry*, Oxford University Press, (8th Ed.) 2006.

Software

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