(*)Facultade de Química

Presentation

The studies of Chemistry have a large tradition at the University of Vigo, where it has been taught during more than 30 years. The stablisment of the Universitary System of Galicia in the 90s and the current process of implantation of the European Space of Higher Education (EEES) modified the offer of degrees, but no the pioneering spirit of the chemists in research of in the quest for a better service to the society.

Degrees given in the Faculty

Degree in Chemistry

- Masters And Doctorates:
  - Industry and Chemical Research and Industrial Chemistry
  - Theoretical chemistry and Computational Modelling
- Master:
  - Science and Technology of Conservation of Fishing Products

Web page

Information about the Faculty of Chemistry:

http://quimica.uvigo.es

Grado en Química

Subjects

Year 1st

Code	Name	Quadmester	Total Cr.
V11G201V01101	Biology: Biology	1st	6
V11G201V01102	Physics: Physics I	1st	6
V11G201V01103	Mathematics: Mathematics 1	1st	6
V11G201V01104	Chemistry: Chemistry 1	1st	6
V11G201V01105	Chemistry: Chemistry Lab I	1st	6
V11G201V01106	Geology: Geology	2nd	6
V11G201V01107	Physics: Physics 2	2nd	6
V11G201V01108	Mathematics: Mathematics 2	2nd	6

V11G201V01109	Chemistry: Chemistry 2	2nd	6
V11G201V01110	Chemistry: Chemistry Lab II	2nd	6

Year 2nd			
Code	Name	Quadmester	Total Cr.
V11G201V01201	Biochemistry	1st	6
V11G201V01202	Analytical Chemistry I: Principles of Analytical Chemistry	1st	6
V11G201V01203	Physical chemistry I: Chemical thermodynamics	1st	6
V11G201V01204	Inorganic chemistry I	1st	6
V11G201V01205	Organic chemistry I	1st	6
V11G201V01206	Structural Determination	2nd	6
V11G201V01207	Analytical Chemistry II: Optical Methods of Analysis	2nd	6
V11G201V01208	Physical Chemistry II: Surfaces and Colloids	2nd	6
V11G201V01209	Inorganic chemistry II	2nd	6
V11G201V01210	Organic chemistry II	2nd	6

Year 3rd			
Code	Name	Quadmester	Total Cr.
V11G201V01301	Chemical engineering	1st	6
V11G201V01302	Analytical Chemistry III: Electroanalytical Methods and Separations	1st	6
V11G201V01303	Physical Chemistry III: Quantum Chemistry	1st	6
V11G201V01304	Inorganic Chemistry III: Coordination Chemistry	1st	6
V11G201V01305	Organic Chemistry III: Concerted, Radical and Photochemical Reactions	1st	6
V11G201V01306	Analytical Chemistry IV: Chromatographic and Affine Methods	2nd	6
V11G201V01307	Physical Chemistry IV: Molecular Structure and Spectroscopy	2nd	6
V11G201V01308	Physical Chemistry V: Chemical Kinetics	2nd	6
V11G201V01309	Inorganic Chemistry IV: Transition Metals and Solid State	2nd	6
V11G201V01310	Organic Chemistry IV: Design of Organic Synthesis	2nd	6

Year 4th			
Code	Name	Quadmester	Total Cr.
V11G201V01401	Project	1st	6
V11G201V01402	Chemistry of Materials	1st	6

V11G201V01403	Nanochemistry	1st	6
V11G201V01404	Organometallic Chemistry	1st	6
V11G201V01405	Stereoselective Synthesis of Bioactive Compounds	1st	6
V11G201V01406	Enhancement of Analytical Chemistry	2nd	6
V11G201V01407	Quality in Analytical Labs	1st	6
V11G201V01408	Industrial Chemistry	1st	6
V11G201V01410	Food, Agricultural and Environmental Analytical Chemistry	2nd	6
V11G201V01411	Computational Chemistry	2nd	6
V11G201V01412	Environmental and Bioinorganic Chemistry	2nd	6
V11G201V01413	Therapeutic Chemistry	2nd	6
V11G201V01415	Computing Techniques for Chemistry	2nd	6
V11G201V01417	Theory of Organic Reactions	2nd	6
V11G201V01419	Immunochemistry	2nd	6
V11G201V01981	Internships	2nd	6
V11G201V01991	Final Year Dissertation	2nd	18

IDENTIFYING DATA				
Biology: Biology				
Subject	Biology: Biology			
Code	V11G201V01101			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	#EnglishFriendly			
Department				
Coordinator	Arenas Busto, Miguel			
Lecturers	Arenas Busto, Miguel			
E-mail	marenas@uvigo.es			
Web	http://cme.webs.uvigo.es			
General description	The subject of Biology has the aim of preparing the students to understand and explain the composition and function of the organisms. Including how they are constituted and their functionalities at the molecular, cellular, and population levels. Indeed, how to study them and how to evaluate hypotheses with experimental findings. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B1	Ability for auronomous learning
B3	Ability to manage information
C20	Know the structure and reactivity of the main classes of biomolecules and the chemistry of important biological processes
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Understand the cell as a fundamental unit in the organisms.	A2	B1 B3	C20	D1
Describe the cellular structure in prokaryotes and eukaryotes.	A2	B1 B3	C20	D1
Differentiate the properties, organisation and function of the distinct cellular organelles.	A2	B1 B3	C20	D1
Associate the cellular structures with the metabolism.	A2	B1 B3	C20	D1
Identify and relate the metabolic routes of the distinct organic molecules.	A2	B1 B3	C20	D1
Recognise the structure and function of the hereditary material and interpret the principles of the central dogma.	A2	B1 B3	C20	D1
Discuss the processes of mutation and their implications for the evolution of organisms.	A2	B1 B3	C20	D1
Understand the methods of recombinant DNA.	A2	B1 B3	C20	D1
Understand the importance of the immune system.	A2	B1 B3	C20	D1

Contents	
Topic	
1. The cellular structure of the organisms. The cell theory.	Size, form and cellular function. Cell classification. Cell Theory. Procaryotic cell and eukaryotic cell.
2. Biomembranes and cellular transport systems.	Cell membrane: functions, biochemical composition, physicochemical properties. Synthesis of the cellular membrane. Transport system through the biological membranes: pumps, protein transporters, and channels.

3. The cell nucleus and the chromosomes. The cell organelles.	Cell nucleus: structure, composition and functions. Structure and functions of the nucleus. Structures and functions of the chromatin and chromosomes. Structure, composition, and functions of: extracellular matrix, cytoskeleton and centrioles, endoplasmic reticulum, Golgi apparatus, endosomes and lysosomes, mitochondria, peroxisomes, and chloroplasts.
4. Cellular division and cellular cycle.	Definition and characteristics of mitosis. Differences between somatic and germinal cells. Phases of the cellular cycle. Biological meaning of the mitosis. Concept of apoptosis, cellular proliferation and cancer. Concept and differences between asexual and sexual reproduction. Definition and characteristics of meiosis. Phases of the meiosis. Origin of the genetic variability produced in the meiosis. Differences between mitosis and meiosis.
5. General design of the metabolism: catabolism and anabolism.	Concepts of enzyme, energetic metabolism, metabolic route, catabolism, anabolism. Functional blocks of metabolism and their coupling: catabolic block, anabolic block, growth and differentiation block. The ATP equivalent. Extraction of chemical energy from organic compounds: carbohydrates, fats, and proteins.
6. Photosynthesis.	Nature of the light. Photosynthetic pigments. Stages of photosynthesis: light stage and dark stage (Calvin cycle). The problem of the photorespiration: C4 plants and CAM plants.
7. DNA: structure, function and techniques of recombinant DNA.	Composition and structure of the DNA. Function of the DNA. Replication of the DNA. Initiation to techniques of recombinant DNA.
8. RNA and expression of the genetic message.	Composition and structure of the RNA. Main types of RNA: messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA). Other types of cell RNA and their functions. Transcription and translation processes. The language of the genic information.
9. Mutation and evolution.	Genetic mutations: concept and types. Molecular consequences of genetic mutations. Structural chromosomal mutations: deletion, duplication, inversion, and translocation. Numerical chromosomal mutations: haploidy, polyploidy, and aneuploidy. Origin and consequences of mutations. Relation of mutations with diseases such as cancer. Evolutionary theories. Arguments that support evolution.
10. The immune system.	Concept of the immune system. Components of the immune system. Mechanism of the innate defense of the immune system. Antibodies and interferons. Types of immune response. Alterations of the immune system. Vaccines and their importance.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	60	86
Problem solving	10	30	40
Mentored work	3	9	12
Essay questions exam	2	4	6
Essay questions exam	2	4	6

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

Methodologies

	Description

Lecturing	In these classes, the professor will explain the concepts and fundamentals of the contents to facilitate their understanding. The contents for each section will be provided to the students through the online platform with sufficient time. It is recommended that the student works on this material, also consulting the recommended bibliography.
Problem solving	These classes include the following aspects. a) Each student will have to perform a series of exercises to understand the topics of the subject. These exercises will be considered for the evaluation. b) Resolution of doubts on the previously explained concepts in the Lecture classes. c) The students, separately or in groups, will make illustrative schemes of the contents presented in the Lecture classes to have an overview of the subject, which will facilitate its understanding and interrelationships. d) We will work on some concepts that by experience are more difficult to understand and require a higher didactic support. e) If necessary, these classes will also be used to present works.
Mentored work	Performance (research of information, preparation, and presentation) of a work in a group. The work will be related to the fields of cellular biology, molecular biology, genetics, immunology, and biotechnology, and will be proposed by the professor. The professor could provide support and part of the necessary information for the performance of this activity. This activity will be considered for the evaluation.

Personalized assistance

Methodologies	Description
Mentored work	The activity of oral presentation of a work. Discussion and solving questions, exercises, and problems related to the activity. Each student can ask the professor the explanations that may consider to better understand the activity and successfully develop the proposed tasks. These queries will be attended in scheduled personalized sessions.
Problem solving	Discussion and solving of questions, exercises, and problems related to the subject. Each student can ask the professor the explanations that may consider to better understand the activity and successfully develop the proposed tasks. These queries will be attended in scheduled personalized sessions.

Assessment

	Description	Qualification	Training and Learning Results			
Problem solving	Resolution by the students of a series of problems and/or exercises as academic follow-up of the student (skills CB1, CG1, CG3, CE20 y CT1).	15	A2	B1 B3	C20	D1
Mentored work	The student performs an activity of oral presentation of a work. The evaluation considers the structuring and organization of the contents, the complexity of the work, the presentation of results and the consulted sources (skills CB1, CG1, CG3, CE20 y CT1). These works will be presented in the seminar sessions. Further information in "Other comments on the Evaluation".	10	A2	B1 B3	C20	
Essay questions exam	Exam at the middle of the course (partial) on the contents explained in the lectures and seminars. It will consist of short answer questions, although it could include some long answer questions (skills CB1, CG1, CG3, CE20 y CT1).	35	A2	B1 B3	C20	D1
Essay questions exam	Final exam on the contents explained in the lectures and seminars. It will consist of short answer questions, although it could include some long answer questions (skills CB1, CG1, CG3, CE20 y CT1).	40	A2	B1 B3	C20	D1

Other comments on the Evaluation

The student who performs the final exam will be considered as presented.
The final mark in the subject will be given by the weighted average of the evaluation in the mentioned sections. To pass the subject, the weighted average must be equal or higher than 5.0.

In the second call, the evaluation will be obtained by any of the following two options (selecting that one that would be better for the student):

1. The score reached by the student during the course in the supervised works and seminars is conserved (25% of the final mark). None of them are recoverable. An exam similar to that done at the end of the semester, this exam will include all the contents of the subject (skills CB1, CG1, CG3, CE20 y CT1). This exam will provide the 75% of the final mark.

2. An exam similar to that done at the end of the semester, this exam will include all the contents of the subject (skills CB1, CG1, CG3, CE20 y CT1). This exam will provide the 100% of the final mark.

Evaluation of the Mentored work

The student (in a team) performs an activity of oral presentation of a work related to the subject (10% of the final mark). The mark will be based on the work done by the student in this activity, the complexity, structuring and organization of the contents, and the sources consulted by the student (skills CB1, CG1, CG3, CE20 y CT1.

Global evaluation

The student who indicate it can be evaluated by a global evaluation, where the mark will be based on an exam (on all the contents of the subject) done at the end of the course.

Evaluation of students of the Seniors Programme

Students from the Senior Programme will be evaluated as follows:
- Mandatory attendance of the 75% of theoretical classes and seminars.
- Preparation and oral presentation of an individual or group work related to the subject that will be used to obtain the evaluation mark (skills CB1, CG1, CG3, CE20 y CT1).

Sources of information

Basic Bibliography

John Kimball, **http://biology-pages.info/**,

Bruce Alberts, Dennis Bray, Karel Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Robert, **Introducción a la Biología Celular**, Tercera Edición, 2011,

Peter J Rusell, **iGenetics. A molecular approach**, Third Edition, 2010,

Leonardo Fainboin, Jorge Geffner, **Introducción a la Inmunologia Humana**, Sexta Edición, 2011,

James D. Watson, **Biología Molecular del gen**, Séptima edición, 2016,

Christopher Mathews, K. E. van Holde, **Bioquímica**, Segunda edición,

Complementary Bibliography

Helmut Plattner, Joachim Hentschal, **Biología Celular**, Cuarta Edición, 2014,

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Physics I/V11G201V01102
Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry 1/V11G201V01104

Other comments

It is recommended to have studied the subject "Biology" in the 2º course of Bachillerato (high school).

IDENTIFYING DATA				
Physics: Physics I				
Subject	Physics: Physics I			
Code	V11G201V01102			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Martínez Piñeiro, Manuel			
Lecturers	Martínez Piñeiro, Manuel Salgueiriño Maceira, Verónica Torres Palenzuela, Jesús Manuel			
E-mail	mmpineiro@uvigo.es			
Web	http://faitic.uvigo.es			
General description	Physics of first course in the Chemistry Degree, with contents of kinematics, Newton laws and waves			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B1	Ability for auronomous learning
C22	Know and apply the foundations of Physics necessary to understand the theoretical and practical aspects of Chemistry that need it
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
1. Describe the frame of validity of Classical mechanics.	A1 A2	B1	C22 C29	D3
2. Calculate, from the initial state of a mechanical system, the values of his distinct dynamic magnitudes (energy, linear and angular moments).	A1 A2	B1	C22 C29	D3
3. Calculate, given a group of strengths that act on a mechanical system, his temporary evolution, obtaining the corresponding paths and the temporary variation of his physical properties.	A1 A2	B1	C22 C29	D3
4. Explain the importance of the theorems of conservation and apply any of them.	A1 A2	B1	C22 C29	D3
5. Calculate the strength of push on an object in a fluid and relate the pressure, the height and the speed in a fluid in movement.	A1 A2	B1	C22 C29	D3
6. Define and calculate the parameters that characterise the harmonic and standing waves.	A1 A2	B1	C22 C29	D3
7. Determine experimentally different physical magnitudes (density of solids and liquids, superficial tension, specific heat, etc.).	A1 A2	B1	C22 C29	D3

Contents	
Topic	
Topic 1. Introduction	1. The nature of Physics 2. Consistency and unit conversion 3. Uncertainty and significant figures 4. Vectors (vector sum, vector components, unit vectors, vector product)

Topic 2. Kinematics of a point particle	1. Motion in one dimension Position, median and instant velocity Median and instant acceleration Motion with constant acceleration 2. Motion in two and three dimensions Position and velocity vectors Acceleration vector Parabolic motion Circular motion
Topic 3. Newton's laws of motion	1. Force and interactions 2. First law of Newton 3. Second law of Newton 4. Third law of Newton 5. Linear and angular momentum
Topic 4. Work and kinetic energy	1. Work done by a force. Power 2. Kinetic energy 3. Conservative and non-conservative forces 4. Potential energy 5. Potential energy in the gravitational field 6. Mechanical energy 7. Force and potential energy 8. Principle of conservation of the mechanical energy
Topic 5. Rigid body kinetics	1. System 2. Rigid body 3. Traslation motion 4. Rotation motion around a fixed axis
Topic 6. Particulate system kinetics	1. Systems of particles 2. Center of mass of the system. Motion of c.m.s 3. Ecuations of motion of a system of particles 4. Linear momentum. Conservation of linear momentum 5. Angular momentum. Conservation of angular momentum 6. Work and power 7. Potential and kinetic energy 8. Total mechanical energy
Topic 7. Rigid body dynamics	1. Rotation of a rigid body 2. Moment of inertia 3. Calculation of moment of inertia 4. Theorem of Steiner 5. Momentum of force and of pair of forces 6. Equations of motion of the rigid body 7. Kinetic energy of the rigid body 8. Work 9. Angular momentum. Conservation
Topic 8. Periodic motion	1. Oscillations 2. Simple harmonic motion (SHM) 3. Energy of SHM 4. Applications of the SHM 5. Pendulum 6. Damped oscillations 7. Driven oscillations. Resonance
Topic 9. Mechanical waves	1. Mechanical waves 2. Periodic waves 3. Mathematical description of a wave 4. Velocity of a transverse wave 5. Energy of the wave motion 6. Interference, superposition 7. Stationary waves 8. Normal modes
Lab. Introduction to error analysis	Lab exercises for the introduction to error analysis: 1. Geometrical dimensions 2. Density of a liquid and a solid 3. Surface tension 4. Viscosity

Planning			
	Class hours	Hours outside the classroom	Total hours
Presentation	1	0	1

Lecturing	26	52	78
Seminars	23	34	57
Laboratory practical	12	0	12
Objective questions exam	1	0	1
Essay questions exam	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	
	Description
Presentation	general description of the subject, including content, methodology, development and evaluation
Lecturing	In the FAITIC platform information and materials concerning the theoretical lessons will be available for students . a) The specific objectives in each subject are detailed, indicating their motivation and possible applications. b) The methods proposed to reach the different objectives are explained. c) Suggested bibliographic references are listed and commented.
Seminars	a) Exercises and problems, available previously in FAITC platform, will be solved b) Doubts and concepts of difficult understanding will be discussed and explained in detail c) Different problems of the bulletins will be proposed for the students to be resolved individually
Laboratory practical	A script is proposed to prepare the experimental setting, intended to obtain a series of experimental measures on a physical magnitude. Then, the statistical analysis of the data is explained, to determine the uncertainty of the measures made, and the propagation of statistical errors from the experimental data until the final values of the magnitudes to be calculated

Personalized assistance	
Methodologies	**Description**
Seminars	Bulletins of questions and problems to be solved by the students will be proposed, and in case of neccessity, students may attend to personal tutories to clarify concepts and help them with their resolutions.
Lecturing	Concepts related with the theory sessions will be asked to the students. In case of need students may attend to personal tutories to clarify concepts and help them with their resolutions.
Tests	**Description**
Objective questions exam	Short questions and problems to be solved by the students
Essay questions exam	

Assessment						
	Description	Qualification	Training and Learning Results			
Lecturing	Answers to concepts proposed during the session	0				
Seminars	Realisation of exercises of individual form or in group and assistance	0				
Laboratory practical	Preparation of a report containing a description of the experimental setting made, experimental data measured, derivative properties calculated, and statistical analysis of errors of each one of the magnitudes analysed	20	A2	B1	C29	D3
Objective questions exam	1 short proof written at half term	40	A1 A2	B1	C22 C29	D3
Essay questions exam	Problen and case study resolution exam at the end of the semester	40	A1 A2	B1	C22 C29	D3

Other comments on the Evaluation

- If the student does not have qualification along the semester in any in the different sections he will be qualified as Non Presented, (NP).

- July. Evaluation of the second call,a) The qualification of the first partial examination will be conserved if it has been passedb) The student will have the opportunity to pass the subject by doing only this final written examination, or alternatively may apply to this call to improve the global qualification

Sources of information

Basic Bibliography

Young H.D., Freedman R.A., **Física universitaria**, 12, Pearson Educación, 2013

Tipler, P.A., Mosca G., **Física para la ciencia y la tecnología (Vol. 2)**, Reverté, 2010

Taylor, J. R., **An introduction to Error Analysis**, 2, University Science Books, 1997

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Physics: Physics 2/V11G201V01107

Subjects that are recommended to be taken simultaneously

Mathematics: Mathematics 1/V11G201V01103

IDENTIFYING DATA				
Mathematics: Mathematics 1				
Subject	Mathematics: Mathematics 1			
Code	V11G201V01103			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	#EnglishFriendly Galician			
Department				
Coordinator	Quinteiro Sandomingo, María del Carmen			
Lecturers	Quinteiro Sandomingo, María del Carmen			
E-mail	quinteir@uvigo.gal			
Web	http://moovi.uvigo.gal/			
General description	"Machine translation into English of the original teaching guide". The course has theoretical contents, as well as practical, of linear algebra, multivariable calculus and integration. Undertaking this course will allow the students to improve his/her capacity to understand and use of mathematical language and let them to acquire certain proficiency in calculus and initiate oneself in the use of related computer applications. English Friendly course. International students may request from the teachers: a) material and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
B4	Ability for analysis and synthesis
C21	Know mathematical concepts based on previous ones and be able to use them in the different contexts of Chemistry
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
To calculate eigenvalues of a square matrix and classify quadratic forms attending to the sign.			C21	D1
To operate with real and complex numbers.			C21	D1
To apply the differential calculus to the local approximation of functions and to the resolution of optimization problems.	A1	B4	C21	D1
Employ integral calculus to determine areas and volumes.			C21	D1
To handle computing programs of calculus and graphic representation.			C21	D1

Contents	
Topic	
Real numbers and complex numbers	The real numbers and the real line. Operations with real numbers. Complex numbers. Operations with complex numbers.
Eigenvalues and symmetric matrices	Computation of eigenvalues of a matrix. Diagonalizable matrices. Quadratic forms. Sign of a quadratic form.
Calculus of several variables	Introduction to the real functions of several variables. Differentiable functions. Higher order derivatives. The chain rule. Implicit differentiation. Computation of extreme points
Integration in one and several variables	Riemann integral. Fundamental Theorem of the Integral Calculus. Calculation of primitives. Integrals of functions of several variables on bounded domains.

Planning	Class hours	Hours outside the classroom	Total hours

Lecturing	22	28	50
Problem solving	26	26	52
Practices through ICT	6	3	9
Problem and/or exercise solving	0	10	10
Problem and/or exercise solving	0	7	7
Essay questions exam	2	20	22

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

Methodologies

	Description
Lecturing	The teaching staff will expose the theoretical bases of the subject. They will present possible applications, formulate problems, questions and exercises. They will propose tasks and activities oriented towards the methods and techniques to employ to carry them out.
Problem solving	Activity in which we will propose problems and/or exercises related with the subject. The student should develop the correct solutions by means of exercice of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. It will be employed as a supplement of the lectures.
Practices through ICT	Activities oriented towards learning and handling mathematical computer programs, for calculus and graphical representation of functions and data.

Personalized assistance

Methodologies	Description
Lecturing	Each student will request the teaching staff the clarifications that he/she sees fit for a better understanding of the subject and successfully develop the proposed tasks. These queries will be responded during the tutorials. The tutorial sessions will be able to be realized remotely having made a previous agreement with the professor.
Practices through ICT	Each student will request the teaching staff the clarifications that he/she sees fit for a better understanding of the subject and successfully develop the proposed tasks. These queries will be responded during the tutorials. The tutorial sessions will be able to be realized remotely having made a previous agreement with the professor.
Problem solving	Each student will request the teaching staff the clarifications that he/she sees fit for a better understanding of the subject and successfully develop the proposed tasks. These queries will be responded during the tutorials. The tutorial sessions will be able to be realized remotely having made a previous agreement with the professor.

Assessment

	Description	Qualification	Training and Learning Results			
Problem and/or exercise solving	Each student should resolve given tasks during the time and under the conditions established by the teaching staff. These activities will be related to the first three lessons of the program and will be done during the class hours corresponding to Lecturing or Problem solving.	35	A1			D1
Problem and/or exercise solving	Each student should resolve given tasks during the time and under the conditions established by the teaching staff. These activities will be related to the last lessons of the program and to the handling of computer programs. It will be done during the class hours corresponding to Lecturing, Problem solving or Practices through ICT .	25	A1			D1
Essay questions exam	Final exam. It will include questions and exercises that the students will answer organizing and presenting the knowledge that they have on the subject. It will take place on the official exam dates for each evaluation opportunity.	40	A1	B4	C21	D1

Other comments on the Evaluation

The final qualification of the subject (NF) will be computed by the formula:

NF=A+(10-A)E/10

where A is the sum of the scores obtained by "Problem and/or exercise solving" (up to 6 points) and E is the "Essay questions exam" score (up to 10 points).

To pass the subject the final score has to be greater or equal to 5 points (NF>=5). The students who fail to pass the subject on the first opportunity, and want to do it on the second one, will have to repeat the "Essay questions exam". The score obtained by "Problem and/or exercise solving" will be the same for the second opportunity.

The qualification NOT PRESENTED can not be given to a student who attended at least one of the final exams.

Sources of information

Basic Bibliography

Adams, R. A., **Cálculo**, 6ª, Pearson, 2009

Besada, M.; García, J.; Mirás, M.; Quinteiro, C.; Vázquez, C., **MAReMÁTICAS. Contidos matemáticos para os estudos universitarios de Ciencias**, Servicio de Publicacións. Universidade de Vigo, 2024

Larson, R.; Hostetler, R.; Edwards, B., **Cálculo esencial**, Cengage Learning, cop., 2010

Rogawski, J., **Cálculo: una variable**, 2ª, Editorial Reverté, 2016

Rogawski, J., **Cálculo: varias variables**, 2ª, Editorial Reverté, 2012

Steiner, E., **The Chemistry Maths Book**, Oxford University Press, 2008

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Mathematics: Mathematics 2/V11G201V01108

Subjects that are recommended to be taken simultaneously

Biology: Biology/V11G201V01101
Physics: Physics I/V11G201V01102
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA

Chemistry: Chemistry 1

Subject	Chemistry: Chemistry 1			
Code	V11G201V01104			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Alonso Gómez, José Lorenzo García Martínez, Emilia			
Lecturers	Alonso Gómez, José Lorenzo			
E-mail	lorenzo@uvigo.es emgarcia@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	t is a six-credit subject that is taught in the first semester of the first year and belongs to the basic subjects module of the Degree in Chemistry. The objective of the subject is to provide the student with the knowledge as well as the skills in chemistry necessary so that he can successfully continue learning the subjects Analytical Chemistry, Physical Chemistry, Inorganic Chemistry and Organic Chemistry, of subsequent courses. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B1	Ability for auronomous learning
B2	Organization and planning capacity
C1	Ability to know and understand essential facts, concepts, principles and theories related to Chemistry
C2	Use correctly chemical terminology, nomenclature, conversions and units
C8	Know the characteristic properties of the elements and their compounds, including the relations between groups and their variations in the periodic table
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Balance chemical equations and use stoichiometric methods.	A2	B1 B2	C2	D1
Describe the electronic structure of any atom or ion.	A2	B1 B2	C1 C8 C9	D1
To establish how the bonds between the atoms of a molecule are formed according to the different theories, as well as the origin of the intermolecular forces.	A2	B1 B2	C1 C2 C8 C9	D1
Relate the bonding theories with the characteristics and structures of the chemical compounds.	A2	B1 B2	C1 C2 C9	D1
Explain the properties of gases, liquids and solids, as well as phase changes.	A2	B1 B2	C1 C2 C9	D1
Recognize the main functional groups of organic compounds,know the nomenclature and basic organic formulation and identify the stereochemical aspects and the three-dimensional representation of organic molecules.	A2	B1 B2	C1 C2 C8 C9	D1

Contents

Topic	
CHAPTER 1. CHEMICAL REACTIONS.	Chemical equations. Stoichiometric methods. Limiting reagent. Theoretical yields. Gases in chemical reactions. Properties of ideal and real gases. Kinetic-molecular theory.
CHAPTER 2. ATOMIC STRUCTURE.	Subatomic particles. The electronic structure of atoms.
CHAPTER 3. THE PERIODIC TABLE AND PERIODICITY.	Periodic properties of the elements.
CHAPTER 4. CHEMICAL BONDING I.	Basic concepts. Ionic bond and energetic aspects. Metallic bond.
CHAPTER 5. CHEMICAL BONDING II.	Covalent bond. Lewis structures. Molecular geometry and bond theories.
CHAPTER 6. INTERMOLECULAR vs INTRAMOLECULAR FORCES. STATE OF MATTER.	Factors that determine the presence and nature of intermolecular bonds. Properties of compounds according to the types of bonds present in the system.
CHAPTER 7. THE STRUCTURE AND GEOMETRY OF ORGANIC COMPOUNDS.	Functional groups: nature, representation and nomenclature.
CHAPTER 8. ISOMERISM IN ORGANIC COMPOUNDS.	Conformational isomerism, structural isomerism, and stereoisomerism. Examples in acyclic compounds.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	26	52
Problem solving	26	32	58
Essay questions exam	1	19	20
Essay questions exam	1	19	20

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

Methodologies

	Description
Lecturing	Presentation by the teacher of the contents on the subject under study, theoretical and / or guidelines for a job, exercise or project to be developed by the student.
Problem solving	Activity which formulated problem and / or exercises related to the course. The student should develop appropriate solutions or right through the exercise routines, application of formulas or algorithms, application processing procedures available information and interpretation of the results. It is often used to complement the lecture.

Personalized assistance

Methodologies	**Description**
Problem solving	Each student will be able to request from the teacher the clarifications he deems appropriate for a better understanding of the subject and the successful development of the exercises and problems proposed. This consultation can also be attended during tutorials. The time and place, in which the tutorials of each teacher take place, is collected on the website of the center.
Lecturing	Each student will be able to request from the teacher the clarifications he deems appropriate for a better understanding of the subject and the successful development of the exercises and problems proposed. This consultation can also be attended during tutorials. The schedule and the place, in which the tutorials of each teacher take place, is collected on the website of the center.
Tests	**Description**
Essay questions exam	Each student has tutorials with teachers of the subject to solve individually the doubts that may arise throughout the course in any of its aspects: Theory classes, seminar classes or problem solving and / or autonomous activities that should perform the students. The objective of these tutorials is to help students to consolidate their knowledge and face the different evaluation activities that are proposed in better conditions (written tests, resolution of exercises).
Essay questions exam	

Assessment

	Description	Qualification	Training and Learning Results			
Problem solving	For each subject, problems, exercises and/or self-assessed tests will be proposed, which the students must solve in the seminar classes or outside the classroom. The score of this section will only be considered if in the essay questions exam the grade is equal to or greater than 5 out of 10.	32	A2	B1 B2	C1 C2 C8 C9	D1

Essay questions exam	A written exam about the contents taught until chapter 4. To pass the subject, a minimum grade of 5 out of 10 has to be obtained in the final written exam.	34	A2	B1 B2	C1 C2 C8 C9	D1
Essay questions exam	A written exam about the contents taught between chapter 5 and 8. To pass the subject, a minimum grade of 5 out of 10 has to be obtained in the final written exam.	34	A2	B1 B2	C1 C2 C8 C9	D1

Other comments on the Evaluation

First Opportunity (June-July)

Continuous assessment:

In the case of not achieving the minimum grade required in any test to pass the subject, the final grade will reflect as closely as possible the actual grade obtained throughout the course.

It is understood that a student has submitted to the evaluation of the subject and, therefore, a grade will be assigned, in the following cases:

1. If you take an exam with development questions.

2. If you participate in tests or continuous assessment activities beyond the deadlines established by the center for the request for global assessment modality. A minimum grade of 5 out of 10 is required to pass the subject.

Global assessment:

The students who have been granted the global evaluation by the deanship will have an exam of development questions (100%) that will be carried out on the official exam date for each evaluation opportunity. Within the official testing period marked in the academic calendar of each course. A minimum score of 5 out of 10 is required to pass the subject.

Evaluation of the students of the Integrated Cycle of the Senior Program:

- Mandatory attendance at 80% of theoretical classes and seminars.

- Completion of self-assessment problems, exercises or tests.

- Completion of a project on a topic related to the subject.

Second opportunity (July): The same criteria will be followed as in the first opportunity.

Sources of information

Basic Bibliography

Chang, R. y Goldsby, K.A., **Química**, 13ª, McGraw-Hill, 2021

Chang, R. y Goldsby, K.A., **Química. https://www.ingebook.com/ib/NPcd/IB_Escritorio_Visualizar?cod_primaria=1000193&libro=10619**, 13ª, McGraw-Hill, 2021

Petrucci, R.H., et al., **Química General: principios y aplicaciones modernas**, 11ª, Pearson Educación, 2017

Petrucci, R.H., et al., **Química General: principios y aplicaciones modernas. https://www.ingebook.com/ib/NPcd/IB_Escritorio_Visualizar?cod_primaria=1000193&libro=6751**, 11ª, Pearson Educación, 2017

Quiñoá, E. y Riguera, R., **Nomenclatura y representación de los compuestos orgánicos.**, 2ª, McGraw-Hill Interamericana, 2005

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Chemistry: Chemistry 2/V11G201V01109

Subjects that are recommended to be taken simultaneously

Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry Lab I/V11G201V01105

IDENTIFYING DATA				
Chemistry: Chemistry Lab I				
Subject	Chemistry: Chemistry Lab I			
Code	V11G201V01105			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	1st
Teaching language	Galician			
Department				
Coordinator	Silva López, Carlos Valencia Matarranz, Laura María			
Lecturers	Besada Pereira, Pedro García Martínez, Emilia Silva López, Carlos Tojo Suárez, Emilia Valencia Matarranz, Laura María			
E-mail	carlos.silva@uvigo.es qilaura@uvigo.es			
Web	http://https://moovi.uvigo.gal/course/view.php?id=9853			
General description	The aim of this subject is that the students learn to work in a chemistry laboratory. Safety regulations must be respected and the suitable material used. Students will also study the chemical behaviour of different compounds as well as the synthesis of some of them. Finally, they will learn to interpret the data obtained and to collect the experiences in the laboratory notebook.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B2	Organization and planning capacity
C25	Safely handle chemical substances, considering their physical and chemical properties, evaluating the risks associated with their use and laboratory procedures and including their environmental repercussions
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Apply the norms of safety in the laboratory.			C25 C26	
Use properly the basic material of laboratory, included the one of measurement, and manipulate properly the chemical products and waste.			C25 C26	
Employ basic laboratory technics and interpret the data obtained.	A2	B2	C25 C26 C27 C28 C29	D2 D3
Elaborate the laboratory notebook.			C27 C28 C29	D2 D3
Recognise the structure of the main chemical compounds and relate them with their reactivity.	A2			
Apply nomenclature norms for chemical compounds.	A2			D3

Carry out the synthesis of simple chemical compounds.	A2	B2	C25 C26 C27 C28 C29	D2 D3

Contents
Topic
P1. Laboratory safety and laboratory material recognition
P2. Preparation of solutions
P3. Reactions in organic solvents
P4. Separation by crystallization
P5. Distillation of solvents
P6. Liquid-liquid extraction
P7. Separation by liquid-liquid extraction
P8. Molecular models
P9. Separation by thin layer chromatography
P10. Formation of polymers
P11. Reactions in aqueous solutions
P12. Obtaining calcium carbonate
P13. Obtaining double salt
P14. Determination of water content in a salt
P15. Separation of the three components of a mixture
P16. Determining the stoichiometry of a chemical reaction
P17. Obtaining copper(II) oxide
P18. Obtaining a solubility curve

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	0	36	36
Laboratory practical	54	0	54
Problem solving	0	18	18
Laboratory practice	3	18	21
Laboratory practice	3	18	21
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	Each laboratory practice will be associated with a theoretical explanation that facilitates the students` understanding and realisation of it. Students must complete an initial questionnaire related to this experiment previously to the laboratory session, which can be found on Moovi.
Laboratory practical	Experimental practice. The laboratory experiments will be carried out individually, in sessions of 3 hours. The experimental procedure will be available to students on Moovi. It will be necessary the preparation of a laboratory notebook in accordance with the norms that are collected in Moovi.
Problem solving	After completing each practical session, the student will have to solve some questions found on Moovi.

Personalized assistance	
Methodologies	**Description**
Laboratory practical	During the practical sessions, the professor will resolve the questions regarding the experiment as well as the preparation of the laboratory notebook.
Introductory activities	The professor will resolve any doubts related to the introductory questions of each practical session prior to carrying them out. Students can consult and/or request tutorials at the following link: http://quimica.uvigo.es/en/teaching/teaching-staff/
Problem solving	The students will be able to consult the doubts related to the realisation of the final questionnaire for each practice. Students can consult and/or request tutorials at the following link: http://quimica.uvigo.es/en/teaching/teaching-staff/
Tests	**Description**

Laboratory practice	In the schedule of tutorials, students will be able to consult with the professor the questions related to the exam. Students can consult and/or request tutorials at the following link: http://quimica.uvigo.es/en/teaching/teaching-staff/
Laboratory practice	In the schedule of tutorials, students will be able to consult with the professor the questions related to the exam. Students can consult and/or request tutorials at the following link: http://quimica.uvigo.es/en/teaching/teaching-staff/

Assessment

	Description	Qualification	Training and Learning Results			
Introductory activities	A questionnaire carried out in Moovi on the material provided for each practice will be evaluated before the beginning of each session	10	A2		C29	D3
Laboratory practical	The realisation of experiments in the laboratory as well as the preparation of the laboratory notebook will be evaluated.	30	A2	B2	C25 C26 C27 C28 C29	D3
Problem solving	The questions that the student will have to do in Moovi, after the completion of each practice, will be evaluated.	10	A2		C29	D3
Laboratory practice	The student will take a practical laboratory exam in the middle of the semester	25		B2	C25 C26 C27 C28 C29	D3
Laboratory practice	The student will take a practical laboratory exam at the end of the semester	25		B2	C25 C26 C27 C28 C29	D3

Other comments on the Evaluation

A minimum grade of 3.5 out of 10 will be required in each two practical exams, as well as in each other two evaluacion sections (introductory activities, laboratory practices and problem solving). If some of the parts do not exceed this minimum, the final grade will be a weighted grade (50%) of two practical laboratory exams.

Attendance at all laboratory sessions is mandatory. The absences must be justified.

Participation in continuous assessment test or activities or attendance at laboratory sessions after the deadline established by the center for the global evaluation modality request, implies on condition of being presented.

If the student waives the continuous evaluation and opts for a global evaluation, he must take a practical test in the laboratory (qualification 100%). In the global evaluation mode, attendance at all laboratory sessions is also mandatory as they are experimental practices.

In the call for June-July, a practical laboratory test will be carried out (qualification100%).

Sources of information

Basic Bibliography

Brown, T.L.; Lemay, H.E.; Bursten, B.E.; Murphy, C.J.; Woodward, P.M.; Stoltzfus, **Chemistry: The Central Science**, 15, Pearson Education Limited, 2021

Chang, R.; Overby, J., **Química**, 13, McGrawHill, 2020

Martínez Grau, M. A. y Csákÿ, A. G., **Técnicas experimentales en síntesis orgánica**, Sintesis, 2001

Petrucci, R.; Herring, F.; Madura, J.; Bissonnette, C., **General Chemistry: Principles and Modern Applications**, 12, Pearson Education Limited, 2023

Whitten, K.W, **Química**, 10, Cengage Learning, 2015

Complementary Bibliography

Recommendations

Subjects that continue the syllabus

Chemistry: Chemistry Lab II/V11G201V01110

Subjects that are recommended to be taken simultaneously

Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA

Geology: Geology

Subject	Geology: Geology			
Code	V11G201V01106			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Gago Duport, Luís Carlos			
Lecturers	Gago Duport, Luís Carlos			
E-mail	duport@uvigo.es			
Web	http://moovi.uvigo.gal/login/index.php			
General description	The study of the structure of matter in a crystalline state -objective of Crystallography- is of great relevance for the understanding of the most diverse phenomena in the field of Chemistry, therefore, after a general view of the Earth as a geochemical system, the Approach of the subject Geology corresponding to the first year of the degree in Chemistry is mainly oriented towards the study of crystalline structures and crystallization mechanisms. These topics are approached from the point of view of Crystallography, Mineralogy and Geochemistry. Starting from the thermodynamic and kinetic mechanisms that lead to the formation of crystalline phases, structural aspects, crystallographic notation and diffraction are studied. As a corollary, the importance of these processes is introduced for the study of natural (mineral) crystals and synthetic materials, such as semiconductors, pharmaceuticals, biological macromolecules, and ceramic materials, among others. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C4	Use computer tools properly to obtain information, process data, perform computational calculations and calculate matter properties
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
C10	Know the characteristics of the different states of matter and the theories used to describe them
C15	Know the main techniques of structural research, including spectroscopy
C16	Know the relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids, crystals and other materials
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Describe and explain the Earth as a system.	A2 A3	B4	C10 C16	D3
Differentiate the processes that generate minerals and rocks in nature.	A3	B3	C9 C10 C15 C16	
Distinguish the stages of nucleation and crystalline growthin in the crystallization process.			C9 C10 C16	
Use concepts as periodicity, symmetry and morphology to describe crystals.	A2		C9 C10 C15 C16	

Use of the crystallographic notation and its application to the structural characterisation of crystalline solids.	A3	B3 B4	C9 C15	D3
Describe and apply the basic principles of diffraction for structural analysis.			C4 C9 C10 C16	
Use isotopic analysis techniques for measuring the geological time and following geochemical processes.	A2	B1 B3 B4	C4 C15	

Contents

Topic	
The Earth as a Geochemical System: Rocks forming minerals	Geochemical evolution of the Earth. Plate Tectonic. The rocks cycle. Comparison of Earth with other planets in the solar system: The case of of Mars.
The crystallization process: thermodynamic and kinetic aspects.	Differences between nucleation and crystal growth.Crystal growth kinetics. Structural aspects.
Characterization of crystalline solids: structure vs. morphology.	Microscopic and macroscopic approaches to crystalline solids
Isotopes in Geology: Measuring the geological time with radiactive isotopes. Analyzing kinetic processes by fractionation of stable isotopes.	Radioactive isotopes and stable isotopes. Isotopic dating techniques. The Isochrone method. Kinetic tracking of processes using stable isotopic techniques. Notation and units. Rayleigh fractionation.
Geometric crystallography: Periodicity and symmetry in the crystals.	Two-dimensional lattices. Point symmetry. Schoenflies and Hermann-Mauguin notations of point symmetry elements and clases. Bravais lattices. Microscopic symmetry Space groups. Miller indices and zone axes. Fractional coordinates
X-ray crystallography: Bragg's Law and the Phase problem	The physical basis of diffraction. Diffraction by crystals lattices and radiation sources. The Bragg Law The reciprocal lattice. Diffraction Patterns. Indexing of diffraction diagrams. powder diagrams and monocrystal diagrams Quantitative Analysis. The Phase problem. Methods of resolution of structures from diffraction datasets.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	70	96
Mentored work	1	5	6
Laboratory practical	6	0	6
Problem solving	6	34	40
Objective questions exam	1	0	1
Problem and/or exercise solving	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

	Description
Lecturing	First, the basic principles of crystallization are analyzed from a geological and thermodynamic point of view. Further, we introduce to the student the fundamentals of isotope geochemistry. Next themes are devoted to the structural characterization of crystals, analyzing the concepts of periodicity and symmetry in 2D and 3D crystalline lattices. Finally we introduce the principles and practical aspects of diffraction techniques applied to the estructural analysis
Mentored work	A short paper will be write by groups summarizing the laboratory work. Some guidelines concerning formats and content will be given before the realization. A seminar will be assigned to guide each working group in this task.
Laboratory practical	They will be dedicated to the study of the crystallization process, analyzing three aspects: (1) Crystallization in nature: mineral recognition (2) Optical microscopy with polarized light. (3) Crystal growth from solutions and silica gels in the laboratory.
Problem solving	Seminars will be used to solve practical exercises about nucleation and crystal process and to solve issues related to crystallographic notation and concepts

Personalized assistance

Methodologies	Description

Problem solving	The resolution of exercises will be carried out during the seminars by answering to the questions raised in class.
Mentored work	They will be developed in the computer classroom and in theoretical class as well as through the realization of tutorials or consultations using the Tema platform or the electronic mail.

