



Teaching Guide				
Identifying Data			2022/23	
Subject (*)	Chemistry: Equilibrium and Change	Code	610G04008	
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	First	Basic training	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Martinez Cebeira, Montserrat	E-mail	monserrat.martinez.cebeira@udc.es	
Lecturers	Carlosena Zubieta, Alatzne Del Castillo Busto, Estela Martinez Cebeira, Montserrat	E-mail	alatzne.carlosena@udc.es estela.delcastillo@udc.es monserrat.martinez.cebeira@udc.es	
Web				
General description	In the subject "Chemistry: Equilibrium and Change", of the first course of the degree in Nanoscience and Nanotechnology, the fundamentals of thermochemistry, the most relevant aspects of chemical equilibria in solution and surface, the bases of chemical kinetics, etc. are studied. Preparing students for the study of equilibrium phenomena and chemical reactivity.			

Study programme competences / results	
Code	Study programme competences / results
A1	CE1 - Comprender los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología.
A2	CE2 - Aplicar los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología a la resolución de problemas de naturaleza cuantitativa o cualitativa.
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
A7	CE7 - Interpretar los datos obtenidos mediante medidas experimentales y simulaciones, incluyendo el uso de herramientas informáticas, identificar su significado y relacionarlos con las teorías químicas, físicas o biológicas apropiadas.
A8	CE8 - Aplicar las normas generales de seguridad y funcionamiento de un laboratorio y las normativas específicas para la manipulación de la instrumentación y de los productos y nanomateriales.
B1	CB1 - Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio
B2	CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
B6	CG1 - Aprender a aprender
B7	CG2 - Resolver problemas de forma efectiva.
B8	CG3 - Aplicar un pensamiento crítico, lógico y creativo.
B9	CG4 - Trabajar de forma autónoma con iniciativa.
C1	CT1 - Expresarse correctamente, tanto de forma oral como escrita, en las lenguas oficiales de la comunidad autónoma
C2	CT2 - Dominar la expresión y la comprensión de forma oral y escrita de un idioma extranjero
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
C6	CT6 - Adquirir habilidades para la vida y hábitos, rutinas y estilos de vida saludables

## Learning outcomes

Learning outcomes	Study programme competences / results		
Know the kinetics of chemical change, including catalysis and reaction mechanisms.	A1	B1	C1
	A2	B2	C2
	A7	B3	C3
		B8	
		B9	
To understand the elementary principles of thermodynamics and its applications in chemistry.	A1	B6	C1
	A2	B7	C3
		B8	
		B9	
Knowledge of chemical equilibrium, acid-base equilibrium, complex formation equilibrium, solubility equilibrium, redox equilibrium and electrochemistry.	A1	B1	C1
	A2	B2	C2
	A3	B3	C3
	A7	B6	
		B7	
		B8	
		B9	
Acquisition of experimental skills and knowledge to correctly use the most common materials and products in a chemical laboratory. To interpret the results obtained in the laboratory.	A7	B2	C1
	A8	B3	C2
		B7	C3
		B8	C6
		B9	

Contents	
Topic	Sub-topic
1. Thermochemistry.	Introduction to Thermodynamics. Thermochemistry. Heat, work and internal energy. First Principle of Thermodynamics. Heat of reaction at constant volume and constant pressure. Concept of enthalpy. Standard enthalpy of formation. Calorimetry: measurement of heat of reaction. Hess's law. Bond enthalpy and reaction enthalpy. Nanoscience applications.
2. Spontaneity and Equilibrium.	Second Principle of Thermodynamics. Concept of entropy. Gibbs free energy. Spontaneity. Concept of chemical equilibrium and the constants of equilibrium. The reaction quotient Q. Modifications of the conditions of equilibrium: principle of Le Châtelier. Relationship between Gibbs energy and equilibrium constant. Prediction of chemical change. Temperature dependence. Nanoscience applications
3. Acid-Base Equilibrium	Review of Arrhenius' theory. Bronsted-Lowry theory. Self-ionization of water and pH scale. Strength of acids and bases. Polyprotic acids. Ions as acids and bases. Lewis acids and bases. Common ion effect. Regulatory solutions. Indicators. Neutralization reactions and titration curves. Nanoscience applications.
4. Equilibrium of complex formation.	General considerations. Types of ligands. Constants of formation and dissociation. Acid-base reactions of complex ions. Nanoscience applications.
5. Solubility Equilibrium	Solubility and solubility product. Common ion effect. Total and fractional precipitation. Factors that influence the solubility of salts: common ion effect, saline effect, pH and complex formation. Nanoscience applications.
6. Electrochemistry.	Basic concepts: redox reactions. Electrode potential and standard electrode potential. Relationship between potential, Gibbs free energy and constant of equilibrium. Energy variation with concentration: Nernst equation. Mixed equilibria: influence of other equilibria. Batteries and cells. Corrosion. Electrolysis.