Assessment

	Description	Qualification	Training and Learning Results
Mentored work	The completion of a report/work whose content will be related to the activity carried out in the laboratory and seminars will be evaluated.	10	
Laboratory practical	The activity carried out in the mineralogy laboratory and in the completion of exercises and questionnaires proposed through the Moovi platform will be evaluated.	30	
Problem solving	The seminars will also include exercises and/or problems.	20	
Objective questions exam	Exam with short questions and multiple choice questions, exercices, as well as a topic about the content of the theoretical classes and/or seminars.	40	

Other comments on the Evaluation

Sources of information

Basic Bibliography

Andrew Putnis, **Introduction to Mineral Sciences**, 6ª, Cambridge University Press, 2008

Edward Tarbuck y FredericK Lutgens, **Ciencias de la Tierra. Una introducción a la Geología Física**, 10ª, Pearson, 2013

Complementary Bibliography

Christofer Hammond,, **The Basic of Crystallography and Diffraction**, 3ª, Oxford University Press, 2009

Jose Luis Amorós, **La gran aventura del cristal**, 1ª, Ediciones Complutense, 2017

Carmelo Giacovazzo et al., **Fundamentals of Crystallography**, 2ª, Oxford University Press,

Recommendations

Subjects that continue the syllabus

Chemistry: Chemistry 2/V11G201V01109

Subjects that are recommended to be taken simultaneously

Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 2/V11G201V01109

Subjects that it is recommended to have taken before

Biology: Biology/V11G201V01101
Physics: Physics I/V11G201V01102
Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry Lab I/V11G201V01105

IDENTIFYING DATA				
Physics: Physics 2				
Subject	Physics: Physics 2			
Code	V11G201V01107			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Pérez Iglesias, María Teresa			
Lecturers	Pérez Iglesias, María Teresa			
E-mail	tpigles@uvigo.es			
Web	http://http://faitic.uvigo.es/			
General description	Broadly Physics is the general scientific analysis of nature, with the goal of understanding how the universe behaves. It is fundamentally an experimental science. The theories that are developed are tested with observations. From such a wide definition, different perspectives or application levels can be adopted, from microscopic phenomena to macroscopic ones. Physics is thus the basis of innumerable scientific and technological applications. In particular for the student of Chemistry, it is a fundamental tool to understand theories and methods belonging to that of domain of science. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B1	Ability for auronomous learning
C22	Know and apply the foundations of Physics necessary to understand the theoretical and practical aspects of Chemistry that need it
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Determine the electric field of discrete point charges or a continuous charge distribution. The case of high symmetry is also considered.	A2	B1	C22	D3
Describe the effect of an electrostatic field on dielectrics and conductors.	A1 A2	B1	C22	D3
Describe the physical effects of electrical currents and calculate the power in a circuit.	A2	B1	C22	D3
Calculate the characteristics and type of trajectory of charged particles in electric and/ or magnetic fields.	A1 A2	B1	C22	D3
Distinguish the different material behaviours in a magnetic field.	A1 A2	B1	C22	D3
Explain the difference between conservative and non conservative electric fields.	A2	B1	C22	D3
Describe unified the electromagnectic field by Maxwell's equations.	A1 A2	B1	C22	D3
Deduce the equation of an electromagnetic radiation and characterize it.	A2	B1	C22	D3
Handle different instrumentation which is usual in electromagnetic lab (as polymeter, power supply, oscilloscope, etc.) reproducing basic experiments.	A2	B1	C22 C29	D3

Contents
Topic

1.-BASIC THEORY OF FIELDS.	- Vector functions - Scalar and vector fields - Line integral - Conservative fields. Potential - Central fields - Flux, divergence and curl of a vector field
2. ELECTROSTATICS	- Electric charge. Conductors and dielectrics - Coulomb□s Law - Superposition principle. Electric Potential - Electric field - Potential and field created by an electric dipole. Effect of electric field on a dipole - Gauss´ theorem
3. ELECTRIC FIELDS IN CONDUCTORS AND DIELECTRICS.	- Effect of electric field on a conductor - Charge distributions on electrostatic conductors - Capacitors and capacitance - Effect of a dielectric between the plates of a capacitor - Effect of electric field on a dielectric
4. DIRECT CURRENT	- Direct Current. Current Density - Ohm□s Law. Conductivity - Joule´s Law - Electromotive force - Kirchoff´s Law
5. MAGNETIC FIELD	- Phenomenoly. Causes of magnetism - Biot and Savart´s Law. Examples - Ampère's theoreme - Charged particles in a static magnetic field - Introduction to magnetism in matter
6. ELECTROMAGNETIC INDUCTION	- Magnetic Flux. Ampère's Law - Phenomenology - Faraday´s law. Lenz´s law - Mutual inductance and self-inductance
7. ELECTROMAGNETIC WAVES	- Maxwell□s Equations. Ampère-Maxwell's law - Plane Electromagnetic Waves - Energy of the electromagnetic waves - Electromagnetic spectrum

Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	26	33.2	59.2
Laboratory practical	12	13.2	25.2
Lecturing	26	28.6	54.6
Essay questions exam	1	2	3
Objective questions exam	0	4	4
Problem and/or exercise solving	1	3	4

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

Methodologies

	Description
Seminars	a) The exercises and problems will be solved, by the students or by the teacher. a) Problem sheets will be available with sufficient anticipation, either at the course web page or in printed form. b) The different tasks that the students have to carry out will be programmed. c) The different tasks that students have to carry out, as presentations based on discussions or the first test, will be assessed.
Laboratory practical	a) Laboratory activities will be carried out in groups. b) In order that the students have a clear idea of the objectives to reach and the available material, information about laboratory work will be provided with enough time in advance. c) In the laboratory, students will be assisted by a teacher.
Lecturing	a) In each topic the specific objectives will be analyzed. Its need and the possible applications will be indicated. b) The way to reach objectives will be indicated. Emphasis will be made on those aspects that are more problematic and difficult. Different examples will be solved. c) Bibliographic references will be proposed d) Diverse tasks that students have to carry out will be programmed.

Personalized assistance

Methodologies	Description
Seminars	Doubts will be discussed and clarified individually or during the debates that may arise.
Laboratory practical	The questions that can arise during the conduct of the practices will be clarified .

Assessment						
	Description	Qualification	Training and Learning Results			
Laboratory practical	Practices of laboratory: a) They are compulsory for all the students. b) They are compulsory to pass the subject. c) The minimum mark to pass will be of 5 out of 10. d) The student's laboratory work will be monitored and given a mark. e) The report of the practices, elaborated by the student, will be assessed.	20	A2	B1	C22 C29	D3
Essay questions exam	Continuous evaluation. Three written tests.They will be 35% of the final mark: a) The minimum qualification to pass each one of these tests will be of 5 out of 10. b) The third test will be done with the first term final exam. c) The marks of the two first tests will be kept until the first term final exam. d) At the first term's final exam each student will have the opportunity to repeat the test he/ she has failed. e) Students who have not passed the three written tests but whose grade is 5, or higher, will appear with a grade of 4 in the records. The students who do not wish to follow the continuous evaluation will have one written test, which will contribute 40% of the final mark: a) The exam will have three parts. b) It is neccesary to pass each one of these parts to pass the subject. The minimum qualification to pass each part will be of 5 out of 10.	35/40	A1 A2	B1	C22	D3
Objective questions exam	Intended for students who wish to follow the continuous evaluation: sort written tests related with the contents of the subject will be carried out during seminar time.	10	A1 A2		C22	D3
Problem and/or exercise solving	Continuous evaluation. Three written tests.They will be 35% of the final mark: a) The minimum qualification to pass each one of these tests will be of 5 out of 10. b) The third test will be done with the first term final exam. c) The marks of the two first tests will be kept until the first term final exam. d) At the first term's final exam each student will have the opportunity to repeat the tests he/ she has failed . e) Students who have not passed the three written tests but whose grade is 5, or higher, will appear with a grade of 4 in the records. The students who do not wish to follow the continuous evaluation will have one written test, which will contribute 40% of the final mark: a) The exam will have three parts. b) It is neccesary to pass each one of these parts to pass the subject. The minimum qualification to pass each part will be of 5 out of 10.	35/40	A1 A2	B1	C22	D3

Other comments on the Evaluation

Sources of information

Basic Bibliography

José Mª de Juana, **Física General , vol. 2**, 2ª edición, Pearson,

Tipler P.A.; Mosca G., **Física para la Ciencia y la Tecnología , vol. 2**, 6ª edición, Reverté,

Serway & Jewett, **Física para ciencias e ingeniería, vol. 2,**, 9ª edición, Cengage Learning,

Gettys E.; Keller F.; Skove M., **Física para Ingeniería y Ciencias**, 2ª edición, McGraw-Hill Interamericanal,

Young & Freedman, **Física Universitaria vol. 2,**, 12ª edición, Pearson Educación,

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry 2/V11G201V01109

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA				
Mathematics: Mathematics 2				
Subject	Mathematics: Mathematics 2			
Code	V11G201V01108			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Mirás Calvo, Miguel Ángel			
Lecturers	Mirás Calvo, Miguel Ángel			
E-mail	mmiras@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	The subject is a basic introduction to vector calculus, differential equations and statistics. It will be oriented to apply the mathematical models studied to specific problems of the scientific fields.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
B4	Ability for analysis and synthesis
C21	Know mathematical concepts based on previous ones and be able to use them in the different contexts of Chemistry
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
To use vector calculus to compute lengths of curves, areas of surfaces and the curl of a vector field.	A1	B4	C21	D1
To build and solve differential equation models of simple systems from physics or chemistry.	A1	B4	C21	D1
To compute probabilities associated to discreet and continuous random variables that follow well known probability distributions.	A1	B4	C21	D1
To use computer programs for mathematical computations and graphic representation.		B4		D1

Contents	
Topic	
Line and surface integrals	Curves and parametrizations Line integrals Parametric surfaces Surface integrals and flux integrals
Ordinary differential equations	Mathematical models and methods for solving first-order differential equations Linear models of higher order
Basic probability theory	Probability spaces Random variables

Planning	Class hours	Hours outside the classroom	Total hours
Lecturing	22	33	55
Practices through ICT	0	6	6
Problem solving	16	26	42
Problem solving	16	26	42
Essay questions exam	2	3	5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	Description

Lecturing	The teachers will present the theoretical foundations of the different topics; showing possible applications; formulating problems, questions and exercises; and proposing tasks and activities with orientations on the methods and techniques to employ to carry them out.
Practices through ICT	Activities oriented to learn how to handle computer programs for the calculation and graphic representation of functions and data.
Problem solving	The students will have to solve the proposed problems and exercises on vector calculus.
Problem solving	The students will have to solve the proposed problems and exercises on differential equations and probability.

Personalized assistance

Methodologies	Description
Lecturing	The doubts concerning the theoretical concepts presented in the classes will be attended in tutoring hours.
Problem solving	The doubts relative to vector calculus will be attended during the classes and in the scheduled tutoring hours.
Practices through ICT	The doubts relative to the laboratory classes will be attended in the scheduled tutoring hours.
Problem solving	The doubts relative to differential equations and probability will be attended during the classes and in the scheduled tutoring hours.
Tests	**Description**
Essay questions exam	The doubts relative to the final examinations will be attended in the scheduled tutoring hours.

Assessment

	Description	Qualification	Training and Learning Results	
Problem solving	Tasks (that conform the so called continuous evaluation) in which each student will have to solve applied problems or exercises of vector calculus.	30	A1	D1
Problem solving	Tasks (that conform the so called continuous evaluation) in which each student will have to solve applied problems or exercises of ordinary differential equations and probability.	30	A1	D1
Essay questions exam	Final examination. Individual exam that will take place right after the class period and that will include theoretical questions and exercises.	40	C21	

Other comments on the Evaluation

The final qualification of the subject (NF) will be compute by the formula:

NF=A+(10-A)E/10

where A is the continuous evaluation score and E is the final examination score.

To pass the matter the final score has to be bigger or equal than 5 points (NF>=5). The students who fail to pass the matter at the first opportunity and want to do it in July, will have to repeat the final examination. The continuous evaluation score will be the same for the July evaluation.

The qualification NOT PRESENTED could not be assigned to a student who attended at least one of the final exams.

Sources of information

Basic Bibliography

Besada, M.; García, J.; Mirás, M.; Quinteiro, C.; Vázquez, C., **MAReMÁTICAS. Contidos matemáticos para os estudos universitarios de Ciencias**, 1, Servicio de Publicacións Universidade de Vigo, 2024

Mirás Calvo, Miguel Ángel; Sánchez Rodríguez, María Estela, **Técnicas estadísticas con hoja de cálculo y R: azar y variabilidad en las ciencias naturales**, 1, Servicio de Publicacións Universidade de Vigo, 2018

Adams, Robert A., **Cálculo**, 6, Addison Wesley, 2009

Simmons, George F., **Ecuaciones diferenciales: con aplicaciones y notas históricas**, 2, McGraw-Hill, 2002

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Physics 2/V11G201V01107
Geology: Geology/V11G201V01106

Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 2/V11G201V01109

Subjects that it is recommended to have taken before

Biology: Biology/V11G201V01101
Physics: Physics I/V11G201V01102
Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA				
Chemistry: Chemistry 2				
Subject	Chemistry: Chemistry 2			
Code	V11G201V01109			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	Galician			
Department				
Coordinator	Fernández Nóvoa, Alejandro			
Lecturers	Fernández Nóvoa, Alejandro			
E-mail	afnovoa@uvigo.es			
Web	http://quimica.uvigo.es			
General description	The Chemistry II subject, which belongs to the basic subjects module and is taught in the second semester of the first year, introduces students to the basic concepts of chemical thermodynamics, chemical equilibrium and chemical kinetics.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B1	Ability for auronomous learning
B2	Organization and planning capacity
C1	Ability to know and understand essential facts, concepts, principles and theories related to Chemistry
C2	Use correctly chemical terminology, nomenclature, conversions and units
C11	Know the principles of Thermodynamics and its applications in Chemistry
C12	Know the kinetics of chemical change, including catalysis and reaction mechanisms
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Determine the variations of thermodynamic magnitudes in chemical reactions	A2	B1 B2	C1 C2 C11	D1
Identify the properties of electrolyte and non-electrolyte solutions	A2	B1 B2	C1 C2	D1
Interpret and recognise the concepts of chemical equlibrium and, in particular, those corresponding to chemical equilibrium in aqueous solution	A2	B1 B2	C1 C2 C11	D1
Calculate the kinetical parameters of simple reactions	A2	B1 B2	C1 C2 C12	D1

Contents	
Topic	
I. THERMODYNAMICS	Heat, work and internal energy. First Law of thermodynamics. Thermochemistry. Determination of heats of reaction: Calorimetry. Second law of thermodynamics. Spontaneity of chemical processes.
II. SOLUTIONS	General characteristics. Expression of concentration. Solubility. Colligative properties.
III. CHEMICAL EQUILIBRIUM	Chemical equilibrium. Equilibrium constant. Factors that affect chemical equilibrium. Dependence of the equilibrium constant with temperature.
IV. ACID-BASE EQUILIBRIUM	Theories of acids and bases. Acid-base equlibria. pH scale. Hydrolysis reactións. Buffer solutions. Acid-base titrations. Indicators.
V. SOLUBILITY EQUILIBRIUM	Solubillity equilibrium and solubility product. The common ion effect. Effect of pH. Complex formation.
VI. OXIDATION-REDUCTION PROCESSES	Oxidation-reduction reactions. Redox equilibrium. Thermodynamic aspect of redox reactions: The Nernst equation. Electrode potential. Galvanic cells. Electrolytic cells.

VII. CHEMICAL KINETICS	Reaction rate. Rate law. Analysis of kinetic data. The effect of temperature on the reaction rate. Reaction mechanisms. Catalysis.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	26	34	60
Seminars	26	34	60
Essay questions exam	2	0	2
Essay questions exam	0	0	0
Problem and/or exercise solving	0	18	18
Self-assessment	0	10	10

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

Methodologies	
	Description
Lecturing	Presentation by the teaching staff of the fundamental aspects and contents of each topic, based on the material available on the MOOVI platform. Numerical problems will also be formulated to help understand and establish concepts.
Seminars	The seminar classes will be fundamentally dedicated to solving problems and, when necessary, delving into those aspects that present the greatest difficulties for the students.

Personalized assistance	
Methodologies	**Description**
Lecturing	In the office hours with the teaching staff, any student doubts that may arise throughout the course in the theoretical classes will be resolved in an individualized and more personal way. The aim of these office hours is to help students to reinforce their knowledge so that they can face in better conditions to the different evaluation activities.
Seminars	In the office hours with the teaching staff, any student doubts that may arise throughout the course in the seminar classes will be resolved in an individualized and more personal way. The aim of these office hours is to help students to reinforce their knowledge so that they can face in better conditions to the different evaluation activities.
Tests	**Description**
Essay questions exam	In the office hours with the teaching staff, any student doubts that may arise throughout the course during the preparation of the first written exam will be resolved in an individualized and more personal way. The aim of these office hours is to help students to reinforce their knowledge so that they can face in better conditions to the different evaluation activities.
Essay questions exam	In the office hours with the teaching staff, any student doubts that may arise throughout the course during the preparation of the second written exam will be resolved in an individualized and more personal way. The aim of these office hours is to help students to reinforce their knowledge so that they can face in better conditions to the different evaluation activities.

Assessment							
	Description	Qualification	Training and Learning Results				
Essay questions exam	A written exam will be taken in the middle of the semester on the date approved by the Xunta de Facultade. This exam will deal with the contents of topics I, II and III.	37.5	A2	B1 B2	C2 C11	D1	
Essay questions exam	A written exam will be taken at the end of the semester on the date approved by the Xunta de Facultade (the date will coincide with the date corresponding to the Global Test for students in the Global Assessment modality). This exam will deal with the contents of topics IV, V, VI and VII.	37.5	A2	B1 B2	C2 C11 C12	D1	
Problem and/or exercise solving	In addition to the Problem Bulletins, at the end of each topic or group of topics, a series of "Evaluable Exercises" will be proposed that the students will have to solve autonomously and deliver within the deadline set by the teaching staff.	15	A2	B1 B2	C1 C2 C11 C12	D1	
Self-assessment	At the end of each topic, students will have the opportunity to answer, through the MOOVI platform, a self-correcting "Self-Assessment Test".	10		B1	C1 C2 C11 C12		

Other comments on the Evaluation

Continuous assessment:

- The voluntary work of the students ("*Self-assessment Test*" and "*Evaluable Exercises*") may constitute up to 25% of the final grade as long as the student carries out at least half of the activities proposed throughout the course.

- To pass the subject, it is an essential requirement that the average of the grades in the written exams be equal to or greater than 4.0 out of 10.0 points. In the case of not achieving this score, the qualification that will be reflected in the record will only be the average of the written exams grades, not counting any of the other sections.

- To pass the subject, it is an essential requirement to obtain a grade equal to or greater than 5.0 points out of 10 in the overall grade of the subject (15% evaluable exercises, 10% self-assessment questionnaires and 75% written exams).

Overall evaluation:

Students who, within the deadline set by the Faculty, opt for the *Global Assessment* modality, will take a global written exam on the date set by the Xunta de Facultade. This global written exam will account for 100% of the grade for the subject.

- To pass the subject, it is an essential requirement to obtain a grade equal to or greater than 5.0 out of 10.0 in the overall written exam.

Presented/Non-Presented Status:

The participation of the students in any of the written exams will imply the condition of "presented" and, therefore, the assignment of a grade.

Second opportunity:

In the case of the *Continuous Evaluation* for the evaluation of the second opportunity, the qualifications of the "*Evaluable Exercises*" and the "*Self-assessment Test*" will be maintained.

Sources of information

Basic Bibliography

PETRUCCI, R. H.; HERRING, F. G.; MADURA, J. D.; BISSONNETTE, C., **"Química General"**, 11, Pearson Educación, 2017

CHANG, R.; GOLDSBY, K., **"Química"**, 12, McGraw-Hill, 2016

LÓPEZ CANCIO, J. A., **"Problemas de Química: Cuestiones y Ejercicios"**, 1, Prentice Hall, 2000

Complementary Bibliography

ATKINS, P. W.; JONES, L., **"Principios de Química. Los Caminos del Descubrimiento"**, 5, Médica Panamericana, 2012

WHITTEN, K. W.; DAVIS, R. E.; PECK, M.; STANLEY G. G., **"Química"**, 10, Cengage Learning, 2015

BROWN, T. L.; LEMAY, E., **"Química. La Ciencia Central"**, 12, Pearson Educación, 2013

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Physics 2/V11G201V01107
Geology: Geology/V11G201V01106
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry Lab II/V11G201V01110

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA				
Chemistry: Chemistry Lab II				
Subject	Chemistry: Chemistry Lab II			
Code	V11G201V01110			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Basic education	1st	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Losada Barreiro, Sonia Romero Rivas, Vanesa			
Lecturers	Calle González, Inmaculada de la Lavilla Beltrán, María Isela Losada Barreiro, Sonia Pena Pereira, Francisco Javier Romero Rivas, Vanesa Sousa Castillo, Ana			
E-mail	sonia@uvigo.es vromero@uvigo.gal			
Web	http://http://quimica.uvigo.es			
General description	In this subject it is intended that students start in the chemical laboratory and learn criteria and essential manipulations to work properly, safely and respectfully with the environment. The student will become familiar with the glassware, the instrumentation and the basic operations, achieving a learning that will allow him/her to approach other more specialized laboratories. Emphasis will also be placed on the observation and preparation of a laboratory notebook.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
B2	Organization and planning capacity
C25	Safely handle chemical substances, considering their physical and chemical properties, evaluating the risks associated with their use and laboratory procedures and including their environmental repercussions
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Use correctly the basic laboratory material, including the measurement material, and properly handle chemicals and their waste	A2	B2	C25 C26	D2
Use basic laboratory techniques and interpret the obtained data	A2	B2	C25 C26 C27 C28 C29	D2
Elaborate a notebook and/or an internship report	A2	B2	C27 C28 C29	D3
Measure chemical properties	A2	B2	C26 C27 C28 C29	D2

Identify chemical substances	A2	B2	C25 C26 C27 C28	D2

Contents	
Topic	
Separation and identification of metals in aqueous solution	- Metals that precipitate as chlorides [Ag(I), Hg(I) and Pb(II)] (1 session) - Metals that precipitate as sulfates [Ca(II), Pb(II) and Ba(II)] (1 session) - Metals that precipitate as hydroxides [Fe(III), Cr(III) and Bi(III)] (1 session) - Metals that form amino complexes [Cu(II), Ni(II), Co(II) and Hg(II)] and alkaline earth metals [(Mg(II)] (1 session) - Identification of the metals present in a sample of unknown composition (1 session)
Titrations	- Acid-base titrations: standardization of a solution of sodium hydroxide with potassium hydrogen phthalate and determination of total acidity in juices (2 sessions) - Redox titrations: standardization of a solution of potassium permanganate with sodium oxalate and determination of iron sulphate in tablets (2 sessions)
Detemination of chemical properties	- Equation of state of ideal gases (1 session) - Colligative properties: Ebullioscopy (1-2 sessions) - Determination of the electromotive force in galvanic cells (1-2 sessions) - Electrolytic cells: Faraday laws (1-2 sessions)
Calorimetry	- Determination of heat of solution (1 session) - Determination of heat of neutralization (2 sessions)
Chemical equilibrium	- Study of a dissociation equilibrium (2-3 sessions)
Chemical kinetics	- Kinetic study of a chemical reaction (2 sessions)

Planning			
	Class hours	Hours outside the classroom	Total hours
Introductory activities	4	0	4
Laboratory practical	25	25	50
Laboratory practical	25	25	50
Laboratory practice	3	25	28
Essay questions exam	3	15	18
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Introductory activities	At the beginning of each laboratory session, the teacher will present the contents to be developed by the students.
Laboratory practical	- Laboratory experiments corresponding to separation and identification of metals in aqueous solution and titrations will be carried out in 9 sessions of 3 hours. - Prior to the beginning of each practice, the student will find support material on MOOVI for the preparation of the experiments to be carried out. The student will be provided with questionnaires to be fill in before the start of the first practice session, where key content is collected for carrying out the practices. - During the development of the practices, the student will elaborate a laboratory notebook in which he / she must write down all the observations related to the experiment carried out.

Laboratory practical	- Laboratory experiments corresponding to the determination of chemical properties, calorimetry, chemical equilibrium and chemical kinetics will be carried out in 9 sessions of 3 hours. - Prior to the beginning of each practice, the student will find support material on MOOVI for the preparation of the experiments to be carried out. The student will be provided with questionnaires to be fill in before the start of the first practice session, where key content is collected for carrying out the practices. - During the development of the practices, the student will elaborate a laboratory notebook in which he / she must write down all the observations related to the experiment carried out.

Personalized assistance

Methodologies	Description
Laboratory practical	Each student will be able to request from the teacher the clarifications that it deems appropriate for a better understanding of the subject and the successful development of the proposed tasks. These consultations will be attended during tutorials.
Tests	**Description**
Laboratory practice	Each student will be able to request from the teacher the clarifications that it deems appropriate for a better understanding of the subject and the successful development of the proposed tasks. These consultations will be attended during tutorials.
Essay questions exam	Each student will be able to request from the teacher the clarifications that it deems appropriate for a better understanding of the subject and the successful development of the proposed tasks. These consultations will be attended during tutorials.

Assessment

	Description	Qualification	Training and Learning Results			
Laboratory practical	- The teacher will monitor the experimental work done by the student in the laboratory sessions corresponding to separation and identification of metals in aqueous solution and titrations through observation, questionnaires and / or the laboratory notebook. - Since it is a experimental subject, the ATTENDANCE to the laboratory sessions is COMPULSORY.	30	A2	B2	C25 C26 C27 C28 C29	D2 D3
Laboratory practical	- The teacher will monitor the experimental work done by the student in the laboratory sessions corresponding to the determination of chemical properties, calorimetry, chemical equilibrium and chemical kinetics through observation, questionnaires, tasks and / or the laboratory notebook. - Since it is a experimental subject, the ATTENDANCE to the laboratory sessions is COMPULSORY.	20	A2	B2	C25 C26 C27 C28 C29	D2 D3
Laboratory practice	Two practical laboratory tests will be carried out to assess the competences and skills acquired by the student.	30	A2	B2	C25 C26 C27 C28 C29	D3
Essay questions exam	Once all the practical sessions are finished, two short written tests will be carried out regarding the concrete aspects of the operations carried out in the laboratory.	20	A2	B2	C28 C29	D3

Other comments on the Evaluation

- The absences in laboratory sessions must be duly justified by an official document. These absences will penalize the grade.

- One unexcused absence implies the direct failure of the subject.

- More than 3 excused absences will mean failing the subject.

First ordinary examination call

- Attendance at more than two laboratory sessions implies that the student is already being evaluated, so that his/her qualification in the record can not be "not presented".

- It is necessary to obtain a grade higher than 4 (out of 10) in each of the sections of the evaluation to make an average. This criterion will also be applied in second call.

- The final grade will be the sum of the grades of all the sections provided that the required minimums are exceeded.

- It will be necessary to obtain a mark of more than 3 out of 10 in each of the practical laboratory tests and reach the minimum mark required in the "Laboratory practice" section (mark of more than 4 out of 10) to be able to average the rest of the evaluation elements.

- It will be necessary to obtain a mark of more than 3 out of 10 in each of the short written tests and reach the minimum mark required in the "Essay questions exam" section (mark of more than 4 out of 10) to be able to average the rest of the evaluation elements.

- In the case of not passing the subject, the grade of the record will be the weighted grade of the practical laboratory test and essay question exam.

Second ordinary examination call

In second call, the evaluation will be carried out in the following way: the score obtained by the student during the course will be kept in the section "laboratory practices" (not recoverable). The rest of the sections (laboratory practice, exam) can be recovered. In the event of having passed any of the practical and/or short written tests (marks of 5 out of 10 or more), the marks obtained by the student will be retained so that he/she will only have to repeat those tests that have not been passed in the first ordinary exam call. The final grade will be the sum of the grades of all the sections as long as the required minimums are exceeded. If the subject is not passed, the grade of the record will be the weighted grade of the practical laboratory test and essay question exam.

Sources of information

Basic Bibliography

J. Guiteras, R. Rubio, G. Fonrodona, **Curso Experimental en Química Analítica**, 1, Síntesis, 2003

F. Burriel, F. Lucena, S. Arribas, J. Hernández, **Química Analítica Cualitativa**, 18, Thomson Paraninfo, S.A., 2006

S. Arribas, **Análisis Cualitativo Inorgánico**, 5, Paraninfo, 1993

P. Atkins, L. Jones, **Principios de Química**, 5, Panamérica, 2012

R. Chang, K. A. Goldsby, **Química**, 12, McGraw-Hill, 2016

R. H. Petrucci, F. G. Herring, J. D. Madura, C. Bissonnette, **Química General**, 11, Pearson, 2017

Complementary Bibliography

D. P. Shoemaker, C. W. Garland, J. W. Nibler, **Experiments in Physical Chemistry**, 8, McGraw-Hill, 2008

Recommendations

Subjects that are recommended to be taken simultaneously

Physics: Physics 2/V11G201V01107
Geology: Geology/V11G201V01106
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry 2/V11G201V01109

Subjects that it is recommended to have taken before

Biology: Biology/V11G201V01101
Physics: Physics I/V11G201V01102
Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA				
Biochemistry				
Subject	Biochemistry			
Code	V11G201V01201			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	García Hevia, Lorena			
Lecturers	García Hevia, Lorena			
E-mail	lorena.garciahevia@unican.es			
Web	http://faitic.es			
General description	The objective of Biochemistry is to provide students with the basic knowledge about the structure and function of biomolecules, as well as about their corresponding biosynthesis and degradation routes. It also enables them to analyze and identify biomolecules.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C20	Know the structure and reactivity of the main classes of biomolecules and the chemistry of important biological processes
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Identify and recognise the structure of the distinct types of biomolecules and represent them properly.	A1 A3 A5	B1	C20	D3
Recognise the different biological activities of the distinct types of biomolecules.	A1 A3 A5	B1	C20	D3
Define the kinetical enzymatic of the reactions catalized by enzymes as well as his general mechanisms.	A1 A3 A5	B1	C20	D3
Relate the vitamins with the corresponding coenzymes of enzymatic reactions.	A1 A3 A5	B1	C20	D3
Explain the concept of Bioenergetics. Conceptually reason the importance of the coupling of endergonic and exergonic processes in biological systems.	A1 A3 A5	B1	C20	D3
It enumerate the main structural appearances of the ATP that determine his paper in the transfer of energy. It describes the cycle ATP.	A1 A3 A5	B1	C20	D3
Distinguish the metabolic roads of the biomolecules, as well as his interrelationships and regulation.	A1 A3 A5	B1	C20	D3
Justify the application of the different instrumental technicians in the analysis of biomolecules.	A1 A3 A5	B1 B3 B4	C20	D3
Distinguish and propose analytical protocols to apply the technicians mentioned for the analysis of biomolecules in diverse areas (clinical, pharmaceutical, biomedical, ...)	A1 A3 A5	B1 B3 B4	C20	D3

Contents	
Topic	
Subject 1. Amino acids and peptides	Amino acids: structure and classification. The peptide bond. Natural peptides of biological interest.
Subject 2. Proteins	General concept. Main functions of the proteins. Structural levels of the proteins
Subject 3. Enzymes and catalisis enzymatic	Concept, nomenclature and classification of the enzymes. Characteristics of the active centre. Kinetical of the enzymatic reactions: equation of Michaelis-Menten. Kinetical of the alosteric enzymes. Other mechanisms of the modulation of the enzymatic activities
Subject 4. Glucides	Monosaccharides: aldoses and cetoses. Linear structure. Structure cyclic and space formings. Monosaccharides of biological interest. Oligosaccharides and polysaccharides: general characteristics, structure and types more important to biological level.
Subject 5. Lipids	General characteristics and biological importance of the lipids. General classification. Characteristics and structure of the fatty acids. Saponifiable lipids: neutral and polar. Unsaponifiable lipids: eicosanoids, isoprenoids and steroids.
Subject 6. Vitamins and coenzymes	Structure and function of vitamins and coenzymes in metabolic reactions.
Subject 7. Nucleotides: structure and function	Biological importance. Composition and structure of nucleosides and nucleotides. Functions of the nucleotides.
Subject 8. Introduction to the metabolism.	General concepts of the energetic metabolism. The equivalent of the ATP. Definition of metabolic route: catabolic, anabolic and amphibole routes. Importance of the regulation of the metabolic routes.
Subject 9. Glycolysis and pyruvate metabolic destination	Stages and reactions of the glucolisis. Biological importance of this universal route. The glucolisis how amphibole route. Pyruvate metabolic destinations in anaerobiosis (fermentation lactic and alcoholic) and aerobiosis (acetilCoA synthesis in the mitochondrial matrix). Reoxidation of the cytosolic NADH. Stoichiometry and energetic balance of the glucolisis.
Subject 10. Cycle of the tricarboxilic acids (cycle of Krebs) and Pentose phosphate pathway	Central position of the acetilCoA molecule in the energetic metabolism. Reaccions of the cycle of Krebs. Paper of the cycle of Krebs like amphibole route. Energetic balance of the cycle Krebs and of the aerobic degradation of the glucose. Pentose phosphate pathway
Subject 11. Chain of electronic transport and oxidative phosphorylation	Chain of electronic transport: components, location and sequence of the electronic transport. Oxidative phosphorylation: ATP sintase enzymatic complex.
Subject 12. Gluconeogenesis	Overview of the synthesis of glucose de novo. Main gluconeogenic substrates. Own reactions of the gluconeogenesis.
Subject 13. Metabolism of the fatty acids	Activation and intracelular trnasport of the fatty acids. The beta-oxidation of the fatty acids. Energetic balance of the acid palmitic. Biosynthesis of acids fatty: acetilCoA carboxilase and Fatty acid synthase reaction. Elongation and desaturation of fatty acids.
Subject 14. Degradation of the amino acids and destination of the ammonium ion .	Overview of the catabolism of the amino acids: transamination and oxidative desamination reactions. Destination of the carbonate skeleton of the amino acids. Form of excretion of the ammonium ion in the alive organisms: the urea cycle
Subject 15. Aminoacids anabolism.	Nitrogen cycle in the nature. Incorporation of the ammonium ion to the biomoléculas through the glutamate and glutamine. Aminoacids biosynthesis.
Subject 16. Experimental methods in Biochemistry	Techniques used in the field of protein study: homogenization, subcellular fractionation, precipitation with salts, chromatographic, electrophoretic ...

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	12	24	36
Problem solving	24	54	78
Mentored work	0	10	10
Objective questions exam	1	12	13
Essay questions exam	1	12	13
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	In these classes the professor will explain and will develop the concepts and basic foundations of the *temario of clear form and *amena to facilitate his understanding. The contents of each subject will be exposed in the platform FEAR with sufficient time so that the students can consult them. It recommends that the student work on this material, consulting besides the bibliography recommended.
Problem solving	In this section we will try to: a) Each student of individual way or in groups will have to do a series of exercises to strengthen the study and understanding of the matter. These exercises will be considered for the evaluation. b) Clarify the doubts of the concepts previously explained in the master classes and in the seminars. c) In this section, we will also work on some contents related to energy metabolism, which, due to their difficult understanding, require didactic support.
Mentored work	Realization (search for information, preparation and presentation) of two work groups of 5 students. The works will be related to some of the contents of the subject of Biochemistry and will be proposed by the teacher. The teacher will be able to provide some of the information necessary for its execution. The work will be considered for evaluation. .

Personalized assistance	
Methodologies	**Description**
Lecturing	To resolve all the doubts that can arise in relation to the masterclasses, the students have to his disposal personalized tutorials that will take place in the dispatch 9 (block B of the Building of Experimental Sciences, flat 3º) of the professor PILAR SÚAREZ ALONSO, in the schedule established.
Problem solving	To resolve all the doubts that can arise in relation to the seminars, the students have to his disposal personalized tutorials that will take place in the dispatch 9 (block B of the Building of Experimental Sciences, flat 3º) of the professor PILAR SÚAREZ ALONSO, in the schedule established.
Mentored work	To resolve all the doubts that can arise in relation with the realization of the works, the students have to his disposal personalized tutorials that will take place in the dispatch 9 (block B of the Building of Experimental Sciences, flat 3º) of the professor PILAR SÚAREZ ALONSO, in the schedule established.
Tests	**Description**
Objective questions exam	To resolve all the doubts that can arise in relation with the examinations, the students will have to his disposal personalized tutorials that will take place in the dispatch 9 (Block B, Building of Experimental Sciences, flat 3º) of the professor PILAR SÚAREZ ALONSO, in the schedule established.
Essay questions exam	To resolve all the doubts that can arise in relation with the examinations, the students will have to his disposal personalized tutorials that will take place in the dispatch 9 (Block B, Building of Experimental Sciences, flat 3º) of the professor PILAR SÚAREZ ALONSO, in the schedule established.

Assessment			
	Description	Qualification	Training and Learning Results
Problem solving	The assistance the masterclasses and seminars is very recommended for the back realization of a series of exercises: multiple choice questions, reasoning questions and various calculations that will reinforce the content acquired by the student. The realization of the exercises of each subject is obligatory and always in groups of 2 or 3 students. They are not individual. It is essential to obtain a minimum score of 6.0 out of 10 to be able to consider the rest of the sections. This activity is not recoverable if the required minimum is not reached.	20	A1 B1 C20 D3 A3
Mentored work	The realization of the works is obligatory, always in groups of 4 or 5 students and they will deal with some of the contents of the subject of Biochemistry. Both individual student work and group work will be assessed. The structure, originality, use of language in general and scientific terminology will be taken into account. The adequacy of the format previously required will also be taken into account. The works may be presented in the languages: Galician or Spanish. It is essential to obtain a minimum score of 7.0 out of 10 to be able to consider the rest of the sections. This activity is not recoverable if the required minimum is not reached.	20	A3 B1 C20 D3 A5 B3 B4

Objective questions exam	There will be a partial test in the middle of the academic year, which will consist of test questions and short questions, and will represent 20% of the Biochemistry subject. It is essential to obtain a minimum grade of 5.0 out of 10 to be able to weigh with the rest of the sections. For students who passed the previous partial test, the final exam will cover the syllabus from the first partial onwards, and will represent 40% of the final grade. For students who did not pass the previous test, this exam will correspond to the entire Biochemistry syllabus and will account for 60% of the final grade. In any case, it is essential to obtain in this section a minimum grade of 5.0 out of 10 to be able to pass the Biochemistry subject, as well as weigh with the rest of the sections.	25	A1 B1 C20 D3 B3
Essay questions exam	There will be a second partial written test corresponding to the Metabolic Biochemistry part (items 8 - 15) on the date approved by the Faculty Board (consult the center's website). This test will consist of multiple choice questions, a metabolism integration question that includes the calculation of ATP performance. It is essential to obtain a minimum grade of 4.0 out of 10 in order to be weighted with the rest of the sections. This test will account for 35% of the final grade for the Biochemistry subject.	35	A3 B1 C20 D3 A5 B3 B4

Other comments on the Evaluation

The evaluation of the subject of Biochemistry is continuous throughout the entire academic year. To be evaluated in this way, the student must carry out all the evaluable activities (problem solving, tutored work and two partial written tests).

The particular situations of each student that prevent participation in these activities on a regular basis (Example: employment contract, illness... etc) must be communicated as soon as possible to the responsible teacher to find a solution.

To pass the Biochemistry course (final grade as the sum of the weighted grades) it is essential to have obtained a grade equal to or higher than the minimum grade required in each of the activities that can be evaluated separately. If this is not the case, the total calculation will not be carried out and the grade that will appear in the Biochemistry report will be the highest of the failed sections, and the student must take the entire subject exam in the second call (July).

The final exam in the xullo call is equivalent to 60% of the final grade and is considered approved when a grade equal to or greater than 4.0 out of 10 is achieved.

It is important to note that problem solving activities and tutored work are not recoverable.

In the event that the student does not participate in any of the evaluable activities, he will appear as NOT PRESENTED in the Biochemistry certificate in both calls (January and July). On the contrary, participation in some of the evaluable activities but not in all of them will automatically imply a fail in the Biochemistry Act (both calls).

These criteria will be applied identically in the two calls (January and July).

The notes of the activities carried out during the course (solving exercises, supervised works and partial examination of objective questions) are kept throughout the academic year, as long as they have reached the required minimum grade.

Schedule: http://química.uvigo.es/eres/docencia/horariosExaminations: http://química.uvigo.es/eres/docencia/examenes

Sources of information

Basic Bibliography

J:M. Berg; J.L. Tymoczko; G.J. Gatto Jr; Stryer, L., **Biochemistry**, 9th, MacMillan, 2019

NELSON D. L. & COX M. M, **Lehninger. Principles of Biochemistry. International edition**, 7th, W.H.Freman &Co Ltd, 2017

Complementary Bibliography

José Mª Teijón Rivera y Mª Dolores Blanco Gaitán, **Fundamentos de la Bioquímica metabólica**, 4ª, Tebar, 2016

José Mª Teijón Rivera y Mª Dolores Blanco Gaitán, **Fundamentos de la Bioquímica estructural**, 3ª, Tebar, 2017

NELSON D. L. & COX M. M, **Lehninger. Principios de Bioquímica**, 7ª, Omega, 2019

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA

Analytical Chemistry I: Principles of Analytical Chemistry

Subject	Analytical Chemistry I: Principles of Analytical Chemistry			
Code	V11G201V01202			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Pérez Cid, Benita			
Lecturers	Calle González, Inmaculada de la Pena Pereira, Francisco Javier Pérez Cid, Benita			
E-mail	benita@uvigo.es			
Web				
General description	The main objective of this matter is that the students achieve the competences to be able to handle volumetric and gravimetric chemical analysis, both in the theoretical and applied aspects. The theory classes are complemented with seminars and laboratory practices.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B4	Ability for analysis and synthesis
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Describe the fundamental steps of the analytical process like methodology for the resolution of analytical problems.	A3	B4	C6	D1
Identify basic analytical properties and errors that can affect analytical results.	A3	B4	C6 C29	D1
Solve the possible interaction between concurrent reactions in solution (acid-base, complexes, precipitation and redox).	A1	B4	C6 C29	D1
Construct and interpret titration curves (acid-base, complex, precipitation and redox) and select the most appropriate indicators in each case.	A3	B4	C6 C29	D1
Handle the systematic calculation in volumetric and gravimetric analysis and interpret the results.	A3	B4	C6 C26 C29	D1
Experimentally apply volumetric and gravimetric analysis procedures and correctly express the results obtained.	A1 A3	B4	C6 C26 C29	D1
Appropriately handle the material used in the analytical laboratory and apply the safety standards required.	A1		C26	D1

Contents

Topic	
Subject 1: Analytical Chemistry and analytical process	Analytical chemistry as a metrological science. Classification of analytical methods. The analytical process: stages.

Subject 2. Evaluation of the analytical results	Analytical properties. Errors in Analytical Chemistry: Classification. Basic statistics applied to the expression of the analytical results. Comparison and rejection of results.
Subject 3: Introduction to volumetric and gravimetric quantitative analysis	Volumetric reactions. Standard solutions. Direct, indirect and back titrations. Formation, properties and purity of precipitates. Calculations of gravimetric and volumetric analysis.
Subject 4: Acid-base titrations	Behavior of monoprotic, polyprotic and amphoteric species. Titration curves. End point detection: acid-base indicators. Titran reagents. Analytical applications.
Subject 5: Complexometric titrations	Stability of the complexes. Masking reactions. Titration curves. Detection of the end point: metallochromic indicators. Analytical applications.
Subject 6: Precipitation titrations.	Factors affecting the solubility of precipitates. Titration curves. Detection of the end point: Mohr, Volhard and Fajans methods. Analytical applications.
Subject 7: Redox titrations	Factors influencing the redox potential. Titration curves. Detection of the end point: redox and specific indicators. Analytical applications.
Gravimetric analysis (Laboratory)	Gravimetric determination of nickel with dimethylglyoxime. (1 session)
Acid-base titrations (Laboratory)	Determination of the acidity of a vinegar sample. (1 session) Determination of acetylsalicylic acid in analgesics (1 sesion)
Complexation titrations (Laboratory)	Determination of the hardness of a water sample . (1 session)
Precipitation titrations (Laboratory)	Determination of chloride in seawater using the Mohr method. (1 session)
Redox titrations (Laboratory)	Determination of wealth in oxygen in a hydrogen peroxide sample. (1session) Determination of active chlorine in a bleach sample. (1 session)
Resolution of a practical case (Laboratory)	Analysis of a problem sample of unknown composition. (1 session)

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	24	48
Seminars	12	24	36
Laboratory practical	24.5	12	36.5
Essay questions exam	2	7	9
Essay questions exam	0	12	12
Laboratory practice	3.5	5	8.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	They are theoretical classes in which the professor will explain each one of the topics of the program, emphasizing in the most relevant aspects and in those with more difficulty for the student. The classes will be developed interactively with the students, commenting the on-line material (available in Moovi) and the most appropriate bibliography for the preparation, in depth, of each topic.
Seminars	In the seminars, numerical exercises will be solved to reinforce the knowledge acquired in the theoretical classes. These exercises will be available in Moovi, as worksheets. The teacher may request the students to provide, individually, some of the proposed exercises to be reviewed and evaluated.
Laboratory practical	Laboratory experiments will be carried out in sessions of 3.5 h each. The students will have the guidelines of practices with sufficient anticipation (on-line material), so that they can have a previous knowledge of the experiments to performe. During the development of the practices the student will elaborate a notebook in which they will annotate all the relative to the experiment carried out (reactions, procedures, observations, results, etc.).Those students who have passed the laboratory practices in the academic years 2022-23 and 2023-24, do not need to repeat them. In this case, the marks reached in the laboratory sessions will be maintained.

Personalized assistance	
Methodologies	**Description**
Seminars	Time dedicated by the professor to attend to all the doubts and questions made by the student during the course. The available time will be informed in the presentation of the course.

Lecturing	Time dedicated by the professor to attend to all the doubts and questions made by the student during the course. The available time will be informed in the presentation of the course.
Laboratory practical	Time dedicated by the professor to attend to all the doubts and questions made by the student during the course. The available time will be informed in the presentation of the course.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	It will value the resolution, by part of the students, of some of the problems and/or exercises proposed in the worksheets, that have to be delivered to the professor.	15	A1 C6 D1 A3 C29
Laboratory practical	The professor will made an evaluation of the experimental work carried out by the students in the laboratory sessions, evaluating the skills acquired as well as the results of each experiment. It is important to indicate that it is COMPULSORY the assistance to all the laboratory sessions. The lack of assistance will penalize the mark and when the number of absences is upper than 25 % of the laboratory sessions, students will not be allowed to pass the practical part of the course.	15	A1 C6 D1 A3 C26 C29
Essay questions exam	SHORT PROOF: A first written proff will be held when the first part of the programme has been given, in which the competences acquired up to that point will be assessed. This exam will not eliminate subject matter and will be carried out on the date indicated in the academic programme of the course, approved by the Faculty Meeting.	15	A1 C6 D1 A3 C29
Essay questions exam	FINAL EXAM: At the end of the course there will be a written proof consisting of theoretical questions and numerical exercises. In order to average both parts it will be necessary to achieve a minimum mark of 3 points out of 10 in each of them. In addition, the student must achieve in this exam a minimum mark of 4 points out of 10 to be added to the rest of the evaluation elements. This test will be carried out on the date indicated in the academic programme of the course, approved by the Faculty Meeting.	40	A1 C6 D1 A3 C29
Laboratory practice	In the last laboratory session, it will make a laboratory proof that will allow to evaluate all the competences and skills acquired by the student during the laboratory sessions. It is mandatory to overcome this exam, with a minimum mark of 5 points out of 10, to pass the practical part of the course.	15	A1 C6 D1 A3 C26 C29

Other comments on the Evaluation

First opportunity (continuous evaluation): To pass the course, it is compulsory to pass individually each one of the parts: theory and laboratory practices. For this, it is necessary to achieve a minimum mark of 4 points out of 10 in the final exam (at the end of the course) and 5 points out of 10 in the laboratory proof. The mark corresponding to the practical part of the curse (laboratory) will be only taken into account in the final mark once the theory has been passed. The participation of the student in written exams and the assistance to laboratory sesions (two or more) will involve the condition of presented and, therefore, the assignment of a mark.

Second opportunity (continuous evaluation): In the second opportunity (July) the student may repeat those exams (theory and/or laboratory) that have not passed in the first opportunity. It will be preserved the mark reached by the student, during the course, in the laboratory practicals (15%). In this announcement, the exam corresponding to the theoretical part of the course will represent the 70% of the final mark and the laboratory proof the 15%, always following the same considerations established for the first opportunity.

Global evaluation mode (non-continuous): Students who wish to use this evaluation mode must inform, by writing, within the period stablished in the Faculty at the beginning of the course. In this case, the evaluation will consist of the following parts: laboratory practices (30%) and global evaluation exam (70%) and it will be necessary to achieve a minimum mark of 5 points out of 10 in each of the proofs (theory and laboratory) in order to pass the course.

Sources of information

Basic Bibliography

D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, **Fundamentos de Química Analítica**, 9ª Ed., Cengage Learning, 2015

Gary D. Christian, **Química Analítica**, 6ª Ed., McGraw-Hill, 2009

D.C. Harris, **Análisis Químico Cuantitativo**, 3ª Ed., Reverté, 2007

F. Burriel, S. Arribas, F. Lucena y J. Hernández, **Química Analítica Cualitativa**, 18ª Ed., Paraninfo, 2002

J.N. Miller y J.C. Miller, **Estadística y Quimiometría para Química Analítica**, 4ª Ed., Prentice Hall, 2002
P. Yañez-Sedeño Orive, J.M. Pingarrón Carrazón, A. González Cortés, **300 Problemas Resueltos de Química Analítica**, 1ª Ed., Síntesis, 2022
J. Guiteras, R. Rubio, G. Fonrodona, **Curso Experimental en Química Analítica**, 1ª Ed., Síntesis, 2003

Complementary Bibliography

D.A. Skoog, D.M. West , F.J. Holler, S.R. Crouch, **Química Analítica**, 7ª Ed., McGraw-Hill, 2001
D. Harvey, **Química Analítica Moderna**, 1ª Ed., McGraw-Hill, 2002
J. A. López Cancio, **Problemas Resueltos de Química Analítica**, 1ª Ed., Paraninfo, 2005

Recommendations

Subjects that continue the syllabus

Analytical Chemistry II: Optical Methods of Analysis/V11G201V01207

Subjects that are recommended to be taken simultaneously

Physical chemistry I: Chemical thermodynamics/V11G201V01203
Inorganic chemistry I/V11G201V01204
Organic chemistry I/V11G201V01205

Subjects that it is recommended to have taken before

Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA

Physical chemistry I: Chemical thermodynamics

Subject	Physical chemistry I: Chemical thermodynamics			
Code	V11G201V01203			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Tojo Suárez, María Concepción			
Lecturers	Mandado Alonso, Marcos Ramos Berdullas, Nicolás Tojo Suárez, María Concepción			
E-mail	ctojo@uvigo.es			
Web				
General description	The subject "Physical Chemistry I" is one of the first contacts of the students of the "Degree in Chemistry" with Physical Chemistry. This discipline studies the properties and behavior of chemical systems using the methods of Physics. The subject deals with the rigorous macroscopic treatment of chemical systems in equilibrium, systems already introduced in the subject "Chemistry II". Taking advantage of the basic knowledge of the principles of Thermodynamics, they will be applied to systems of chemical interest to have a quantitative description of them. For this quantitative treatment it is essential to be familiar with the differential calculus of more than one variable and the integral calculus of one variable, aspects addressed in the subject "Mathematics I". The knowledge about the macroscopic description of the chemical systems that will be achieved in this subject is complemented with the contents of the "Physical Chemistry II" of the second semester and with the subject "Physical Chemistry V" of the third year.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
B1	Ability for auronomous learning
B3	Ability to manage information
C11	Know the principles of Thermodynamics and its applications in Chemistry
C13	Know the principles and applications of electrochemistry
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
D1	Ability to solve problems
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Explain the energetic exchanges in the thermodynamic systems in function of the changes in the variables of state.	A1	B1 B3	C11 C28 C29	D1 D3
Establish if a thermodynamic process that is spontaneous or not from the calculation of the variations of the thermodynamic properties.	A1	B1 B3	C11 C29	D1 D3
Handle thermodynamic tables to obtain values of the functions of thermodynamic state of reaction to different temperatures.	A1	B1 B3	C11 C28 C29	D1 D3
Determine the thermodynamic characteristics of a change of phase, and know the interval of applicability of the equations employed	A1	B1 B3	C11 C29	D1 D3
Calculate the thermodynamic properties of an ideal solution from his composition	A1	B1 B3	C11 C29	D1 D3
Analyse the colligative properties of a solution from the concentration of the solute and the properties of the dissolvent.	A1	B1 B3	C11 C28 C29	D1 D3

Describe of the behaviour of the real solutions employing the concepts of activity and coefficient of activity and be able to calculate them from experimental data and theoretical models.	A1	B1 B3	C11 C28 C29	D1 D3
Calculate the thermodynamic constant of reactions, from the concentrations or activities of the species and relate it with the thermodynamic functions.	A1	B1 B3	C11 C13 C28 C29	D1 D3

Contents	
Topic	
The laws of the Thermodynamic in Chemistry.	First Law of Thermodynamics. Internal energy. Enthalpy. Heat capacities . Thermochemistry. Second law of Thermodynamics. Entropy. Third law of Thermodynamics.
Thermodynamic functions.	Gibbs Equations. Maxwell relationships. Calculation of variations of the state functions . Partial Molar quantities. Chemical potential of ideal and real gases.
Phase equilibrrium in one component systems.	Phases Rule. First order transitions. Clapeyron and Clausius-Clapeyron Equations.
Ideal Solutions.	Molar partial Volume. Ideal solutions: Raoult's law. Ideal diluted solutions: Henry's Law. Colligative Properties
Non-ideal Solutions.	Deviations of the Raoult's law. Activity and activity coefficient . Electrolitic solutions. Debye-Hückel theory.
Chemical equilibrium.	Equilibrium in gas phase reactions. Response of equilibrium to temperature and pressure changes. Acid-base equilibria. Solubility Product. Electrochemical systems.
Laboratory Practices.	- Experimental determination of equilibrium constants using spectrophotometric or potentiometric techniques. - Experimental determination of enthalpies of combustion, dissolution, neutralization, fusion or vaporization. - Experimental determination of colligative properties.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	33	57
Seminars	24	33	57
Laboratory practical	14	2.5	16.5
Problem and/or exercise solving	0	8.5	8.5
Self-assessment	0	4	4
Essay questions exam	2	0	2
Essay questions exam	2	2	4
Report of practices, practicum and external practices	0	5	5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	They will consist of an exposition by the teacher of the fundamental aspects of each topic, based on the material available on the MOOVI platform. Numerical problems will also be formulated to help understand and settle concepts.
Seminars	The seminar classes will be devoted mainly to solving problems and, when necessary, to delve into the aspects of the topics that present the greatest difficulties for the students.
Laboratory practical	Carrying out, under the supervision of the teaching staff but independently, of laboratory practices in sessions of 3.5 hours. With enough time in advance, the students will have the scripts for the practices to be carried out on the MOOVI platform, along with all the additional material necessary. The script will present the essential elements to carry out the practice at an experimental level, as well as the basic points of its theoretical foundation and data treatment. At the end of the practices, and within the term set by the teaching staff, it will be necessary to deliver the report of one of them, prepared following the guidelines given by the teaching staff.

Personalized assistance	
Methodologies	**Description**
Lecturing	In the teacher's tutoring schedule, those doubts of the students that may arise throughout the course in the theory classes will be resolved individually and more personally.

Seminars	In the teacher's tutoring schedule, those doubts of the students that may arise throughout the course in the seminar classes will be resolved individually and more personally.
Laboratory practical	In the teacher's tutoring schedule, those doubts of the students that may arise during the course in the laboratory classes or during the preparation of the corresponding practical reports will be resolved individually and on a more personal basis.

Tests	**Description**
Essay questions exam	In the teacher's tutoring schedule, those doubts of the students that may arise throughout the course during the preparation of the first written exam will be resolved individually and more personally.
Report of practices, practicum and external practices	In the teacher's tutoring schedule, those doubts of the students that may arise during the course in the laboratory classes or during the preparation of the corresponding practical reports will be resolved individually and on a more personal basis.
Essay questions exam	In the teacher's tutoring schedule, those doubts of the students that may arise throughout the course during the preparation of the second written exam will be resolved individually and more personally.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	It marks here together with the effort and the attitude, the skills and the competitions developed by the students during the realisation of the distinct practical. Attendance at the practical sessions is mandatory and, therefore, it is not possible to pass the subject if it is not completed.	5	A1 B1 C11 D1 B3 C28 D3 C29
Problem and/or exercise solving	In addition to the problem bulletins, at the end of each topic or group of topics, some "Assessable Exercises" will be proposed. The students must solve them independently and deliver within the deadline set by the teaching staff.	12	A1 B1 C11 D1 B3 C13 D3 C29
Self-assessment	At the end of each topic, students will have the possibility of answering, through the MOOVI platform, a self-correcting "Self-Assessment Test".	8	A1 B1 C11 D1 B3 C13 D3 C29
Essay questions exam	There will be a written exam halfway through the semester on the date approved by the Faculty Board. This test will cover the contents of subjects I, II and III.	35	A1 B1 C11 D1 B3 C29 D3
Essay questions exam	A written exam will be carried out at the end of the semester on the date approved by the Faculty Board (the date will coincide with that of the Global Test for students of the Global Assessment modality). This test will cover the contents of subjects IV, V and VI.	35	A1 B1 C11 D1 B3 C13 D3 C29
Report of practices, practicum and external practices	The report of a practice proposed by the teaching staff will be made, which must be presented taking care of the formal aspects related to the organization, the correct use of the units, the correct preparation of the graphics and the presentation of the results. The critical analysis of these and drawing conclusions will also be valued.	5	A1 B1 C11 D1 B3 C28 D3 C29

Other comments on the Evaluation

Continuous assessment:

- The voluntary work of the student ("*Self-assessment Test*" and "*Evaluable Exercises*") may constitute up to 20% of the final grade provided that the student performs at least half of the activities proposed throughout the course. course.
- To pass the subject, it is an essential requirement that the average of the marks in the written exams be equal to or greater than 4.0 out of 10.0 points. In the case of not reaching said score, the qualification that will be reflected in the minutes will only be the average of the qualifications of the tests, not counting any of the other sections.

- To pass the subject, it is an essential requirement to carry out the laboratory practices and obtain in them a minimum global qualification of 5.0 out of 10 points (50% laboratory work, 50% report). In the case of not reaching said score, the grade that will be reflected in the minutes may not exceed 4.0 points.
- Attendance to the practical sessions is mandatory and, therefore, it is not possible to pass the subject if it has not been done.
- To pass the subject, it is an essential requirement to obtain a grade equal to or greater than 5.0 points out of 10 in its overall grade (10% laboratory practices, 12% evaluable exercises, 8% self-assessment questionnaires and 70% written tests).

Overall evaluation:

Students who, within the term set by the Faculty, opt for the Global Assessment modality, will take a global written exam on the date set by the Xunta de Facultade. This overall written test will account for 85% of the grade for the subject.
In this global evaluation, the Laboratory Practices will constitute 7% of the qualification of the subject and 8% the corresponding reports.
- To pass the subject, it is an essential requirement to obtain a grade equal to or greater than 4.0 out of 10.0 in the overall written exam. In case of not reaching said score, the qualification that will be reflected in the minutes will only be the qualification of the global test, not counting any of the other sections.
-To pass the subject, it is an essential requirement to carry out the laboratory practices and obtain an overall minimum grade of 5.0 out of 10 points (47% laboratory work, 53% report). In the case of not reaching said score, the grade that will be reflected in the minutes may not exceed 4.0 points
- To pass the subject, it is an essential requirement to obtain a grade equal to or greater than 5.0 points out of 10 in its overall grade (85% overall test, 7% laboratory practices and 8% practice reports).
Examined/Not Examined Status:The participation of the students in one of the two written tests or the attendance of more than two laboratory sessions will imply the condition of "taked exam" and, therefore, the assignment of a qualification.
Second opportunity:In the case of the Continuous Evaluation for the evaluation of the second opportunity, the qualifications of the "*Evaluable Exercises*", of the "*Self-assessment Test*", of the laboratory practices and of the corresponding reports will be maintained.

In the case of the Global Evaluation for the evaluation of the second opportunity, the qualifications of the laboratory practices and the corresponding reports will be maintained.

Sources of information

Basic Bibliography

Levine, I. N., **"Principios de Fisicoquímica"**, 6ª Ed, McGraw-Hill Education, 2014
Engel, T.; Reid, P., **"Química Física"**, 1ª Ed, Pearson, Adison Wesley, 2006
Atkins, P.W.; De Paula, J., **"Química Física"**, 8ª Ed, Editorial Médica Panamericana, 2008

Complementary Bibliography

Levine, I.N., **"Problemas de Fisicoquímica"**, 1ª Ed, McGraw-Hill Interamericana, 2005
Rodríguez Renuncio, J.A., **"Termodinámica Química"**, 2ª Ed, Síntesis, 2000
Rodríguez Renuncio, J.A., **"Problemas resueltos de Termodinámica Química"**, 1ª Ed, Síntesis, 2000
Chang, R., **"Fisicoquimica"**, 3ª Ed, McGraw-Hill Interamericana, 2008
Metz, C.R., **"Fisicoquímica. Problemas y Soluciones"**, 1ª Ed, McGraw-Hill Interamericana, 1991

Recommendations

Subjects that continue the syllabus

Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Physical Chemistry V: Chemical Kinetics/V11G201V01308

Subjects that it is recommended to have taken before

Mathematics: Mathematics 1/V11G201V01103
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA				
Inorganic chemistry I				
Subject	Inorganic chemistry I			
Code	V11G201V01204			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	Spanish			
Department				
Coordinator	Castro Fojo, Jesús Antonio			
Lecturers	Carballo Rial, Rosa Castro Fojo, Jesús Antonio González Ballesteros, Noelia Rodríguez Arguelles, María Carmen			
E-mail	jesusc@uvigo.es			
Web				
General description	In this subject pretends give an overview of the chemical behaviour of the no metallic elements of the main groups and of his more important compounds.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C8	Know the characteristic properties of the elements and their compounds, including the relations between groups and their variations in the periodic table
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D2	Capacity for teamwork

Expected results from this subject	Training and Learning Results			
Deduce the physical properties of an element or compound from the type of link and/or intermolecular strengths	A2 A3	B1 B3 B4	C8 C9	
Choose the general method more adapted for the obtaining of the no metallic elements and his more important compounds	A2 A3	B1 B3 B4	C8 C9	
Know the structure and the most stood out reactivity of the no metallic elements and his compounds	A2 A3	B1 B3 B4	C8 C9	
Relate the physical and chemical properties of some substances of interest with his applications	A2 A3	B1 B3 B4	C8 C9	
Carry out in the laboratory the preparation of some elements and of his compounds, as well as the study of some of his physical and chemical properties		B1 B3 B4	C26	D2

Contents	
Topic	
1. Hydrogen	Obtaining. Physical and chemical properties. Hydrides: classification and general study of the same. The water.
2. Noble gases	General characteristics. Properties and uses. Xenon fluorides. Combinations of xenon with oxygen.

3. Halogens	General characteristics. Obtaining, properties and reactivity. Halides. Oxides, oxo acids and oxosalts. Interhalogen compounds and ions polyhalide. Fluorocarbons.
4. The Group 16 elements	General characteristics. Oxygen and ozone. Obtaining, properties and reactivity. Derived ions. Hydrogen peroxide. Sulfur. Obtaining, properties and reactivity. Hydrogenated and halogenated combinations of sulfur. Sulfur oxides, oxoacids and oxosalts.
5. The Group 15 elements	General characteristics. Nitrogen and phosphorous. Obtaining, properties and reactivity. Hydrogenated and halogenated combinations. Oxides, oxoacids and oxosalts of nitrogen and phosphorus
6. The Group 14 elements	General characteristics. Carbon. Obtaining, properties and reactivity. Oxides and carbonates. Carbides Halogenated combinations and nitrogenous. Silicon and germanium. Obtaining, properties and reactivity. Hydrides and halides. Oxides. Silicates. Silicones
7. The Group 13 elements	General characteristics. Boron. Obtaining, properties and reactivity. Hydrides and halides. Compounds with nitrogen. Oxides, oxoacids and oxosalts.
Session 1	Study of the chemical properties of oxides. Covalent and ionic solids. Synthesis of MgO
Session 2	Study of the chemical properties of oxides. Synthesis of sulfur dioxide.
Sessions 3-4	Obtaining and chemical behavior of halogens.
Session 5	Synthesis and reactivity of group 16 compounds. Barium peroxide
Session 6	Synthesis and reactivity of group 16 compounds. Oxoacids and oxosalts of sulfur
Session 7	Synthesis and reactivity of group 15 compounds. Synthesis and study of ammonia.
Session 8	Synthesis and reactivity of group 13 compounds. Synthesis and study of boric acid.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	12	36
Seminars	12	12	24
Laboratory practical	28	0	28
Essay questions exam	1	30	31
Essay questions exam	1	30	31

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

Methodologies

	Description
Lecturing	Presentation by the teaching staff on the subject to be developed, with special emphasis on the most important or difficult to understand aspects for students. Teachers will use the Moovi platform to provide information on the subject or its development.
Seminars	One hour per week will be dedicated to discuss and resolve issues on the subject previously the students will have to work.
Laboratory practical	The experiments will be carried out over 8 sessions of 3.5 hours each. The student body you will have the practice scripts as well as the necessary support material on the platform Moovi so that you can have prior knowledge of the experiments to be performed. The students must prepare the laboratory notebook during the practicals.

Personalized assistance

Methodologies	Description
Lecturing	Personalized attention will be given to students through individual tutorials. In these, an attempt will be made to answer all the doubts that the students have about the subject taught in theory. The schedule available for these tutorials will be indicated in the presentation of the subject, and will always be as information on the Moovi platform.
Seminars	Personalized attention will be given to students through individual tutorials. In these, an attempt will be made to answer all the doubts that the students have about the subject taught in seminars. The schedule available for these tutorials will be indicated in the presentation of the subject, and will always be as information on the Moovi platform.

Laboratory practical	Personalized attention will be given to students and also individual tutorials if needed. The schedule available for these tutorials will be indicated in the presentation of the subject, and will always be as information on the Moovi platform.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	The resolution by the students of issues dealt with will be valued throughout the seminars at the time/conditions established by the professor	20	A2 B1 C8 A3 B3 C9 B4 C26
Laboratory practical	Attendance at laboratory sessions is compulsory. The teaching staff will follow up on the experimental work carried out by the students in the laboratory sessions, as well as the notebook elaborated. A series of questions will be asked during the sessions that will allow evaluate the competences and skills acquired by the students.	20	B1 C26 D2 B3 B4
Essay questions exam	1st Test on specific aspects of the contents explained in class, seminars and practices. This test may be eliminatory when students achieve a minimum grade of 5 points out of 10. This Test will be done on the date listed in the course schedule.	30	A2 B1 C8 A3 B3 C9 B4 C26
Essay questions exam	2nd Test on specific aspects of the contents explained in class, seminars and practices. This test may be eliminatory when students achieve a minimum grade of 5 points out of 10. This Test will be carried out on the date that appears in the schedule as final exam.	30	A2 B1 C8 A3 B3 C9 B4 C26

Other comments on the Evaluation

The participation of the students in any of the acts of evaluation of the matter will imply the condition of presented/to and, therefore, the assignment of a qualification. Acts of evaluation are considered to be attendance at practical laboratory classes (three or more) and taking tests.

To pass the subject, students must have completed the practices of the subject and take the 2 tests of development questions. In these, it will be essential to achieve a minimum score of 5 points out of 10, in order to count the notes acquired in the follow-up of seminars, theoretical classes and in the practices carried out. Once all the scores have been taken into account, students must achieve a global grade of at least 5 out of 10 to pass the subject.

July call. Students who do not pass the subject at the end of the semester must take an assessment test during the July session. Said test will replace the results of the qualifying tests carried out throughout the semester and will have a value of up to 50%. The follow-up qualification of seminars and laboratory practices obtained throughout the semester is maintained.

The students who renounce the continuous evaluation have to chose the global evaluation of the subject. To pass the subject through the overall assessment, the student will take a comprehensive written test (80%) on specific aspects of the content explained in class, seminars and practices. Moreover, there will be a laboratory session (20%). In the written test it will be essential to achieve a minimum score of 5 points out of 10, in order to count the grade acquired in the laboratory practices, also with 5 point minimum. The global written test will be carried out on the official date of the exam for each evaluation opportunity within the official testing period marked in the academic calendar (1st opportunity (December-January) and 2nd opportunity (June-July). The laboratory session will be on the same day, but in the afetrnoon session if probe is at morning, and vice versa.

Sources of information

Basic Bibliography

HOUSECROFT, C.E. Y SHARPE, A. G., **Inorganic Chemistry, 5ª Ed**, 978-1-292-13414-7, 5, Pearson, 2018

RAYNER-CANHAM, G., OVERTON, T., **Descriptive Inorganic Chemistry, 6ª Ed**, 978-1464125577, 6, W.H. Freeman, 2014

Shriver & Atkins, **Química Inorgánica, 5º ed.**, 9780199236176, 5, McGraw-Hill, 2010

Complementary Bibliography

RAYNER-CANHAM, G, **Química Inorgánica Descriptiva, 2.ª Ed**, 9789684443853, Pearson Education, 2000

HOUSECROFT, C.E. Y SHARPE, A. G., **Química Inorgánica, 2.ª Ed (español)**, Pearson- Prentice Hall, 2006

Recommendations

Subjects that continue the syllabus

Inorganic chemistry II/V11G201V01209

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA				
Organic chemistry I				
Subject	Organic chemistry I			
Code	V11G201V01205			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Muñoz López, Luis Iglesias Antelo, María Beatriz			
Lecturers	Iglesias Antelo, María Beatriz Muñoz López, Luis Teijeira Bautista, Marta			
E-mail	bantelo@uvigo.gal lmunoz@uvigo.es			
Web				
General description	In this subject, the students reach an understanding of the fundamental principles of Organic Chemistry, regarding structure and reactivity of organic compounds. Following two lessons on general concepts, the reactivity of functional groups with multiple carbon-carbon bonds (including aromatic compounds) will be studied. English Friendly subject. International students may request from the teaching staff: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B3	Ability to manage information
C17	Know the nature and behavior of functional groups in organic molecules
C25	Safely handle chemical substances, considering their physical and chemical properties, evaluating the risks associated with their use and laboratory procedures and including their environmental repercussions
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Represent the three-dimensional structure of organic molecules.	A2 A5	B1		
Apply the principles of stereochemistry to the analysis of stereoisomers.	A2 A5	B1		
Distinguish the most usual reactions in Organic Chemistry.	A2 A5	B1		
Establish the influence of the structure and the chemical characteristics of the functional groups present in a molecule in its reactivity.	A2 A5	B1	C17	
Explain the reactivity of organic compounds with multiple carbon-carbon bonds through an electrophilic addition mechanism.	A2 A5	B1	C17	
Explain the reactivity of aromatic compounds through an electrophilic substitution mechanism.	A2 A5	B1	C17	
Apply the rules for safety and health in laboratory work and carry out the treatment and correct elimination of the waste generated.			C25	
Appropriately write and describe the experiments in the laboratory notebook, so that they can be reproduced.		B2 B3		D3

Contents	
Topic	
Lesson 1. Conformational analysis. Stereochemistry	Conformational analysis in cyclic compounds. Configurational stereoisomerism.
Lesson 2. Reactivity of organic compounds	Acid-base reactivity of organic compounds. Reaction mechanisms: stepwise reactions. Energetic profile of a reaction. Heterolytic bond cleavage. Ionic reactions. Reaction intermediates: carbanions. Redox reactivity of organic compounds. Formal states of oxidation.
Lesson 3. Addition reactions to carbon-carbon multiple bonds	Structure and general reactivity of functional groups with carbon-carbon multiple bonds: alkenes and alkynes. Hydrogenation: homolytic bond cleavage; concerted reactions. Electrophilic addition reactions to alkenes. Addition of HX; reaction intermediates: carbocations; regioselectivity; electrophiles and nucleophiles. Hydration reactions; orientation and stereochemistry. Addition of halogens. Dihydroxylation reactions. Addition reactions to alkynes.
Lesson 4. Aromatic substitution reactions	Structure and general reactivity of aromatic compounds. General mechanism for the electrophilic aromatic substitution reaction. Reactions with non-carbon electrophiles. Reactions with carbon electrophiles. Electrophilic aromatic substitution reactions in substituted systems: orientation and reactivity. Modulation of the reactivity of aromatic rings.
Laboratory Practices	Application of the techniques acid-base extraction and thin layer chromatography to the separation of mixtures of compounds, their identification and characterization.

Planning			
	Class hours	Hours outside the classroom	Total hours
Flipped Learning	12	24	36
Problem solving	15	48	63
Collaborative Learning	8	6	14
Laboratory practical	14	5	19
Problem and/or exercise solving	1	5	6
Problem and/or exercise solving	1	5	6
Problem and/or exercise solving	1	5	6
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Flipped Learning	Some learning activities will take place out of the classroom. Afterwards, in the classroom, with the presence of the teacher, other processes of knowledge acquisition and practice will be facilitated. Prior to the class sessions, a selection of materials (audiovisual, written etc.) will be available to the students, through the virtual classroom. This material must be employed for the preparation of the class session. Additionally, the students will be expected to carry out some simple tasks applying the concepts reviewed in the previously mentioned material. Detailed information and delivery terms for the tasks will be communicated by the teaching staff in advance. In the class session, different activities will be carried out in order to review, clarify and apply the studied concepts. Some of these activities will be handed for assessment.
Problem solving	Problem solving class sessions will be devoted to solving practical exercises applying the concepts developed in the flipped learning class sessions. The students will carry out individually some activities, that will be handed for assessment.
Collaborative Learning	In this methodology, the class will be organized in small groups, where the students will work collaboratively to develop academic tasks, applying the concepts studied and deepening their own learning.
Laboratory practical	Laboratory practical work will be directed to ensure that students are capable of handling chemicals safely, evaluating any specific risks associated with their use and with the use of laboratory procedures, including their environmental repercussions. Laboratory experiments will be carried out, individually, in 3,5 h class sessions. The students will find, in advance, in the virtual classroom, the material needed for the preparation of the experiments. Work with this material could include performing and delivering some tasks, prior to the class session. During the experiments, students will elaborate a laboratory notebook recording all observations pertinent to the experiment. After completion of the experiment, students will complete the required work.

Personalized assistance	
Methodologies	**Description**

Flipped Learning	During the preparation of the flipped learning sessions, besides using supporting bibliographic material, students will be tutored by the teaching staff. Tutoring sessions can take place in person or by telematic means (email, videoconference, forums in the virtual classroom etc.), by previous appointment. For tutoring sessions request see: https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/
Problem solving	For preparation of the problem solving class sessions and/or to answer their questions, students will be tutored by the teaching staff. Tutoring sessions can take place in person or by telematic means (email, videoconference, forums in the virtual classroom etc.), by previous appointment. For tutoring sessions request see: https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/; https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/
Laboratory practical	For preparation of the laboratory class sessions and/or to answer their questions, students will be tutored by the teaching staff. Tutoring sessions can take place in person or by telematic means (email, videoconference, forums in the virtual classroom etc.), by previous appointment. For tutoring sessions request see: https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/; https://quimica.uvigo.es/gl/docencia/profesorado/marta-teijeira-bautista/
Collaborative Learning	For carrying out the collaborative work and/or to answer their questions, students will be tutored by the teaching staff. Tutoring sessions can take place in person or by telematic means (email, videoconference, forums in the virtual classroom etc.), by previous appointment. For tutoring sessions request see: https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/; https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/
Tests	**Description**
Problem and/or exercise solving	For preparation of the exams and/or to answer their questions, students will be tutored by the teaching staff. Tutoring sessions can take place in person or by telematic means (email, videoconference, forums in the virtual classroom etc.), by previous appointment. For tutoring sessions request see: https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/; https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/; https://quimica.uvigo.es/gl/docencia/profesorado/marta-teijeira-bautista/

Assessment

	Description	Qualification	Training and Learning Results
Flipped Learning	Participation and resolution by the student of the tasks proposed by the teaching staff in relation to the flipped learning sessions.	15	A2 B1 C17 A5
Problem solving	As part of the continuous evaluation, participation and resolution by the student of the tasks proposed by the teaching staff in the class sessions will be evaluated.	20	A2 B1 C17 D3 A5
Collaborative Learning	As part of the continuous evaluation, students will carry out group assignments. Those will be application activities of knowledge and skills developed in the subject.	20	A2 B1 C17 D3 A5 B2 B3
Laboratory practical	Assistance to practical classes is mandatory. Laboratory work will be evaluated as APT or NON APT. The following aspects will be considered: previous and/or subsequent work, development of the experimental work and laboratory notebook. In order to pass the subject, students must obtain an APT mark in the laboratory practical work.	0	B2 C25 D3
Problem and/or exercise solving	Students must take a test covering contents of the first topics: 15% of the final qualification. A minimum mark of 3.0 points out of 10.0 must be achieved.	15	A2 B2 C17 D3 A5 B3
Problem and/or exercise solving	Students must take a test covering ALL THE CONTENTS OF THE SUBJECT: 25% of the final qualification. A minimum mark of 4.0 points out of 10.0 must be achieved.	25	A2 B2 C17 D3 A5 B3
Problem and/or exercise solving	Students must take a written test regarding the experimental part of the subject: 15% of the final qualification. A minimum mark of 4.0 points out of 10.0 must be achieved.	15	A2 B2 C17 D3 A5 B3 C25

Other comments on the Evaluation

In this subject, BASIC learning results will be defined that will be necessary for the students to achieve in order to pass it.

In case of doubt about the acquisition of learning results by the students, additional oral evaluation tests may be carried out.

In order to pass the subject in January, it will be required:

- Achieve mention **APT** in the evaluation of the laboratory practical.
- Achieve a **minimum mark of 3 points out of 10** in test 1.

- Achieve a **minimum mark of 4 points out of 10** in the global test and the written test for the experimental part.

If any of the previous conditions is not fulfilled, the final mark for the subject will be the mark obtained for the tests multiplied by 0.55 (55%).

- Achieve a minimum mark of 5.0 in the weighted addition of the marks for all the sections.

The final grade for the students who pass the subject could be standardized so that the highest mark can reach a value of up to 10 points.

STUDENTS OF 2ND AND SUBSEQUENT ENROLLMENT: Those students who were evaluated as APT during any previous course will be awarded the APT mention for the monitoring of the laboratory practical in the current academic course, not being necessary the completion of the experimental work again. However, they must take the written test for the experimental part in order to achieve the mark for the experimental part of the subject in the current academic course.

EVALUATION IN JULY: The marks obtained for the sections flipped learning, problem solving, collaborative learning and laboratory practical will be kept. Two tests can be retaken: a global test (40% of the final mark) **and/or** a written test for the experimental part (15% of the final mark). The student must achieve a minimum mark of 4 points out of 10 so that the results of these tests will be taken into account in the global mark of the subject.

The final mark will be the weighted addition of the marks for all the sections, as long as all the required minima are reached. If this is not the case, the final mark for the subject will be the mark obtained for the exams multiplied by 0.55 (55%).

GLOBAL EVALUATION OPTION: In order to pass the subject, students must carry out the laboratory practical work, achieving an APT mark, and a minimum mark of 5 out of 10 points in the written test for the experimental part (20% of the final mark). In addition, they must also obtain a minimum mark of 5 out of 10 points in a global exam (80% of the final mark).

Sources of information

Basic Bibliography

Klein, D., **Química Orgánica**, Editorial Médica Panamericana, 2013

Wade, L.G., **Química Orgánica - libro electrónico**, 9ª edición, Pearson-Educación, 2017

Wade, L.G., **Química Orgánica**, 9ª edición, Pearson-Educación, 2017

Csákÿ, A.G.; Martínez Grau, M.A., **Técnicas experimentales en síntesis orgánica**, 2ª edición, Síntesis, 2012

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Carey, F., **Química Orgánica**, 9ª edición, McGraw-Hill Interamericana, 2014

Vollhardt, K.P.C.; Schore, N.E., **Química Orgánica**, 5ª edición, Edicións Omega, 2007

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Quiñoá, E.; Riguera, R., **Nomenclatura y representación de los compuestos orgánicos**, 2ª edición, McGraw-Hill Interamericana, 2005

Palleros, D.R., **Experimental Organic Chemistry**, John Wiley and Sons, 2000

Recommendations

Subjects that continue the syllabus

Organic chemistry II/V11G201V01210

Subjects that are recommended to be taken simultaneously

Biochemistry/V11G201V01201
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Physical chemistry I: Chemical thermodynamics/V11G201V01203
Inorganic chemistry I/V11G201V01204

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA				
Structural Determination				
Subject	Structural Determination			
Code	V11G201V01206			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Tojo Suárez, Emilia Pérez Lourido, Paulo Antonio			
Lecturers	Pérez Lourido, Paulo Antonio Tojo Suárez, Emilia Valencia Matarranz, Laura María			
E-mail	paulo@uvigo.es etojo@uvigo.es			
Web				
General description	The subject devotes to the learning of the application of the methods but used in the structural determination of chemical substances. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C1	Ability to know and understand essential facts, concepts, principles and theories related to Chemistry
C2	Use correctly chemical terminology, nomenclature, conversions and units
C3	Recognize and analyze chemical, qualitative and quantitative problems, proposing strategies to solve them through the evaluation, interpretation and synthesis of data and chemical information
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C15	Know the main techniques of structural research, including spectroscopy
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
New	A3 A5	B3	C1 C2 C6 C15	
Analyze the information that can be obtained from spectroscopic techniques	A3	B1 B3 B4	C1 C6 C15	
Describe the information that supply the distinct methods of X ray diffraction	A3	B3	C1 C6 C15	
Foretell the basic characteristics of a determined spectrum from a known substance	A3 A5	B3 B4	C2 C3	D1
Design the basic process to obtain structural information of a chemical substance.	A3 A4	B3 B4	C2 C3	D1
Resolve the molecular structure of a simple compound from the its spectra	A3 A4	B1 B3 B4	C2 C3	D1

Contents	
Topic	
Subject 1. Gathering of general data of a substance.	Analysis of combustion. Empirical formula. Qualitative analysis. Optical properties.
Subject 2. Methods of diffraction.	Applications and limitations of the technique.
Subject 3. Electronic and photoelectron spectroscopy.	Determination of chromophores.
Subject 4. Vibrational spectroscopy.	Determination of characteristic functional groups.
Subject 5. Mass spectrometry.	Determination of the molecular mass. Ionización methods. Isotopic patterns. Interpretation of the MS spectrum.
Subject 6. NMR spectroscopy.	1H and 13C monodimensional experiments. Structural Information from the chemical shift. Dynamic NMR: chemical equilibrium. Noe experiment. Heteronuclear NMR.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	12	26	38
Problem solving	24	70	94
Objective questions exam	2	7	9
Objective questions exam	2	7	9
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The theoretical sessions will be devoted to present the fundaments of the techniques that are relevant to this subject
Problem solving	The sessions will br devoted to solve exercises or problems

Personalized assistance	
Methodologies	**Description**
Problem solving	Students will be able to consult with professors during the spring term

Assessment				
	Description	Qualification	Training and Learning	Results
Problem solving	In class students will be asked to solve a number of practical examples and exercises that will be graded.	20	A3	D1
Objective questions exam	There will be a test along the period of 2 h. of length that will include the Subjects 1-4.	40	A3 A4	D1
Objective questions exam	There will be a second test focused on MS, IR and NMR applied to the structural determination of organic compounds	40	A3 A4	D1

Other comments on the Evaluation

To surpass the matter the student has to:

- Achieve a 5 (out of 10) of average on all the graded activities.

- Achieve a minimum of 4 in each one of the exams of objective questions.

In the case of not achieving these two conditions the final grade will be the mean of the two exam

A student that enrolls in 20% of the total work scheduled will be qualified in accordance with the valid legislation. In any case, the realization of any of the tests will imply a final grade.The students that do not pass the subject at the end of the term will have the opportunity to do a final test in July. The grade of such test will replace the grades of the written tests (hence it will weigh 80% of the final grade of the student, no more)

Students who do not pass the subject at the end of the semester must take an overall written test in the final evaluation closing period in July. This test will replace the results of the written tests. The qualification of the seminar tests, deliverables (of the face-to-face activities) and the work/project, etc., are not recoverable.

For students who renounce continuous assessment and opt for a global assessment, the first of the short tests will be equivalent to 50% of the final mark, and the second to the remaining 50%. Students who do not pass one or both of the short tests that are carried out during the semester must take the corresponding part in the July session.

In order to guarantee a quality and individualized evaluation, any certifiable competence in this subject can be verified by means of an oral test, at any time before the final closing of the official records.

Sources of information
Basic Bibliography
Complementary Bibliography
Williams, D.H., Fleming, I., **Spectroscopic Methods in Organic Chemistry**, 6ª, 2007
Hammond, Christopher, **The Basics of crystallography and diffraction**, 2009
Pavia, D.L., Lampman, G.M., Kriz, G.S., Vyvyan, J.R., **Introduction to Spectroscopy**, 5ª, 2014
Pretsch, Ernö, **Structure determination of organic compounds : tables of spectral data**, 4a, Springer, 2009
Clayden, Jonathan, **Organic Chemistry**, 2a, 2012
Hesse, M, Meier, H, Zeeh, B., **Métodos espectroscópicos en Química orgánica**, 2a, Sintesis, 2005

Recommendations

IDENTIFYING DATA

Analytical Chemistry II: Optical Methods of Analysis

Subject	Analytical Chemistry II: Optical Methods of Analysis			
Code	V11G201V01207			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Bendicho Hernández, José Carlos			
Lecturers	Bendicho Hernández, José Carlos Calle González, Inmaculada de la Pérez Cid, Benita Romero Rivas, Vanesa			
E-mail	bendicho@uvigo.gal			
Web				
General description	Description of the course: the optical methods of analysis (analytical spectroscopy), constitute a powerful and versatile tool in the chemical laboratories, resolving problems in areas of interest such as food, environment, industry or biomedicine. In this subject, students will learn the fundamentals, instrumentation and applications of the main optical methods of analysis that rely on phenomena such as absorption, emission, fluorescence, scattering, etc.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B4	Ability for analysis and synthesis
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Choose the suitable instrumental analytical technique in function of the analyte to be determined and the characteristics of the sample.			C6	
Define, calculate and interpret the different quality parameters of an analytical method.		B4	C6	
Explain the fundamentals of the main optical methods of analysis and describe their relevant applications in the laboratories.	A1		C6	
Describe the interaction processes of the electromagnetic radiation with the matter, classify the optical methods and recognise the differences between the molecular and atomic spectrometry.			C6	
Distinguish the instrumentation of the modern spectroscopy techniques and their different components.			C6	
Select the suitable calibration method for any analytical problem posed and compute the experimental data to obtain the function of calibration.			C26	D1
Apply the optical methods of analysis for the resolution of problems in different working areas.	A1 A3		C26	
Carry out correct mathematical calculations in the problem solving of the optical methods of analysis.	A1 A3	B4	C26	D1

Contents

Topic

SUBJECT 1. Introduction to instrumental analytical methods.	Classification of the instrumental analytical methods. Quality parameters of an instrumental method: Validation. Methods of calibration in instrumental analysis: external calibration, standard addition and internal standard. Characteristics of the calibration curves. Fitting and statistical parameters of calibration lines.
SUBJECT 2. Optical methods of analysis: generalities.	Electromagnetic spectrum. Phenomena of interaction between the electromagnetic radiation and the matter. Classification of the optical methods of analysis. Instrumental components and representative configurations of the different instruments. Signals and noise.
SUBJECT 3. UV-vis molecular absorption spectroscopy	Fundamentals of the UV-vis molecular absorption spectroscopy. Basic concepts. Lambert-Beer Law. Deviations of the Lambert-Beer law. Absorbent species. Types of instruments. Analytical methodology and applications.
SUBJECT 4. Luminescent techniques.	Fundamentals. Mechanisms of molecular deactivation. Fluorescence and Phosphorescence. Factors influencing the luminescence. Quenching of the fluorescence. Chemiluminescence and Bioluminescence. Instrumentation. Analytical methodology and applications.
SUBJECT 5. Infrared and Raman spectroscopy.	Fundamentals. Modes of molecular vibration. Infrared spectrum and molecular structure. Raman spectroscopy. Origin of the Raman spectra. Instrumentation. Methodology. Applications in qualitative, quantitative and structural analysis.
SUBJECT 6. Atomic absorption spectroscopy.	Fundamentals. Origin of atomic spectra. Flame atomizer. Atomization processes in flames. Graphite furnace atomizer. Thermal programs. Interferences. Instrumentation. Background correctors. Methods of vapor generation. Analytical methodology and applications. Atomic fluorescence spectrometry.
SUBJECT 7. Atomic emission spectroscopy and atomic mass spectrometry.	Fundamentals of atomic emission spectroscopy. Excitation sources and temperature effect. Flame emission spectrometry (flame photometry). Arc and spark emission spectrometry. Inductively-coupled plasma atomic emission spectrometry. Plasma source mass spectrometry. Comparative analytical characteristics of the main techniques for trace inorganic analysis.

Planning

	Class hours	Hours outside the classroom	Total hours
Problem solving	24	24	48
Laboratory practical	14	3	17
Lecturing	24	31	55
Essay questions exam	2	4	6
Essay questions exam	0	8	8
Report of practices, practicum and external practices	0	4	4
Objective questions exam	0	8	8
Problem and/or exercise solving	0	4	4

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

Methodologies

	Description
Problem solving	Problem solving will allow to reinforce the learning of theoretical contents explained during the masterclasses. Activities in these classes may comprise solving of numerical problems, handling of spreadsheets for calibration exercises, discussion of practical cases related with the optical methods of analysis and published in educational journals, etc. The teacher will propose different problems/exercises/questionnaires that will be solved by students and delivered for their evaluation.
Laboratory practical	In the lab sessions, student will learn to operate with the different instruments corresponding to atomic and molecular spectrometries, acquiring skills in the different stages of method development such as the preparation of standards, optimisation of instrumental parameters, calibration, etc. For this purpose, the teacher will provide the student with the scripts describing the theoretical foundations, objectives, instrumentation, reagents and operation procedure. Students will elaborate a lab notebook during the development of the hands-on experiments, in which they will reflect all the operations made, experimental data, calculations and conclusions reached. Those students that have overcome lab practices in the academic years 22-23 and 23-24 will not need to repeate them. In this case, the mark obtained in lab practices will be kept.
Lecturing	The teacher will explain in masterclasses the theoretical contents of the program with the support of slides provided through the learning platform moovi. Several questionnaires will be proposed to students for their self-evaluation.

Personalized assistance	
Methodologies	**Description**
Lecturing	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Problem solving	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Laboratory practical	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Tests	**Description**
Report of practices, practicum and external practices	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.

Assessment			
	Description	Qualification	Training and Learning Results
Laboratory practical	In lab sessions, a follow-up experimental work carried out by the student will be monitored (attitude and practical skills acquired) will be performed. Attendance at all laboratory sessions is compulsory (it is not possible to overcome the course without doing the practical sessions).	10	A3 B4 C6 C26 D1
Essay questions exam	1st Examination: exam (subjects 1,2,3) of 2 hours of duration carried out approximately in the middle of the term and included in the course schedule. The test will have two parts, one of numerical problems/exercises and the other of multiple-choice questions.	30	A1 B4 C6 D1
Essay questions exam	2nd Examination: exam (subjects 4,5,6,7) of 2 hours of duration, to be held on a date approved by the Faculty Board, corresponding to the end of the term. The examination will have two parts, one of numerical problems/exercises and the other of multiple-choice questions.	30	A1 B4 C6 D1
Report of practices, practicum and external practices	Students will elaborate a lab report in which the experimental work will be reflected (preparation of standards, calibration of instruments, operation procedures, observations, results, etc.). The assessment will consider both formal issues and quality of the results.	10	A3 B4 C26
Objective questions exam	At the end of the subjects corresponding to the theoretical program, students will perform a self-evaluation test (multiple choice questions) so as to strengthen the understanding of the contents.	10	C6
Problem and/or exercise solving	Students will solve similar problems/exercises to those included in the problem/exercise sheets (deliverables). Likewise, deliverables of questionnaires posed in the discussion of different case studies will be requested. It will be necessary to accomplish a minimum number of deliverables established by the teacher so that the mark of this activity can be added to the rest of the assessment items.	10	A1 A3 B4 C6 D1

Other comments on the Evaluation

Continuous assessment mode:

Considerations on the evaluation of the practical subjects:-Lab practices (hands-on work follow-up): lack of attendance, even if justified, will penalise the mark. A number of absences of more than 25% of the laboratory sessions will mean failing the lab practices. A minimum mark of 4 out of 10 will be required to be added to the rest of the evaluation elements. The completion of the lab practices and the lab report is essential to pass the course both in the continuous assessment mode and in the global assessment mode (non-continuous).-Lab report: it will be necessary to obtain a minimum grade of 4 points out of 10 in the Lab Report in order to be added to the rest of the evaluation elements.

Considerations on the evaluation of the tests (intermediate and end of term test):

The part of multiple-choice questions and the part of numerical problems/exercises will have a weight of 50% each in the two tests. In order to be able to average the theory part and the problems/exercises part, a minimum of 3 points out of 10 must be obtained in either part.

-A minimum score of 4 points out of 10 must be achieved in the first examination in order for it to be averaged with the second one. Students who have not achieved a grade of at least 4 points out of 10 in the first examination must take a recovery exam of the first part of the course (1 hour time) whose grade will replace the one obtained previously. This

recovery test will take place on the date scheduled for the 2nd examination The average of the two exams must be at least 4 points out of 10 in order to be added to the rest of the evaluation elements. If this minimum score is not reached, only the weighted grade of both exams will appear in the student grading reports.

Qualification in the 1st chance of the call (May-June):

-Once the above criteria have been taken into account, passing the course is achieved with an overall mark of 5 points out of 10.The student's participation in any of the assessement items with the exception of problem solving and/or exercises (deliverables) and self-assessment tests disqualifies him/her from obtaining the grade of NOT PRESENTED. The overall qualification in the first edition of the call will be made up of the marks obtained in the problem solving classes (deliverables) (1 point), self-assessment tests (1 point), hands-on work follow-up (1 point), Lab report (1 point), 1st examination (3 points) and 2nd examination (3 points).