7. Adsorption-Desorption Equilibrium.	Adsorption. Desorption. Adsorption-desorption balance. Langmuir model.
8. Introduction to Chemical Kinetics.	Reaction rates and temperature. Measurement of reaction rates. Rate equation, order reaction, molecularity. Relationship between kinetics and equilibrium. Influence of temperature: Arrhenius equation. Collision theory. Transition state theory. Homogeneous and heterogeneous catalysis. Nanoscience applications.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student's personal work hours	Total hours
Guest lecture / keynote speech	A1 A2 A3 B1 B2 B6 B8 B9 C1 C3 C6	28	56	84
Seminar	A1 A2 A3 A7 B1 B2 B3 B6 B7 B8 B9 C1 C2 C3 C6	8	24	32
Laboratory practice	A1 A2 A3 A7 A8 B1 B2 B3 B6 B7 B8 B9 C1 C3 C6	15	15	30
Objective test	A1 A2 A3 A7 B1 B2 B3 B7 C1	1	0	1
Mixed objective/subjective test	A1 A2 A3 A7 B1 B2 B3 B7 B8 C1	2	0	2
Personalized attention		1	0	1

(\*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The teacher will develop the fundamental contents of each topics through theoretical explanations and practical examples. For better learning, students will have the appropriate teaching materials in advance for their personal preparation on the subject's website (Moodle). Students' participation will be encouraged. It will be taught in a large group.
Seminar	Sessions dedicated to the analysis and resolution of problems and questions with the active participation of students and teachers. It will be given in small groups. The bulletins to be solved will be found on the website of the subject (Moodle) before the students work prior to the seminar.
Laboratory practice	In the laboratory sessions (in small group) the student will develop experimental examples of the theoretical contents exposed in the classroom. It will be fundamental to carry out the pre-laboratories before doing the corresponding practice (if not, the student will not be able to do it), as well as to update the laboratory notebook, according to the teacher's indications. Short tests will be conducted to evaluate the degree of rationalization of the theoretical contents with the experimental ones. An initial session will be given in the classroom (large group) to expose the students to the contents and dynamics of the practices.
Objective test	Periodically, short tests will be carried out in the guest lectures or seminars to evaluate the degree of acquisition of knowledge and skills by the students and to promote continuous assessment throughout the course.
Mixed objective/subjective test	The student will have to take a mixed objective/subjective test of the whole subject that allows to evaluate the degree of acquisition of knowledge and competences by the students. It will include questions and problems about the contents of the whole subject that will have to be solved in a reasoned way.

Personalized attention	
Methodologies	Description



Seminar Laboratory practice	<p>In the seminars the professor supervises for each student the methodology applied in the process of solving the problems proposed, solving individually the doubts formulated by the student and guiding the learning process.</p> <p>In the laboratory practices there is also a personalized attention to the acquisition of skills and knowledge by the students. When the teachers consider it necessary, they may call the students to individualized tutorials to guide them in relation to their evolution in the subject, establishing the schedule in accordance with them.</p> <p>Those students who take advantage of the "recognition of part-time dedication and academic waiver of attendance exemption" regimen according to the regulations of the UDC, will have specific attention, at their own request and at a time to be agreed, of tutorial help for orientation and Resolution of doubts about the contents of the subject.</p> <p>The student in this situation must speak with the responsible Professor in the first week of the course to replace the face-to-face regimen with other qualifying activities.</p>
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Assessment			
Methodologies	Competencies / Results	Description	Qualification
Objective test	A1 A2 A3 A7 B1 B2 B3 B7 C1	Periodically, short tests will be carried out in which students answer questions or solve problems in a reasoned manner that allows them to evaluate their degree of understanding of the most important aspects of the subject.	20
Seminar	A1 A2 A3 A7 B1 B2 B3 B6 B7 B8 B9 C1 C2 C3 C6	The resolution of questions and/or problems bulletins, the fulfilment of dates for their delivery or revision and also the participation of the students through the raising of questions before or after the development of the seminars will be valued.	5
Laboratory practice	A1 A2 A3 A7 A8 B1 B2 B3 B6 B7 B8 B9 C1 C3 C6	The completion of the laboratory practices is mandatory in order to pass the course. The performance of the pre-laboratories, the capacities and skills of the student in the performance of the experimental work, his capacity to interpret the results obtained, the elaboration of the laboratory diary, etc. will be valued. The degree of rationalization will be evaluated by means of short tests regarding the practices.	15
Mixed objective/subjective test	A1 A2 A3 A7 B1 B2 B3 B7 B8 C1	The mixed test shall consist of the resolution of problems and questions relating to the whole contents of the subject. This final test will be held on the official dates agreed at the Centre.	60

Assessment comments
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To pass the subject you must:

1) Perform the laboratory practices.