Qualification in the 2nd chance of the call (July):
The qualification in this edition will be made up of two components:
1. Grades obtained by the student during the course:
Only the marks obtained by the student during the course in the lab practices (1 point) and the Lab report (1 point) will be retained.
2. Final exam on the contents of the subject (8 points).
This exam will include numerical problems/exercises and multiple-choice questions. A minimum grade of 4 out of 10 points will be required in this exam in order to be added to the grade obtained in the practicals.

Global assessment mode (not continuous):

-Students who wish to take this option must notify the subject coordinator in writing within one month of the start of the term. It is compulsory to complete the Lab practices/Lab report and a global assessment examination in order to pass the course.
-Lab practices/Lab report (2 points): the same considerations established above for continuous assessment will apply.
-Global assessment examination (8 points): The exam will have two parts, one of numerical problems/exercises and the other of multiple-choice questions and will cover all the topics of the course, with the same considerations as those determined above for continuous assessment. Passing the subject requires an overall mark of 5 points out of 10.
The date of this exam will coincide with the date of the final exam of the four-month period established for continuous assessment.

Evaluation of students in the Integrated Cycle of the Seniors Programme:

-Compulsory attendance to 80% of the theoretical and practical classes and seminars.
-Accomplishement of a theoretical-practical work on a subject of the course.
-Accomplishement of the self-assessment tests programmed through the e-learning platform.

Sources of information

Basic Bibliography

D.A. Skoog, F.J. Holler, S.R. Crouch, **Principios de Análisis Instrumental**, 7ª edición, Cengage Learning Editores, 2018

A. Rios, M.C. Moreno, M. Simonet, **Técnicas espectroscópicas en química analítica**, Síntesis, 2012

L. Hernández, C. González, **Introducción al Análisis Instrumental**, Ariel, 2002

Complementary Bibliography

J.D. Ingle, S.R. Crouch, **Spectrochemical Analysis**, Wiley, 1988

J.N. Miller, J.C. Miller, **Estadística y Quimiometría para Química Analítica**, Prentice Hall, 2002

J.M. Fernández Solís, J. Pérez Iglesias, H.M. Seco Lago, **Estadística sencilla para estudiantes de ciencias**, Síntesis, 2012

J. Guiteras, R. Rubio, G. Fonrodona, **Curso experimental en Química Analítica**, Síntesis, 2003

J.M. Andrade y 5 autores más, **Problems of Instrumental Analysis: a hands-on guide**, World Scientific Publishing Europe, 2017

Recommendations

Subjects that continue the syllabus

Analytical Chemistry III: Electroanalytical Methods and Separations/V11G201V01302
Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306
Enhancement of Analytical Chemistry/V11G201V01406
Quality in Analytical Labs/V11G201V01407
Food, Agricultural and Environmental Analytical Chemistry/V11G201V01410

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202

IDENTIFYING DATA				
Physical Chemistry II: Surfaces and Colloids				
Subject	Physical Chemistry II: Surfaces and Colloids			
Code	V11G201V01208			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Hervés Beloso, Juan Pablo			
Lecturers	Hervés Beloso, Juan Pablo Pérez Juste, Ignacio Polavarapu , Lakshminarayana			
E-mail	jherves@uvigo.es			
Web	http://https://faitic.uvigo.es/index.php/es/			
General description	In the present subject we intend to develop the fundamentals of Chemical Thermodynamics which have been introduced in previous subjects in order to apply them to systems of particular chemical interest, such as macromolecules and colloids, as well as to the adsorption processes. For accomplishing these purposes, Transport Phenomena are studied first, using some basic elements of Kinetic Theory which will be analyzed more deeply in the subject 'Química Física V: Cinética Química' of the third year. It is then possible to study the origin of ionic conductivity and discuss its chemical applications extensively. By using the thermodynamic treatment of the interface, the stability of colloidal systems can be analyzed and the adsorption processes studied. The experimental methods for the study of the structure and composition of interfaces are presented and used as far as possible in lab experiments. Such methods include those based on surface tension measurements and also those related to adsorption on solid surfaces. The experimental methods needed for the study of macromolecules and colloids are also studied. : English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B2	Organization and planning capacity
B4	Ability for analysis and synthesis
C16	Know the relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids, crystals and other materials
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
To know the general mechanisms of transport processes, its equations and applications.	A1	B1 B2 B4	C16 C27 C28	D1
To understand the origin of ionic conductivity and its chemical applications.	A1	B1 B2 B4	C16 C27 C28	D1
To know the structure of the interfaces and the magnitudes that characterise it.	A1	B1 B2 B4	C16	

To explain the principles which govern the adsorption phenomena and to know various adsorption isotherms.	A1	B1 B2 B4	C16 C27 C28	D1
To explain the nature and structure of polymers and macromolecules.	A1 A3	B1 B2 B4	C16	
To explain the causes of the stability of colloidal systems and their control.	A1 A3	B1 B2 B4	C16 C27 C28	D1
To describe the fundamentals of the experimental techniques used in the determination of the structure of macromolecules and colloidal systems	A1 A3	B1 B2 B4	C16 C27 C28	D1

Contents

Topic	
I. TRANSPORT PHENOMENA.	1. Fundamental results of the kinetic theory of gases. 2. Non-electric transport phenomena: Diffusion. Thermal conductivity. Viscosity. 3. Electric transport phenomena. ionic conductivity. Ionic mobility. Applications of conductivity measurements.
II. SURFACE PHENOMENA and SURFACE TENSION	1. Interfaces. 2. Thermodynamic treatment: surface tension. curved interfaces. Kelvin equation 3. Capillarity and contact angle. 4. Interfaces with more than one component: Gibbs Law. 5. Monolayers. Detergency.
III. ADSORPTION ON SOLIDS	1. Description of the structure of solid surfaces. 2. Adsorption: general aspects. 3. Physisorption and Chemisorption. 4. Adsorption isotherms. 5. Electrified interface. Double layer models.
V. COLLOIDS	1. Classification of colloidal systems. 2. Synthesis of colloids. 3. Colloidal stability. 4. DLVO theory. 5. Association colloids: micelles, vesicles and microemulsions
IV. POLYMERS AND MACROMOLECULES	1. Structure of macromolecules. 2. Structural models. Conformations. 3. Distribution of molecular masses. 4. Characterization of macromolecules. 5. Polymerization. Degree of polymerization.
LABORATORY LESSONS	Laboratory practices related to the contents of the theory classes: - Transport phenomena: ionic conductivity. - Surface phenomena: Surface tension Measurements. - Adsorption on solid surfaces. - Synthesis and characterization of macromolecules and colloids.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	42	66
Problem solving	12	22	34
Laboratory practical	28	20	48
Objective questions exam	1	0	1
Objective questions exam	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

	Description
Lecturing	Discussion of the fundamental aspects of each topic and description of those to be addressed in the seminars. Discussion of the specific issues raised by students. The student will be provided with the study material necessary to follow the lessons through the Moovi platform.

Problem solving	Resolution of numerical problems and theoretical questions as well as test-type exercises. Numerical and theoretical problems will be solved by the teacher with the participation of the students. The results will be analyzed and interpreted. On a voluntary basis, the student may solve some of these exercises in the seminar, with the assistance of the teacher and the participation of the rest of the students.
Laboratory practical	Every student is expected to perform a well balanced set of experiments which exemplifies and develops the fundamental topics. In principle, we expect the experiments to be carried out by couples of students for agility, but they may also be done individually, depending on the circumstances. Scripts describing every experiment, references to bibliographic material and instructions for the use of the devices if needed, as well as others related to laboratory safety, will be made available. The student must draw up the fugures and make the necessary calculations to obtain the final results, as well as analyze and discuss them.

Personalized assistance

Methodologies	Description
Lecturing	The student may raise specific questions in the lectures and more extensive ones in the teacher's tutoring schedule
Problem solving	The solution to the proposed exercises will be discussed with students in connection with the development of the theoretical foundations. The additional questions students may raise will be answered during the teacher's tutoring schedule.
Laboratory practical	The problems or doubts the students might have regarding the theoretical foundation of the experiments, their development and the key aspects of the calculations needed to obtain the result will be discussed during the practical sessions. Additional issues will be addressed in tutoring hours.
Tests	**Description**
Objective questions exam	Any doubts regarding the exams, in particular those related to their scope and configuration, shall be clarified. In the case of the short test, the solutions to the exercises will be briefly presented and discussed in the following seminar. During tutoring hours, the answers provided by the student will be discussed with him/her at his/her request; the time deadlines will be respected in the case of the exam (long-duration test).
Objective questions exam	

Assessment

	Description	Qualification	Training and Learning Results			
Problem solving	The resolution by the student of the proposed exercises and their presentation will be valued. Test-type questionnaires will also be carried out. In both cases voluntarily. The weight in the score is between the limits 0-20%	20	A1	B1 B2 B4	C16	D1
Laboratory practical	Laboratory leasons are compulsory. Its experimental development is valued as well as the presentation of a practice report. This must contain tables, graphs and the necessary calculations to obtain the results, as well as an analysis of the same, in relation to the experimental procedure and the theoretical theories used. The weight in the score is between the limits 0-15%)	15	A1 A3	B1 B2 B4	C16 C27 C28	D1
Objective questions exam	First short exam. It will take place in the middle of the semester approximately. It will consist of solving questions and problems. If its mark reaches or surpasses 5 on the 10-point scale the corresponding topics can be considered as passed. Its weight, depending on the other sections of the evaluation, will be 35%.	32.5	A1		C16 C28	D1
Objective questions exam	Second short exam. It will take place at the end of the semester. It will consist of solving questions and problems. Its weight, depending on the other sections of the evaluation, will be 35%.	32.5	A1		C16 C28	D1

Other comments on the Evaluation

To pass the subject it is necessary to pass the laboratory practices.
The qualification of each exam (and the average of them) must be at least 4.0 out of 10 so that an average can be made with the other sections.
Presenting any exercise, performing any practice or test makes it impossible for the qualification to be 'non qualified'.

Sources of information

Basic Bibliography

Atkins, P.W.; de Paula, J., **Atkin's Physical Chemistry**, 10th ed., Oxford University Press, 2014

Levine, I. N, **Physical Chemistry**, 6th ed., McGraw-Hill, 2009

Complementary Bibliography

Bertrán-Rusca, J; Núñez-Delgado, J, **Química Física (Vol II)**, 1º edición, Ariel Ciencia, 2002

Adamson, A. W.; Gast, A. P, **Physical Chemistry of Surfaces**, 6th ed, Physical Chemistry of Surfaces, 1997

Everett, D. H. F.R.S, **Basic Principles of Colloid Science**, RSC Paperbacks, 1988

Recommendations

Subjects that it is recommended to have taken before

Chemistry: Chemistry 2/V11G201V01109

Physical chemistry I: Chemical thermodynamics/V11G201V01203

Other comments

Some contents will be developped and complemented in subjetcs taught in the third and fourth year. For instance "Química Física V: Cinética Química" (3rd year), "Química de Materiales" (4th year) and, the optional subjects "Nanoquímica" and "Materia Condensada" of the 4th year.

IDENTIFYING DATA

Inorganic chemistry II

Subject	Inorganic chemistry II			
Code	V11G201V01209			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	García Martínez, Emilia			
Lecturers	Castro Fojo, Jesús Antonio García Martínez, Emilia Pérez Lourido, Paulo Antonio Valencia Matarranz, Laura María			
E-mail	emgarcia@uvigo.es			
Web	http://moovi.uvigo.gal			
General description	It is a subject of six credits that is taught in the second semester of the second year and belongs to the module of compulsory subjects of the Degree in Chemistry. The objective of the subject is the study of the metallic elements of the main groups (s and p blocks) and a brief introduction to the study of transition (d block) and internal transition metals (f block).			

Training and Learning Results

Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C8	Know the characteristic properties of the elements and their compounds, including the relations between groups and their variations in the periodic table
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D2	Capacity for teamwork

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Be able to foretell the properties of the metals depending on its position in the Periodic Table	A2 A3	B1 B3 B4	C8	
Be able to choose the general metal suitable for obtaining of the main group metals and their more relevant compounds	A2 A3	B1 B3 B4	C8 C9	
Be able to describe the structure and the more relevant reactivity of the main group metals and their compounds	A2 A3	B1 B3 B4	C8 C9	
Be able to deduce the physical properties of an element or compound from the type of bond and/or intermolecular forces	A2 A3	B1 B3 B4	C8 C9	
Show capacity to relate the physical and chemical properties of any substances of interest with his applications	A2 A3	B1 B3 B4	C8 C9	
Be able to carry out in the laboratory to preparation of some elements and his compounds as well as the study of any of the their physical and chemical properties	A2 A3	B1 B3 B4	C8 C9 C26	D2

Contents

Topic	
Chapter 1. The metals and the metallic behaviour	Crystalline structure of the metals Metallic bond Distribution of the metals in the Periodic Table Properties of the metals Alloys
Chapter 2. Extactive metallurgy	Mineral processing Ellingham diagrams Refining
Chapter 3. Introduction to Coordination and Organometallic Chemistry.	Coordination and organometallic compounds definition Coordination numbers and stereochemistries Ligands classification Nomenclature introduction Rule of the 18 electrons
Chapter 4. Group 1. The Alkali metals	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Chapter 5. Group 2. The Alkaline earth metals	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Chapter 6. Al , Ga, In and Tl	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Chapter 7. Sn and Pb	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Chapter 8. As, Sb and Bi	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Pincipal compounds Organometallic compounds Bioinoganic
Chapter 9. The d-block elements. An introduction to the transition elements	Introduction Differences between the first row and the otherr two rows Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Chapter 10. Group 12: Zn, Cd and Hg	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic

Chapter 11. The f-block elements. An introduction to transition internal elements: Lanthanide and Actinide elements.	Ocurrence and abundance Extraction and uses Physical properties Reactivity (chemical properties) Principal compounds Organometallic compounds Bioinoganic
Laboratory. There will be 4 practical sessions of 3.5 hours each.	Session 1. Thermite reaction Session 2. Study of reactivity of calcium and some calcium compounds in water Session 3. Study of comparative reactivity of some transition and main groups metals Session 4. Salts identification

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	24	48
Problem solving	12	24	36
Laboratory practical	14	8	22
Mentored work	0	20	20
Essay questions exam	2	11	13
Essay questions exam	0	11	11
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Exposition by the teacher of the contents on the subject focusing on the most relevant aspects and those that are more difficult for students to understand. The classes will be developed interactively with the students, commenting on the online material (available on Moovi and the Internet) as well as the most appropriate bibliography for the in-depth preparation of each topic. Doubts that arise will be resolved.
Problem solving	Activity which formulated problem and / or exercises related to the course. The student should develop appropriate solutions or right through the exercise routines, application of formulas or algorithms, application processing procedures available information and interpretation of the results. It is often used to complement the lecture.
Laboratory practical	Realization under the supervision of the teaching staff but in an autonomous way, of practices of laboratory in sessions of 3.5 hours each. The students will have, through the virtual classroom, the necessary material for the previous preparation of the experiments. The work with said material, prior to the laboratory class session, may include the completion and delivery of tasks. During the development of the practices, each student will prepare a laboratory notebook, where they will write down all the information related to the experiment carried out (reactions, observations, results, etc). After completing the practice, students must complete the work indicated in each case. Those students who did them and be approved in the 2022-23 academic year, if desired. In this case, it will remain, in the part laboratory, the qualification achieved in its day.
Mentored work	Students will take the course "In-fórmate coa Biblio" available in Moovi. The grade achieved in this course will be the one that corresponds to this section.

Personalized assistance	
Methodologies	**Description**
Lecturing	Throughout the teaching period, students will be able to consult their doubts both in face-to-face sessions and during tutorial hours, in the latter case, by appointment. The teaching team will inform of their availability with the tutorial schedules published on the Faculty's website. Additionally, the telematic communication channels with the students will be used (email, virtual classroom tools or the Moovi tele-teaching platform).
Laboratory practical	The teaching staff will attend to the students' queries related to the development of laboratory teaching, both in the practice sessions and before and after their delivery. The hours of attention to the students of the teaching staff of the subject will be available in the virtual classroom and through other channels established by the University.

Mentored work	Students must take the course "In-fórmate coa Biblio" whose estimated duration is 15 hours, which will be available to them on the Moovi telelearning platform. Students who obtain the grade "apto" will receive a certificate that can be counted for 15 hours of work for the recognition of ECTS credits. The grade obtained in this course will constitute the grade for this section.
Problem solving	The resolution of the proposed exercises will be discussed with the students and the results obtained will be analyzed in connection with the development of theoretical aspects. Additional questions that students may raise during the teacher's tutorial schedule will be answered.

Tests	**Description**
Essay questions exam	Throughout the teaching period, students will be able to consult their doubts both in face-to-face sessions and during tutorial hours, in the latter case, by appointment. The teaching team will inform of their availability with the tutorial schedules published on the Faculty's website. Additionally, the telematic communication channels with the students will be used (email, virtual classroom tools or the Moovi tele-teaching platform). During the exam, the student can ask the teacher for any clarifications he deems appropriate for the correct understanding of the questions asked.
Essay questions exam	Throughout the teaching period, students will be able to consult their doubts both in face-to-face sessions and during tutorial hours, in the latter case, by appointment. The teaching team will inform of their availability with the tutorial schedules published on the Faculty's website. Additionally, the telematic communication channels with the students will be used (email, virtual classroom tools or the Moovi tele-teaching platform). During the exam, the student can ask the teacher for any clarifications he deems appropriate for the correct understanding of the questions asked.

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	Each student will solve formulation exercises, questions and/or problems similar to those included in the bulletins. Deliveries of those exercises and/or questions raised in the different practical case studies that have been discussed both in the problem-solving classes and in the master classes will also be carried out. The mark in the development questions exams must be equal to or greater than 5 out of 10, so that the qualification of this section can be added to the rest of the evaluation elements.	20	A2 B3 C8 D2 A3 B4 C9
Laboratory practical	In the laboratory sessions, a follow-up of the experimental work carried out by the students (attitude and acquired skills) will be carried out. It is important to indicate that attendance at all laboratory sessions is MANDATORY. Lack of attendance, even if justified, will penalize the grade (in case of justified absences it is recommended to make up the session in another group). If the number of absences is greater than 25% of the laboratory sessions, it will mean failing the subject. Failure to achieve a grade equal to or greater than 5 in laboratory practices will also mean failing the subject. The evaluation of these practical sessions will be based on the correct elaboration of the laboratory notebook, the behavior and the acquired skills. Students may also be asked to solve simple questions and/or exams that will be used for their evaluation. The students who carried out and approved the practices in the previous course (2022-2023) are exempt from doing them this course if they wish. The note in this section will be kept. The assessment of this section will be taken into account if the grade in the development questions exams is equal to or greater than 5 out of 10.	15	A2 B3 C8 A3 B4 C26
Mentored work	The students must take the course "In-fórmate coa Biblio" whose estimated duration is 15 hours, which will be available to them on the Moovi telelearning platform. Students who obtain the grade "apto" will receive a certificate that can be counted for 15 hours of work for the recognition of ECTS credits. The grade obtained in this course will constitute the grade for this section. This score will only be considered when calculating the final grade if a score equal to or greater than 5 points out of 10 is achieved in the development questions exams.	10	A2 B3 C8 D2 A3 B4 C9

Essay questions exam	Development questions exam On the date set in the official exam calendar of the Faculty, a written test will be carried out on the subject taught in chapters 1 to 5. It is necessary to achieve a score equal to or greater than 5 out of 10 to pass the subject.	25	A2 B1 C8 A3 B3 C9 B4
Essay questions exam	Development questions exam On the date set in the official exam calendar of the Faculty, a written test will be carried out on the subject taught in chapters 6 to 11. It is necessary to achieve a score equal to or greater than 5 out of 10 to pass the subject.	30	A2 B1 C8 A3 B3 C9 B4

Other comments on the Evaluation

First Opportunity (June-July)

Continuous assessment: In the case of not achieving the minimum grade required in any test to pass the subject, the final grade will reflect as closely as possible the actual grade obtained throughout the course. It is understood that a student has submitted to the evaluation of the subject and, therefore, a grade will be assigned, in the following cases:1. If you take an exam with development questions.2. If you participate in tests or continuous assessment activities beyond the deadlines established by the center for the request for global assessment modality. A minimum grade of 5 out of 10 is required to pass the subject.
Global assessment:The students who have been granted the global evaluation by the deanship will have an exam of development questions (75%) that will be carried out on the official exam date for each evaluation opportunity within the official testing period marked in the academic calendar of each course. A minimum score of 5 out of 10 is required in global exam and laboratorio Practical to pass the subject.
Evaluation of the students of the Integrated Cycle of the Senior Program:- Mandatory attendance at 80% of theoretical classes and seminars.- Completion of self-assessment problems, exercises or tests.- Completion of a project on a topic related to the subject.
Second opportunity (July): The same criteria will be followed as in the first opportunity.

Sources of information

Basic Bibliography

Catherine E. Housecroft, Alan G. Sharpe ; traducción Pilar Gil Ruiz, **Química inorgánica**, 2ª, Pearson, 2006

Catherine E. Housecroft, Alan G. Sharpe ; traducción Pilar Gil Ruiz, **Química inorgánica. https://www.ingebook.com/ib/NPcd/IB_Escritorio_Visualizar?cod_primaria=1000193&libro=2154**, 2ª, Pearson, 2006

Complementary Bibliography

Rochow E.G., **Química inorgánica descrptiva. https://www.digitaliapublishing.com/a/103289/quimica-inorganica-descriptiva**, 1ª, Reverté, 1981 (2010)

James E. Huheey, Ellen A. Keiter, Richard L. Keiter, **Química inorgánica: principios de estructura y reactividad**, 4ª, Oxford University Press, 1997

Cotton F.A. , Wilkinson G., **Química inorgánica avanzada**, 4ª, LIMUSA WILEY, 2006

Rayner-Canham G., **Química inorgánica descriptiva**, 2ª, Pearson Education, 2000

House, James E., **Inorganic Chemistry**, 3ª, Academic Press, 2020

Hosmane, Narayan S., **Advanced Inoraganic Chemistry. Application in every day life**, 1ª, Academic Press, 2017

Crichton, Robert, **Biological inorganic chemistry**, 3ª, Academic Press, 2019

Recommendations

Subjects that continue the syllabus

Inorganic chemistry II/V11G201V01209

Subjects that are recommended to be taken simultaneously

Structural Determination/V11G201V01206

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Physical chemistry I: Chemical thermodynamics/V11G201V01203
Inorganic chemistry I/V11G201V01204

IDENTIFYING DATA				
Organic chemistry II				
Subject	Organic chemistry II			
Code	V11G201V01210			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	Cid Fernández, María Magdalena Iglesias Antelo, María Beatriz			
Lecturers	Cid Fernández, María Magdalena Domínguez Seoane, Marta Iglesias Antelo, María Beatriz Teijeira Bautista, Marta			
E-mail	bantelo@uvigo.gal mcid@uvigo.es			
Web				
General description	The main objective of this subject is to go in depth in the knowledge of the properties and reactivity of the functional groups. After a detailed study of the reactions of nucleophile substitution and elimination, the reactions of addition to carbonyl group, the carboxylic acid derivatives and the reactivity in alpha to carbonyl group will be tackled. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B5	Ability to adapt to new situations and to make decisions
C17	Know the nature and behavior of functional groups in organic molecules
C18	Know the properties of aliphatic, aromatic, heterocyclic and organometallic compounds
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
D1	Ability to solve problems
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results		
To distinguish, according to the reaction conditions and substrates used, the mechanisms of nucleophilic substitutions SN1 and SN2.	A1 A5	C17 C18	D1 D3
To apply nucleophilic substitution reactions on sp3 carbons to obtain organic compounds with single bonds.	A1 A5	C17 C18	D1 D3
To distinguish, according to the reaction conditions and substrates used, the E1 and E2 mechanisms of elimination reactions.	A1 A5	C17 C18	D1 D3
To explain the reactivity of carbonyl compounds through nucleophilic addition.	A5	C17 C18	D1 D3
To explain the reactivity of carboxylic acid derivatives by means of an addition-elimination mechanism.	A5	C17 C18	D1 D3
To apply the reactivity of enols and enolates.	A1 A5	C17 C18	D1 D3
To apply the reactivity of beta-dicarbonyl compounds and alfa,beta-unsaturated carbonyl compounds in organic synthesis.	A1 A5	C17 C18	D1 D3

To carry out properly the usual experimental procedures in simple organic preparations.	A1 A5	B5	C17 C18 C26 C28	D1 D3

Contents	
Topic	
LESSON 1. Reactions of nucleophilic substitution on sp3 carbons	Bimolecular and unimolecular nucleophilic substitution reactions (SN2 and SN1): kinetic, mechanisms and stereochemistry. Competition between SN2 and SN1. Transformation of functional groups through SN2 and SN1 reactions.
LESSON 2. Reactions of elimination	Bimolecular elimination reaction (E2). Unimolecular elimination reaction (E1). Competition between substitution and elimination. Application of elimination reactions in organic synthesis.
LESSON 3. Reactions of nucleophilic addition to the carbonyl group	Structure and general reactivity of the carbonyl group (aldehydes and ketones). General mechanism of the nucleophilic addition. Addition of oxygenated and sulfur compounds, nitrogenated compounds, hydride, organometallic compounds, cyanide, and acetylides. The reaction of Wittig.
LESSON 4. Reactions of nucleophilic substitution on the carbonyl group	Structure and general reactivity of carboxylic acids and derivatives. Preparation and reactivity of acid halides, acid anhydrides, esters, and amides. Structure and reactivity of nitriles.
LESSON 5. Reactivity in alpha position of the carbonyl group	Enols and enolates: general reactivity. Keto-enol Tautomerism. Alpha-alquilación of enolates. Alpha-halogenation of enols and enolates. Reactions of enolate anions with carbonyl compounds (aldolic condensation).
LESSON 6. Reactivity of bifunctional carbonyl compounds	Reactions of beta-dicarbonyl compounds. Reactions of alpha-beta unsaturated carbonyl compounds. Michael reaction. Robinson annulation.
LABORATORY	In these sessions, experiments related to the theoretical content of the lessons will be carried out.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	23	30	53
Problem solving	12	18	30
Mentored work	0	6	6
Laboratory practical	27	8	35
Objective questions exam	1	6	7
Problem and/or exercise solving	1	4	5
Problem and/or exercise solving	1	8	9
Problem and/or exercise solving	1	4	5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The teaching staff will expose, in a structured way, those general aspects of the subject, paying special attention to those of greatest relevance to the program and the most difficult for students to assimilate. The teaching staff will provide, through the virtual classroom, the necessary material for the realization of the personal work of the students. In the class session, activities will be carried out that can lead to qualifiable deliverables.
Problem solving	In this activity, a series of exercises and problems previously elaborated and proposed by the teacher will be resolved. The teacher will solve the doubts and will comment on the specific aspects. The students will carry out tasks individually that will be graded.
Mentored work	The students, grouped into teams, must work on a topic assigned by the teacher. This activity will be graded.
Laboratory practical	A series of experiments in the laboratory will be carried out in face-to-face sessions 3,5 h long. The students will have all the necessary material for the previous preparation of the experiments through the virtual classroom. During the laboratory sessions, the students will elaborate a laboratory notebook in which they will annotate all observations related to the experiments. After the development of the practices, the students will have to complete the work indicated in each case.

Personalized assistance	
Methodologies	**Description**

Lecturing	The teacher will attend to the queries of the students related to the study of the contents related to the subject through tutories. The teacher will also use channels of telematic communication with the students (email, tools of the virtual classroom). For consultation and/or request for tutorials: https://quimica.uvigo.eres/gl/docencia/profesorado/maria-magdalena-cid-fernandez/
Laboratory practical	Teachers will attend to the queries of the students related to the experiments during the laboratory sessions and in tutories. The schedule office hours will be available in the virtual classroom and through other ways established by the University. For consultation and/or request for tutorials: https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-teijeira-bautista/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-dominguez-seoane/
Problem solving	Teachers will attend to the queries of the students related to the problems and exercises linked to the contents of the subject, through the schedules of tutories. The teacher will also employ channels of telematic communication with the students (email, tools of the virtual classroom). For consultation and/or request for tutorials: https://quimica.uvigo.eres/gl/docencia/profesorado/maria-magdalena-cid-fernandez/
Mentored work	The teaching staff will attend in a personalized way the queries of the students related to the group work. The tutoring sessions may be carried out in person or by telematic means under the modality of prior consultation. For consultation and/or request for tutorials: https://quimica.uvigo.eres/gl/docencia/profesorado/maria-magdalena-cid-fernandez/
Tests	**Description**
Objective questions exam	Teachers will attend to the queries of the students, during the schedules of tutories, which will be available in the virtual classroom and through other ways established by the University. The teacher will also employ channels of telematic communication with the students (email, tools of the virtual classroom). For consultation and/or request for tutorials: https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-teijeira-bautista/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-dominguez-seoane/
Problem and/or exercise solving	Teachers will attend to the queries of the students, during the schedules of tutories, which will be available in the virtual classroom and through other ways established by the University. The teacher will also employ channels of telematic communication with the students (email, tools of the virtual classroom). For consultation and/or request for tutorials: https://quimica.uvigo.eres/gl/docencia/profesorado/maria-magdalena-cid-fernandez/ https://quimica.uvigo.es/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-teijeira-bautista/ https://quimica.uvigo.es/gl/docencia/profesorado/marta-dominguez-seoane/

Assessment

	Description	Qualification	Training and Learning Results			
Problem solving	The participation and resolution of the exercises proposed by the teacher will be evaluated.	25	A1 A5	B5	C17 C18	D1 D3
Mentored work	The students will work in groups. It will be an activity of application of the knowledges/skills developed in the subject.	10	A1 A5		C17 C18	D3
Laboratory practical	The assistance to the practical classes of laboratory is compulsory. The work of laboratory will be evaluated as APT or NO APT. The following aspects will be evaluated: previous or later work, development of the experimental work and lab notebook. In order for the students to pass the subject, a qualification of APT in laboratory practices must be reached.	0		B5	C17 C18 C26 C28	D1
Objective questions exam	After the laboratory practical, the students will answer a questionnaire regarding the experimental part of the subject.	10		B5	C17 C26 C28	D1
Problem and/or exercise solving	A test of the contents of the first lessons, that will weight 15% of the final mark.	15	A1 A5	B5	C17 C18	D1 D3
Problem and/or exercise solving	A test of all the contents of the subject, that will weight 25 % of the final mark. A minimum score of 4.0 points out of 10.0 in this test will be demanded to pass the subject.	25	A1 A5	B5	C17 C18	D1 D3
Problem and/or exercise solving	A written test related to the experimental part of the subject, that will weight 15% of the final mark. A minimum score of 4.0 points out of 10.0 will be demanded in this test.	15		B5	C17 C18 C26 C28	D1

Other comments on the Evaluation

Basic learning outcomes for this subject:

- Chemical language (functional groups; organic formulation and nomenclature; reaction and resonance arrows; curved arrows; resonance forms).
- Stereochemistry (representing 3D-structures; chair conformations; chiral centres; absolute and alkene configuration assignation).
- Basic reactivity (identifying acids, bases, nucleophiles and electrophiles; formal oxidation states; carbocations; cations and anions stability).
- Laboratory (determination of a reaction yield).

In case of doubt about the acquisition of the learning results by the students, additional oral assessment tests may be taken.

To pass the subject in June you will need:

- Achieve the mention of PASS in the evaluation of laboratory practices
- Achieve a minimum score of 4 points out of 10 in the global test
- Get a minimum score of 4 points out of 10 in the written test of the experimental part

If any of the above conditions is not met, the mark that will appear in the report will be the weighted mark of the tests.

Achieve a minimum score of 5.0 in the weighted sum of all sections.

The final grade of the student who passes the subject may be normalized so that the highest grade can reach a value of up to 10 points.

2nd AND SUBSEQUENT REGISTRATION STUDENTS: Students who have been evaluated with PASS in the laboratory work in a previous year will be awarded a PASS in the follow-up of the laboratory work in the current academic year. It is not needed to redo the experiments. However, they must carry out the questionnaire (10%) and the written test of the experimental part (15%) to obtain the corresponding qualification for the experimental part of the subject in the current academic year.

EVALUATION IN JULY: The grade obtained by the students during the course in the problem solving, mentored work, laboratory practical and laboratory questionnaire will be maintained. It will be possible to take a test of all the theoretical content of the subject that will mean 40% of the final grade and/or a written test of the experimental part that will mean 15% of the final grade.

It will be necessary to achieve a minimum of 4 points out of 10 in these tests to pass the subject and take into account the rest of the evaluation elements.

The final mark will be the weighted sum of all the sections, provided that the required minimums are reached. Otherwise, the score that will appear in the report will be the weighted score of the tests.

GLOBAL EVALUATION OPTION: To pass the subject, the student must carry out the laboratory practices, achieve a PASS grade in the work developed in the laboratory and a grade equal to or greater than 5 points out of 10 in the written test of the experimental part (20% of the final mark). In addition, it is neccesary to achieve at least 5 points out of 10 in a test in which all the contents of the subject will be evaluated (80% of the final grade).

Sources of information

Basic Bibliography

KLEIN, D., **Química Orgánica**, 1ª edición en español, Médica Panamericana, 2013

VOLLHARDT, K.P.C.; SCHORE, N.E., **Química Orgánica**, 5ª en español, Ediciones Omega, 2007

WADE, L.G., **Química Orgánica**, 9ª en español, Pearsons-Educación, 2017

M A Martínez Grau, **TECNICAS EXPERIMENTALES EN SINTESIS ORGANICA**, 2ª Edición, Síntesis, 1988

Complementary Bibliography

PALLEROS, D.R., **Experimental Organic Chemistry**, John Wiley and Sons, 2000

QUIÑOÁ, E.; RIGUERA, R., **Cuestiones y ejercicios de Química Orgánica**, 2ª edición, McGraw-Hill Interamericana, 2004

QUIÑOÁ, E.; RIGUERA, R., **Nomenclatura y representación de los compuestos orgánicos**, 2ª edición, McGraw-Hill Interamericana, 2005

DOBADO, J.A.; GARCÍA-CALVO, F.; GARCÍA, J.I., **Química Orgánica: ejercicios comentados**, Garceta, 2012

CAREY, F., **Química Orgánica**, 9ª en español, McGraw-Hill Interamericana, 2014

CLAYDEN, J.; GREEVES, N.; WARREN, S., **Organic Chemistry**, 2ª edición, Oxford University Press, 2012

Recommendations

Subjects that continue the syllabus

Organic Chemistry III: Concerted, Radical and Photochemical Reactions/V11G201V01305
Organic Chemistry IV: Design of Organic Synthesis/V11G201V01310

Subjects that are recommended to be taken simultaneously

Structural Determination/V11G201V01206

Subjects that it is recommended to have taken before

Organic chemistry I/V11G201V01205

IDENTIFYING DATA				
Chemical engineering				
Subject	Chemical engineering			
Code	V11G201V01301			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	González de Prado, Begoña			
Lecturers	Gómez Costas, Elena González de Prado, Begoña			
E-mail	bgp@uvigo.es			
Web				
General description	This subject is an introduction to Chemical Engineering, where the knowledge gained in the previous Chemistry degree courses is related to Chemical industry processes. The mail goal is to enable the students to learn the basic knowledge about material and energy balances so that they can applied it to the design of separation processes such as distillation or liquid-liquid extraction. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English. This subject gives the basis to understand other subjects such as Environmental Quemistry, Food Chemistry and Industrial Chemistry.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
B4	Ability for analysis and synthesis
C3	Recognize and analyze chemical, qualitative and quantitative problems, proposing strategies to solve them through the evaluation, interpretation and synthesis of data and chemical information
C23	Know the principles and procedures of chemical engineering
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Know and identify the diverse operations of separation and their fields of application.	A1	B4	C3 C23	D1
Draw and interpret liquid vapour equilibria, liquid- liquid equilibria and liquid-gas equilibria diagrams	A1	B4	C3 C23	D1
Design the different operations of separation based in liquid vapour, liquid-liquid and liquid-gas equilibria	A1		C23	D1
Design chemical reactors ideals.	A1		C3 C23	D1

Contents	
Topic	
Subject 1. Introduction to Chemical Engineering	Origin, concept and evolution of the Chemical Engineering. Discontinuous and continuous operation. Stationary and non stationary state. Cocurrent and countercurrent operations. Classification of the unit operations. Systems of units.
Subject 2. Mass and energy balances	General equation of balance. Mass balances in systems without chemical reaction in steady and non-steady state. Recycle, purge and bypass. Mass balances in systems with chemical reaction in steady and non-steady state. Energy balances. Energy balances in systems with chemical reaction in steady state.

Subject 3. Distillation	Vapour-liquid equilibria. Phase diagrams for binary mixes. Simple and flash distillation. Multistage distillation
Subject 4. Liquid-liquid extraction	Liquid-liquid equilibrium for binary and ternary systems: binodal curve and distribution coefficients. Liquid-liquid extraction in cocurrent and countercurrent contact.
Subject 5. Chemical reactors	Speed of reaction. Ideal reactors: batch stirred tank reactor, continuos stirred tank reactor and plug flow reactor
Subject 6. Heat transfer	Mechanisms of heat transfer. heat transfer through flat walls, cylindrical and spherical. Heat exchangers.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	25	37
Problem solving	18	20	38
Collaborative Learning	2	0	2
Autonomous problem solving	2	16	18
Case studies	0	20	20
Objective questions exam	2	19	21
Problem and/or exercise solving	2	12	14

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

Methodologies

	Description
Lecturing	During these classes (one hour per week) the teacher will explain the most relevant aspects of the subject. The students will have the available documentation on Moovi.
Problem solving	There will be a set of exercises of each subject available for the students. Some of these exercises will be solve in class and other ones will be solved by each student and presented to the teacher in order to be corrected.
Collaborative Learning	In some classes of resolution of problems will propose some problem so that they resolve it in groups reduced.
Autonomous problem solving	The students will have to solve some exercises and/or questions and they will have to present them to through the platform Moovi
Case studies	It will propose a global problem that cover the greater part of the contents of the subject that will have to resolve of individual form and deliver through the platform Moovi for its evaluation

Personalized assistance

Methodologies	Description
Problem solving	In the assigned hours of tutoring the professor will solve any doubts regarding the subject
Collaborative Learning	During the sessions of collaborative learning the professor will resolve the doubts that can arise
Autonomous problem solving	In the assigned hours of tutoring the professor will solve any doubts regarding the subject
Case studies	In the assigned hours of tutoring the professor will solve any doubts regarding the subject

Assessment

	Description	Qualification	Training and Learning Results			
Collaborative Learning	Resolution of exercises in small groups	5		B4	C3 C23	D1
Autonomous problem solving	The students will have to deliver, in the terms indicated, the problems and activities proposed of each subject.	15		B4	C3	D1
Case studies	It will propose a global problem that cover the greater part of the contents of the subject	10	A1		C3 C23	D1
Objective questions exam	It will make a long proof of all the matter of the subject.	40	A1	B4	C3 C23	D1
Problem and/or exercise solving	They will make two short proofs, one of the subjects 1 and 2 and another of the subjects 3 and 4.	30	A1	B4	C3 C23	D1

Other comments on the Evaluation

There will be two short written tests throughout the quarter that do not eliminate matter. At the date set by the centre, the

entire subject matter will be evaluated and a minimum of 3 out of 10 points must be reached to take account of the other evaluation elements. If the minimum grade is not reached, the final test note is the grade of the subject.

The different activities carried out in the classroom and autonomously by the students together account for 30% of the final grade. To overcome the subject it is essential to have a minimum score of 3.5 out of 10 points in these sections (collaborative learning, problem solving autonomously, case studies).

The participation of the student in some of the evaluation tests, the delivery of 20% or more of the work ordered by the teacher, implies the condition of "presented" and the assignment of a grade.

Second chance. There will be a long test of all the material that will make up 70% of the grade. The grades corresponding to the activities carried out in the classroom and autonomously obtained, by the students, throughout the course

Sources of information

Basic Bibliography

G. Calleja, F. García, A. de Lucas, D. Prats, J.M. Rodriguez, **Introducción a la Ingeniería Química**, Síntesis, 1999

D.M. Himmelblau,, **Principios Básicos y Cálculos en Ingeniería Química**, Prentice-Hall, 2002

C.J. GEANKOPLIS, **Procesos de transporte y principios de procesos de separación**, CECSA, 2006

W.L. McCabe, J.C. Smith, P. Harriot, **Operaciones Unitarias en Ingeniería Química**, McGraw-Hill, 2002

Complementary Bibliography

C.J. King, **Procesos de Separación**, Reverté, 1986

H.S. Fogler, **Elementos de Ingeniería de la Reacción Química**, Prentice-Hall, 2001

R.M. Felder, R.W. Rousseau, **Principios elementales de los procesos químicos**, Limusa,

Recommendations

IDENTIFYING DATA				
Analytical Chemistry III: Electroanalytical Methods and Separations				
Subject	Analytical Chemistry III: Electroanalytical Methods and Separations			
Code	V11G201V01302			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	González Romero, Elisa			
Lecturers	Costas Rodríguez, Marta González Romero, Elisa			
E-mail	eromero@uvigo.es			
Web				
General description	Give knowledge of the analysis of compound (organic and inorganic, ions, atoms and molecules) of environmental interest, clinical, biomedical, in the food and pharmaceutical industries, in laboratories quality control, etc, by means of the main Electrometric Techniques of analysis and Classical Separation methods. Inside the process/analytical procedure, will take into account the conditions for the direct measurement and those other situations in which it would be necessary the previous separation of the analyte and/or interferences of the matrix (treatment of sample). It will give a wide and current vision of the versatility of these techniques like tool to resolve problems in the areas of application mentioned, already was carried out the analysis in the chemical laboratories (involves transport and storage of the sample) or directly in the place of sample collection (analysis in situ or decentralised), because of its advantages of miniaturisation and, therefore, of portability, its easy handle and its rapidity of answer (methods of screening). With all this, pretends that the student can acquire the sufficient skill, in the first place, in the handle of the sources of bibliographic documentation and, second, in the set up and maintenance of teams, so that it can apply the analytical methodology in the resolution of real problems. Matter of the program English Friendly: the international students will be able to follow the classes without difficulty then , so much the visual material (presentations in PowerPoint) like the bibliography recommended, presents in English, in addition to having to his disposal another material of support for the follow-up of the matter in English and to be able to request to the professors any another material or additional bibliographic references in this language. They will attend the interventions in class, the tutorial and the realisation of the proofs and evaluations also in English. Matter Offered for the Elderly Program; to the students of this program that select this matter, will facilitate them material of support in Spanish (books of text, monographs, articles, etc) so that they can follow fluently the contents, in addition to having of the bibliography recommended.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B5	Ability to adapt to new situations and to make decisions
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C13	Know the principles and applications of electrochemistry
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results		
Identify and distinguish properly the different steps of the analytical process	A3		D1
Know and apply the main systems of sampling, storage and treatment of samples for electroanalytical purposes	A1	C13	D1

Describe and explain the fundamentals and the analytical applications of separation techniques (no chromatographic ones) in the treatment of sample and the electroanalysis in the determination	A3		C13	D1
Purchase critical trial to evaluate and select the ideal technique, so much electroanalytical as of separation, to resolve a real analytical problem, taking into account to the analyte, to the type of sample and the analytical quality that demands to the results.	A1	B5	C13 C26	D1
Differentiate, choose and correctly handle the instrumentation involved in electroanalysis and the material used in non-chromatographic separations	A1	B5	C13 C26	D1
Acquire skills to plan and develop an analysis method, as well as to calibrate, measure and interpret the results obtained when solving, experimentally, the analytical problem that is proposed and successfully evaluate / defend any situation, simulated or real, that arises at the laboratory.	A3	B5	C26	D1
Acquire skills to discuss and defend the choice of an analysis method in different situations and its validation.	A3	B5	C13 C26	D1
Correctly carry out calculations in the preparation of solutions, in the calibration and in the evaluation of the results and recognize errors.	A1 A3	B5	C6 C26	D1
Collect information to prepare, argue and present reports.	A1	B5		D1
Handle chemicals correctly, assess risks and manage the waste produced in the lab.	A3	B5		D1

Contents

Topic	
UNIT 1.- Electroanalysis in the measurement step. Fundamentals of electrometric methods.	Redox and electrochemical chemical reactions. Interface electrode / dissolution. Transportation phenomena. Electrolysis and model of stationary diffusion. Classification of electrometric techniques. Instrumentation: basic components in potentiometric systems, conductimetric and potentiostatic / galvanostatic.
UNIT 2.- Electrodes and cells.	Working, reference and auxiliary electrodes. Working Electrodes: ISE, ISFET, solids (metallic and carbon), liquids (Hg), screen-printed electrodes (SPE) and modified. Supporting electrolytes and solvents. Cell configuration in electroanalysis and equivalent circuit. Calibration, the role of blank in electroanalysis and calculation of analytical parameters. Direct measurement and measurement after sample treatment: separation and derivatization in electroanalysis. Validation.
UNIT 3.- Conductimetry and potentiometry.	Conductometric analysis. Potentiometric analysis. Conductometric and potentiometric titrations. Analytical applications
UNIT 4.- Electroanalysis in dynamic systems I.	Coulombimetry, chronocoulombimetry and coulometric titrations. Analytical applications. Chronoamperometry and amperometry.Linear sweep voltammetry (LSV) and cyclic (CV). Processes of electrode for organic and inorganic compounds and criteria. Analytical applications.
UNIT 5.- Electroanalysis in dynamic systems II.	Pulse techniques: normal pulse voltammetry (NPV), differential pulse(DPV), square wave (SWV). Alternate current techniques (AC). Stripping techniques. Hybrid techniques and couplings. Analytical applications. Reflections and comparative study with others analytical techniques.
UNIT 6.- Fundamentals and aims of the separations in analytical chemistry.	Treatment of sample by digestion. Preparation of the sample: purification and pre-concentration. Studies of recovery.
UNIT 7.- Non-chromatographic Separations.	Precipitation, Leaching, Volatilisation and Distillation (lyophilisation, Kjeldhal, Willard-Winter), Electrodeposition and stripping.
UNIT 8.- Extraction	Liquid-liquid extraction, S-L extraction (Soxhlet, Assisted Extraction by Ultrasonic, microwave and accelerated-ASE), microextraction and solid phase extraction (SPE).
LABORATORY EXPERIMENTS	Experiments related to the contents in electroanalysis and non-chromatographic separations, applying the analytical process and including the evaluation and data processing, as well as the delivery of reports.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	18	42
Seminars	12	4	16
Laboratory practical	26	14	40
Workshops	0	6	6
Objective questions exam	1	8	9
Essay questions exam	2	12	14
Report of practices, practicum and external practices	0	12	12

Laboratory practice	1	10	11

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

Methodologies	
	Description
Lecturing	The master classes (55 min) aim to give a global and real vision of electroanalysis, both from organic and inorganic compounds, by direct measurement or prior separation of the analyte. Each one of the topics will be documented with scientific articles, the contents of which will serve to establish and expand the knowledge acquired in the theoretical classes, and with representative examples of the fundamental concepts that are collected in each topic. The teaching-learning methodology will be centered on the student, so the classes will be aimed at motivating / encouraging a high participation on the part of these in the classroom. Therefore, the classes will be developed in a very interactive with the students, using the didactic material for their development online, as well as the most appropriate bibliography. The use of ICTs (MooVi and My Moodle) will be the resource that allows the student to communicate with the teacher (in addition to e-mail and the tutorials) and their peers, at the same time being the source of information of immediate access for them. In the tele-teaching platform, they will be able to find the basic information and documentation on the subject being taught, the schedule of activities, the exercises proposals, practice guide, workshop planning and qualifications.
Seminars	After the lectures, the seminars will be dedicated to solving problems / exercises, in which it is intended to strengthen the level of understanding of the students in the topic under study. These problems / exercises, in principle, are worked on in class in small groups, then there is a general debate on them and later the student will have to solve them individually. The seminars aim to reinforce knowledge acquired in the theoretical classes. There will also be a discussion of practical cases and work scientists related to the contents of the subject.
Laboratory practical	The practical laboratory classes play a fundamental role in teaching the subject. On the one hand, they are essential for understanding the theories and concepts taught in the lessons; and on the other, they allow the student to be trained in the handling of analytical methodology, as well as norms and rules of scientific work, both at the level of group and individual work, including report writing. Ultimately, these are procedural objectives. The use of ICTs (MooVi and My Moodle) will be the resource that allows the student to communicate with the teacher and their colleagues, at the same time being the source of information of immediate access for them. In the tele-teaching platform, you will be able to find basic information and documentation on the subject that is taught, the agenda of activities, the proposed exercises, the practice guide, the workshop planning and qualifications.
Workshops	They would be part of the seminars and laboratory practices in which students must solve by themselves, under the teacher's supervision but with greater autonomy, assumptions real practicals of electrochemical processes, detection and determination of compounds of interest (pollutants, drugs, biomolecules, etc.) and design analytical strategies. Both in the seminars and workshops will monitor the personal work that is being carried out by the student at all times. Discussions will be held that will serve to solve problems real, as well as to expose complementary concepts, addressed or not in other subjects, but necessary in the approach to this problem. This task will be subject to the evolution of the student in the learning process.

Personalized assistance	
Methodologies	**Description**
Lecturing	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.
Seminars	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.
Laboratory practical	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.
Workshops	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.

Tests	Description
Report of practices, practicum and external practices	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	PRACTICAL CASES: application of techniques in the RESOLUTION OF environmental, clinical, food industry PROBLEMS, etc. There will be a personalized follow-up of the student and evaluable by the teacher, considering the degree of participation by the students in the practical cases that arise in the seminar classes for the resolution of analytical problems in different fields of application. The ability to resolve questions and issues that arise related to the topic will be taken into account, both in the way of presenting them (ability to synthesize, explain and transmit the information) and in defending them vehemently.	10	A1 B5 C6 D1 A3 C13 C26
Laboratory practical	EXPERIMENTAL IN THE LABORATORY The teachers involved will carry out personalized monitoring of the experimental work carried out by the student in the laboratory sessions, their progress, autonomy, attitude, aptitude and skills developed, as well as their ability to work in a group. It is important to indicate that it is MANDATORY AND ESSENTIAL to attend ALL laboratory sessions and pass the activity to qualify for approval in the matter. Logically, the laboratory practices will be suspended for students who do not complete or fail this activity. A minimum grade of 4/10 must be achieved to qualify for the pass of the subject.	15	A1 B5 C6 D1 A3 C13 C26
Workshops	Resolution of PRACTICAL ASSUMPTIONS (design of experiments, laboratory introduction) A personalized monitoring of the student will be carried out and the way of defending/presenting the information will be evaluated, endorsed by the reliable bibliographic search (ability to search, value, classify and select information), as well as the ability to structure, synthesize, criticize and interrelate the contents for the resolution of the practical case or case raised.	5	A1 B5 C6 D1 A3 C13 C26
Objective questions exam	There will be a short test of objective questions on the topics covered in seminars/workshops that may include theoretical-practical questions/problems or multiple choice. This test serves, at the same time, for the student to assess and evaluate their study methodology. In order to compensate with the rest of the evaluation, a total final grade of 4/10 must be achieved (and a minimum grade of 4/10 in each part of the test). The day and time, as well as the classroom, will be public and the information will be included in the academic program of the center, previously approved by the Faculty Board.	10	A1 B5 C6 D1 A3 C13 C26
Essay questions exam	It corresponds to the official test (ordinary and/or extraordinary calls) and MANDATORY for all enrolled students. It is made up of three parts: theoretical (5%), theoretical-practical (15%) and problems (15%) that integrates the development of an analytical procedure and/or resolution of a practical case. In order to compensate with the rest of the evaluation, a total final grade of 4/10 must be achieved (and a minimum grade of 4/10 in each part of the test). The day and time, as well as the classroom, will be public and the information will be included in the academic program of the center, previously approved by the Faculty Board. OBSERVATION: If there are several teachers involved in the subject (in theory/seminars), the grade that the student must obtain in the part taught and evaluable by each teacher will have to be greater than or equal to 3.5/10, being the necessary requirement for the overall weighting of the exam to take place. Not reaching this qualification, the final result is fail.	40	A1 B5 C6 D1 A3 C13 C26

Report of practices, practicum and external practices	Upon the teacher's indication, the work team will prepare the practical reports (limited number of pages), which will reflect the work done in the laboratory by the team. Two models will be followed: scientific and technical. The fact of adjusting to the norms, the title proposal, layout, discussion of results, ability to synthesize the conclusions, etc. will be valued. The scientific articles/technical reports handled in the practices will serve as a model. Taking as a model does not mean PLAGIARIASING, which will be penalized with a ZERO in the qualification of the reports. These reports, whether scientific or technical, must be delivered within the established period and will be corrected by the professor. A minimum grade of 4/10 must be achieved to qualify for the pass of the subject.	10	A1 B5 C6 D1 A3 C13 C26	
Laboratory practice	A laboratory test will be practiced, at an individual level, which will allow the evaluation of the competencies and skills acquired by the student during the laboratory sessions. Said test will be carried out at the end of the laboratory sessions and is mandatory, and a minimum grade of 4/10 must be achieved to opt for the subject's approval.	10	A1 B5 C6 D1 A3 C13 C26	

Other comments on the Evaluation

Please, pay attention: translated content from main language (*castellano*) using the translation tool of DocNet App.

For better reading, please, go to main language and copy the text to google translator or another.

1.-The ***EVALUACIÃ*N continuous** *harÃ taking into account the *calificaciÃ*n of the distinct activities/test that they describe in this section (see Ã*tems of *evaluaciÃ*n up). It is **indispensable to reach a *calificaciÃ*n of 5/10 in each one of split them/activities/test that *evalÃ*an to SURPASS the matter**. *AdemÃ*s, beÃ necessary to reach a *calificaciÃ*n ***mÃ*nima of 4/10 in each one of these activities/test proposed to OPT To THE APPROVED of the matter**. In **case of not achieving the note *mÃ*nima** demanded in any of the activities/test, supposes the ***calificaciÃ*n of SUSPENSE** in the matter; the ***calificaciÃ*n that appearÃ in the record beÃ the note *ponderada *mÃ*s high reached**, reflecting aceÃ the *calificaciÃ*n *mÃ*s faithful and real of the activities/test made by the student (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023,*TÃ*tulo V. Of the *calificaciÃ*n of the student, *Art. 31.2.).

The ASSISTANCE To THE *PRÃ*CTICAS And To THE SEMINARS/WORKSHOPS, aceÃ like **the development and the *realizaciÃ*n of the activities/test associated** (see Ã*tems of *evaluaciÃ*n), **is COMPULSORY for ALL THE STUDENTS ENROLLED**, receive to the *evaluaciÃ*n continuous or global. **The *prÃ*cticas, the reports and the seminars/workshops are not recoverable** in the second neither successive announcements. The **ABSENCE in the *prÃ*cticas and/or seminars/workshops, aceÃ like the does not deliver of the reports in group, are not recoverable** in the second neither successive announcements, preventing *tambiÃ*n surpass the *evaluaciÃ*n global (in the case of the students that had opted by this way of *evaluaciÃ*n).

THE DELIVERY OF THE REPORTS OF *PRÃ*CTICAS, inside the term established by the *profesorado, is **COMPULSORY**. All the reports happenÃ*n by programs *anti-plagiarism and only allowÃ a *mÃ*ximo of 10% of similarity. The ***detecciÃ*n of plagiarism** with an upper similarity to 10% *tendrÃ like consequence the **SUSPENSE in the activity, with a *calificaciÃ*n of ZERO** and without *opciÃ*n to recover (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023,*TÃ*tulo VII. Of the use of half *ilÃ*citos, *Art. 40.).

The *calificaciÃ*n obtained in the distinct activities/test of *evaluaciÃ*n compulsory, whenever it reach the *mÃ*nimo of 4/10, *mantendrÃ for the announcement of July, by what in this announcement the student presentÃ only to the parts that have not surpassed in the first announcement.

2.- ***EVALUACIÃ*N GLOBAL:** to the *calificaciÃ*n definite of this proof moveÃ*n the qualifications obtained in the activities of *carÃ*cter compulsory and developed in the *prÃ*cticas of laboratory and in the seminars/workshops. **The student that wish to receive to the *evaluaciÃ*n global, have toÃ deliver to the coordinator of the matter**, **IN THE TERM OF TWO WEEKSfrom the start of the teaching**, a writing **signed in which it certify that opts by said *evaluaciÃ*n global**, what him preventÃ go back to the *evaluaciÃ*n continuous.

3.-Regarding the *realizaciÃ*n of the proofs or any official examination of the subject, is **COMPULSORY to carry achieve to be able to access to the classroom: *DNI/*NIF or *carnet to drive, SIMPLE CALCULATOR (no programmable or *electrÃ*nica) and 2 BOWLÃ*GRAFOS BLUE**. No allowÃ the use of an extraneous calculator. Therefore, no allowÃ the access to the classroom with the following UNAUTHORISED material: correctors (*tipex),*lapiceros, *TELÃ*FONO

MÃ�VILE, INTELLIGENT CLOCK Or ANY ANOTHER DEVICE *ELECTRÃ�NICO, coats, hunters, *parcas, sweatshirts marsupials, scarves and similar, etc.

The no allowed material and detected in the interior of the classroom during the *realizaciÃ�*n of the proofs beÃ confiscated by the *profesorado and no *tendrÃ right to *devoluciÃ�*n. *AdemÃ*s, the *incumplimiento of these norms, established by the *profesorado and known by the students with quite *antelaciÃ�*n to the proofs and/or exÃ*menes when being published in the *GUÃ�To EDUCATIONAL OF THE MATTER, considerÃ fraudulent behaviour and *tendrÃ consequences of Ã�*ndole discipline (Regulation on *evaluaciÃ�*n, the *calificaciÃ�*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, *TÃ�*tulo VII. Of the use of half *ilÃ�*citos, *Art. 41.)

The use of means or material *ilÃ�*citos involveÃ the *finalizaciÃ�*n of the proof and the immediate abandonment of the classroom, appearing a SUSPENSE in Records (certifying the fault in the file) and losing the rights to make ANY ACTIVITY, PROOF or EXAMINATION OF THE SUBJECT during the rest of the course. *TambiÃ�*n NotifyÃ the fault committed to the managers of the Centre and of the *Dpto. So that they notify, to his time, to the upper authorities so that they take the timely measures (Regulation on *evaluaciÃ�*n, the *calificaciÃ�*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, *TÃ�*tulo VII. Of the use of half *ilÃ�*citos, *Art. 42.).

4.-All the activities that develop in the classroom or in the laboratories, the material of support (presentations), etc. *estÃ*n subject to the rights of the copyright and of image. The educational of the matter do not allow to be recorded, neither by *vÃ�*deos neither by audios or any another format like the *pantallazos, during the development of the face-to-face classes or in the *telemÃ*ticas. What communicates for the timely effects by the possible consequences of Ã�*ndole disciplinary that can produce .

NOTE: it recommends the reading of the document Regulation on *evaluaciÃ�*n, the *calificaciÃ�*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, that beÃ available in *MooVi to the start of the course.

***EVALUACIÃ�*N OF THE STUDENTS OF THE PROGRAM OF GREATER**

1.- Assistance to the activities programmed 40%

2.- Follow-up of the activities made 30%

3.- The *anÃ*lisis home (sensors and devices *portÃ*tiles) 30%

Sources of information

Basic Bibliography

Hernández, L y González, C, **Introducción al análisis instrumental**, Ariel, 2002

Skoog, DA; Holler, FJ y Crouch, SR, **Principios de análisis instrumental**, 7, Cengage Learning Editores, 2018

Wang, J, **Analytical Electrochemistry**, 3, Wiley, 2006

Cela, R; Lorenzo, RA y Casais, MC, **Técnicas de separación en química analítica**, Síntesis, 2002

Complementary Bibliography

Monk, PMS, **Fundamentals of Electroanalytical Chemistry**, Wiley, 2001

Riley, T y Watson, A, **Polarography and other Voltammetric Methods**, Wiley, 1987

Kissinger, PT y Heineman, WR, **Laboratory Techniques in Electroanalytical Chemistry**, Marcel Dekker, INC, 1984

Valcárcel, M y Silva, M, **Teoría y práctica de la extracción líquido-líquido**, Alhambra, 1984

Miller, JM, **Separation Methods in Chemical Analysis**, Wiley, 1974

Recommendations

Subjects that continue the syllabus

Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306

Subjects that are recommended to be taken simultaneously

Chemical engineering/V11G201V01301
Inorganic Chemistry III: Coordination Chemistry/V11G201V01304
Organic Chemistry III: Concerted, Radical and Photochemical Reactions/V11G201V01305

Subjects that it is recommended to have taken before

Physics: Physics 2/V11G201V01107
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109

Biochemistry/V11G201V01201
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Analytical Chemistry II: Optical Methods of Analysis/V11G201V01207
Physical chemistry I: Chemical thermodynamics/V11G201V01203
Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Inorganic chemistry II/V11G201V01209
Organic chemistry I/V11G201V01205

IDENTIFYING DATA

Physical Chemistry III: Quantum Chemistry

Subject	Physical Chemistry III: Quantum Chemistry			
Code	V11G201V01303			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Galician			
Department				
Coordinator	Mosquera Castro, Ricardo Antonio			
Lecturers	Hermida Ramón, José Manuel Mosquera Castro, Ricardo Antonio Peña Gallego, María de los Ángeles			
E-mail	mosquera@uvigo.es			
Web				
General description	The foundations of the quantum chemistry are presented and applied to simple models to describe: nuclear movements in molecules and the electronic structure of the atoms. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B4	Ability for analysis and synthesis
C1	Ability to know and understand essential facts, concepts, principles and theories related to Chemistry
C4	Use computer tools properly to obtain information, process data, perform computational calculations and calculate matter properties
C14	To know the principles of quantum mechanics and its application in the description of the structure and properties of atoms and molecules
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Write and apply the fundamental operators of the quantum mechanics using the basic concepts of the theory of operators to calculate functions and own values, half values and more likely in the systems model (particle in the box, harmonic oscillator, rigid rotor, electrostatic model of the atom *monoelectrónico).		B2 B4	C1 C14	D1
Describe the functions and own values of the systems model.		B1 B2 B4	C1 C14	
Use the methods of variations and perturbations to treat systems more complex (atoms *polielectrónicos, oscillator *anarmónico, etc.)	A1 A5	B1 B2 B4	C1 C4 C14	D1
Pose approximate solutions for the equation of Schrödinger of atoms *polielectrónicos and describe his electronic structure using models of attachment of angular moments.		B1 B2 B4	C1 C14	D1
Describe the spectrums of atoms *monoelectrónicos and *polielectrónicos.	A1 A5	B1 B2 B4	C1 C4 C14	D1
Apply the theory of groups of symmetry in the context of the chemistry	A1 A5	B2	C1	D1

Contents

Topic	
1. Foundations of the quantum mechanics.	1.1. Origin of the quantum mechanics (experimental facts). Formalisms of the quantum mechanics. Non relativistic quantum mechanics. Atomic units. 1.2. Wavefunction. Constrains of the wavefunction. Wavefunctions for a single particle and a set of particles. Slater Determinants. Interpretation of the wavefunction. Normalization. Molecular and atomic wavefunctions. Separation of movements. 1.3. Operators. Hermiticity. Values for a magnitude. Eigenvalues. Orthogonality. Conmutation. Angular momentum operators. Ladder operators. Symmetry operators. Point groups. Symmetry classification of the wavefunctions (symmetry species). Character tables. 1.4. Half value. Most probable values. Uncertainty. Hypervirial and virial theorems. 1.5. Time-dependent Schrödinger equation. Stationary States (Non-time dependent Schrödinger equation).
2. Molecular translation	2.1. Free particle in 1-dimension and 3-dimension spaces. 2.2. Particle in a monodimentional box of infinite potential walls. 2.3. Particle in a 3-dimentional box. Level degeneration. 2.4. Infinite thick barriers. Reflection and transmission coefficients. 2.5. Finite thick barriers. Tunnelling.
3. Approximate treatments to resolve the equation of Schrödinger.	3.1. Variational Method. Eckart's Theorem. 3.2. Variational functions (linear combinations). Secular determinant. 3.3. Theory of time-independent perturbations in non degenerated levels. 3.4. Theory of independent perturbations of the time in degenerate levels. 3.5. Semiclassical treatment for radiation-matter interaction: theory of dependent perturbations of the time. Consequences in non-elastic interaction between radiation and matter. Dipole transition. Coefficients of absorption and broadcast stimulated. Coefficient of spontaneous broadcast. Half life of the states aroused. 3.6. Distribution of a sample of particles between his levels of energy (statistics of Maxwell-Boltzmann). Intensity of absorption and broadcast of radiation.
4. Molecular rotation.	4.1. Diatomic molecules: rigid Rotor. 4.2. Polyatomic molecules: spherical, symmetric and asymmetric tops. Rigid polyatomic rotors. 4.3. Centrifugal distortion in diatomic molecules.
5. Molecular vibration.	5.1. Harmonic oscillator (diatomic molecules). 5.2. Systems with connected harmonic oscillators (polyatomic molecules). 5.3. Effect of the molecular symmetry. 5.4. Limitations of the harmonic model. Anharmonic oscillator (diatomic molecules).
6. Electronic structure: one electron atoms.	6.1. Electrostatic model. Time-independent Schrödinger equation. 6.2. Results of the electrostatic model. Orbitals. 6.3. Electronic spin. Spin-orbit coupling. Fine structure. 6.4. Atomic nucleus. Hyperfine structure. 6.5. Interpretation of electronic spectra of 1-electron atoms. Zeeman effect.
7. Electronic structure: many electron atoms.	7.1. Electrostatic model. Impossibility to solve Schrödinger equation exactly. 7.2. Description of the Hartree-Fock method. Limitations. 7.3. Angular momentum coupling. 7.4. Interpretation of electronic spectra of polyelectronic atoms.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	48	72
Problem solving	12	30	42
Laboratory practical	14	14	28
Essay questions exam	2	3	5
Essay questions exam	0	3	3

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

Methodologies

	Description

Lecturing	The professor will expose the concepts, methods and main knowledges of each subject. It will orient the autonomous work of the student marking objectives and proposing questions and/or exercises. In the classroom the student has to pay attention to the exposiition, take his/her notes and formulate the questions that he/she considers. In the autonomous work the student has to complete the elements of the subject that remained as autonomous work, resolve the questions that have been proposed, assimilate this information and, if necessary, elaborate new questions to formulate to the professor in next sessions or in tutorials.
Problem solving	The professor will resolve the exercises that he considers fundamental in each subject. Problems for autonomous resolution will be proposed to students. The participation of the students will be motivated, thus, in part of the sessions the students are those who resolve the problems. Students have to assist to these classes with participatory spirit, procuring to understand the resolution of the exercises and connect it with the knowledges purchased in theory. Modelling of problems and its mechanical resolution should be avoided. In the autonomous work the student has to solve the problems proposed and even look for other related.
Laboratory practical	The professors will propose exercises, longer than those usual in problem solving lectures. In its majority the problems will be solved with computers. The students will obtain results to the exercises proposed. In the autonomous work thye will have to analyse the results obtained. It is always important that they relate the work made with that studied in lecturing.

Personalized assistance

Methodologies	Description
Lecturing	The student can request tutorials to consult the doubts that go generating in his autonomous work.
Problem solving	The student is allowed to request tutorials to consult the doubts that go generating in his autonomous work.
Laboratory practical	The student could request tutorials to consult the doubts that go generating in his autonomous work.
Tests	**Description**
Essay questions exam	The student can request tutorials to consult the doubts that go generating in his autonomous work and to review the results of his examinations.
Essay questions exam	

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	In each subject or group of subjects will open a control of evaluation that the students will have to resolve in an interval of time. These controls will be able to contain short questions or of development and numerical problems.	10	A1 B2 C1 D1 A5 C4 C14
Laboratory practical	The systematic observation of the work made and the answer to the questions of the professors will be valued. Besides they will make , at least, 2 you control type test, one face-to-face (in final examination) and another/*s telematic/*s. Obtain at least 4 on 10 in the practical is indispensable requirement to approve the subject. In case of not reaching the 4 on 10 in this part of the subject the global qualification will not be able to exceed 4,0 on 10 points.	15	A1 B1 C1 D1 A5 B2 C4 B4 C14
Essay questions exam	During the course will make the following examinations: to) A partial proof that will include, probably, the subjects 1, 2 and 3.	35	A1 B1 C1 D1 A5 B2 C14 B4
Essay questions exam	*b) A final examination, with two opportunities, in the dates that fix the Faculty: December/January the first and June/July the second. East will include at the earliest opportunity the subjects 4, 5, 6 and 7, except so that those students that have opted by global evaluation. In the second opportunity (except exceptional cases) this examination will comprise all the matter of the course.	40	A1 B1 C1 D1 A5 B2 C4 B4 C14

Other comments on the Evaluation

Rule 1: To be able to surpass the matter is indispensable requirement have made satisfactorily the practices. For this requires : a) have assisted to all the sessions of practices or present a certificate that to trial of the professors accredit a reason justified to be missing to a maximum of 1 session; b) reach a punctuation of 4,0 to trial of the professor commissioned. If they do not fulfil both requirements the global qualification will not be able to exceed 4,0 points.

Rule 2: In each examination (was partial or final) will include theoretical questions and numerical problems. To surpass the examination, in addition to a global qualification of 5,0 points, will be necessary to obtain a minimum punctuation of 4,0 points on 10 in the theoretical questions and of 3,0 points on 10 in the numerical problems. In contrary case the global

qualification of the examination never will be able to be upper to 4,0 points.
Rule 3. The students that, fulfilling rule 2, reach an equal or upper punctuation to 4,5 on 10 points in the partial proof will be able to present to the first opportunity of the final examination answering only the exercises and questions related with the no included subjects in the partial examination. This option will have to be indicated to the professor when beginning the final examination. When exercising this option the global qualification of the examinations will obtain valuing with coefficient 35/75 the first examination and 40/75 the second.
Rule 4. In case to verify the previous norms, the global qualification of the matter will be the highest of: a) that obtained in the examination (or group of examinations using the norm 3);and b) the resultant to apply the following weighting: resolution of exercises 10%, practices of laboratory 15%, examination/s 75%.
Rule 5. They will not validate practices approved in past courses neither in this course neither in the following.
Rule 6. It is not contemplated to keep approved parts of the subject between different academic courses.
Rule 7. During the process of qualification, professors will be able to require that, in personal interview, the student clear any doubt that affect to the correct qualification of any one of his examinations. This procedure will apply for cases of not readable, presumption of copy, or other problems that professors consider that they can solve of this way.
Rule 8. The detection of any type of copy will suppose the expulsion of the examination and the qualification of zero, that will be applied to this opportunity and to the following of this course.

Sources of information

Basic Bibliography

Bertrán, J.; Branchadell, V.; Moreno, M; Sodupe, M., **Química cuántica**, 1, Síntesis, 2000

Complementary Bibliography

Levine, I. N., **Química cuántica**, 5, Prentice-Hall, 2001
Atkins, P.; Friedman, R., **Molecular quantum mechanics**, 5, Oxford University Press, 2010
Pilar, F. L., **Elementary quantum chemistry**, 2, McGraw-Hill, 1990
McQuarrie, D. A., **Quantum chemistry**, 1, Viva Books, 2003

Recommendations

Subjects that continue the syllabus

Physical Chemistry IV: Molecular Structure and Spectroscopy/V11G201V01307

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry 1/V11G201V01104

IDENTIFYING DATA				
Inorganic Chemistry III: Coordination Chemistry				
Subject	Inorganic Chemistry III: Coordination Chemistry			
Code	V11G201V01304			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Galician			
Department				
Coordinator	Vázquez López, Ezequiel Manuel			
Lecturers	Couce Fortúnez, María Delfina Vázquez López, Ezequiel Manuel			
E-mail	ezequiel@uvigo.es			
Web				
General description	This subject addresses the most relevant aspects of Coordination Chemistry: This type of compound will be studied from the structural, synthetic point of view and also its most outstanding properties. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C7	Distinguish the main types of chemical reactions and their characteristics
C15	Know the main techniques of structural research, including spectroscopy
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D2	Capacity for teamwork

Expected results from this subject	Training and Learning Results			
Define the global and steps thermodynamic stabilities constants and describe the chelated, macrocyclic and crypto effects.			C7	
Classify the ligands and the compounds of coordination, as well as recognize the presence of isomerism.	A2	B3	C15	
Deduce the spectroscopic term for the electronic configuration of a metal in a coordination compound.	A5		C15	
Construct and interpret a qualitative diagram of energies from molecular orbitals to octahedral complexes.	A5	B1		
Interpret the electronic spectra of the octahedral and tetrahedral complexes of transition metals and rationalize their magnetic behavior.		B3 B4	C15	
Describe the different types of substitution mechanisms and rationalize the different products obtained in substitution reactions of octahedral and plane-square complexes.		B3	C7	
Rationalize the thermodynamic stability of coordination compounds as a function of the oxidation state of the metal and the type of ligand.	A3	B3	C7	
Describe the mechanisms of internal sphere and external sphere in the processes of electronic transfer in complexes.			C7	
Be that to carry out in the laboratory to preparation of any composed of coordination as well as to realize his structural determination			C26	D2

Contents	
Topic	
Types of ligands.	Denticity of the ligands Functionality of the ligands
The coordination polyhedron	Number of coordination Geometry of coordination *Isomería. Nomenclature and indexes of coordination
The bond in coordination compounds(I)	Introduction to crystal field theory Octahedral complexes of weak field and strong field. Tetrahedral and Square-plane complexes
Thermodinamic properties of the coordination compounds	Stability constants and factors that affect them Chelate, macrocycle and criptate effects Irvin-Williams series Approximation of Pearson
The bond in coordination compounds(II)	Molecular orbital theory in octahedral complexes Metal-Ligand Interaction
Spectroscopic and magnetic properties of complex.	Energetic states. Rules of selection. General characteristics of the electronic spectra. Magnetic behaviour
Reaction mechanism in coordination compounds.	Substitution reactions in square-plane and octahedral complexes. Electronic transfer processes.
Practices of laboratory	Synthesis of transition metal coordination compounds. Characterization by means of different spectrocopic techniques Study of properties and catalysis applications

Planning			
	Class hours	Hours outside the classroom	Total hours
Seminars	24	36	60
Laboratory practical	14	14	28
Lecturing	24	24	48
Objective questions exam	2	0	2
Report of practices, practicum and external practices	0	12	12
Objective questions exam	0	0	0
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Seminars	The seminar classes will be dedicated to the resolution of practical cases related with the subject as well as to the resolution of doubts or questions that arose in the development of each subject. It is also contemplated to carry out seminars in which aspects not taught in previous subjects but necessary for the course of the course will be addressed.
Laboratory practical	The laboratory practices will consist of 4 sessions of 3.5 hours attendance. The students will carry out different experiences in the laboratory and must make the corresponding laboratory book. Some of the experiences may require the previous study individually or by group.
Lecturing	In the theoretical kinds will present the fundamental aspects of the subjects

Personalized assistance	
Methodologies	**Description**
Seminars	During all the teaching period them/the students will be able to consult all type of doubts of the subject in schedule of tutorships or previous appointment.
Laboratory practical	The students will be able to consult to professors all type of doubts of the work in the practices of laboratory
Lecturing	During all the teaching period them/the students will be able to consult all type of doubts of the subject in schedule of tutorships or previous appointment.

Assessment			
	Description	Qualification	Training and Learning Results

Seminars	In the seminar sessions, students may be asked to solve simple questions that they must deliver at that time and that will serve for their evaluation. The score will only be taken into account if the score obtained in the global test is equal to or greater than 3 points out of 10.	15		C7 C15
Laboratory practical	The evaluation in the laboratory practices will have 10% regarding the laboratory notebook (it can be through a written test) and 5% to the behavior and skills by direct observation of the teacher. Students may also be asked to solve simple questions that they must deliver at that time and that will serve for their evaluation.	15	A2 A3	C26 D2
Lecturing	In the lecturing sesions, Students may also be asked to solve simple questions that they must deliver at that time and that will serve for their evaluation. The score will only be taken into account if the score obtained in the global test is equal to or greater than 3 points out of 10.	5	A3 B3 B4	C7 C15
Objective questions exam	There will be two short tests (1 hour) where the skills acquired at the time will be evaluated. The date and time of completion will appear in the academic schedule approved by the corresponding Faculty Board.	30		C7 C15
Objective questions exam	There will be a final test in which an overall evaluation of the subject will be made. The date and time of completion will appear in the academic schedule approved by the corresponding Faculty Board.	35		C7 C15 C26

Other comments on the Evaluation

Conditions that affect **any type of evaluation**:

- All written tests will include a set of questions on nomenclature and formulating simple inorganic compounds. If you do not achieve 90% of correct answers, the qualification of the corresponding test will not be considered in the corresponding evaluation.
- You can be requested, in person, from the student, the clarifications he deems appropriate regarding his/her answers in any of the written tests. Your answers may be considered in the evaluation of the test and modify its qualification.
- Laboratory practices are of an experimental nature and compulsory attendance at all sessions (Article 14 of the Regulation on Evaluation, Qualification and Quality of Teaching and the Student Learning Process of the University of Vigo). The evaluation of experimental skills will be carried out in the compulsory attendance sessions.
- The final grade of the students, if it is higher than 7 points out of 10, may be normalized so that the highest grade can be up to 10 points.

Conditions to qualify for **continuous evaluation**:

- Attendance at theoretical classes and seminars (Article 13 Evaluation regulation) and laboratory practices is mandatory
- The teacher must have a minimum of 80% of the deliverables proposed in the different face-to-face activities (exercises in theoretical classes and seminars or autonomous work exercises) in time and form at the end of the course.
- It is also mandatory for the student to take all the written tests planned to pass the subject.
- Failure to comply with any of these conditions implies the loss of the right to continuous evaluation.

Development of continuous evaluation:

- The specific competences of the subject related to the competences of the degree (CE7, CE15 and CE26) will be explicitly evaluated in exercises in the classroom and written tests. The basic, general and transversal competences will be evaluated implicitly in the qualification of the exercises.
- A score greater than or equal to 30% of the total value will be required in each of the written tests (short and final) and in the total sum of the grades of the deliverables, as well as 50% of the laboratory practices, so that the final grade has taking into account the rest of the evaluation elements (deliverables and short tests).
- In the case of not achieving any of the minimums, the report will include the weighted result of the tests and qualified exercises in which the criterion was achieved.
- Students who do not pass the subject at the end of the semester must take a written test in the closing period of the final evaluation in July. This test will have a value of 35% of the grade and will replace the results of the test at the end of the semester.
- The qualification of the deliverables (of the classroom activities) and short tests are not recoverable.

Global assessment
1) For non-compliance with the conditions for continuous evaluationIf the conditions for continuous assessment are not met, the student may take a test at the end of the semester where he/she must solve questions related to all the specific skills of the subject. If you have passed the CE26 competency (relating to laboratory practices) in the same course, this will be considered passed.2) Within the period determined by the Faculty of Chemistry, the student may request the overall assessment.
Respect for the final test:
It will be written and in each question, the learning outcome competence that is being evaluated will be identified. In that case:

- It will be necessary to obtain a minimum of 3 points out of 10 on average in the evaluation in those related to the CE7 and CE15 skills and 5 in those related to the CE26 skill (laboratory work skills) to pass the subject
- It will be necessary to obtain an overall grade equal to or higher than 5 out of 10 in that test to pass the subject and, in no case will the previous grades obtained during the semester be taken into account
- This test will be different in extension to the one carried out by those who opt for continuous evaluation, although it will be carried out on the same date.

Sources of information

Basic Bibliography

Bhatt, Vasishta, **Essentials of coordination chemistry [Recurso de Internet] : a simplified approach with 3D visuals**, Elsevier : Academic Press, 2016

Catherine E. Housecroft, Alan G. Sharpe ; traducción Pilar Gil Ruiz,, **Química inorgánica**, 2ª, Pearson Prentice Hall, 2006

Catherine E. Housecroft, Alan G. Sharpe, **Inorganic Chemistry**, 5ª, Harlow: Pearson Education, 2018

Complementary Bibliography

Ribas Gispert, Joan, **Coordination chemistry**, Wiley-VCH, 2008

Winter, Mark J., **D-block chemistry**, 2ª, Oxford University Press, 2015

Huheey, James E., **Inorganic chemistry : principles of structure and reactivity**, 4ª, New York : Harper Collins, 1993

Recommendations

Subjects that continue the syllabus

Inorganic Chemistry IV: Transition Metals and Solid State/V11G201V01309

Subjects that are recommended to be taken simultaneously

Physical Chemistry III: Quantum Chemistry/V11G201V01303

Subjects that it is recommended to have taken before

Inorganic chemistry I/V11G201V01204
Inorganic chemistry II/V11G201V01209

IDENTIFYING DATA

Organic Chemistry III: Concerted, Radical and Photochemical Reactions

Subject	Organic Chemistry III: Concerted, Radical and Photochemical Reactions			
Code	V11G201V01305			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Nieto Faza, Olalla			
Lecturers	Gómez Pacios, María Generosa Nieto Faza, Olalla Silva López, Carlos			
E-mail	faza@uvigo.es			
Web				
General description	This class will study radical, pericyclic and photochemical processes, using a mechanistic approximation with emphasis on selectivity. The teaching methodology is centered around problem-solving, and includes laboratory and molecular modeling practical work. Subject in the English Friendly program: International students can ask the instructors for a) learning materials and bibliography in English, b) personal attention in English at office hours and c) assignments and exams in English.			

Training and Learning Results

Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B3	Ability to manage information
B4	Ability for analysis and synthesis
C18	Know the properties of aliphatic, aromatic, heterocyclic and organometallic compounds
C19	Know the main synthesic routes in organic chemistry, including the interconversions of functional groups and the formation of carbon-carbon and carbon-heteroatom bonds
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Know and apply the factors affecting the stability of organic radicals.	A3 A4	B3 B4	C18 C19	D3
Identify and understand the mechanisms of radical reactions and use this knowledge to propose strategies to either avoid or exploit them.	A3 A4	B3 B4	C18 C19	D3
Use the Woodward-Hoffmann rules to differentiate between allowed and forbidden reaction paths in pericyclic processes.	A3 A4	B3 B4	C18 C19	D3
Recognize the most common pericyclic mechanisms (electrocyclizations, cycloadditions, and sigmatropic and ene reactions) and use them in synthetic sequences.	A3 A4	B3 B4	C18 C19	D3
Predict the regio and stereoselectivity of pericyclic reactions.	A3 A4	B3 B4	C18 C19	D3
Understand the mechanisms of photochemical activation of organic molecules.	A3 A4	B3 B4	C18 C19	D3
Understand and apply the mechanisms of photochemical reactions: double bond isomerizations, photodissociations, photoreductions and pericyclic reactions.	A3 A4	B3 B4	C18 C19	D3

Perform pericyclic, radical and photochemical reactions and elaborate, separate and purify their products using common techniques.	A3 A4	B3 B4	C18 C19 C27 C28	D3
Use spectroscopic tools to establish the structure of organic compounds.	A3 A4	B3 B4	C18 C27 C28	D3
Use molecular modeling tools to study the properties of organic compounds and reaction mechanisms.	A3 A4	B3 B4	C18 C19 C27 C28	D3

Contents

Topic	
1. Reaction mechanisms	1.1. Reaction mechanism. Reaction profiles and transition state theory. 1.2. Reaction driving force. Frontier orbital theory. 1.3. Types of selectivity in organic transformations. 1.4. Mechanism classifications.
2. Radical reactions	2.1. Homolytic vs. heterolytic bond breaking. 2.2. Radical stability. 2.3. Chain reactions, alkane halogenation. 2.4. Radical polymerizations. 2.5. Radical reductions and reductive couplings. 2.6. Radical reactions in nature.
3. Pericyclic reactions	3.1. Woodward-Hoffmann rules. Orbital symmetry conservation and transition state aromaticity. Thermal and photochemical allowed and forbidden reactions. 3.2. Electrocyclizations. 3.3. Cycloadditions. Frontier orbital theory. 3.4. Sigmatropic and ene reactions.
4. Photochemical reactions	4.1. UV/vis spectra of organic molecules. Properties of excited states. 4.2. Photophysical processes: unimolecular deactivation, internal conversion, intersystem crossing, emission (fluorescence, phosphorescence). 4.3. Double bond isomerizations. 4.4. Photodissociations. 4.5. Photoreductions. 4.6. Pericyclic reactions. 4.7. Photochemical reactions in nature.
5. Laboratory work	Practical work on experiments related to the previous sections of the course. Synthesis, purification and characterization of organic compounds.
6. Molecular modeling	Use of computational chemistry tools to study the properties of organic molecules and reaction mechanisms associated to the previous sections of the course.

Planning

	Class hours	Hours outside the classroom	Total hours
Introductory activities	0	2	2
Flipped Learning	12	20	32
Problem solving	24	44	68
Laboratory practical	28	10	38
Mentored work	0	8	8
Problem and/or exercise solving	2	0	2

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

Methodologies

	Description
Introductory activities	Presentation of the course and instructors. Review of the syllabus and the structure of the course in the remote learning platform.
Flipped Learning	The interaction of the students with the materials available in the remote learning platform is expected, as is working on the activities proposed to prepare for class. Classroom time will be used to consolidate, review, clarify and apply the studied concepts.
Problem solving	Practical exercises and problems will be solved to apply the concepts developed in the flipped classroom sessions.

Laboratory practical	The students will perform in the laboratory basic techniques related to the synthesis, separation, purification and structural characterization of organic compounds. The work includes evaluation of risk, experiment planning and analysis of results. Molecular modeling techniques will be used to study the properties of organic compounds and selected reaction mechanisms. To be allowed in the laboratory, the student is required to perform a set of preliminary preparation tasks on the remote learning platform. The work will be carried out individually in 3.5 h sessions, and will be documented in a laboratory notebook. After the practical sessions, a paper will be prepared according to the instructions of the professors.
Mentored work	

Personalized assistance

Methodologies	Description
Flipped Learning	Continuous evaluation provides both instructors and students with feedback about the evolution of student learning and students' strengths and weaknesses. Although instructors can set tutorial appointments for students they deem at risk, it is expected that the students will take responsibility for they own learning and ask for help when needed. Students can request personalized support from the instructors at any time along the course, in order to solve any problem related to the subject, to review difficult concepts or to ask for help with the assignments. Tutorial sessions can be held through office hours in person or online, using the virtual campus. Personalized attention will also be provided through e-mail or the forums in the remote learning platform.
Problem solving	Problem-solving sessions in small groups facilitates personalized support to the student as soon as difficulties arise. As in the previous section, personalized attention will be provided in office hours, as well as through e-mail or forums in the remote learning platform.
Laboratory practical	In the laboratory sessions, most individual problems will be solved in class. As in the previous section, personalized attention will be provided in office hours, as well as through e-mail or forums in the remote learning platform.
Mentored work	

Assessment

	Description	Qualification	Training and Learning Results
Flipped Learning	Students must participate in class activities and interact with the contents planned in the online learning platform. The results of the tests and other online activities integrated in every lesson in the platform will be evaluated.	10	A3 B3 C18 D3 A4 B4 C19
Problem solving	Students must solve short questions, problems and exercises, actively participating in the seminar sessions and completing them with independent work. A series of assignments will be graded. The grading will take into account the correctness of the provided answers, the quality of argumentation and the presentation of the results.	15	A3 B3 C18 D3 A4 B4 C19
Laboratory practical	The competencies associated to the safe handling of chemicals, the assessment of risks in the laboratory and the planning and execution of experiments (both computational and in the laboratory) and the analysis of results, will be evaluated. For this, we will use the systematic observation of the student's work, the preliminary work, previous to the laboratory sessions, and the quality of the laboratory notebook and the assigned report. The laboratory work will get a PASS/FAIL grade. Attendance to laboratory sessions and a PASS grade in them is needed to pass this course. 10% of the final grade is associated to an assignment related to the practical sessions.	10	
Mentored work	The students will work on the elaboration of documents in different formats, associated to the contents of the course.	10	

Problem and/or exercise solving	There will be three exams, involving problems and exercises: 1. A test about the first sections of the subject (2 hours), associated to a 15% of the final grade. 2. A test about all the contents covered in the class (2 hours), associated to a 40% of the final grade. A minimum grade of 4.0 out of 10 is required for a global passing grade. 3. A written exam (0.5 hours) related to the experimental part of the subject, associated to a 10% of the final grade. A 4.0 grade (out of 10) in this test is required for a global passing grade.	55	A3 B3 C18 D3 A4 B4 C19 C27 C28

Other comments on the Evaluation

Students need to demonstrate complete mastery of a set of essential learning outcomes in order to pass the course.

In case there is doubt about the mastery of the course's learning outcomes by any student, further or complementary oral tests can be scheduled for a sound evaluation.

Student participation in any of the graded activities will result in the assignment of a grade in this course (the student will be considered "presentado"). Attendance to laboratory sessions, participation in exams and the handing out of assignments are considered graded activities in this context.

Students who have attended the course in previous academic years: Those evaluated with a PASS grade in the experimental part of the course, upon request, will be awarded a PASS grade in this part of the course this year. As a result, their attendance to the laboratory sessions will not be required. However, assignments and the written test associated to the experimental part are required to achieve the grades associated to the experimental contents of the course this year (20%).

In the 2ª Edición de la Convocatoria Ordinaria, the grades obtained by the student in the problem solving, flipped learning and laboratory practical parts will be kept. An exam covering all the theoretical contents of the subject will be proposed, with a qualification that will represent a 45% of the final grade. A written test covering the experimental work will also be administered, with a contribution of 10% to the final grade. A minimum grade of 4.0 out of 10 in each of these two tests is needed for a passing grade and the consideration of the other grading elements.

The students desiring to opt-out of the continuous evaluation mode, need to attend the laboratory sessions and obtain a PASS in them, as well as obtaining a grade equal or higher than 5 out of 10 in the written test associated to the experimental part of the class (20% of the grade). On top of that, a grade equal or higher to 5 out of 10 is needed in a written exam covering all the contents of the course (80% of the grade).

Sources of information

Basic Bibliography

Eric V. Anslyn, Dennis A. Dougherty, **Modern physical organic chemistry**, University Science Books, 2006

Felix A. Carroll, **Perspectives on structure and mechanism in organic chemistry**, John Wiley, 2010

John Perkins, **Radical chemistry : the fundamentals**, Oxford University Press, 2000

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Carol E. Wayne, Richard P. Wayne, **Photochemistry**, Oxford University Press, 1996

Steven M. Bachrach, **Computational organic chemistry**, John Wiley & Sons,, 2007

James W. Zubrick, **The Organic Chem Lab Survival Manual: a student's guide to techniques**, John Wiley & Sons, 2009

Jerry R. Mohrig ... [et al.], **Laboratory techniques in organic chemistry : supporting inquiry-driven experiments**, W.H. Freeman, 2014

Complementary Bibliography

Nicholas J. Turro, V. Ramamurthy, J.C. Scaiano, **Modern molecular photochemistry of organic molecules**, University Science Books, 2010

Ernö Pretsch, Philippe Buhlmann, Martin Badertscher, **Structure determination of organic compounds : tables of spectral data**, Springer,, 2009

Chemistry Libre Texts, **ChemistryLibre Texts**, ookshelves/Organic_Chemistry,

James Ashenhurst, **MasterOrganicChemistry**, https://www.masterorganicchemistry.com/,

Recommendations

Subjects that continue the syllabus

Organic Chemistry IV: Design of Organic Synthesis/V11G201V01310

Subjects that are recommended to be taken simultaneously

Physical Chemistry III: Quantum Chemistry/V11G201V01303

Subjects that it is recommended to have taken before

Structural Determination/V11G201V01206
Organic chemistry I/V11G201V01205
Organic chemistry II/V11G201V01210

Other comments

In this class, the student is expected to learn how to deftly manipulate a relevant number of new concepts in a short period of time. As a result, daily work and study is a must. The same applies to class attendance and active participation in all the proposed activities, including interaction with the materials available in the online platform or the reading of the designated documents before every in person session.

It is strongly advised to have passed Organic Chemistry I and II and Structural Determination or equivalent, since the concepts learnt in these classes will be required in this one.

The use of molecular models is heavily recommended, as one of the main difficulties of this course is the visualization of the three-dimensional structure of molecules.

A laboratory coat and notebook is needed for the laboratory sessions.