2) Obtain a higher or equal to 5 points rating (out of 10) in the laboratory practices and in the mixed test. If the total sum value was equal to or greater than 5 (out of 10) but this threshold mark was not met, the final mark will be 4.5 (fail).

-Students who do not participate in the seminars activities and do not realize the objective tests will score 0 in these sections (5% and 20%, respectively, of the overall grade). In the second opportunity, these grades will be maintained for the overall rating.

-In the first and second time, students who do practices and obtain less than 5, have the opportunity to, in addition to the mixed test, perform a specific test related to the labs. The score of this test específica replaced the grade obtained in practice for the overall rating.

- The student will obtain the qualification of No Presented when the student does not assist to the laboratory practice and neither attend to the mixed test. As regards the successive academic years, the teaching-learning process, including continuous assessment, refers to an academic course and, therefore, would comezar a new course, including all activities and procedures the Assessment that is scheduled for that course.

- Second Opportunity: The mixed test's mark obtained in the second opportunity will replace the first one's. The students tested on the second occasion shall be eligible for honors if the maximum number of these to the corresponding course not covered in full at the first opportunity.

In the case of exceptional, objective and adequately justified circumstances, the Responsible Teacher may exempt totally or partially a member of the student body from attending the continuous evaluation process. Students who are in this circumstance must pass a specific exam that leaves no doubt about the achievement of the competences of the subject.

Students with recognition of dedication and part-time academic exemption waiver assistance:

Conducting laboratory practices are mandatory and it will be provided within the flexibility to allow coordinating schedules and material and human resources. They shall be deemed exempt from the keynote sessions while assistance will be provided to the greatest number of seminars. If they can not attend the seminars will make a mentored work.

Students in part-time study regime due to work or duly justified will have to talk to the Responsible Professor in the first week of the course to substitute the face-to-face regime with other type of gradable activities. These activities will be indicated in an individual work plan that will be given to the student.

In the evaluation of the subject, all that is established in article 14, regarding the Fraud Commission and disciplinary responsibilities, of the UDC's Rules for the Evaluation of Bachelor's Degrees and Master's Degrees will be applied.



<b>Basic</b>	<p>- Petrucci, R.H.; Herring, F.G.; Madura, J.D.; Bissonette, C. (2011). Química General: principios y aplicaciones modernas. Madrid, 10ª Ed., Prentice Hall.</p> <p>- Levine, I.N. (2014). Principios de Físicoquímica. México, 6ª Ed., MacGraw Hill.</p> <p>Tamén existen edicións anteriores do libro de texto recomendado Petrucci. Por exemplo na biblioteca dispónse de exemplares da 8ª Ed., con referencia: QX-240.</p>
<b>Complementary</b>	<p>- Reboiras, M.D. (2007). Problemas resueltos de Química. Madrid, Thomson Paraninfo, S.A.</p> <p>- Chang, R. L (2013). Química. 11ª Ed., México, Mc Graw Hill</p> <p>En xeral calquera libro de texto de química xeral serve como guía de estudo para a materia.</p>

## Recommendations

### Subjects that it is recommended to have taken before

Chemistry: Structure and Bonding/610G04005

Integrated Basic Laboratory/610G04004

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

Nanofabrication/610G04040

Kinetic and Catalysis/610G04026

Thermodynamics: Equilibrium and Phases/610G04018

### Other comments

To successfully overcome the matter, it is imperative that students have a number of prior knowledge of chemistry and mathematics, according to the level required in middle and high school, including: nomenclature and chemical formula, set of chemical reactions, stoichiometric calculations, acid-base character identification of common compounds, obtaining oxidation states of the elements in the chemical species, management of logarithms, exponents, etc. GREEN CAMPUS PROGRAM RECOMMENDATION: in order to help achieve an immediate sustainable environment and comply with point 6 of the "Environmental Declaration of the Faculty of Science (2020)", the documentary works requested in this subject: (a) Will be requested mostly in virtual format and computer support. (b) If paper is used: -No plastics will be used -Double-sided printing will be used -Recycled paper will be used -The use of drafts will be avoided.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.