IDENTIFYING DATA				
Química analítica IV: Métodos cromatográficos e afins				
Subject	Química analítica IV: Métodos cromatográficos e afins			
Code	V11G201V01306			
Study programme	Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3	2c
Teaching language	Castelán			
Department				
Coordinator	Gago Martínez, Ana			
Lecturers	Costas Rodríguez, Marta Gago Martínez, Ana Leao Martins, Jose Manuel			
E-mail	anagago@uvigo.es			
Web				
General description	Coñecementos básicos sobre as técnicas de separación e a súa aplicación na análise química. Aplicacións xerais.			

Resultados de Formación e Aprendizaxe	
Code	
A1	Que os estudantes saiban aplicar os seus coñecementos ó seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A4	Que os estudantes poidan transmitir información, ideas, problemas e solución a un público tanto especializado coma non especializado
B5	Capacidade de adaptarse a novas situacións e adoptar decisións
C6	Coñecer os fundamentos e ferrramentas habituais na resolución de problemas analíticos e na caracterización de substancias químicas
C26	Levar a cabo correctamente procedementos habituais no laboratorio, incluíndo o uso de instrumentación química estándar para o traballo sintético e analítico
D1	Capacidade para resolver problemas

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Describir os fundamentos e principios da *cromatografía de gases, identificar e saber seleccionar detectores en función das aplicacións analíticas.	A1 A4	B5		D1
Describir os fundamentos da *cromatografía e os seus principios	A1 A4	B5	C6	D1
Describir os fundamentos e principios da *cromatografía de líquidos, identificar e saber seleccionar detectores en función das aplicacións analíticas.	A1 A4	B5	C6	D1
Describir os fundamentos e principios da *electroforesis *capilar, identificar e saber seleccionar detectores en función das aplicacións analíticas.	A1 A4	B5	C6	D1
Describir os fundamentos e principios dos axustes das diferentes técnicas de separación á *espectrometría de masas e as súas aplicacións na análise química.	A1 A4	B5	C6	D1
Aplicacións prácticas e de laboratorio das diferentes técnicas de separación no ámbito da análise ambiental, alimentos ou outras aplicacións	A1 A4	B5	C6 C26	D1

Contidos	
Topic	
1- Introdución á *cromatografía	Antecedentes, evolución, definicións e clasificación das técnicas *cromatográficas, principios da *cromatografía, parámetros *cromatográficos, aspectos cualitativos e cuantitativos
2 - *Cromatografía de gases	Introdución, Clasificación e compoñentes instrumentais. Detectores (principios e selección). Estratexias de preparación de mostra previos á análise *cromatográfico, optimizacións *cromatográficas, *calibración e medida. Aplicacións.

3- *Cromatografía de líquidos	Introdución, Clasificación e compoñentes instrumentais. Detectores (principios e selección). Estratexias de preparación de mostra previos á análise *cromatográfico, optimizacións *cromatográficas, *calibración e medida. Aplicacións.
4- *Electroforesis *capilar	Introdución, Clasificación e compoñentes instrumentais. Detectores (principios e selección. Estratexias de preparación de mostra previos á análise *electroforético, optimizacións *electroforéticas, *calibración e medida. Aplicacións.
5- *Espectrometría de masas	Principios e conceptos básicos da *espectrometría de masas. Principios da *ionización. Sistemas de *ionización. *Analizadores de masas. Espectros de masas: interpretación.
6- Técnicas axustadas	Introdución e principios do axuste *GC-*MS, *LC-*MS e CE-*MS. *Interfaces. Aplicacións

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	24	21	45
Seminario	12	20	32
Prácticas de laboratorio	14	19	33
Obradoiro	0	22	22
Resolución de problemas e/ou exercicios	0	6	6
Exame de preguntas de desenvolvemento	2	10	12
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Metodoloxía docente

	Description
Lección maxistral	As clases maxistrais teñen unha duración de 50 minutos pretenden dar unha visión global e a nivel *introductorio sobre as técnicas de separación e a súa aplicación na análise. Os temas abordados nas clases teóricas poden estar acompañados de artigos científicos que poderán servir para ampliar os coñecementos abordados na clase teórica. A plataforma *Moodle utilizarase como ferramenta e recurso de comunicación entre o alumnado e os docentes.
Seminario	O obxectivo que se pretende alcanzar coa esta actividade pedagóxica é asentar os coñecementos e ampliar as competencias adquiridas nas clases maxistrais, explorando. Tanto nos seminarios, talleres como actividades de laboratorio farase un seguimento do traballo individual e/ou colectivo que estea a realizar os estudantes. Os estudantes disporán dos medios facilitados para dita atención personalizada (*tutorías presenciais, foros na plataforma *Moodle, correo electrónico, etc.).
Prácticas de laboratorio	As sesións de laboratorio están orientadas á aprendizaxe dunha serie de técnicas *cromatográficas que permitan a identificación e cuantificación de *analitos en diferentes matrices (contaminantes ambientais e alimentos, aditivos en alimentos, residuos farmacéuticos, etc.). A partir de experimentos de laboratorio preténdese aproximar os conceptos das clases maxistrais e casos prácticos dos seminarios á actividade práctica de laboratorio. Os estudantes deberán, de forma autónoma e en grupo, ser capaces de planificar e executar a actividade de laboratorio. A execución dos experimentos deberá ir acompañada con análises e organización datos. Cálculos, interpretación e discusión dos mesmos. Redacción adecuada e apropiada dos experimentos realizados.
Obradoiro	Formarían parte dunha actividade non presencial complementaria ás clases maxistrais, seminarios e de laboratorio. Os estudantes deberán resolver por si mesmos de forma autónoma, individualmente e/ou en grupos, un traballo de investigación e/ou *monografía escrito de temas relacionados cos contidos da materia.

Atención personalizada

Methodologies	Description
Lección maxistral	As clases maxistrais teñen unha duración de 50 minutos pretenden dar unha visión global e a nivel *introductorio sobre as técnicas de separación e a súa aplicación na análise. Os temas abordados nas clases teóricas poden estar acompañados de artigos científicos que poderán servir para ampliar os coñecementos abordados na clase teórica. A plataforma *Moodle utilizarase como ferramenta e recurso de comunicación entre o alumnado e os docentes.
Seminario	O obxectivo que se pretende alcanzar coa esta actividade pedagóxica é asentar os coñecementos e ampliar as competencias adquiridas nas clases maxistrais, explorando Tanto nos seminarios, talleres como actividades de laboratorio farase un seguimento do traballo individual e/ou colectivo que estea a realizar os estudantes. Os estudantes disporán dos medios facilitados para dita atención personalizada (*tutorías presenciais, foros na plataforma *Moodle, correo electrónico, etc.).

Prácticas de laboratorio	As sesións de laboratorio están orientadas á aprendizaxe dunha serie de técnicas *cromatográficas que permitan a identificación e cuantificación de *analitos en diferentes matrices (contaminantes ambientais e alimentos, aditivos en alimentos, residuos farmacéuticos, etc.). A partir de experimentos de laboratorio preténdese aproximar os conceptos das clases maxistrais e casos prácticos dos seminarios á actividade práctica de laboratorio. Os estudantes deberán, de forma autónoma e en grupo, ser capaces de planificar e executar a actividade de laboratorio. A execución dos experimentos deberá ir acompañada con análises e organización datos. Cálculos, interpretación e discusión dos mesmos. Redacción adecuada e apropiada dos experimentos realizados.

Tests	**Description**
Resolución de problemas e/ou exercicios	Formarían parte dunha actividade complementaria ás clases maxistrais, seminarios e de laboratorio. Os estudantes deberán resolver por si mesmos de forma autónoma, individualmente e/ou en grupos, exercicios prácticos relacionados cos contidos da materia.
Exame de preguntas de desenvolvemento	O exame das preguntas de desenvolvemento terá unha duración máxima de tres horas. Nela incluiranse preguntas relacionados cos temas impartidos na materia.

Avaliación

	Description	Qualification	Training and Learning Results			
Seminario	Realizarase un seguimento do traballo individual e/ou colectivo desenvolvido polos estudantes, os cales disporán dos medios facilitados para unha atención personalizada (*tutorías presenciais, foros na plataforma *Moodle, correo electrónico, etc.). A nota mínima a alcanzar neste apartado deberá ser de 4 puntos (nunha cualificación global sobre 10)	25	A1		C6	D1
Prácticas de laboratorio	Realizarase un seguimento do traballo individual e/ou colectivo do traballo desenvolvido en lle laboratorio podendo requirirse a presentación dun informe ou resolución de cuestións expostas no Laboratorio. A nota mínima a alcanzar neste apartado deberá ser de 4 puntos (nunha cualificación global sobre 10)	15	A1		C6 C26	D1
Resolución de problemas e/ou exercicios	Realizarase unha proba curta dunha hora de duración con data establecida no *cronograma definido pola Facultade. É unha proba de carácter non *eliminatorio e permite ao alumno facer o seu seguimento de estudo na materia. Os seus contidos estarán relacionados coa materia impartida na materia.	20	A1		C6	D1
Exame de preguntas de desenvolvemento	O exame (proba longa), estará constituída por contidos impartidos nas clases maxistrais, actividades desenvolvidas nos seminarios, talleres e laboratorio. Terá a duración de tres horas. É requisito alcanzar un valor mínimo de 4 puntos (nunha cualificación global sobre 10)	40	A1 A4	B5	C6 C26	D1

Other comments on the Evaluation

Dado que las actividades de formación y evaluación continua programadas dentro de las Prácticas de Laboratorio y del Estudio de casos (incluida en el seguimiento de la actividad de seminarios) están diseñadas para formar al alumnado en habilidades y competencias directamente relacionadas con el ejercicio de la profesión en el campo del Análisis Químico, por ello la asistencia y participación del alumnado en ambas actividades evaluables es OBLIGATORIA, de tal manera que la ausencia o no realización injustificada de estas actividades impedirá superar la materia. Por lo tanto, considerando el carácter teórico-práctico de la asignatura y los resultados de formación y aprendizaje que se persiguen alcanzar con ambas metodologías, el alumnado que opte por la Modalidad de Evaluación Global Final también deberá realizar OBLIGATORIAMENTE estas actividades.

Para SUPERAR la materia será necesario alcanzar una calificación GLOBAL FINAL de 5,0 (sobre 10), una vez sumadas las calificaciones ponderadas obtenidas en las componentes evaluables de la asignatura y descritas con detalle en esta sección de evaluación. Muy Importante, PARA PODER SUPERAR LA MATERIA (poder sumar las calificaciones obtenidas en cada actividad evaluable), es OBLIGATORIO alcanzar una nota mínima de 4,0 (sobre 10) en cada una de las actividades evaluables mencionadas anteriormente (Pruebas cortas, Prueba final, Prácticas de laboratorio y Seminarios). Los alumnos que no cumplan este requisito en la primera oportunidad, serán calificados en el acta con la nota más alta alcanzada en las partes suspensas, y deberán repetir en la segunda oportunidad (convocatoria de Julio) la prueba relativa a la parte o partes en las que no hayan alcanzado el 4,0. Lógicamente, los alumnos que se encuentren en esta situación conservarán la nota de la/s parte/s superada/s (≥4,0) en primera oportunidad.

En la segunda oportunidad de evaluación, tal como fue ya descrito, es OBLIGATORIO alcanzar como mínimo una calificación de 4.0 (sobre 10) en todas las partes objeto de recuperación.

Los alumnos que optan por la modalidad **evaluación global final,** deberán tener en cuenta que las actividades de contenido práctico (seminarios y Prácticas de laboratorio) son de carácter obligatorio, por lo que la evaluación de dichas actividades, se realizará independientemente de la evaluación final.

ATENCIÓN: El alumno que desee optar por la modalidad EVALUACIÓN FINAL deberá informar y entregar un documento escrito y firmado a los docentes responsables de la materia durante las dos primeras semanas desde el inicio de la docencia de la materia correspondiente.

En la presentación de la materia, así como en la pagina de la Facultad de Química disponen de las fechas para las actividades de evaluación.

Bibliografía. Fontes de información

Basic Bibliography

Luis María Polo Díez, **Fundamentos de la cromatografía**, 1ª Ed., Dextra Editorial S.L, 2015

A. Braithwaite and J.F. Smith,, **Chromatographic Methods,**, 1ª Ed, Springer, Dordrecht, 1999

Phillipe Schmitt Kopplin, **Capillary Electrophoresis: Methods and Protocols**, 2ª Ed, Humana Press, 2016

Complementary Bibliography

Chhabil Dass,, **Fundamentals of Contemporany Mass Spectrometry,**, 1ª Ed., Wiley-Interscience,, 2010

Recomendacións

Subjects that are recommended to be taken simultaneously

Química analítica III: Métodos eletroanalíticos e separacións/V11G201V01302

Subjects that it is recommended to have taken before

Química analítica I: Principios de química analítica/V11G201V01202
Química analítica II: Métodos ópticos de análise/V11G201V01207

IDENTIFYING DATA

Physical Chemistry IV: Molecular Structure and Spectroscopy

Subject	Physical Chemistry IV: Molecular Structure and Spectroscopy			
Code	V11G201V01307			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Flores Rodríguez, Jesús Ramón			
Lecturers	Flores Rodríguez, Jesús Ramón Graña Rodríguez, Ana María			
E-mail	flores@uvigo.es			
Web	http://moovi.uvigo.gal/			
General description	In the present subject Quantum Mechanics is applied to the study of molecules and the fundamentals of molecular spectroscopy. First, the Born-Oppenheimer approximation is introduced and the concept of potential energy surface presented, so a relatively detailed study of the rotation and vibration-rotation spectroscopies can later be done. The molecular orbital (MO) and valence bond (VB) methods for the analysis of the electronic structure of molecules are presented, so that of simple molecules can be studied and some basic aspects discussed. The concepts needed for studying the electron and photoelectron spectroscopies are, therefore, given. The most important computational methods for the study of the electronic structure, which form the basis of Computational Chemistry, are also presented in a simple way. The analysis of the spectroscopic methods includes the fundamentals of the magnetic resonance techniques, which is done from a theoretical perspective, as well as those of some other methods, including those based on the use of the laser. The theoretical developments studied in this subject rely on the fundamentals of Quantum Mechanics and the models for translation, vibration and rotation as presented in Química Física III: Química Cuántica. The introduction to Group Theory provided in that subject is completed in the present one by the first theme. Some elements of Statistical Mechanics are used to analyze the intensity and width/shape of the spectral lines for instance. Also, the Fermi-Dirac and the Bose-Einstein distribution laws are presented. By its theoretical and experimental contents, it provides some support to Química Física V: Cinética Química.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B4	Ability for analysis and synthesis
C2	Use correctly chemical terminology, nomenclature, conversions and units
C4	Use computer tools properly to obtain information, process data, perform computational calculations and calculate matter properties
C14	To know the principles of quantum mechanics and its application in the description of the structure and properties of atoms and molecules
C15	Know the main techniques of structural research, including spectroscopy
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
To apply the group theory in the context of the chemistry	A1 A5		C4	D1
To formulate the molecular Hamiltonian taking into account the Born-Oppenheimer approximation and to know about potential energy surfaces	A1 A5	B4	C2 C4 C14	D1
To describe the MO and VB methods and to apply the MO method to simple molecules.	A1 A5	B1 B2 B4	C2 C4 C14	D1

To describe some important computational methods and apply them to molecular electronic structure calculations.	A1 A5	B1 B2 B4	C2 C4 C14	D1
To apply the basic concepts of molecular spectroscopy.	A1 A5	B1 B2 B4	C2 C4 C14 C15	D1
To interpret distinct types of molecular spectra (microwave, infrared and visible-ultraviolet) in order to obtain structural information.	A1 A5	B1 B2 B4	C2 C4 C14 C15	D1
To describe the foundations of resonance spectroscopies	A1 A5	B1 B2 B4	C2 C4 C14 C15	D1

Contents	
Topic	
Subject I. The Group Theory in Chemistry.	1. Matrix representations. 2. Character tables. Degeneracy. 3. Basis functions. 4. Direct product representations. 5. Vanishing integrals. 6. Symmetry adapted linear combinations and projection operators. 7. Group Theory and Quantum Chemistry.
Subject II. Molecular electronic structure I.	1. The molecular hamiltonian: the Born-Oppenheimer approximation. 2. Potential energy surfaces. 3. The hydrogen molecule ion H2+: the MO method. 4. The hydrogen molecule H2: the VB method 5. Comparison of the MO and VB methods. 6. The Hellmann-Feynman theorem and the virial theorem applied to molecules 7. On the validity of the Born-Oppenheimer approximation.
Subject III. Molecular electronic structure II.	1. Electronic configurations and electronic terms in diatomic molecules. 2. The effect of the spin-orbit interaction. 3. Electron density and bond polarity. 4. The MO and VB methods applied to diatomic molecules. 5. Polyatomic molecules: classification of the electronic states. 6. Application of the MO method to simple polyatomic molecules. 7. Electron population analysis. 8. Localized MOs. 9. Molecules with conjugate bonds: the sigma-pi separation. The free electron MO method. 10. The Hückel MO method. 11. Electron delocalization and aromatic stability. 12. Population of the energy levels: Fermi-Dirac and Bose-Einstein distributions. 13. Electronic bands. 14. Application of the VB method to polyatomic molecules: types of hybridization. 15. Resonance and its meaning in Physical Chemistry.
Subject IV. Electronic structure and Computational Chemistry.	1. The Hartree-Fock SCF method applied to molecules. 2. Basis functions in molecular calculations. 3. The Roothaan-Hall and Pople-Nesbet equations. 4. Limitations of the Hartree-Fock SCF method. 5. Post-Hartree-Fock methods. 6. Density Functional Theory (DFT). 7. Relativity in molecular calculations. 8. Semi-empirical methods.
Subject V. Interaction of the electromagnetic radiation with matter and molecular spectroscopy.	1. Interaction of the electromagnetic radiation with matter. 2. Diffusion. 3. Absorption: transition moments and selection rules. 4. The Lambert-Beer law. 5. Broadening of the spectral lines. 6. Raman effect. 7. Laser and laser types. 8. Fourier transform. 9. General aspects of the experimental techniques

Subject VI. Molecular rotation and rotational spectroscopies.	1. The polyatomic rigid rotor: results of the classical and quantum treatments. 2. Rotational spectra. 2.1. Selection rules, populations and line intensities 2.2. Stark effect. 2.3. Hyperfine structure and nuclear quadrupole moment. 2.4. Molecules with non-zero electronic angular momentum. 2.5. Type-l doubling. 3. Microwave spectroscopy (MW) and its applications. 4. Rotational Raman spectra. 5. Obtaining the molecular geometry from the rotational constants. 6. Nuclear spin and rotational states.
Subject VII. Molecular vibration and vibrational spectroscopies.	1. Vibration in diatomics. 2. Anharmonicity, vibration-rotation interaction and centrifugal distortion. 3. Vibration and vibration-rotation spectra in diatomic molecules. 4. Line intensity and nuclear spin. 5. Vibration in polyatomic molecules. 6. Vibration-rotation spectra in polyatomic molecules. 7. Analysis based on the symmetry: IR and Raman activities. 8. Anharmonicity and potential energy surfaces. 9. Normal modes with more than a minimum.
Subject VIII. Electronic spectra.	1. Electronic spectra. 2. Diatomic molecules. 2.1 Selection rules. 2.2 Franck-Condon principle and fine structure. 2.3 Dissociation and predissociation. 3. Electronic spectra in polyatomic molecules. 4. Fluorescence and phosphorescence. 5. Non-radiative transitions. 6. Photoelectron spectroscopies 7. Optically active molecules. Circular dicroism. 8. Laser techniques.
Subject IX. Resonance spectroscopies	1. Introduction. 2. Foundations of the RMN and RSE spectroscopies : Chemical shift. 3. Interpretation of the shielding constants. 4. Interpretation of the fine structure. 5. RMN and nuclear exchange processes. 6. RMN for the solid state. 7. Foundations of the pulse techniques and spin relaxation. 8. RSE spectroscopy: hyperfine structure. 9. Quadrupole resonance spectroscopy. 10. Mössbauer spectroscopy.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	23	57.6	80.6
Problem solving	12	26.4	38.4
Laboratory practical	14	14	28
Objective questions exam	2	0	2
Objective questions exam	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

	Description
Lecturing	Discussion of the basic aspects of each topic and description of those to be addressed in the seminars. Discussion of the specific issues raised by students. The student will be provided with the necessary study material to follow the lessons through the Moovi (Moodle) platform.
Problem solving	Solution to numerical problems and theoretical questions, as well as test-type exercises or guided exercises. Some basic numerical and theoretical problems will be solved by the teacher in the seminars with the participation of the students. The results will be analyzed and interpreted. On a voluntary basis, the student may present the solution to some selected exercises in the seminar, with the assistance of the teacher and the participation of the other students. They may, voluntarily as well, present a written resolution to an exercise and debate it with the teacher in tutoring time.

Laboratory practical	Every student is expected to perform a well-balanced set of experiments which exemplifies and develops the basic topics. The experiments will be carried out by couples of students for agility. Scripts describing every experiment, references to bibliography and instructions for the use of computers, programs and instrumentation, as well as others related to laboratory safety, will be made available as needed. The student must produce the figures and do the necessary calculations to obtain the final results, as well as analyze and discuss them.

Personalized assistance

Methodologies	Description
Lecturing	The student may raise specific questions in the lectures and wider ones in the teacher's tutoring time.
Problem solving	The solution to the exercises will be discussed with the students in connection with the development of the theoretical aspects. Also the solution to the tests. Students will be helped in the classroom with the guided exercises. The additional questions they may raise will be answered during the teacher's tutoring time.
Laboratory practical	The practical problems or doubts the students may raise regarding the theoretical foundation of the experiments, their development or the key aspects of the calculations needed to obtain the result will be discussed during the practical sessions. Additional issues may be addressed in tutoring hours.
Tests	**Description**
Objective questions exam	Any doubts regarding the exams, in particular those related to their scope and configuration, will be clarified. In the case of the short exams, the solutions to the exercises will be briefly presented and discussed in a seminar after the short exam. During tutoring hours, the answers provided by the student will be discussed with him/her at his/her request.

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	The resolution of one or more exercises by the student and their presentation in the seminar will be rated. Short tests taken in the seminar will be rated too, as well as the final part of the guided exercises. In all cases on a voluntary basis. The weight in the global grade lies between 0-10%.	10	A1 B1 C2 D1 A5 B2 C4 B4 C14 C15
Laboratory practical	Lab practices are compulsory. They will be rated by the assessment of their development (5%) as well as by that of the corresponding practice reports (15%), one per practice. Those reports have to be elaborated individually, must contain tables, figures and graphics and the calculations needed to obtain the results, as well as a detailed discussion in relation to all relevant theoretical and experimental aspects of the subject. Students must upload the reports to the Moovi platform before the established deadline.	20	A1 B1 C2 D1 A5 B2 C4 B4 C14 C15
Objective questions exam	For the written exams the subject is divided into two parts (I and II), which have a relative weight of 50% in the mark. The written exams consist in the resolution of questions and problems. First short exam ("Primera prueba corta", Part I). Voluntary. It will take place by about half of the lecturing period. If its mark is equal or greater than 5 points over 10, part I will be considered as passed by the student. If it is lower than 5 but equal or greater than 3.75, it may represent 50% of the mark of part I, the other 50% coming from part I of the Final Exam, if that leads to improvement; otherwise the latter mark prevails. Its weight on the global mark depends on the results of other items and lies in the range: 0-40%.	35	A1 B1 C2 D1 A5 B2 C14 B4 C15

Objective questions exam	Second short exam (Part II). Voluntary. It will take place near the end of the lecturing period. Independently of the mark, the students must take part II in the Final Exam (see below). Its mark is only valid for calculating an average for part II with corresponding mark of the Final Exam, not independently of the latter. It may represent 25% of the mark of part II if that leads to an improvement, otherwise the mark obtained for part II in the Final Exam will prevail. Its weight on the global mark, depending on that other sections is: 0-10%. Final Exam. Compulsory. It will take place shortly after the lecturing period (May/June). Those students who have not passed the first short exam (mark>=5) will have to take all the exercises. Those who passed it can still try to solve the exercises of part I to improve the corresponding mark. Its weight on the global mark depends on that of other sections and lies within 26.5%-80%. The combined mark of the exams (not including the tests nor the other exercises of the first item) has to be at least 3.75 on the 10-point scale for the subject to be passed. The lab practices and the final exam are compulsory. See also the second and third points of the next section (Other Comments on the Evaluation) The assessment rules of the second call (late June or early July) to those students who have not passed the subject, are given in the first point of the next section.	35	A1 B1 C2 D1 A5 B2 C14 B4 C15

Other comments on the Evaluation

- In the *second-opportunity evaluation,* the corresponding Final Exam is also compulsory, otherwise the mark will be the same as in the first opportunity. In any case, the mark can never be lower than that of the first-opportunity evaluation. Lab practices represent 20% of the mark. The marks corresponding to "Problem Solving", second short exam and also that of the first short exam if >= 3.75, will be kept and used to calculate the average by the weights given in the last section, but only if their use gives a higher grade. Otherwise the mark of the Final Exam, including all exercises, will prevail, being 80% of the global grade.
- The average mark corresponding to the exams, third and fourth items of the last section, has to be >=3.75 on a 10 point scale for the other items (problem solving and lab) to be considered in the global average. Such global average must be >=5 on the 10 point scale for the subject to be passed. Lab Practices and the Final Exam are compulsory.
- Taking two or more tests/guided exercises or presenting one exercise (Problem Solving), or attending one Lab session or any of the short exams, makes it impossible to get "No Presentado" as a grade.

Sources of information

Basic Bibliography

Atkins, P.W.; de Paula, J.; Keeler, J., **Atkins Physical Chemistry**, 11th, Oxford University Press, 2018

Levine, I. N, **Physical Chemistry**, 6th, McGraw Hill, 2009

Complementary Bibliography

Berry, S.W.; Rice, S.A.; Ross, J., **Physical Chemistry**, 2nd, Oxford University Press, 2000

Engel, Th; Reid, Ph., **Physical Chemistry**, 3d, Pearson, 2014

Levine, I. N, **Quantum Chemistry**, 7th, Pearson, 2014

Hollas, J.M., **Modern Spectroscopy**, 4th, Wiley, 2004

Levine, I.N., **Molecular Spectroscopy**, 1st, John Wiley & Sons, 1975

Banwell, C. N., **Fundamentals of Molecular Spectroscopy**, 4th, McGraw-Hill, 1994

Requena, A. ; Zúñiga, J., **Espectroscopía**, 1a, Pearson, 2004

Gil Criado, M.; Núñez Barriocanal, J.L., **Espectroscopía Molecular**, 1a, Garceta, 2018

Bernath, P.J., **Spectra of Atoms and Molecules**, 4th, Oxford University Press, 2020

Atkins, P. W. ; Friedman, R., **Molecular Quantum Mechanics**, 4th, Oxford University Press, 2005

Atkins, P. W., **Quanta : a handbook of concepts**, 2nd, Oxford University Press, 1991

McQuarry, D.A., **Quantum Chemistry**, 2nd, University Science Books, 2008

Pilar, F.L., **Elementary Quantum Chemistry**, 2nd, Dover, 2001

Gasser, R.P.H. Richards, W.G., **An introduction to statistical thermodynamics**, 1st, World Scientific, 1995

Recommendations

Subjects that are recommended to be taken simultaneously

Physical Chemistry V: Chemical Kinetics/V11G201V01308

Subjects that it is recommended to have taken before

Physical chemistry I: Chemical thermodynamics/V11G201V01203
Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Physical Chemistry III: Quantum Chemistry/V11G201V01303

IDENTIFYING DATA				
Physical Chemistry V: Chemical Kinetics				
Subject	Physical Chemistry V: Chemical Kinetics			
Code	V11G201V01308			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Bravo Díaz, Carlos Daniel			
Lecturers	Bravo Díaz, Carlos Daniel Mosquera Castro, Ricardo Antonio			
E-mail	cbravo@uvigo.es			
Web				
General description	International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B4	Ability for analysis and synthesis
C12	Know the kinetics of chemical change, including catalysis and reaction mechanisms
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Define with precision, all the basic concepts in Chemical Kinetics, and know the different methods of data analysis to obtain speed equations. Be able to carry out the analysis of kinetic data, including those of complex reactions and relate them to the reaction mechanisms. Explain the fundamental hypotheses of the different theories on chemical change, as well as the results and limitations of each of them (Collision Theory and Transition State Theory and know how to apply them as a tool in the analysis of kinetic results). Describe the different types of catalysis, explain the mechanism of catalyzed reactions, and apply it to specific cases. Know how to particularize said kinetic-formal treatment to the different types of catalysis. Describe the basis of the different experimental techniques available for the study kinetics of chemical reactions.	A1 A3 A5	B1 B4	C12 C27 C28	D1

Contents	
Topic	
Statistical thermodynamics	Introduction to the Statistical Thermodynamics. Configurations. Function of molecular partition. Canonical community. Thermodynamic functions. Constants of balance.
Kinetical theory of the gases	Foundations of the kinetical theory of the gases. Collisions and surfaces. Effusion.

Kinetical formal.	Rates of chemical reactions and rate equations. Orders of reactions, half-lives, elementary steps, molecularity. Analysis of kinetic data. Kinetic analysis of some complex reactions. Mechanisms. Effects of temperature.
Experimental methods in Kinetical Chemical	Transformation of the rate equations. Conventional techniques for slow reactions. Relaxation methods to study fast reactions.
Theoretical interpretation of the speed of reaction.	Collision theory for bimolecular reactions. Transition state theory.
*Catálisis	Catalysis. Homogeneous, acid-base, enzymatic, and heterogeneous catalysis.
Kinetical *electródica	Electrode-solution interface. Steps of an electrodic process. Galvanic cells. Overpotentials. Butler-Volmer and Tafel equations. Corrosion. Experimental techniques.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	0	24
Seminars	12	60	72
Laboratory practical	14	11	25
Objective questions exam	2	16	18
Essay questions exam	0	3	3
Problem and/or exercise solving	0	6	6
Essay questions exam	0	3	3
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Lecturing	Exposition delivered before an audience or class, especially for instruction or to set forth some subject of the course. The students have to develop the ideas and topics delivered after lectures.
Seminars	meeting for giving and discussing information, and that will mostly be employed to solve previously proposed problems and/or exercices to commplement lectures theoretical classes
Laboratory practical	Practical activities developed in laboratories related to topics of the course

Personalized assistance

Methodologies	**Description**
Seminars	Resolution of doubts on the proportionate explanations in classes. These queries will be able to attend also by telematic means (email, videoconference, forums of *FaiTIC, ...),previous application through an email.
Lecturing	Resolution of doubts on the proportionate explanations in classes. During all the educationalperiod the students will be able to consult all type of doubts related with the matter. Thesequeries will be able to attend by telematic means (email, videoconference, forumsof *FaiTIC, ...), previous application through an email.
Laboratory practical	In the schedule of *Tutorías of the professor will resolve of form *individualizada and more personalthose doubts of the students that can arise along the course during the realisation of thepractices of laboratory or the preparation of the corresponding reports. These queriesalso will be able to attend by telematic means (email, videoconference, forums of*FaiTIC, ...), previous application through an email.
Tests	**Description**
Problem and/or exercise solving	In the schedule of *Tutorías of the professor will resolve of form *individualizada and more personalthose doubts of the students that can arise along the course during the realisation of thepractices of laboratory or the preparation of the corresponding reports. These queriesalso will be able to attend by telematic means (email, videoconference, forums of*FaiTIC, ...), previous application through an email.
Essay questions exam	The examination will make , in the time that stipulate , on the contents of the subject and will be able to *contenter theoretical questions like practices (problems).

Assessment

	Description	Qualification	Training and Learning Results
Seminars	Examination / short proof	15	A1 C12 D1 A5 C28

Laboratory practical	It marks here, together with the effort and the attitude, the *destrezas and the competitions developed pole student during the realization of the distinct practices. Also it will value the quality of the summary of #each of the practices as well as it of the memory that will have to deliver to it finalize all they (memory of practical). The delivery of the summaries to it finalize each practical, the memory of practices, and the assistance the sessions of practices is MANDATORY and, therefore, is not possible to approve the subject in the case of not to have realized *alguna of them.	15	A1 A3 A5	C12 C27 C28	D1
Essay questions exam	Examination of theory - questions/*cuestions developmental	35	A1 A5	C12 C28	D1
Essay questions exam	*Examen Practical - development of exercises that can be numerical the theorists	35	A1 A5	C12 C28	D1

Other comments on the Evaluation

- On the date indicated for the exams there will be two tests, one theoretical (35%) and another practical (practical exercises, 35%).

- In the second and subsequent exams, the teacher may opt for this scheme or another set, corresponding to a score of 70% of the overall grade.

Attendance at practices, and the delivery of the corresponding reports (summary of each practice and memory of which indicated) is MANDATORY. An unjustified fault will mean a direct failure in the subject and have to do them again the following year. More than three (3) justified absences will mean the suspense of the subject and that they have to be done again in the following course.

Attendance at master classes and seminars is highly recommended.

The score of the laboratory part will have to be equal to or greater than 5.0 (scale 0-10). The minimum grade REQUIRED in each of the development exams will be 3.8 (on a scale 0-10) so that it can be averaged with the scores of the other sections. There is no minimum grade in the control exams / short tests. The overall average score must be equal to or greater than 5.0 (scale 0-10).

Sources of information

Basic Bibliography

I. N. Levine, **Química Física**,
P. W. Atkins, J. De Paula, **Physical Chemistry**, 10,

Complementary Bibliography

T. Engel, P. J. Reid, **Physical Chemistry**,
K. J.. Laidler, **Chemical Kinetics**,
S. Senent, **Química Física II, 3ª Ed.**,
M. E. Robson, **Chemical Kinetics**,

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 2/V11G201V01108
Physical chemistry I: Chemical thermodynamics/V11G201V01203
Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Physical Chemistry III: Quantum Chemistry/V11G201V01303

IDENTIFYING DATA

Inorganic Chemistry IV: Transition Metals and Solid State

Subject	Inorganic Chemistry IV: Transition Metals and Solid State			
Code	V11G201V01309			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	García Fontán, María Soledad			
Lecturers	Carballo Rial, Rosa García Fontán, María Soledad			
E-mail	sgarcia@uvigo.es			
Web				
General description	The first part of the subject focuses on the structural study and the structure/properties relationship of inorganic solids. In the second part of the subject, the most relevant aspects of the Chemistry of Transition Metals and their derivatives, such as coordination compounds, are addressed. Experiments on the synthesis and characterization of coordination compounds and inorganic solids will be carried out in the laboratory.			

Training and Learning Results

Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C8	Know the characteristic properties of the elements and their compounds, including the relations between groups and their variations in the periodic table
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D2	Capacity for teamwork

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Recognize and predict the main structural types of solids and their implications for physical and chemical properties.	A2 A3	B1 B3 B4	C8	
List and recognize the types of defects in crystals and their effect on the properties of the solid.	A2		C9	
Identify non-stoichiometric compounds.	A2		C9	
Recognize the effect of the addition of impurities on the color and optical properties of some inorganic solids.	A3	B3	C9	
Identify the main methods of preparation of inorganic solids.	A3		C8	
Describe how transition metals can be obtained from their natural resources and differentiate the behavior between the elements of the first, second and third transition series.	A2 A3	B3 B4	C8 C9	
Predict the reactivity of metal halides and oxides and coordination compounds based on the bond and oxidation state of the metal.	A2 A3	B3 B4	C8 C9	
Rationalize the thermodynamic stability of coordination compounds depending on the oxidation state of the metal and the type of ligand.	A2 A3	B3 B4	C8 C9	
Carry out in the laboratory the preparation, characterization and study of some physical and chemical properties of the main structural types of solids as well as other derivatives of transition metals.	A2 A3	B3 B4	C8 C9 C26	D2

Contents	
Topic	
1. Introduction and fundamentals.	(*)Importancia tecnolóxica dos sólidos . Clasificación de sólidos. Formulación de sólidos inorgánicos incorporando información estrutural. Polimorfismo, pseudomorfismo, politipismo
2. Structural rationalization.	(*)Empaquetamento de esferas. Representacións poliédricas Regras de Pauling. Regra da conectividade
3. Structure of solids.	(*)Principais tipos estruturais e a súa implicación na xeración de propiedades útiles dos sólidos
4. Perfect and imperfect crystals and their properties.	(*)Tipos de defectos Defectos puntuais. Consecuencias da presenza de defectos nas propiedades dos sólidos. Condutividade. Propiedades ópticas.
5. Solid preparation methods.	(*)Método cerámico. Química branda. Síntese en altas presión.Formación de sólidos a partir de gases e de líquidos.
6. Chemistry of metals in groups 3 and 4.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do titanio: haloxenuros, óxidos e óxidos mixtos. Compostos de coordinación.
7. Chemistry of group 5 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do vanadio: haloxenuros, óxidos e oxoanións. Compostos de coordinación.
8. Chemistry of group 6 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do cromo: haloxenuros, óxidos e oxoanións. Compostos de coordinación.
9. Chemistry of group 7 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do manganeso: haloxenuros, óxidos e oxoanións. Compostos de coordinación. Bioinorgánica do manganeso e tecnecio
10. Chemistry of group 8 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do ferro: óxidos e óxidos mixtos. Compostos de coordinación. Bioinorgánica do ferro.
11. Chemistry of group 9 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do cobalto: haloxenuros e óxidos. Compostos de coordinación. Bioinorgánica do cobalto.
12. Chemistry of group 10 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do níquel: haloxenuros e óxidos e compostos de coordinación. Bioinorgánica do platino.
13. Chemistry of group 11 metals.	(*)Obtención e usos. Estados de oxidación máis frecuentes. Compostos representativos do cobre: haloxenuros e óxidos e compostos de coordinación. Bioinorgánica do cobre e ouro.
Chemistry Practices of Compounds transition metais (4 sessions).	(*)Preparación e caracterización de compostos de metáis do bloque d
Inorganic Solids Practices (4 sessions).	(*)Preparación e estudo das propiedades dalgúns sólidos inorgánicos.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	31	55
Laboratory practical	28	14	42
Seminars	12	12	24
Objective questions exam	2	9	11
Objective questions exam	0	18	18
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	(*)As clases teóricas adicaránse a presentar os aspectos fundamentáis dos temas.
Laboratory practical	(*)Realizaranse prácticas de laboratorio nas que se aplicarán os coñecementos teóricos adquiridos. As prácticas realizaranse en 8 sesións de 3,5 horas e os alumnos deberán reflectir e interpretar o observado no correspondente caderno de laboratorio.
Seminars	(*)As clases de seminario adicaranse á resolución de casos prácticos relacionados coa materia así como á resolución de dudas ou cuestións que surxan no desenvolvemento de cada tema. Contemplase tamén realizar seminarios nos que se abordarán aspectos non impartidos en materias anteriores pero necesarios para a marcha do curso.

Personalized assistance	
Methodologies	**Description**
Lecturing	
Laboratory practical	
Seminars	

Assessment			
	Description	Qualification	Training and Learning Results
Laboratory practical	(*)A asistencia ás clases prácticas presenciais é obrigatoria. A avaliación nas prácticas de laboratorio constará dun 10% de resolución de cuestións sinxelas e un 5% baseado no comportamento e destreza por observación directa do/a profesor/a. A puntuación soamente será considerada na proba longa conséguese unha cualificación igual ou superior a 3 puntos sobre 10.	15	A2 B3 C8 D2 A3 B4 C9 C26
Seminars	(*)Nas sesións de seminario pediráselles aos/*as estudantes a resolución de cuestións sinxelas que deberán entregar nese momento e que servirán para a súa avaliación. A puntuación soamente será considerada si na proba longa conséguese unha cualificación igual ou superior a 3 puntos sobre 10.	15	B1 C8 B3 C9 B4
Objective questions exam	(*)Haberá dúas probas curtas no cuadrimestre onde se avaliarán as competencias relacionadas cos temas. A puntuación soamente será considerada na proba longa si conséguese unha cualificación igual ou superior a 3 puntos sobre 10. A data e hora de realización é público e consta na programación académica aprobada na Xunta de Facultade correspondente.	30	B3 C8 B4 C9
Objective questions exam	(*)Haberá unha proba final na que se fará unha avaliación global da materia. A puntuación da proba soamente será considerada si conséguese na proba de *formulación un 9 sobre 10. A data e hora de realización é público e consta na programación académica aprobada na Xunta de Facultade correspondente.	40	B3 C8 B4 C9

Other comments on the Evaluation

Sources of information

Basic Bibliography

A. R. West, **Solid State Chemistry and its applications,**, 2, Wiley, 2014

L. Smart, E. Moore, **Solid State Chemistry. An introduction**, CRC, 2012

C. E. Housecroft y A. G. Sharpe.,, **Inorganic Chemistry,**, 5, Pearson, 2018

Complementary Bibliography

Winter, Mark J., **D-block chemistry, 1994**, Oxford University Press, 1994

Atkins, Peter, **Inorganic Chemistry,**, Willey-VCH, 2008

N.N. GREENWOOD , A. EARNSHAW, **Chemistry of the Elements**, 2, Butterwoth Heinemann, 1997

Recommendations

Subjects that it is recommended to have taken before

Structural Determination/V11G201V01206

Inorganic chemistry I/V11G201V01204

Inorganic chemistry II/V11G201V01209

Inorganic Chemistry III: Coordination Chemistry/V11G201V01304

IDENTIFYING DATA				
Organic Chemistry IV: Design of Organic Synthesis				
Subject	Organic Chemistry IV: Design of Organic Synthesis			
Code	V11G201V01310			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Álvarez Rodríguez, Rosana			
Lecturers	Álvarez Rodríguez, Rosana Domínguez Seoane, Marta Gómez Pacios, María Generosa Vaz Araújo, Belén			
E-mail	rar@uvigo.es			
Web				
General description	In this subject, all previous knowledge of Organic Chemistry subjects will be integrated, in particular with regard to organic synthesis and its consequences in the creation of new elements. stereogenic. To do this, we will use the tools of retrosynthetic analysis, with special attention to the analysis of synthetic proposals that pass with selectivity (chemo, regio and stereoselectivity). English Friendly program subject: Foreign students may request from the teaching staff: a) material and bibliographic references for the follow-up of the subject in English, b) attend tutorials in English, c) tests and evaluations in English.			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B3	Ability to manage information
B4	Ability for analysis and synthesis
C15	Know the main techniques of structural research, including spectroscopy
C19	Know the main synthesic routes in organic chemistry, including the interconversions of functional groups and the formation of carbon-carbon and carbon-heteroatom bonds
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
D2	Capacity for teamwork

Expected results from this subject	Training and Learning Results		
Recognize structural elements in organic molecules	A3	B3	C19
	A5	B4	C28
Propose retrosynthetic sequences of target molecules	A3	B3	C19
	A5	B4	C28
Analyze alternative retrosynthetic proposals	A3	B3	C19
	A5	B4	C28
Design selective synthetic sequences of target molecules	A3	B3	C19
	A5	B4	C28
Assess the use of efficient structural simplification transformations	A3	B3	C19
	A5	B4	C28
Properly manage interconversions between functional groups and protecting groups.	A3	B3	C19
	A5	B4	C28
Study the reactions that can provide selectivity and its mechanisms	A3	B3	C19
	A5	B4	C28

Apply in the laboratory, rigorously, the corresponding safety rules,as well as the proper treatment of the waste	A3		C15 C27 C28	D2
Write in the notebook laboratory, rigorously, the experiments carried out.		B4	C27 C28	
Perform the synthesis of an organic molecule using a selective stepwise synthesis	A3 A5	B3 B4	C15 C27 C28	D2

Contents	
Topic	
1. Design of the Organic Synthesis. Analysis retrosynthetic.	1.1. Target-oriented synthesis 1.2. The principles of retrosynthetic analysis 1.3. Strategic selection criteria 1.4. General principles of reactivity. Natural and unnatural polarity. 1.5 Selectivity. Basic concepts 1.6 Retrosynthetic strategies
2. Strategies based on transforms I. Selection of disconnections	2.1. C-X disconnections of monofunctional compounds 2.2. C-X disconnections of difunctional compounds (1, n) 2.3. C-C disconnections of monofunctional compounds 2.4. C-C disconnections of difunctional compounds (1, n) 2.5. Aromatic Compound Disconnections
3. Strategies based on functional groups I. Interconversion	3.1. Interconversion of functional groups. Oxidation levels 3.2. Functional group interconversion reactions 3.3. Oxidation reactions 3.4. Reduction reactions
4. Strategy based on functional groups II. Protective groups in Organic synthesis	4.1. Description of the protecting groups. 4.2. Sensitive to acid, basic, fluoride, oxidizing agents and reducing agents. 4.3. Selection of protecting groups
5. Strategy based on transfroms II. Disconnection of unsaturated compounds	5.1. Stereoselective synthesis of olefins. Csp2 = Csp2 disconnections 5.2. Palladium catalyzed reactions. Csp2-Csp2, Csp2-Csp, Csp-Ar and Ar-X (X = O, N) disconnections.
6. Strategy based on stereochemical	6.1. Description of stereochemistry. Chirality and descriptors. Topicity 6.2. Stereochemistry of chemical reactions. Product selectivity. Simple and induced diastereoselectivity.
7. Strategies based on molecular topology. Disconnection of cyclic compounds	7.1. Retrosynthetic analysis using topological strategies 7.2 Isolated ring retrosynthesis 7.3. Spiro ring retrosynthesis 7.4. Fused Ring Retrosynthesis 7.5. Bridging ring retrosynthesis
Experimental Section. The synthetic milestone of design and discovery of organic compounds with therapeutic applications.	4 sessions

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	24	48
Seminars	24	24	48
Laboratory practical	14	16	30
Essay questions exam	2	10	12
Essay questions exam	2	10	12
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The material of the subject will be available on the Moovi platform in advance. The teaching staff will present, in a clear and structured way, the most relevant aspects of the subject assigned to each master session.
Seminars	The aspects discussed during the lectures will be worked on by solving the exercises proposed by teachers.

Laboratory practical	The laboratory work will be developed in 4 sessions of 3.5h. During the synthesis, they will have to write the laboratory notebook, rigorously and clarity, which will be delivered at the end of the practices. In addition, the students will carry out a questionnaire about the experiments carried out in the laboratory, through the Moovi platform.

Personalized assistance

Methodologies	Description
Lecturing	The teaching staff will dedicate the necessary time to answer the questions of the students related to the subject of the course
Seminars	The teaching staff will dedicate the necessary time to answer the questions of the students about the exercises and problems solved in the seminar sessions, as well as those proposed in the Moovi platform
Laboratory practical	The teaching staff will dedicate the necessary time to answer the questions of the students related to retrosynthetic analysis of the target molecule and sequence design synthetic During the laboratory sessions, the faculty will supervise the development of the experiments proposed by students as well as compliance with security rules.
Tests	**Description**
Essay questions exam	
Essay questions exam	

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	1. It is mandatory to carry out the laboratory practices 2. It will be valued: 2.1. The laboratory notebook (20% of practical qualification), structural analysis (25% of practical qualification), reaction mechanisms (20% of practical qualification), safety data sheets (10% of practical qualification) and questions about IUPAC nomenclature (15% of practical qualification) 2.2. Resolution of questions about work experimental, carried out in the laboratory, through the Moovi platform (10% of practical qualification)) 3. To achive the experimental sessions it is mandatory to have achived each one of the evaluated parts Learning outcome: All	30	A3 B3 C15 D2 A5 B4 C19 C27 C28
Essay questions exam	The following tests will be carried out throughout the subject: Two short tests (1h long; 15%) Learning outcome: - Recognize structural elements in organic molecules. - Propose retrosynthetic sequences of proposed molecules -Analyze alternative retrosynthetic proposals - Design selective synthetic sequences of target molecules . - Assess the use of efficient transformations of structural simplification. - Properly manage interconversions between functional groups and protecting groups. - Know the reactions that can provide selectivity and their mechanisms. Therefore, the qualification from the remaining sections will only be added when the score obtained in the sum of the written tests is equal to or greater than two points and a half.	30	

Essay questions exam	A long written test (2h long; 40%) will be carried out throughout the subject: To achive the subject, students must obtain a minimum of 50% in all the written tests (proof of short answer and long answer test). Learning outcome: - Recognize structural elements in organic molecules. - Propose retrosynthetic sequences of proposed molecules -Analyze alternative retrosynthetic proposals - Design selective synthetic sequences of target molecules . - Assess the use of efficient transformations of structural simplification. - Properly manage interconversions between functional groups and protecting groups. - Know the reactions that can provide selectivity and their mechanisms. Therefore, the qualification from the remaining sections will only be added when the score obtained in the sum of the written tests is equal to or greater than two points and a half.	40

Other comments on the Evaluation

1. The participation of the students in any of the evaluation activities of the subject will imply that they acquire the condition of presented, therefore, they will be assigned a grade.

2. In addition, students may choose to be evaluated by a **single test** at the end of the semester and not by continuous evaluation. To do this, they will have to communicate it, in writing, to the subject coordinator at the beginning of the semester. In this case, the final evaluation will be 30% the laboratory work and 70% the single test .

June Assessment:

To achieve the subject it is mandatory to obtain a qualification equal or greater than 5 points in both of the evaluated parts, experimental and theoretical works.

July assessment:

1. The score obtained by students on the course: maximun of 3 points for laboratory practices

2. Written test: maximun 7 points.

Additional information:

1. The students who achieve the laboratory practices, in the previous course, will not have to do the laboratory work again.2. Serious conceptual mistakes, will mean the assignment of new activities aimed at solvent learning problems as soon as possible

Sources of information

Basic Bibliography

Clayden, J.; Greeves, N.; Warren, S., **Organic Chemistry**, 2nd, Oxford University Press, 2012

Starkey, S., **Introduction to strategies for organic synthesis**, 2nd, Wiley, 2018

Complementary Bibliography

Warren, S.; Wyatt, P., **Organic Synthesis the Disconnection Approach**, 2nd, Wiley, 2011

Sunjic, V.; Perokovic, V. P., **Organic Chemistry from Retrosynthesis to Asymmetric Synthesis**, 1st, Springer, 2016

Recommendations

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Structural Determination/V11G201V01206
Organic chemistry I/V11G201V01205

IDENTIFYING DATA				
Project				
Subject	Project			
Code	V11G201V01401			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Álvarez Álvarez, María Salomé			
Lecturers	Álvarez Álvarez, María Salomé Vecino Bello, Xanel			
E-mail	msaa@uvigo.es			
Web	http://https://moovi.uvigo.gal/			
General description	This subject, from the fourth year of the Chemistry Degree, has as main objective to introduce the student to the methodology, direction, management and organization of projects in the field of Chemistry. With the knowledge acquired in Chemistry, Chemical Engineering and other related subjects, the student must be able to develop a project in Chemistry. At the end of the course, the student must be able to write, plan, execute and direct industrial projects in the field of Chemistry. As a subject of the English Friendly program, international students may request from the teacher: a) materials and bibliographical references to follow the subject in English, b) attend tutorials in English, c) tests and evaluations in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B3	Ability to manage information
C4	Use computer tools properly to obtain information, process data, perform computational calculations and calculate matter properties
C5	Present material and scientific arguments in oral and written form to a specialized audience
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Evaluate the feasibility of carrying out a project related to the competencies of a chemist.	A1 A4	B3	C4	D2
Organise, manage and develop a project in Chemistry	A1 A4		C5	D3
Evaluate the potential impact (environmental, socioeconomic) of a project.	A1 A4		C4	D3
Elaborate structured technical reports and present them using appropriate audiovisual means.	A1	B3		D3

Contents	
Topic	
Subject 1. The projects in chemistry	Professional competitions of the chemists. Definition and aims and classification. Stages and organisation. Legal appearances
Subject 2. Design of a project	Analysis of the sector. Study of market. Size of the project. Location.
Subject 3. Engineering of the project	Diagrams of flow. Calculations and balances. Equipment.
Subject 4. Economic evaluation of a project	Investment and costs. Profitability. Analysis of risk.

Subject 5. Environmental evaluation of a project	Pollution. Preventive measures and/or of correction. Waste. Cycle of Life.
Subject 6. Documentation of a project	Memory. Planes. I fold of conditions. Methods. Norms.

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	12	17	29
Seminars	28	39	67
Essay questions exam	2	0	2
Objective questions exam	2	0	2
Project	0	50	50
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	Exhibition by part of the professor of the most fundamental appearances of each subject, taking like base the available documentation in the platform Moovi. The students will be able to work, before each session, the material that provides him the professor related with the content that will treat in each subject.
Seminars	The students, with the support of the professor, will make the design and development of some concrete projects of chemistry that will form part of the evaluation of the subject, and resolution of practical cases related with the matter.

Personalized assistance	
Methodologies	**Description**
Lecturing	It will resolve him to the student any doubt related with the contents, problems or the project of face-to-face form (previous appointment by email), or of virtual form, according to preference of the student.
Seminars	It will resolve him to the student any doubt related with the contents, problems or the project of face-to-face form (previous appointment by email), or of virtual form, according to preference of the student.
Tests	**Description**
Objective questions exam	It will resolve him to the student any doubt related with the contents, problems or the project of face-to-face form (previous appointment by email), or of virtual form, according to preference of the student.
Essay questions exam	It will resolve him to the student any doubt related with the contents, problems or the project of face-to-face form (previous appointment by email), or of virtual form, according to preference of the student.
Project	It will resolve him to the student any doubt related with the contents, problems or the project of face-to-face form (previous appointment by email), or of virtual form, according to preference of the student.

Assessment			
	Description	Qualification	Training and Learning Results
Essay questions exam	It will make a long proof of all the matter	30	D3
Objective questions exam	They will make three exam tests during the course. Said exam tests consist in one splits type test and in another part of resolution of practical cases. The first when finalising the two first subjects, the second of the subject 4 and the third of the subject 5. The time to perform the exams tests will be 1 hour.	40	D3
Project	The student will make the approach and development of a concrete project of chemistry, and east will be evaluated so much by his oral exhibition as by his presentation written.	30	

Other comments on the Evaluation

FIRST ANNOUNCEMENT

To pass the subject it is mandatory to obtain at least 40% of the grade assigned to the total completion of the project (written presentation/final presentation) and the final exam.
CONDITION OF PRESENTED: The student's participation in any of the written tests or the delivery of any part of the project will imply the condition of being presented and therefore a grade will be assigned.

SECOND ANNOUNCEMENT

For the second announcement keep the qualifications of evaluation continuous (so much of the 3 exam tests of questions written as of the work) obtained along the course, always that these were equal or upper to 4. The student will present to the no surpassed parts previously.

Commitment etic

It expects that the present student a behaviour etic suitable. In case to detect a behaviour no etic (copy, plagiarism, use of devices electronics unauthorised, for example), there are that the student have not the necessary requirements to surpass the matter.

Sources of information

Basic Bibliography

J. Frank Valle-Riestra, **Project evaluation in the chemical process industries**, McGraw-Hill, 1983

Manuel de Cos Castillo, **Teoría General del Proyecto**, Editorial Síntesis, 1997

H.F. Rase y M.H. Barrow, **Ingeniería de proyectos para plantas de procesos**, CECSA, 1977

Complementary Bibliography

Luis Cabra, Antonio de Lucas, Fernando Ruiz y María Jesús Ramos, **Metodologías del diseño aplicado y gestíon de proyectos para ingenierios químicos**, Ediciones de la Universidad de Castilla-La Mancha., 2010

Arturo Jimenez Gutiérrez, **Diseño de procesos en ingeniería química.**, Editorial Reverté, 2003

Nassir Sapag Chain, Reinaldo Sapag Chain., **Preparación y evaluación de proyectos.**, Mc-Graw-Hill., 2000

J.M. Smith, H.C. Van Ness, M.M. Abbott., **Introducción a la termodinámica en Ingeniería Química.**, Mc Graw-Hill., 2007

A. Vian., **El pronóstico económico en química industrial.**, Alhambra., 1975

Eliseo Gómez, Domingo Gómez, Pablo Aragonés, Miguel Angel Sanchez, Domingo López., **Cuadernos de Ingeniería de Proyectos I.**, Universidad Politécnica de Valencia., 1997

Recommendations

Subjects that it is recommended to have taken before

Chemical engineering/V11G201V01301

IDENTIFYING DATA				
Chemistry of Materials				
Subject	Chemistry of Materials			
Code	V11G201V01402			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Correa Duarte, Miguel Ángel Valencia Matarranz, Laura María			
Lecturers	Correa Duarte, Miguel Ángel Pastoriza Santos, Isabel Pérez Lourido, Paulo Antonio Puértolas Lacambra, Begoña Valencia Matarranz, Laura María			
E-mail	macorrea@uvigo.es qilaura@uvigo.es			
Web				
General description	Structure, properties and application of the different types of materials. English Friendly Subject: International students may request from teachers: a) materials and bibliographic references in english, b) tutoring sessions in english, c) exams and assessments in english.			

Training and Learning Results	
Code	
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C16	Know the relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids, crystals and other materials
C24	Know the properties and applications of materials
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Recognise the differences between the plastic and elastic deformation		B1 B3 B4	C16 C24	D3
Differentiate between electrical and ionic conductivity. Distinguish the intrinsic semiconductors of the *extrínsecos.		B1 B3 B4	C16 C24	D3
Distinguish hard magnetic materials and soft from his cycle of *histérisis.		B1 B3 B4	C16 C24	D3
Describe the optical properties of the metals and no metals		B1 B3 B4	C16 C24	D3
Explain the thermal properties more important of the materials.		B1 B3 B4	C16 C24	D3
Analyse and describe the characteristics of the alloys in function of his diagrams of phases.	A2 A3	B1 B3 B4	C16 C24	D3
Describe the properties of the different ceramic materials, polymers and compound.	A2 A3	B1 B3 B4	C16 C24	D3

Tackle the processes and basic technicians for the obtaining and characterisation of (*nano)material.	A2 A3	B1 B3 B4	C16 C24	D3

Contents	
Topic	
Subject 1. Introduction	Historical perspective of the development of the materials. Why study the materials? Classification of the materials. Need of new materials.
Subject 2. Properties of the materials	Mechanical properties, electrical, magnetic, optical and thermal of the materials.
Subject 3. Metallic materials and alloys, polymeric and ceramic materials.	Characteristics, properties and applications of the metals, alloys (diagrams of phases), polymers and ceramic.
Subject 4. Compound materials	General characteristics. Classification. Materials reinforced.
Subject 5. New materials and Nanomaterials	Nanoscience and nanotechnology. Methods of preparation. Properties to nanoscale.
Subject 6. Characterisation of materials	Isotherms of adsorption and quimisorción to temperature programmed. Microscopy of vicinity and electronic. Fotoelectrónic Spectroscopy.

Planning			
	Class hours	Hours outside the classroom	Total hours
Seminars	12	45	57
Lecturing	24	45	69
Objective questions exam	2	10	12
Objective questions exam	2	10	12
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Seminars	They will devote to the resolution of doubts and questions that arise in the development of each subject, to the resolution of problems and/or exposed exercises by the profes@r and to the presentation by part of the alumn@s of some report and/or work related with the matter.
Lecturing	The alumn@s will receive 24 hours of classes *expositivas in an only group, that will devote to the presentation of the fundamental appearances of each subject.

Personalized assistance	
Methodologies	**Description**
Seminars	The alumn@s will be able to consult all type of doubts related with the matter in the *tutorías.

Assessment							
	Description	Qualification	Training and Learning Results				
Seminars	In addition to resolving practical exercises that allow to the alumn@s settle the knowledges on the subjects unrolled in the classes of theory, and to resolve all the exposed doubts, the classes of seminar will use also to carry out the continuous evaluation of the alumn@s. This process of continuous evaluation will make through the resolution of exercises and/or problems as well as by means of the realisation of reports and/or works that will be exposed by the alumn@s and that will be related with the contents of the matter. The evaluation of the Seminars of the subjects 1-3 *equivaldrá to 10% of the final note and the one of the subjects 4-6 to 25%.	35	A3	B1 B3 B4	C16 C24	D3
Objective questions exam	A short test will be carried out throughout the cuatrimester which will account for 25% of the final note.	25	A3	B1 B3 B4	C16 C24	D3
Objective questions exam	At the end of the cuatrimester, a second test will be held, covering the rest of the subjects and accounting for 40% of the final grade. To pass this test, students must obtain at least 50% of the score in each of the two sections (theory and problems).	40	A3	B1 B3 B4	C16 C24	D3

Other comments on the Evaluation

Observations:

The participation of any of the proofs planned evaluation will involve the condition of presented and, therefore, the allocation of a qualification in the record of the matter. It will be necessary to surpass the two short proofs (obtain a minimum of 40% of the note in each one) to be able to take into account the other elements of evaluation.

Evaluation of July: The students that non surpass one or the two short proofs that make during the cuatrimestre, will have to present to the corresponding part in the announcement of July. This proof will substitute the results obtained in the tests/s short/s made along the cuatrimestre. The remaining elements of evaluation are not recoverable and the qualifications obtained will add to the one of the quoted proof as long as the qualification obtained was equal or upper to 4 on 10. In case to obtain a lower qualification, will be this the one who appear like final qualification of the matter.
If the student renounces to the continuous evaluation and opts by a global evaluation, each one of the short proofs will cost 50% of the final note. The students that non surpass one or the two short proofs that make during the cuatrimestre, will have to present to the corresponding part in the announcement of July.

Sources of information

Basic Bibliography

Callister, W.D., Rethwisch, D.G., **Introducción a la Ciencia e Ingeniería de los Materiales**, Reverté (trad. 9ºed),
Smart, L.E. Moore, E.A., **Solid State Chemistry. An introduction**, Taylor & Francis, 4ªed,
West, A.R.., **West, A.R.. Solid state chemistry and its applications**, John Wiley & Sons.,
Levine, I.N., **Fisicoquímica**, McGraw-Hill / Interamericana de España, S. A.,
Kirkland, A.I., Hutchison, J.L., **Nanocharacterisation**, RSC, Cambridge,
Singh, S. C, Hoboken J., **Nanomaterials**, John Wiley & Sons,
Vollath, D., **Nanomaterials : an introduction to synthesis, properties and application**, Wiley-VCH,

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Nanochemistry/V11G201V01403

Subjects that it is recommended to have taken before

Physics: Physics 2/V11G201V01107
Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Inorganic chemistry II/V11G201V01209
Inorganic Chemistry III: Coordination Chemistry/V11G201V01304
Inorganic Chemistry IV: Transition Metals and Solid State/V11G201V01309

IDENTIFYING DATA				
Nanoquímica				
Subject	Nanoquímica			
Code	V11G201V01403			
Study programme	Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4	1c
Teaching language	Castelán			
Department	Química Física			
Coordinator	Correa Duarte, Miguel Ángel Pastoriza Santos, Isabel			
Lecturers	Correa Duarte, Miguel Ángel Pastoriza Santos, Isabel			
E-mail	macorrea@uvigo.es pastoriza@uvigo.es			
Web				
General description	Esta asignatura optativa do 1º cuatrimestre de 4º do Grao en Química combina coñecementos de química cos de otras ciencias fundamentais eaplicadas nos temas que trata, como biotecnoloxía, mediciña, física, materiais, inxeniería, etc. Por iso está pensada con un gran carácter práctico. Deste modo diferentes conceptos relacionados coa nanoquímica serán explicados en las clases maxistrales e seminarios (superhidrofobicidade, materiais autoreparables, células fotovoltaicas, propiedades ópticas, magnéticas de nanomateriais, etc□) e después nas clases de laboratorio os alumnos, dende un punto de vista práctico, verán como estos coñecementos teñen una traducción directa na nanotecnoloxía, xenerando aplicacions reales y tanxibles (materiales autolimpiables, sensores colorimétricos, células fotovoltaicas, catalizadores, etc□).			

Resultados de Formación e Aprendizaxe	
Code	
A1	Que os estudantes saiban aplicar os seus coñecementos ó seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
A5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B4	Capacidade de análise e síntese
B5	Capacidade de adaptarse a novas situacións e adoptar decisións
C34	Seleccionar e utilizar distintos procedementos de obtención e caracterización de nanomateriales e coñecer o seu potencial no desenvolvemento de novas aplicacións
D2	Capacidade para traballar en equipo
D3	Capacidade para comunicarse de forma oral e escrita en castelán e/ou galego e/ou inglés

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Coñecer os métodos de síntese de nanomateriais máis extendidos e ser capaz de describir os aspectos máis importantes dos mesmos.	A1 A5		C34	D3
Coñecer técnicas básicas de analisis de nanoestructuras.	A5	B4 B5	C34	
Coñecemento das principais aplicacións das nanoestruturas	A1	B4 B5	C34	D2 D3

Contidos	
Topic	
Tema 1. Introducción a Nanoquímica. Mecanismos de obtención de nanomateriales. Propiedades de Nanomateriales	Introducción. Metodos de síntesis de nanomateriales Propiedades de los Materiales
Tema 2. Tecnicas de caracterización de nanomateriales.	Microscopía de forzas atómicas e microscopía de efecto tunel.
Tema 3. Aplicaciones dos nanomateriales	Applicaciones en nanomedicina, enerxía, catalises, etc...

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	12	20	32
Seminario	12	24	36

Prácticas de laboratorio	28	37	65
Exame de preguntas obxectivas	2	15	17

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

Metodoloxía docente

	Description
Lección maxistral	Exposición oral e directa, por parte do profesorado, dos coñecementos fundamentais correspondentes aos contidos da materia.
Seminario	Presentación e discusión de publicacións científicas e diferentes tópicos previamente asignados polo profesorado.
Prácticas de laboratorio	Realización, por parte do alumnado, de experimentos relacionados cos contidos da materia

Atención personalizada

Methodologies	Description
Lección maxistral	Resolución de dúbidas, mediante concertación de cita previa, ao través do Campus Remoto.
Seminario	Resolución de dúbidas, mediante concertación de cita previa, ao través do Campus Remoto.
Prácticas de laboratorio	Resolución de dúbidas, mediante concertación de cita previa, ao través do Campus Remoto.

Avaliación

	Description	Qualification	Training and Learning Results			
Lección maxistral	A finalidade desta proba coñecementos alcanzado polo alumnado. O seu peso, dependendo dos outros apartados da avaliación será: 40%-100%. A cualificación ha de ser polo menos 4.0 sobre 10 para que poida realizarse media cos outros apartados.	40	A5		C34	
Seminario	A súa realización é obrigatoria. Puntúanse por valoración da participación activa do alumno nos seminarios, resolución de problemas, exposición de traballos, etc.	30	A1	B4	C34	D2 D3
Prácticas de laboratorio	A súa realización é obrigatoria. Puntúanse por valoración do seu desenvolvemento experimental (15%) así como pola dun informe de prácticas. Este ha de confeccionarse de forma individual ou en grupo (segun determine o profesor), conter táboas, gráficas e os cálculos necesarios para a obtención dos resultados, así como unha análise dos mesmos, en relación co procedemento experimental e o fundamento teórico empregados. Debe entregarse ao profesor encargado do correspondente grupo de laboratorio no prazo que se estableza (15%)	30	A1 A5		C34	D2 D3

Other comments on the Evaluation

Para aprobar a materia é necesario aprobar as prácticas de laboratorio e seminarios.

De realizarse unha proba escrita a puntuación debe ser polo menos 4 sobre 10 para poder facer media coas outras seccións da avaliación. A puntuación media total debe ser de 5 puntos sobre 10 ou superior para que poda superarse a materia.

A presentación de calquera exercicio que poida ser avaliado, ou a realización de práctica ou proba imposibilita que a cualificación sexa 'non presentado'.

No exame de Xullo (2ª oportunidade) manterase a cualificación obtida polo alumnado na presentación e nas prácticas de laboratorio realizadas durante o período docente. Iso significa que o alumnado unicamente realizará a proba de preguntas obxectivas no devandito exame.

Compromiso ético. Espérase que o alumnado presente un comportamento ético adecuado. En caso de detectar un comportamento non ético (copia, plaxio, utilización de aparellos electrónicos non autorizados, por exemplo), considerarase que esa persoa non reúne os requisitos necesarios para superar a materia.

Bibliografía. Fontes de información

Basic Bibliography

Kirkland, A.I., Hutchison, J.L., **Nanocharacterisation**, RSC, Cambridge, 2007

Dieter Vollath, **Nanomaterials : an introduction to synthesis, properties and application**, 2, Weinheim : Wiley-VCH, cop., 2013

Complementary Bibliography

C. Bréchignac, P. Houdy, M. Lahmani, **Nanomaterials and nanochemistry**, Berlin : Springer,, 2010
Ozin, Geoffrey A., **Nanochemistry : a chemical approach to nanomaterials**, Cambridge : RSC Publishing, cop., 2005

Recomendacións

IDENTIFYING DATA				
Organometallic Chemistry				
Subject	Organometallic Chemistry			
Code	V11G201V01404			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	García Fontán, María Soledad			
Lecturers	García Fontán, María Soledad Talavera Nevado, María			
E-mail	sgarcia@uvigo.es			
Web				
General description	In this subject we'll study the properties of the compounds that have, at least, one bond between a transition metal and a carbon atom. We'll also study their applications in different processes of organic synthesis catalized by transition metals. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B1	Ability for auronomous learning
B3	Ability to manage information
B4	Ability for analysis and synthesis
C38	Relate the structural bases of organometallic compounds with their physical, spectroscopic and chemical properties
C39	Select the appropriate techniques and procedures for problems of structural elucidation, synthesis, isolation and purification of organometallic compounds
D2	Capacity for teamwork

Expected results from this subject	Training and Learning Results			
Define organometallic compound.			C38	
Rationalize the information provided by the usual spectroscopic techniques for the characterization of the different types of organometallic compounds.	A3	B1 B3 B4	C38 C39	
Identify the main types of organometallic reactions.		B1	C38	
Propose methods of synthesis for the different types of organometallic compounds.	A3	B1 B3 B4	C38 C39	
Predict the stability and reactivity of the different types of organometallic compounds.	A3	B1 B3 B4	C38	
Describe the most important catalytic cycles.	A3	B1	C38	
Carry out in the laboratory the preparation, characterization and study of organometallic compounds.	A3		C38 C39	D2

Contents	
Topic	
Subject 1. Introduction	Definition. History. Ranking. Types of ligands. Rule of the 18 electrons.
Subject 2. Organometallic compounds with type L ligands (I).	Carbonyls, phosphines, carbenes and carbines.
Subject 3. Organometallic compounds with type L ligands (II).	Pi complexes: Alkenes, alkynes, polyenes and arenes.
Subject 4. Organometallic compounds with type L ligands (III).	Sigma complexes: Dihydrogen, silanes, boranes and alcanes.
Subject 5. Organometallic compounds with type X ligands.	Hydrides, alkyls, aryls and vinyls.

Subject 6. Organometallic compounds with carbon LnX ligands.	Alyls and cyclopentadienyls.
Subject 7. Types of organometallic reactions (I).	Ligand substitution reactions.
Subject 8. Types of organometallic reactions (II).	Reactions of oxidative addition and reductive elimination.
Subject 9. Types of organometallic reactions (III).	Reactions of migratory insertion and elimination.
Subject 10. Types of organometallic reactions (IV).	Reactions of nucleophilic and electrophilic attack to coordinated ligands.
Subject 11. Organometallic catalysis.	General comments. Relevant catalytic cycles.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	48	72
Problem solving	10	20	30
Laboratory practical	14	14	28
Presentation	2	4	6
Essay questions exam	1	4	5
Essay questions exam	1	8	9

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

Methodologies

	Description
Lecturing	Students, in a single group, will receive 24 hours of expository classes in which the teacher will present the most relevant aspects of each topic.
Problem solving	Students, in a single group, will receive 12 hours of seminar classes that will be dedicated to solving doubts or questions that arise in the development of each topic, and to the resolution of questions, exercises and problems proposed by the teacher.
Laboratory practical	Laboratory practices will be carried out in which the theoretical knowledge acquired will be applied. The practices will be carried out in 4 sessions of 3.5 hours and the students must reflect and interpret what is observed in the corresponding laboratory notebook.
Presentation	Students will make a short presentation of a research article in organometallic chemistry from the last year applying the concepts learned during the course.

Personalized assistance

Methodologies	Description
Lecturing	Students will be able to consult all kinds of doubts related to the subject during the tutorial hours.
Problem solving	Students will be able to consult all kinds of doubts related to the subject during the tutorial hours.
Laboratory practical	Students will be able to consult all kinds of doubts related to the subject during the tutorial hours.
Presentation	Oral presentation

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	In addition to resolving practical exercises that allow to the students settle the knowledges on the subjects developed in the classes of theory, and to resolve all the exposed doubts, the classes of seminar, will use to carry out the continuous evaluation of the students. This process of continuous evaluation will make through the resolution of exercises inside and out of the classroom related with the contents of the matter as well as the resolution of short questions proposals by the professor. The global note of all the exercises will have to surpass the 3 on 10 to be taken into account in the final note.	20	A3 B1 C38 B3 C39 B4
Laboratory practical	The assistance to the face-to-face practical classes is compulsory. The evaluation in the practices of laboratory will consist of a part based in the behaviour and skill by direct observation of the/to professor/to as well as of the previous and back work to the experimental work. It needs a 5 on 10 to pass the course. Those students that have the practices approved in the previous course will be able to request not to repeat them in the current course keeping the qualification obtained.	15	A3 B1 C38 D2 B3 C39 B4
Presentation	Individual or group presentation of a research article related to the subject. The presentation and clarity of the slides as well as the answers to questions from teachers and students will be taken into account.	15	A3 B1 C38 B3 C39 B4

Essay questions exam	A short proof on the contents of the first part of the course. It will demand a minimum note of 3 points out of 10 to pass the course	20	B1 C38 B3 C39 B4
Essay questions exam	A final proof in which it will have a global evaluation of the course and will cost 40% of the final note. It requires a 3 on 10 to pass the course	30	B1 C38 B3 C39 B4

Other comments on the Evaluation

Requirements for passing the course

- Pass the laboratory practicals with a grade equal to or higher than 5 out of 10.

-A mark of 5 out of 10 in the global calification of all the methodologies/tests in continuous assessment or in the final exam in the second opportunity, considering the practical laboratory grade, for non-continuous assessment

Development of continuous evaluation

- The specific competences of the subject related to the competences of the degree will be evaluated explicitly in deliverable exercises and written tests. The basic, general and transversal competences will be assessed implicitly in the marking of the exercises.

- In order to take them into account in the final grade, a score higher or equal to that detailed in the description of each test will be required.

-Students who do not pass the subject at the end of the term will have to take a written test in the final evaluation period in July. This test will be worth 50% of the grade and will replace the results of the two essay question tests. The marks for the rest of the activities are not recoverable.

Non-continuous evaluation

The choice of the non-continuous assessment modality implies the renunciation of the right to continue the assessment of the remaining activities of the continuous assessment modality and of the grade obtained up to that moment in any of the tests that have already taken place.

In the case of choosing the non-continuous evaluation or not achieving the minimum mark required for continuous assessment, the student may take a test at the end of the term in which he/she will have to solve questions related to all the specific competences of the subject except the practicals. This test will be different in length from the one taken by those who opt for continuous assessment and the grade obtained will be 85% of the final grade. A 5 out of 10 will be required to pass the course.

Sources of information

Basic Bibliography

Housecroft, C. E.; Sharpe, A. G., **Inorganic Chemistry**, 5, Harlow: Pearson Education, 2018

Crabtree, R. H., **The organometallic chemistry of the transition metals**, 6, Wiley, 2014

Complementary Bibliography

Spessard, G. O., **Organometallic chemistry**, 3, Oxford University Press, 2015

Astruc, D., **Química organometálica con ejercicios corregidos**, 1, Reverté, 2003

Elschenbroich, Ch., **Organometallics**, 3, Wiley-VCH, 2006

Haiduc, I., **Basic organometallic chemistry**, 1, Walter De Gruyter, 1985

Toreki, R., **The Organometallic Hypertext Book, http://www.ilpi.com/organomet/index.html**, 2016

Recommendations

IDENTIFYING DATA				
Síntese estereoselectiva de compostos bioactivos				
Subject	Síntese estereoselectiva de compostos bioactivos			
Code	V11G201V01405			
Study programme	Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4	1c
Teaching language	Castelán			
Department	Química orgánica			
Coordinator	Rodríguez de Lera, Angel			
Lecturers	Rodríguez de Lera, Angel			
E-mail	qolera@uvigo.es			
Web	http://https://cinbio.es/orchid			
General description	Tras haber recibido formación en las propiedades de los grupos funcionales y en los procesos de transformación entre los mismos, se abordará en este curso la creación de nuevos estereocentros en moléculas orgánicas, y se detallarán las consideraciones conformacionales y electrostáticas de las moléculas que puedan participar en la creación de nuevos estereocentros. Los estudiantes internacionales pueden solicitar al profesorado el material del curso en inglés, así como recibir tutorías, pruebas y evaluaciones en dicho idioma.			

Resultados de Formación e Aprendizaxe	
Code	
A4	Que os estudantes poidan transmitir información, ideas, problemas e solución a un público tanto especializado coma non especializado
A5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B4	Capacidade de análise e síntese
C42	Coñecer estratexias sintéticas que permitan a obtención estereoselectiva de compostos con actividade biolóxica
D1	Capacidade para resolver problemas
D2	Capacidade para traballar en equipo

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
(*)Nueva	A4 A5	B4	C42	D1 D2

Contidos
Topic
1. FUNDAMENTOS DA SÍNTESE ESTEREOSELECTIVA 1.1. Introducción. Evolución da síntese estereoselectiva 1.2. Descripción da estereoselectividade 1.2.1. Simple 1.2.2. Inducida 1.2.2.1. Inducida polo sustrato 1.2.2.2. Inducida polo auxiliar 1.2.2.3. Inducida polo aditivo 1.2.2.4. Ligandos enantiopuros 1.3. Análisis Conformacional 1.3.1. Alcanos 1.3.2. Olefinas. Tensión alílica 1.3.3. Ciclohexanos e derivados 1.3.4. Tetrahidropiranos. O efecto anomérico 1.3.5. Tensión I 1.3.6. Compuostos bicíclicos 1.3.7. A regla de Fürst-Plattner

2. CINÉTICA E TERMODINÁMICA DAS REACCIÓNS ESTEREOSELECTIVAS
2.1. Procesos de creación de novos estereocentros
2.1.1. Reaccións non estereoselectivas
2.1.2. Reaccións estereoselectivas
2.2. Análisis de traxectorias de adición nucleófila
2.3. Postulado de Hammond
2.4. O principio de Curtin-Hammett
2.5. Reaccións organocatalizadas
2.5.1. Modos de activación con organocatalizadores
2.5.2. Reaccións en cascada organocatalizadas

3. PROCESOS DE OXIDACIÓN ASIMÉTRICA
3.1. Epoxidación asimétrica de Sharpless
3.1.1. Fundamento e aplicacións
3.1.2. Modelo de enantioselectividade
3.1.3. Aplicacións sintéticas
3.2. Epoxidación asimétrica de Jacobsen
3.2.1. Fundamento e aplicacións
3.2.2. Modelo de enantioselectividade
3.2.3. Aplicacións sintéticas
3.3. Dihidroxilación asimétrica de Sharpless
3.3.1. Fundamento e aplicacións
3.3.2. Modelo de enantioselectividade
3.3.3. Aplicacións sintéticas

4. PROCESOS DE REDUCCIÓN ASIMÉTRICA
4.1. Hidroxenación enantioselectiva catalítica de olefinas
4.2. Reducción enantioselectiva de cetonas
4.2.1. Reacción de Corey-Bakshi-Shibata (CBS)
4.2.2. Reducción diastereoselectiva de □-hidroxicetonas
4.2.3. Reducción diastereo e enantioselectiva de □-dicarbonilos

5. PROCESOS DE FORMACIÓN ESTEREOSELECTIVA DE ENLACES C-C
5.1. Adición enantioselectiva a grupos carbonilo
5.1.1. Reacción de organozincios
5.1.2. Reacción de derivados de alquinilo
5.1.3. Reacción de Nozaki-Hiyama-Kishi
5.2. Adición conxugada enantioselectiva a compostos □□□-insaturados
5.2.1. Adición de organozincios
5.2.2. Reducción asimétrica
5.2.3. Adición de heteroátomos
5.2.3. Alquilación de enolatos
5.2.4. Alquilación de azaenolatos
5.3. Reaccións enantioselectivas organocatalizadas
5.3.1. Adición conxugada
5.3.2. Epoxidación
5.3.3. Oxidación de cetonas
5.3.4. Adicións conxugadas con inversión de polaridade
5.3.5. Reaccións organocatalizadas en cascada

Planificación

	Class hours	Hours outside the classroom	Total hours
Lección maxistral	24	24	48
Seminario	12	36	48
Prácticas de laboratorio	14	11	25
Resolución de problemas e/ou exercicios	0	27	27
Exame de preguntas de desenvolvemento	1	0	1
Exame de preguntas de desenvolvemento	1	0	1

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

Metodoloxía docente	
	Description
Lección maxistral	Descripción, por parte del profesorado, dos contidos sobre a materia obxecto do estudo, bases teóricas e/ou directrices dun traballo, exercicio ou proxecto a desenvolver polos estudantes.
Seminario	Actividade de consolidación dos coñecementos adquiridos ao propoñer e resolver problemas de transformacións estereoselectivas na construcción de esqueletos funcionalizados con estereocentros.
Prácticas de laboratorio	Desenvolvemento práctico de tres procesos de síntese estereoselectiva empregando catalizadores quirais enantiopuros, incluíndo a organocatálise, complementado co análise espectroscópico dos estereoisómeros mayoritarios das transformacións sintéticas.

Atención personalizada	
Methodologies	**Description**
Lección maxistral	Cada estudante poderá solicitar ao docente as aclaracións que estime oportunas para unha mellor comprensión da materia e sobre a resolución con éxito dos exercicios e problemas propostos. Esta consulta puede tamén ser atendida en horario de titorías. Os horarios e despachos das mesmas estarán recollidas na páxina web do centro.
Seminario	Cada estudante poderá solicitar ao docente las aclaraciones que estime oportunas para unha mellor comprensión da materia e sobre a resolución con éxito dos exercicios e problemas propostos. Esta consulta pode tamén ser atendida en horario de titorías. Os horarios e despachos das mesmas están recollidas na páxina web do centro.
Prácticas de laboratorio	As prácticas de laboratorio xa presentan o diseño de aprendizaxe previo e a proposta metodolóxica que requiren antes da execución práctica. Os profesores atenden as mesmas de forma personalizada.
Tests	**Description**
Resolución de problemas e/ou exercicios	Similar ao indicado en Seminario.

Avaliación								
	Description	Qualification	Training and Learning Results					
Prácticas de laboratorio	A avaliación das clases de prácticas de xeito continuo, con cuestións do profesorado sobre o contido e desenvolvemento, así como e a Memoria das mesmas, suporá un 15% da cualificación final. Esixirase unha nota mínima de 4.0 puntos sobre 10.0 para superar a materia.	15	A4 A5	B4	C42	D1 D2		
Resolución de problemas e/ou exercicios	Cada estudante terá á súa disposición as titorías cos profesores da materia para resolver de forma individualizada as dúbidas que poidan xurdir ao longo do curso en cualquera dos seus aspectos: clases de teoría, clases de seminario ou resolución de problemas e/ou actividades autónomas. O obxectivo de ditas titorías é o de contribuir a que os estudantes poidan afianzar os seus coñecementos e enfrentarse en millores condicións as distintas actividades de avaliación propostas (probas escritas, resolución de exercicios). Entregables: O alumnado realizará traballos relacionados co contido da materia. Estes traballos deberán axustarse aos parámetros especificados polo profesorado, e presentaranse de forma escrita a través da plataforma habilitada ou a través dunha exposición oral e formarán parte da avaliación continua (20%).	40	A4 A5	B4	C42	D1 D2		
Exame de preguntas de desenvolvemento	Unha proba sobre os contidos dos primeiros temas, que suporá o 15% da cualificación final. Esixirase unha nota mínima de 2.5 puntos sobre 10.0 nesta proba para superar a materia.	15	A4 A5	B4	C42	D1 D2		
Exame de preguntas de desenvolvemento	Unha proba sobre TODOS OS CONTIDOS DA MATERIA, que suporá un 30% da cualificación final. Esixirase unha nota mínima de 4.0 puntos sobre 10.0 nesta proba para superar a materia.	30	A4 A5	B4	C42	D1 D2		

Other comments on the Evaluation

Prácticas de laboratorio:

A asistencia ás clases prácticas de laboratorio é obrigatoria.

O traballo de laboratorio será avaliado como se indicóu con anterioridade. Neste apartado incluiranse os seguintes aspectos: traballo previo e/ou posterior, desenvolvemento do traballo experimental e caderno de laboratorio. A avaliación do desenvolvemento do traballo experimental realizarase utilizando a ferramenta de observación sistemática.

Para que o alumnado supere a materia deberá obter a cualificación de APTO no traballo de prácticas de laboratorio.

No caso de que non se superen os mínimos esixidos nalghuna das probas anteriores, a cualificación final obtida na materia será a cualificación ponderada da proba de avaliación global.

Mínimos esixibles:

A identificación de erros conceptuais graves, conlevará unha asignación de actividades específicas orientadas a adquirir ditas competencias. Estas actividades serán evaluadas como parte do 20% correspondente aos entregables.

AVALIACIÓN EN XULLO: manterase a cualificación obtida polo alumnado durante o curso en resolución de problemas, prácticas de laboratorio e traballos. Realizarase unha proba sobre todos os contidos teóricos da materia que suporá un 45% da cualificación final e unha proba escrita da parte experimental que suporá un 15% da cualificación final. Será necesario alcanzar nestas probas un mínimo de 4 puntos sobre 10 para superar a materia e para ter en conta o resto dos elementos de avaliación.

ALUMNADO DE 2ª E POSTERIORES MATRÍCULAS: Ao estudantado que fose avaliado con APTO/A no traballo de laboratorio no curso anterior outorgaráselle mención de APTO/A no seguimento do traballo de laboratorio no curso académico actual, non sendo necesaria a realización dos experimentos novamente. Con todo, deberán realizar os entregables e a proba escrita da parte experimental para conseguir a cualificación correspondente á parte experimental da materia no curso académico actual.

CONDICIÓN DE PRESENTADO/A: A participación do/a estudante nalgún dos actos de avaliación da materia implicará a condición de presentado/a e, polo tanto, a asignación dunha cualificación. Considéranse actos de avaliación a asistencia a clases prácticas de laboratorio, a entrega de traballos e exercicios encargados polo profesorado, ou a realización de algunha proba.

OPCIÓN DE AVALIACIÓN NON CONTINUA: (provisional). A UVigo está a elaborar unha normativa ao respecto) o alumnado que desexe non optar á avaliación continua deberá solicitalo durante as tres primeiras semanas de curso á persoa coordinadora da materia.Para superar a materia deberá realizar as Prácticas de Laboratorio, acadar cualificación APTO/A no traballo desenvolvido no laboratorio e cualificación igual ou superior a 5 puntos sobre 10 na proba escrita da parte experimental. Ademais deberá obter como mínimo 5 puntos sobre 10 nunha proba na que se avaliarán todos os contidos da materia.

Bibliografía. Fontes de información

Basic Bibliography

Clayden, J.; Greeves, N.; Warren, S.,, **Organic Chemistry, 2nd ed.**, Oxford, 2012

Zweifel, G. S.; Nantz, M. H.; Somfai, P., **Modern Organic Synthesis. An Introduction**, Wiley, 2017

Complementary Bibliography

Corey, E. J.; Kürti, L., **Enantioselective Chemical Synthesis. Methods, Logic and Practice.**, Direct Book Publishing. Dallas: Texas, 2010

Corey, E. J.; Czakó, B.; Kürti, L., **Molecules and Medicines**, Wily, 2007

Recomendacións

Subjects that it is recommended to have taken before

Química orgánica III: Reaccións concertadas, radicalarias e fotoquímicas/V11G201V01305
Química orgánica IV: Deseño da síntese orgánica/V11G201V01310

IDENTIFYING DATA				
Enhancement of Analytical Chemistry				
Subject	Enhancement of Analytical Chemistry			
Code	V11G201V01406			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Lavilla Beltrán, María Isela			
Lecturers	Calle González, Inmaculada de la Lavilla Beltrán, María Isela Romero Rivas, Vanesa			
E-mail	isela@uvigo.es			
Web	http://quimica.uvigo.es/gl/			
General description	This subject provides students with knowledge about important and current aspects of analytical chemistry (e.g., bioanalytical techniques, automation and miniaturisation, sensors and chemometrics). Students will be able to complete their training and integrate the knowledge acquired in analytical chemistry, which will allow them to address problem-solving in areas of special interest (e.g., clinical, environmental and industrial fields).			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B4	Ability for analysis and synthesis
C30	Ability to understand, interpret and adapt the advances in the field of Analytical Chemistry
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Recognize the main current trends in analytical chemistry.		B4	C30	
Use and recognize different bioanalytical methodologies.	A1		C30	
Describe and distinguish the different types of automatic analysis systems.		B4	C30	
Understand the advantages and limitations of automation.	A3	B4	C30	
To train students in the development of miniaturized analytical tools and their application.	A1		C30	
Value the importance of the use of sensors to obtain fast and reliable analytical information.	A3		C30	
Correctly apply different chemometric techniques to solve analytical problems.	A1 A3		C30	D1
Acquire skills to approach an analytical problem in all its stages (from the selection of an appropriate analytical methodology, through the practical laboratory work, to the interpretation of results).	A1 A3	B4	C30	D1

Contents	
Topic	
Topic 1. Immunoassay	Introduction. In vitro antigen-antibody reaction. Immunoassay techniques without marker. Immunoassay techniques with marker: generalities. Radioimmunoassay. Enzyme immunoassay. Fluoroimmunoassay. Luminoimmunoassay.
Topic 2. Enzymatic methods of analysis	Introduction. Enzymatic end-point methods: single-step methods and methods with coupled reactions. Enzyme kinetic methods: methods based on zero-order kinetics and methods based on one-order kinetics.
Topic 3. Determination of nucleic acids: Hybridization and PCR techniques	Introduction. Nucleic acid extraction and purification techniques. Hybridization assays: liquid phase, solid phase and in situ. Polymerase chain reaction: basics. Variants of classical PCR.
Topic 4. Automation and miniaturization	Introduction. Automation: generalities. Analyzers. Flow Injection Analysis (FIA). Sequential injection analysis (SIA). Miniaturization: fundamentals and approaches.

Topic 5. Chemical sensors and biosensors	Introduction. Recognition systems. Classification of chemical sensors and biosensors. Analytical characteristics of the sensors. Applications of interest.
Topic 6. Chemometrics	Introduction to chemometrics. Structure of hypothesis testing. Rejection of anomalous results. Comparison of analytical results: parametric and non-parametric tests. Control charts. Introduction to experimental design.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	36	60
Seminars	12	24	36
Laboratory practical	14	10	24
Objective questions exam	2	10	12
Objective questions exam	0	18	18

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

Methodologies

	Description
Lecturing	The lecturer will develop the contents of the programme based on the material provided to the student through Moovi. In the lecture sessions, the lecturer will present the fundamental aspects of the subject, which should be complemented by the recommended bibliography.
Seminars	The seminar classes will help to reinforce the learning of the subject matter explained during the lectures by solving numerical problems and/or theoretical-practical exercises. The lecturer will regularly propose different problems, exercises or questionnaires that will be solved individually by the student and delivered for evaluation.
Laboratory practical	Laboratory experiments will be carried out in 4 sessions of 3.5 hours each. Prior to each practical session, the student will be provided with supporting material in Moovi for the preparation of the experiments to be carried out.

Personalized assistance

Methodologies	**Description**
Lecturing	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Seminars	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Laboratory practical	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Tests	**Description**
Objective questions exam	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Objective questions exam	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.

Assessment

	Description	Qualification	Training and Learning Results			
Seminars	For the evaluation of this activity, the teacher will propose the resolution and delivery by the student of some problems, exercises and/or questionnaires in seminar classes.	5	A1 A3	B4	C30	D1
Laboratory practical	The teacher will assess the experimental work carried out by the student in the laboratory sessions through observation and the delivery of the obtained results (laboratory report). Attendance at laboratory sessions is compulsory. Absence from any laboratory session must be duly justified.	15	A1 A3	B4	C30	D1

Objective questions exam	There will be a first examination limited to approximately half of the subject. This exam may consist of short answer questions, problems and multiple choice questions. The fact of sitting the exam precludes the student from the grade "Not presented". Students who obtain a minimum score of 5 out of 10 will not be examined again in the contents considered in the first examination.	40	A1 A3	B4	C30	D1
Objective questions exam	This final exam is compulsory. Students who have passed the first part will take the second part of the syllabus. This examination may consist of short answer questions, problems and/or multiple-choice questions. The fact of sitting the exam precludes the student from the grade "Not presented". Students who have not passed the first part will have to take the first part of the sylabus (40% final mark).	40	A1 A3	B4	C30	D1

Other comments on the Evaluation

Second opportunity (July):

The marks obtained by the student during the course in the laboratory practicals and seminars will be retained (20 % of the grade).

Students will be able may do both exams.
The student who wishes may opt for the overall assessment.

Sources of information

Basic Bibliography

Paolo Ugo, Pietro Marafini, Marta Meneghello, **Bioanalytival chemistry. From biomolecular recognition to nanobiosensing**, Primera, De Gruyter, 2021

Miguel Valcárcel, Soledad Cárdenas, **Automatización y miniaturización en Química Analítica**, Primera, Springer, 2000

Florinel-Gabriel Bănică, **Chemical sensors and biosensors: Fundamentals and applications**, Primera, Wiley, 2012

Guillermo Ramis Ramos, María Celia García Álvarez-Coque, **Quimiometría**, Prmera, Síntesis, 2001

Complementary Bibliography

Recommendations

Subjects that are recommended to be taken simultaneously

Quality in Analytical Labs/V11G201V01407
Food, Agricultural and Environmental Analytical Chemistry/V11G201V01410

Subjects that it is recommended to have taken before

Biochemistry/V11G201V01201
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Analytical Chemistry II: Optical Methods of Analysis/V11G201V01207
Analytical Chemistry III: Electroanalytical Methods and Separations/V11G201V01302
Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306

IDENTIFYING DATA

Quality in Analytical Labs

Subject	Quality in Analytical Labs			
Code	V11G201V01407			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Pena Pereira, Francisco Javier			
Lecturers	Calle González, Inmaculada de la Pena Pereira, Francisco Javier			
E-mail	fjpena@uvigo.es			
Web				
General description	Quality assurance in analytical laboratories is an increasingly important aspect. The aim of this subject is to introduce students in the final year of the degree to the general principles for the evaluation and continuous improvement of quality in analytical laboratories. Throughout the course, the regulatory standards and basic documentation of quality systems will be introduced, statistical tools used systematically to achieve analytical quality will be described and applied, the selection and validation of analytical methods and aspects related to laboratory management will be addressed. Students will also understand the difficulties in sampling and the importance of designing a sampling plan. In addition, students will learn how internal and external quality assessment is carried out. In the first case, through the control of blanks, reagents, the use of certified reference materials and, in the second case, through intercomparison exercises, audits and accreditations. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B5	Ability to adapt to new situations and to make decisions
C31	Know the control processes applied in the analytical laboratories to achieve their correct management and ensure the quality of the results
C33	Know the metrology of chemical processes, including quality management
D1	Ability to solve problems

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Interpret the quality management standards applicable to the analytical laboratory.	A4	B5	C33	D1
Explain the main quality parameters.	A1 A4		C31 C33	
Calculate and interpret the different quality parameters.	A4	B5	C31 C33	D1
Interpret the application of different statistical tools.	A1 A4	B5	C31 C33	D1
Interpret the standards and validation parameters of an analytical method.	A1 A4	B5	C31 C33	D1
Explain the essential parameters for quality assessment.	A1 A4		C31 C33	

Contents

Topic	
SUBJECT 1. Introduction to quality.	General concepts. Historical evolution of the concept of quality. Basic elements and commitments of quality. Quality in the analytical process. Analytical and metrological properties. Traceability. Implementation of quality systems.

SUBJECT 2. Regulatory standards and documentation of quality systems.	Standardization, certification and accreditation. Generic systems of quality management. Series of ISO 9000 standards. The standard UNE-EN ISO/IEC 17025. Good Laboratory Practice. Documentation used in quality systems. Management of quality documentation.
SUBJECT 3. Statistical tools to ensure the analytical quality.	Statistical proofs of significance. Components of uncertainty. Evaluation of uncertainties of unitary operations and of analytical processes. Expression of results.
SUBJECT 4. Selection and validation of methods of analysis.	Selection of methods of analysis. Concept and scope of the validation of an analytical method. Types of validation. Quality parameters of analytical methods.
SUBJECT 5. Management of laboratory, equipment and reagents.	Organisation and infrastructure of the laboratories. Materials and methods. Classifications of analytical methods. Quality of reagents.
SUBJECT 6. Quality in sampling.	Sampling in the analytical process (sampling plan, types of sampling, sample handling). Limitations of sampling. Quality assurance in sampling.
SUBJECT 7. Internal quality assurance.	Analytical references. Certified reference materials (preparation, selection and use of CRMs). Recovery studies. Application of t test. Activities of internal control. Blanks and control samples. Control charts.
SUBJECT 8. External quality assurance.	Intercomparison exercises (definition and types). Audits in a quality system (objectives, types, planning, performance and documents). Accreditation (concept, implications, accreditation bodies, process and documents of accreditation).

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	36	60
Seminars	12	24	36
Laboratory practical	14	10	24
Objective questions exam	2	10	12
Objective questions exam	0	18	18

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

Methodologies

	Description
Lecturing	The lecturer will develop the contents of the programme based on the material provided to the student through Moovi. In the lecture sessions, the lecturer will present the fundamental aspects of the subject, which should be complemented by the recommended bibliography.
Seminars	The seminar classes will help to reinforce the learning of the subject matter explained during the lectures by solving numerical problems and/or theoretical-practical exercises. The lecturer will regularly propose different problems, exercises or questionnaires that will be solved individually by the student and delivered for evaluation.
Laboratory practical	Laboratory experiments will be carried out in 4 sessions of 3.5 hours each. Prior to each practical session, the student will be provided with supporting material in Moovi for the preparation of the experiments to be carried out. Those students that have overcome lab practices in the academic year 23-24 will not need to repeat them. In this case, the mark obtained in lab practices will be kept.

Personalized assistance

Methodologies	**Description**
Lecturing	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Seminars	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Laboratory practical	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.
Tests	**Description**
Objective questions exam	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.

Objective questions exam	The lecturer will resolve doubts in a personalised manner on any of the proposed activities (lectures, seminars, laboratory practicals and exams). For this purpose, the tutoring hours of the teaching staff will be used.

Assessment

	Description	Qualification	Training and Learning Results			
Seminars	For the evaluation of this activity, the teacher will propose to the students the resolution and delivery of problems, exercises and/or questionnaires in seminar classes.	5	A1 A4	B5	C31 C33	D1
Laboratory practical	The teacher will assess the experimental work carried out by the student in the laboratory sessions through observation and the evaluation of the obtained results delivered as a laboratory report. Attendance at laboratory sessions is compulsory. Absence from any laboratory session must be duly justified.	15	A1 A4	B5	C31 C33	D1
Objective questions exam	There will be a first exam limited to approximately half of the subject. This exam may consist of short-answer questions, problems and multiple-choice questions. By taking the exam, the student will be prevented from receiving the grade "Not presented". Students who obtain a minimum score of 5 out of 10 will not be tested again on the contents of the first exam.	40	A1 A4	B5	C31 C33	D1
Objective questions exam	This final exam is compulsory. This exam may consist of short-answer questions, problems and/or multiple-choice questions. By taking the exam, the student will be prevented from receiving the grade "Not presented". Students who have passed the first part will take the second part of the subject. Students who have not passed the first part of the subject will have to take an examen of this first part of the subject (40% of the final grade).	40	A1 A4	B5	C31 C33	D1

Other comments on the Evaluation

Second call (July):

The marks obtained by the student during the course in the laboratory practices and seminars will be retained (20 % of the grade).

This exam may consist of short answer questions, problems and/or multiple choice questions.

Students can choose the global evaluation modality and they should inform in writing to the coordinator of the subject during the first month of the semester, in this case, the evaluation will be 85 % the exam an 15 % the laboratory practicals.

Sources of information

Basic Bibliography

R. Compañó Beltrán, Á. Ríos Castro, **Garantía de la calidad en los laboratorios analíticos**, Síntesis, 2002

M. Valcárcel, Á. Ríos, **La calidad en los laboratorios analíticos**, Reverté, 1992

E. Prichard, V. Barwick, **Quality assurance in analytical chemistry**, Wiley, 2007

Complementary Bibliography

S. Sagrado, E. Bonet, M.J. Medina, Y. Martín, **Manual práctico de calidad en los laboratorios - Enfoque ISO 17025 (2ª edición)**, AENOR, 2005

P.P. Morillas Bravo, **Guía para la aplicación de UNE-EN ISO/IEC 17025:2017**, AENOR, 2019

J.C. Miller; J.N. Miller, **Estadística y quimiometría para química analítica**, Prentice-Hall, 2002

G. Ramis Ramos; M.C. Álvarez Coque, **Quimiometría**, Síntesis, 2001

D.L. Massart, B.G.M. Vandeginste, L.M.C. Buydens, S. de Jong, P.J. Lewi, J. Smeyers-Verbeke, **Handbook of chemometrics and qualimetrics. Part A**, Elsevier Science, 1997

S. Sáez Ramirez, L.G. Gómez-Cambronero, **Sistema de mejora continua de la calidad en el laboratorio - Teoría y práctica**, Universitat de València, 2006

Recommendations

Subjects that are recommended to be taken simultaneously

Enhancement of Analytical Chemistry/V11G201V01406
Food, Agricultural and Environmental Analytical Chemistry/V11G201V01410

Subjects that it is recommended to have taken before

Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Analytical Chemistry II: Optical Methods of Analysis/V11G201V01207
Analytical Chemistry III: Electroanalytical Methods and Separations/V11G201V01302
Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306

IDENTIFYING DATA

Industrial Chemistry

Subject	Industrial Chemistry			
Code	V11G201V01408			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Rosales Villanueva, Emilio			
Lecturers	Rosales Villanueva, Emilio			
E-mail	emiliorv@uvigo.es			
Web				
General description	The chemical industry represents one of the most thriving sectors in the economies of many countries, serving as the basis for producing a wide variety of products that range from materials for general use, to materials with a high technological content and cutting-edge for other industries. Recent advances in obtaining new products together with new technologies to remedy environmental damage and increase productivity arise from innovations and continuous improvement developed in each of the stages of chemical processes. This subject aims to provide students with a global vision of Industrial Chemistry, ranging from the development and understanding of flow diagrams of chemical processes of great economic and social relevance to the quality principles that govern them. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results

Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
C45	Apply chemical and chemical engineering knowledge to industrial processes
D1	Ability to solve problems
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject

Expected results from this subject	Training and Learning Results		
Appreciate the importance and complexity of the industrial chemical processes.	A3	C45	D1
Describe the main stages of an industrial chemical process and elaborate flow diagrams of simple processes.	A3	C45	D1 D2 D3
Identify the main raw materials used in the chemical industry and their characteristics.	A3	C45	D1 D2
Compare the diverse sources of energy used in the industry and make simple studies of energetic integration.	A3	C45	D1 D2
Describe the industrial chemical processes more usual in diverse productive sectors.	A3	C45	D2 D3

Contents

Topic	
General appearances of the Industrial Chemistry.	Introduction to the processes of the Chemical Industry. Characteristics and sectorial structure of the chemical industry. Situation of the chemical industry Spaniard in the European and world-wide context. Introduction to the diagrams of flow for processes of industrial chemistry
Raw materials used in the chemical industry	Classification and typology. Sources. Circular economy.
The energy in the chemical industry	General characteristics. Sources of traditional and alternative energy. Energetic integration.
Industrial chemical processes	Petrochemical, biotechnological processes and other productive processes for raw materials transformation.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	24	36
Problem solving	16	25	41
Seminars	3	9	12
Mentored work	4	30	34
Presentation	1	4	5
Laboratory practical	14	5	19
Essay questions exam	1	0	1
Objective questions exam	0.5	0.5	1
Oral exam	0.5	0.5	1

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

Methodologies

	Description
Lecturing	Presentation by the teacher of the general aspects of the programme in a structured way, with special emphasis on the fundamentals and the most important or difficult aspects for the student to understand. The professor will facilitate, through the platform MOOVI, the necessary material for a correct follow-up of the matter. The student will have to work previously the material delivered by the professor and consult the bibliography recommended to complete the information.
Problem solving	During the development of the subject will use the resolution of questions and problems so as to reinforce the appearances presented in the lectures.
Seminars	With the development of the syllabus, some activities focused to the work on a specific subject will be made, that will allow to deepen and complement the contents of the subject as it complement of the lecturing.
Mentored work	Inside the problem solving, the students working in groups will develop a work that will be based in the search of solutions for real problems where the students will have to provide a feasible and viable solution to proposed problem.
Presentation	The students will make by group a short presentation of the mentored work with the solution proposed for the problem assigned.
Laboratory practical	Laboratory experiments and field trips to companies related to subject will be carried out. The student will be provided with practice guide as well as the necessary support material for a proper understanding of the experiments to be carried out. The student will prepare a final report in which the main results and conclusions will be presented.

Personalized assistance

Methodologies	Description
Lecturing	During the hours of tutorship the students, individually or in group, can consult with the lecturers any doubt posed on the subject. The lecturer will inform on the available schedule in the presentation of the subject.
Problem solving	During the hours of tutorship the students, individually or in group, can consult with the lecturers any doubt posed on the problem solving. The lecturer will inform on the available schedule in the presentation of the subject.
Laboratory practical	During the hours of tutorship the students, individually or in group, can consult with the lecturers any doubt posed on the laboratory practical. The lecturer will inform on the available schedule in the presentation of the subject.
Seminars	During the hours of tutorship the students, individually or in group, can consult with the lecturers any doubt posed on the seminars. The lecturer will inform on the available schedule in the presentation of the subject.
Mentored work	During the hours of tutorship the students, in groups or their members of individual way, can consult with the lecturer any doubt posed on the development of the work. The lecturer will inform on the available schedule in the presentation of the matter.
Presentation	During the hours of tutorship the students, in groups or their members of individual way, can consult with the lecturer any doubt posed on the presentation. The lecturer will inform on the available schedule in the presentation of the matter

Assessment

	Description	Qualification	Training and Learning Results		
Problem solving	After each subject will argue the most notable appearances by means of resolution of questions and problems	10	A3	C45	D1 D2 D3

Mentored work	It will be evaluated the solution presented together with structure of contents, quality of the content, sources consulted, format.	10	A3	C45	D1 D2 D3
Presentation	The sudent will present the mentored work for its discussion with the other students of the matter. It will be evaluated the oral presentation as well as the answers to the lecturer and the other students.	10	A3	C45	D1 D2 D3
Laboratory practical	The students will make diverse practices of laboratory and visits to companies. When finalising the diverse practical and in the dates indicated by the professors , they will have to deliver the reports of practices and make a questionnaire on the company visits.	10	A3	C45	D1 D2 D3
Essay questions exam	A global exam of for the evaluation of the acquired knowledge in the subject will be assessed.	25	A3	C45	D1 D3
Objective questions exam	In the final exam the student will have to answer a series of short questions or multiple-choice questions in which they will have to demonstrate their knowledge as well as their capacity for synthesis.	25	A3	C45	D3
Oral exam	There will be an individual oral examination of the laboratory practicals carried out in the course.	10	A3	C45	D3

Other comments on the Evaluation

ASSESSMENT: The participation of the student in any of the systems of evaluation of the subject (problem solving, mentored work , presentation and laboratory practical) will involve the qualificationof the subject. It is required a minimum attendance to 90% of the laboratory practical to have right to its evaluation. Otherwise, the mark for this section will be 0.0 and they will have to take an exam in the FINAL EXAM.The evaluation by both essay and objective questions (50%) will be carried out in several exams along the course. If the students fail to pass the exam, they have to recover it in the FINAL EXAM.

A student who do not "officially renounces to continuous assessment", will fail if he/she does not achieve a MINIMUM mark of 4.0 points (out of 10) in each of the parts of the "FINAL EXAMINATION". If the minimum mark in the "FINAL EXAMINATION" is passed, the student will pass the course if the FINAL GRADE is ≥ 5.0, that is, if the sum of the marks obtained in the different systems of evaluation of the course is ≥ 5.0.

Second call: The same criteria will be applied in the second sitting. With regard to the July exam, the grade of the different assessment systems (laboratory practicals, problem solving and exercises) will be maintained, so students will only take the "FINAL EXAM".

STUDENTS RELEASED FROM CONTINUOUS ASSESSMENT: When the School releases a student from the continuous assessment process, his/her grade will be the sum of 90% of the mark obtained in the "FINAL EXAM" and 10% of the laboratory practicals mark.**ETHICAL COMMITMENT:The student is expected to show appropriate ethical behaviour. If ethically reprehensible behaviour is detected (for example: copying, plagiarism, use of unauthorised electronic devices, etc.) the student will not be considered to meet the necessary requirements to pass the subject. In this case the overall grade for the current academic year will be a fail (0.0). The use of any electronic device will not be permitted during the assessment tests unless expressly authorised. Bringing an unauthorised electronic device into the examination room will be considered as a reason for failing the subject in the current academic year and the overall grade will be a fail (0.0).**

Sources of information

Basic Bibliography

Vián Ortuño, A., **Introducción a la Química Industrial**, 2ª, Reverté, 1994

Sinnott, R.K., **Diseño en ingeniería química**, 5ª, Reverté, 2012

Díaz, M., **Ingeniería de bioprocesos**, Paraninfo, 2012

Wauquier, J.-P., **El refino del petróleo**, 1ª, Dias de Santos, 2004

De Juana, J.M., **Energías renovables para el desarrollo**, 1ª, Thomson Paraninfo, 2003

Complementary Bibliography

Turton, R., **Analysis, synthesis, and design of chemical processes**, 2ª, Pearson education, 2013

Federación Empresarial de la Industria Química Española, **Radiografía del sector químico español 2022**, FEIQUE, 2022

Recommendations

Subjects that it is recommended to have taken before

Chemical engineering/V11G201V01301

IDENTIFYING DATA				
Química analítica ambiental e agroalimentaria				
Subject	Química analítica ambiental e agroalimentaria			
Code	V11G201V01410			
Study programme	Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4	2c
Teaching language	Castelán			
Department	Química analítica e alimentaria			
Coordinator	Gago Martínez, Ana			
Lecturers	Costas Rodríguez, Marta Gago Martínez, Ana Leao Martins, Jose Manuel			
E-mail	anagago@uvigo.es			
Web				
General description	A materia abarca os aspectos relacionados co estudo da *problématica asociada ao estudo desde o punto de vista analítico da contaminación química do ambiente e os alimentos, con especial énfase nos contaminantes máis relevantes tanto naturais como *antropogénicos, identificando as metodoloxías analíticas máis eficaces para o control dos mesmos.			

Resultados de Formación e Aprendizaxe	
Code	
A3	Que os estudantes teñan a capacidade de reunir e interpretar datos relevantes (normalmente dentro da súa área de estudo) para emitir xuízos que inclúan unha reflexión sobre temas relevantes de índole social, científica ou ética
A5	Que os estudantes desenvolvan aquelas habilidades de aprendizaxe necesarias para emprender estudos posteriores cun alto grao de autonomía
B2	Capacidade de organización y planificación
B3	Capacidade de xestión da información
C32	Adquirir coñecementos básicos sobre o control e a avaliación no medio ambiente e na seguridade agroalimentaria
D4	Incorporar no exercicio profesional criterios de sustentabilidade e compromiso ambiental. Adquirir habilidades no uso equitativo, responsable e eficiente dos recursos

Resultados previstos na materia				
Expected results from this subject	Training and Learning Results			
Nova	A3 A5	B2 B3	C32	D4

Contidos	
Topic	
Contaminantes químicos : Xeneralidades	Estrutura e Propiedades Químicas, Toxicoloxía.
Fontes da contaminación química	Contaminantes naturais e antropogénicos Contaminantes emerxentes de interese desde o punto de vista ambiental e alimentario
Clasificación das metodoloxías analíticas para o control dos contaminantes químicos	Metodoloxías analítcas para o control de Contaminantes químicos Inorgánicos e Orgánicos
Mostraxe e Preparación de mostra	Técnicas de mostraxe Estudo das etapas a considerar no protocolo analítico para o control de contaminantes químicos en función da súa natureza e propiedades
Control de calidade (ambiental e alimentaria)	Aspectos xerais a considerar no control de calidade do Laboratorio analítico: Ferramentas de calidade
Seguridade ambiental e alimentaria : lexislacion aplicable	Perspectiva Europea para o control de contaminantes químicos ambientais e alimentarios Lexislación aplicable aos contaminantes químicos obxecto de estudo Armonización metodológica: Organismos involucrados

Planificación			
	Class hours	Hours outside the classroom	Total hours
Lección maxistral	24	24	48
Seminario	12	12	24

Prácticas de laboratorio	14	14	28
Informe de prácticas, prácticum e prácticas externas	0	20	20
Exame de preguntas de desenvolvemento	0	6	6
Presentación	2	20	22

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

Metodoloxía docente

	Description
Lección maxistral	Clases de 50 *min nas que se introducirá ao alumno no campo da seguridade ambiental e alimentaria, presentando os conceptos básicos relacionados coa detección e control dos contaminantes químicos naturais e *antropogenicos presentes no *medioambiente e os alimentos e os mecanismos establecidos para o seu *contro tendo en conta os aspectos lexislativos na UE .
Seminario	Os alumnos, distribuídos en grupos, deberán resolver unha serie de casos prácticos (cálculos, problemas, cuestionarios etc.) . O obxectivo principal desta actividade é que os alumnos completen maneira e apliquen vos conceptos teóricos mediante a resolución dos problemas expostos.
Prácticas de laboratorio	Desenvolvemento e aplicación práctica de metodoloxías analíticas para o control de contaminantes químicos seleccionados en matrices ambientais e alimentarias mediante traballo autónomo do alumno quen deberá resolver ademais unha serie de cuestións expostas polos profesores en relación ás técnicas analíticas empregadas . A resolución de cuestionarios e/ou realización de breves informes e/ou unha proba final permitirá ao alumno completar a súa formación presencial e adquirir unha visión integral da disciplina

Atención personalizada

Methodologies	Description
Lección maxistral	O profesorado tentará facer participativas as clases maxistrais para que os alumnos poidan expor preguntas e, mesmo, breves debates.
Seminario	O profesorado supervisará a resolución de problemas, cálculos etc. *desarrolladps polo alumno . Tamén atenderá e orientará aos alumnos sobre aspectos relacionados coa aplicación práctica dos conceptos teóricos
Prácticas de laboratorio	O profesorado supervisará o traballo de laboratorio dos alumnos de cada grupo, corrixindo os erros detectados no desempeño das técnicas e atendendo todas as cuestións que poidan xurdir ao longo das sesións prácticas

Avaliación

	Description	Qualification	Training and Learning Results			
Prácticas de laboratorio	Se evaluarán los informes presentados sobre el desarrollo de las practicas , los obetivos de las mismas, resultados obtenidos y discusión	15	A3 A5	B2 B3	C32	D4
Informe de prácticas, prácticum e prácticas externas	- Se evaluarán los resultados obtenidos en el cuestionario final planteado sobre la actividad práctica desarrollada (15%) -Se evaluará el desarrollo de los casos prácticos asignados (30%)	45	A3 A5	B2 B3	C32	D4
Exame de preguntas de desenvolvemento	se valuará la presentación oral de los casos prácticos desarrollados y la respuesta a las preguntas sobre el desarrollo de los miamos)	40	A3 A5	B2 B3	C32	D4

Other comments on the Evaluation

Dado que las actividades de formación y evaluación continua programadas dentro de las Prácticas de Laboratorio y del Estudio de casos (incluida en el seguimiento de la actividad de seminarios) están diseñadas para formar al alumnado en habilidades y competencias directamente relacionadas con el ejercicio de la profesión en el campo del Análisis Químico, por ello la asistencia y participación del alumnado en ambas actividades evaluables es OBLIGATORIA, de tal manera que la ausencia o no realización injustificada de estas actividades impedirá superar la materia. Por lo tanto, considerando el carácter teórico-práctico de la asignatura y los resultados de formación y aprendizaje que se persiguen alcanzar con ambas metodologías, el alumnado que opte por la Modalidad de Evaluación Global Final también deberá realizar OBLIGATORIAMENTE estas actividades.

Para SUPERAR la materia será necesario alcanzar una calificación GLOBAL FINAL de 5,0 (sobre 10), una vez sumadas las calificaciones ponderadas obtenidas en las componentes evaluables de la asignatura y descritas con detalle en esta sección

de evaluación. Muy Importante, PARA PODER SUPERAR LA MATERIA (poder sumar las calificaciones obtenidas en cada actividad evaluable), es OBLIGATORIO alcanzar una nota mínima de 4,0 (sobre 10) en cada una de las actividades evaluables mencionadas anteriormente (Prácticas de laboratorio, desarrollo de caso prácticos, exposición y defensa de los mismos). Los alumnos que no cumplan este requisito en la primera oportunidad, serán calificados en el acta con la nota más alta alcanzada en las partes suspensas, y deberán repetir en la segunda oportunidad (convocatoria de Julio) la prueba relativa a la parte o partes en las que no hayan alcanzado el 4,0. Lógicamente, los alumnos que se encuentren en esta situación conservarán la nota de la/s parte/s superada/s (≥4,0) en primera oportunidad.

En la segunda oportunidad de evaluación, tal como fue ya descrito, es OBLIGATORIO alcanzar como mínimo una calificación de 4.0 (sobre 10) en todas las partes objeto de recuperación.

Los alumnos que optan por la modalidad **evaluación global final,** deberán tener en cuenta que las actividades de contenido práctico (seminarios y Prácticas de laboratorio) son de carácter obligatorio, por lo que la evaluación de dichas actividades, se realizará independientemente de la evaluación final.

ATENCIÓN: El alumno que desee optar por la modalidad EVALUACIÓN FINAL deberá informar y entregar un documento escrito y firmado a los docentes responsables de la materia durante las dos primeras semanas desde el inicio de la docencia de la materia correspondiente.

En la presentación de la materia, así como en la pagina de la Facultad de Química disponen de las fechas para las actividades de evaluación.

Bibliografía. Fontes de información

Basic Bibliography

Complementary Bibliography

D.Barcelo, **Environmental Analysis**, ELSEVIER, 1996

ROGER N. REEVE, **ENVIRONMENTAL ANALYSIS**, JOHN WILEY &SONS, 1994

J.P.F. D MELLO, **FOOD SAFETY**, CABI PUBLISHING CAB INT., 2003

Chunlong Zhang, **Fundamentals of Environmental Sampling and Analysis**, WILEY, 2007

CRUZ, KHMELINSKII, VIEIRA, **METHODS IN FOOD ANALYSIS**, CRC PRESS, 2014

Recomendacións

Subjects that it is recommended to have taken before

Química analítica I: Principios de química analítica/V11G201V01202
Química analítica II: Métodos ópticos de análise/V11G201V01207
Química analítica III: Métodos eletroanalíticos e separacións/V11G201V01302
Química analítica IV: Métodos cromatográficos e afins/V11G201V01306

IDENTIFYING DATA				
Computational Chemistry				
Subject	Computational Chemistry			
Code	V11G201V01411			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	#EnglishFriendly Spanish			
Department				
Coordinator	Graña Rodríguez, Ana María			
Lecturers	Graña Rodríguez, Ana María			
E-mail	ana@uvigo.es			
Web				
General description	Computational Chemistry is a discipline using mathematical methods for the calculation of molecular properties or for the simulation of the molecular behaviour.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
B1	Ability for auronomous learning
B2	Organization and planning capacity
C36	Know the basics and be able to use different quantum mechanical methods to be applied to systems of chemical interest
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Describe the main methods of calculation of the computational chemistry, knowing his applications and limitations.			C36	
Describe the elements that can contain a field of strengths of molecular mechanics.			C36	
Choose levels of quantum calculation adapted for the treatment of a chemical problem.	A1	B2	C36	
Describe fundamental algorithms employees in the calculations of computational chemistry.			C36	
Obtain properties of chemical interest doing use of computational methods (static and dynamic).		B1 B2	C36	D1

Contents	
Topic	
Subject 1. Introduction: methods of calculation in Computational Chemistry.	Definition, concepts, and types of Computational Chemistry studies. Molecular Mechanics methods. Hartree-Fock methods. Post Hartree-Fock methods. Density Functional Theory. Basis sets. Molecular Dynamics methods.
Subject 2. Conformational studies.	Potential energy surface. Characterization of singular points. Optimization of molecular geometries. Optimization of transition states. Constrained optimizations. Conduction methods. Conformational sampling. IRC methods.
Subject 3. Application to spectroscopy.	Introduction. Infrared spectra. Ramn spectra. UV-visible spectra. Excited states.
Subject 4. Applications to the calculation of energy properties.	Thermodynamics properties. Basis set superposition error. Isogyric reactions. Isodesmic reactions. Homdesmotic reactions. Gn and CBS methods.
Subject 5. Applications to the chemical reactivity.	Reactivity indices. Reaction dynamics.
Subject 6. Models of solvation.	Introduction. Continuum models of solvation. Inclusion of explicit solvent molecules. Mixed methods.
Subject 7. Applications to biomolecules.	Applications to biomolecules.

Planning			
	Class hours	Hours outside the classroom	Total hours

Lecturing	26	22	48
Practices through ICT	14	14	28
Problem solving	6	18	24
Problem and/or exercise solving	6	18	24
Essay	0	26	26

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

Methodologies

	Description
Lecturing	Exhibition by part of the professor of theoretical and practical concepts.
Practices through ICT	Computational laboratory.
Problem solving	Resolution of problems by part of the students so much in paper as with computational assistance.

Personalized assistance

Methodologies	Description
Lecturing	Students willing so could attend personal tutorials to solve doubts and/or uncertainties. To better optimise the procedure, the student is advised to previously contact her teacher.
Problem solving	Students willing so could attend personal tutorials to solve doubts and/or uncertainties. To better optimise the procedure, the student is advised to previously contact her teacher.
Practices through ICT	Students willing so could attend personal tutorials to solve doubts and/or uncertainties. To better optimise the procedure, the student is advised to previously contact her teacher.
Tests	**Description**
Problem and/or exercise solving	Students willing so could attend personal tutorials to solve doubts and/or uncertainties. To better optimise the procedure, the student is advised to previously contact her teacher.
Essay	Students willing so could attend personal tutorials to solve doubts and/or uncertainties. To better optimise the procedure, the student is advised to previously contact her teacher.

Assessment

	Description	Qualification	Training and Learning			Results
Problem solving	Report of exercises of the subjects 1 to 3.	30	A1	B1 B2	C36	D1
Problem and/or exercise solving	Report of exercises of the subjects 4 to 7.	40	A1	B1 B2	C36	D1
Essay	Delivery of an individual work about practical classes.	30	A1	B1 B2	C36	D1

Other comments on the Evaluation

Sources of information

Basic Bibliography

J. B. Foresman, A. Frisch, **Exploring Chemistry with Electronic Structure Methods**, 3, Gaussian Inc, 2015

Frank Jensen, **Introduction to computational chemistry**, 2, Wiley, 2006

Joan Bertran Rusca, Vicenç Branchadell Gallo, Miquel Moreno Ferrer, Mariona Sodupe Roure, **Química Cuántica**, 1, Síntesis, 2000

Complementary Bibliography

A. Szabo, N. S. Ostlund, **Modern Quantum Chemistry**, 1, Dover, 1996

Recommendations

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Physical Chemistry III: Quantum Chemistry/V11G201V01303
Physical Chemistry IV: Molecular Structure and Spectroscopy/V11G201V01307

IDENTIFYING DATA				
Environmental and Bioinorganic Chemistry				
Subject	Environmental and Bioinorganic Chemistry			
Code	V11G201V01412			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Castro Fojo, Jesús Antonio			
Lecturers	Castro Fojo, Jesús Antonio Rodríguez Arguelles, María Carmen			
E-mail	jesusc@uvigo.es			
Web				
General description	Know and interpret the role of metals and non-metals in the chemical processes present in the life and in the environment. Interpreting and analysing the chemical properties of the active centers of metalloproteins, mechanisms of performance of therapeutic and diagnostic agents.			

Training and Learning Results	
Code	
C40	Acquire knowledge about the variety of roles played by metal ions in Biology. Know the biomolecules that contain metal ions
C41	Evaluate health risk, and environmental and socioeconomic impact of chemical substances
D2	Capacity for teamwork
D4	Incorporate criteria of sustainability and environmental commitment into the professional exercise. Acquire skills in the equitable, responsible and efficient use of resources

Expected results from this subject	Training and Learning Results
Purchase knowledges on the variety of papers that exert the metallic ions in Biology.	C40
Know the *biomoléculas that contain metallic ions	C41
Evaluate the sanitary risks, the environmental and socioeconomic impact of the chemicals	
Capacity to work in team	D2
	D4
Incorporate in the professional exercise criteria of sustainability and environmental commitment.	
Purchase skills in the use *equitativo, responsible and efficient of the resources	

Contents	
Topic	
Essential elements and Metaloprotein	Concept and clasification
Bioinorganic chemistry of Zn	Biological Chemistry of Zn Homeostasis of Zn Metalloenzymes of Zn Metalloproteins in the genetic
Bioinorganic chemistry of iron	Biological Chemistry Homeostasis Metalloenzymes Metalloproteins
Bioinorganic Chemistry of copper.	Chemistry of the copper of biological interest Homeostasis of the copper Metalloproteínas of copper.
Bioinorganic chemistry of Cobaltous	Chemistry of the cobaltous with biological Cobalamin Metalloproteins with cobaltous
Bioinorganic Chemistry of manganese	Chemistry of the manganese with biological issues Homeostasis of the manganese Biological role of Mn
Metals and metallic compounds with application in medicine.	In therapy. In diagnostic. In theragnosis. Nanomedicine

Environment	Environment concepts. Study of the biogeochemistry cycles of CHONPS Polution. Evolution, transport and control of the polutants
Atmosphere	Physical properties. Chemical composition. Chemical reactions. Inorganic pollutants.
Hydrosphere	Chemical composition. Chemical reactions. Inorganic pollutants.
Lithosphere	Soil formation Chemical composition. Chemical reactions. Inorganic pollutants. Radioactiv contamination.
Practices of laboratory	4 sessions related to the subject

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	26	26	52
Seminars	6	18	24
Seminars	2	6	8
Debate	4	12	16
Laboratory practical	14	0	14
Objective questions exam	2	16	18
Essay questions exam	2	16	18

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

Methodologies

	Description
Lecturing	Exhibition by part of the professor of the contained of the subject object of study, theoretical bases and/or guidelines of one work, exercise or project to develop pole student
Seminars	Exercises related to the material covered in the lectures will be proposed, as well as the presentation and defense of a supervised project related to Bioinorganic Chemistry
Seminars	Questions about environment
Debate	Some scientific papers will be proposed and debated
Laboratory practical	Practices in the laboratory will be done, related with the contents of the subject.

Personalized assistance

Methodologies	**Description**
Lecturing	The professors will solve the doubts related with the subjects proposed either in face-to-face form or by email
Seminars	The professors will solve doubts or questions related with the subjects
Laboratory practical	The professor will solve the doubts related with the practices
Seminars	The professor will help with doubts or questions related with the subjects
Debate	The professor will help with doubts or questions related with the subjects
Tests	**Description**
Objective questions exam	The professors will solve the doubts in face-to-face form or by email
Essay questions exam	The professor will help with doubts or questions related with the subjects

Assessment

	Description	Qualification	Training and Learning	Results
Seminars	Resolution of problems or exercises proposed	20	C40	D2
Seminars	Questions about environmental Inorganic Chemistry	10	C40	D2
Debate	A presentation about a previously published paper on environmental Inorganic Chemistry	10	C40	D2
Laboratory practical	The work in the laboratory by the students will be evaluated	10	C40 C41	D2 D4
Objective questions exam	An examination about all the contents of the subject will be done	25	C40 C41	
Essay questions exam	An examination about the contents of the subject related with environmental Inorganic Chemistry	25		

Other comments on the Evaluation

In the first announcement, it will be necessary a minimum mark of 3.5 on 10 in each section of the evaluation that is to say, seminar, practicas of laboratory and presentation.In case of not surpassing this minimum, the final note of the subject

wil be the qualification of the of objective questions exam (50%)
In the second announcement, it will only be possible to take the of objective questions exam

Sources of information

Basic Bibliography

Spiro, Thomas G; Stigliani, William M., **Química medioambiental**, 2, Pearson, 2009

Manahan S.E., **Environmental Chemistry**, 10, CRC Press, 2017

Crichton, R., **Biological inorganic Chemistry A New Introduction to Molecular Structure and Function**, 3, Elsevier, 2019

Gibbs, W., **CONCEPTS AND APPLIED PRINCIPLES OF BIOINORGANIC CHEMISTRY: VOLUME III**, 2, ML Books International, 2015

Complementary Bibliography

Baird, C.; Cann M., **Química ambiental**, 2, Reverte, 2012

Grau Ríos, Mario ; Grau Sáenz, María, **Riesgos en la industria**, 1, UNED, 2006

Domenech, X, Peral, J.; Costa López, J.; Simarro Dorado, J., **Química ambiental de sistemas terrestres**, 1, Reverté, 2012

Kaim, W.; Schwederski, B.; Klein, A., **Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life. An Introduction and Guide**, 2, Wiley, 2013

Sigel, A.; Sigel, H.; Sigel, R.K.O., **The alcali Metal Ions: Their Role for Life**, 1, Springer, 2016

Dieguez, M.; Bäckvall, J-E.; Pàmies, O., **Artificial Metalloenzymes and MetalloDNAzymes in From Design to Applications.**, 1, Wiley, 2018

Kroneck, P.M.H.; Sosa torres, M.E., **Metals, Microbes, and Minerals: The Biogeochemical Side of Life**, 1, De gruyter, 2021

Sigel, A. Freisinger, E. Sigel, R.K.O., **Metals ions in bioimaging Techniques**, 1, De gruyter, 2021

Recommendations

Subjects that it is recommended to have taken before

Biochemistry/V11G201V01201
Inorganic chemistry I/V11G201V01204
Inorganic chemistry II/V11G201V01209
Inorganic Chemistry III: Coordination Chemistry/V11G201V01304
Inorganic Chemistry IV: Transition Metals and Solid State/V11G201V01309

Other comments

Knowledges of English

IDENTIFYING DATA				
Therapeutic Chemistry				
Subject	Therapeutic Chemistry			
Code	V11G201V01413			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	#EnglishFriendly			
Department				
Coordinator	Terán Moldes, María del Carmen			
Lecturers	Teijeira Bautista, Marta Terán Moldes, María del Carmen			
E-mail	mcteran@uvigo.es			
Web				
General description	It is an introductory course in therapeutic chemistry, in which as drugs work at molecular level and processes involved in their in vivo effects will be studied. Drug discovery and design strategies, as well as stages prior to their commercialization will also be discussed. English Friendly subject. International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B3	Ability to manage information
B4	Ability for analysis and synthesis
C43	Know the chemical compounds with therapeutic application
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject	Training and Learning Results			
Familiarize yourself with fundamental concepts of Therapeutic Chemistry	A4	B4		D3
Know the different types of pharmacological targets	A4	B3 B4		D3
Understand and be able to predict drug-target interactions	A3	B3	C43	D3
Know the different types of receptors and understand the signal transduction mechanisms.	A3 A4	B3 B4		D3
Differentiate a chemoterapeutic from a pharmacodynamic agent	A4	B4	C43	D3
Differentiate an agonist drug from an antagonist and from an inverse agonist	A4	B4	C43	D3
Relate the physicochemical properties of drugs with their pharmacokinetics.	A3	B3	C43	D3
Understand and be able to predict metabolic transformations	A3	B3	C43	D3
Know the different stages of drug development	A4	B3	C43	D3
Know and understand the strategies involved in discovering and optimizing leads	A4	B4	C43	D3
Know and understand the computational techniques of molecular modeling: docking strategies, QSAR and pharmacophore design	A4	B3	C43	D3

Contents	
Topic	
Subject 1. General aspects of Therapeutic Chemistry	1.1. Concept and objectives of Therapeutic Chemistry. 1.2. Drug nomenclature systems. 1.3. Drug classification systems.
Subject 2. Drug targets: proteins	2.1. Types of drug targets and location in cell. 2.2. Drug-target interactions. 2.3. Transport proteins as drug targets. 2.4. Structural proteins as drug targets.

Subject 3. Drug targets: enzymes	3.1. Enzyme inhibition mechanisms. 3.2. Design of enzyme inhibitors and types of enzyme inhibitors with therapeutic application. 3.3. Isoenzymes as drug targets. 3.4. Measurement and expression of enzyme inhibition.
Subject 4. Receptors	4.1. Stucture and function of receptors. 4.2. Receptor types and signal transduction mechanisms. 4.3. Agonist, antagonist and inverse agonist drugs. 4.4. Measurement and expression of pharmacological effect.
Subject 5. Drug targets: nucleic acids and other biomolecules	5.1. Nucleic acids as drug targets 5.2. Lipids and carbohydrates as drug targets
Subject 5. Nucleic acids and other biomolecules as drug targets	5.1. Mechanisms of interaction between drugs and nucleic acids. 5.2. Lipids and carbohydrates as drug targets.
Subject 6. Pharmacokinetics and related topics	6.1. Absortion and distribution: mechanisms of transport across biological membranes. 6.2. Drug administration ways. 6.3. Drug metabolism. 6.4. Drug excretion.
Subject 7. Drug discovery and development	7.1. The process of obtaining and getting new drugs to the market. 7.2. Lead discovery and optimization strategies.
Subject 8. Rational drug design	8.1. Biochemical based drug design approaches. 8.2. Computational aided drug design: docking and QSAR strategies, pharmacophore based drug design approach.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	48	72
Seminars	12	18	30
Laboratory practical	14	14	28
Objective questions exam	0	6	6
Essay questions exam	2	12	14

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

Methodologies

	Description
Lecturing	In these sessions the professor will present in a structured form the general contents of the program, doing emphasis in important or difficult aspects of the subject. In addition, the professor, in advance and through the Moovi platform, will make available to the student the material that will be used in these sessions. In order to better understand the content explanations, students should previously check and complete this material by using the recommended literature.
Seminars	They will devote time to discuss the most complicated aspects of the treated subjects by solving exercises and questions, using molecular modeling programs, as well as presenting review works related with the content of the subject.
Laboratory practical	Laboratory practices will be developed in 4 sessions of 3.5 h each. one session will consist of visiting a pharmaceutical company to learn about their facilities and products. Three sessions will be devoted to the synthesis and study of different peptidomimetics.

Personalized assistance

Methodologies	Description
Lecturing	The teachers will be available to have tutoring sessions with the students, which will be arranged in advance. In the tutoring sessions, either in person or online, such as email or the virtual campus, all queries related to the study of the contents of the subject will be answered.
Seminars	The teachers will be available to have tutoring sessions with the students, which will be arranged in advance. In the tutoring sessions, either in person or online, such as email or the virtual campus, all queries related to the study of the contents of the subject will be answered.
Laboratory practical	The teachers will be available to have tutoring sessions with the students, which will be arranged in advance. In the tutoring sessions, either in person or online, such as email or the virtual campus, all queries related to the study of the contents of the subject will be answered.
Tests	**Description**

Objective questions exam	The teachers will be available to have tutoring sessions with the students, which will be arranged in advance. In the tutoring sessions, either in person or online, such as email or the virtual campus, all queries related to the study of the contents of the subject will be answered.
Essay questions exam	The teachers will be available to have tutoring sessions with the students, which will be arranged in advance. In the tutoring sessions, either in person or online, such as email or the virtual campus, all queries related to the study of the contents of the subject will be answered.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	The participation and resolution of all the tasks proposed by the teacher for the seminar classes will be qualified.	25	A3 B3 C43 D3 A4 B4
Laboratory practical	Attendance at the laboratory practical sessions will be mandatory. The laboratory work will be evaluated with a APT or NO APT. For this evaluation, compliance with the safety regulations related to the handling of chemical substances and waste removal, planning and development of proposed experiments, analysis of results and the laboratory notebook quality will be taken into account. The evaluation will be done through the systematic observation of student work. The mark of the laboratory practices will be obtained from the resolution of the tasks and works proposed by the teachers in relation to the experiments performed and the visit to the industry. To pass the subject it is essential to obtain APT at work from laboratory.	15	A3 B4 C43 D3
Objective questions exam	A short exam (one hour long) will be carried out at week eight. In this exam will enter the subject explained until that moment.	20	A3 B3 C43 A4 B4
Essay questions exam	A global exam will be carried on closing date of evaluation in order to analyze the adquired competencies.	40	A3 B3 C43 A4 B4

Other comments on the Evaluation

Participation of students in any of the evaluation parts will involve the condition of presented and therefore the obtaining of a qualification.The presentation of some work in seminars, the attendance to laboratory practical (two or more sessions) or the performace of some written exams will be consiedered evaluation acts.
Students should have a minimum mark in some of the evaluation parts in order to pass the subject (5 or more points). This minimum mark should be of 4 points over 10 in the global exam, as well as in seminars and laboratory practicals.
If the required minimums are not obtained, the final mark will be the weighted mark of the highest-scoring failed part (seminars, laboratory practicats or global exam).

Evaluation in the July Call
The mark achieved in seminars and laboratory practical will be manteined (maximun 40%).A written global exam about all theoretical contents of the subject will be performed (60%).In order to pass the subject (global score equal to or greater than 5) in this call, students must achieve a minimum mark of 5 points out of 10 in the written exam.
Students of subsequent enrollment
Those students who were previouly evaluated as APT will be awarded the APT mention for the monitoring of the laboratory practical, not being necessary the completion of the experimental work again. However, they must perform the tasks or works proposed by the teachers in relation to the laboratory practices in order to achieve the mark for the Laboratory practical (15%).
Non-continuous evaluation option
Students who do not wish to opt for continuous assessment must request it from the subject coordinator. This request will be made during the first three weeks of the course.To pass the subject they will have to do the work of laboratory, obtain the APT qualification, and perform a global test in which all the subject contents will be evaluated, including the laboratory practical. The minimun mark of this exam must be 5 points over 10.

Sources of information

Basic Bibliography

G. L. Patrick, **An introduction to Medicinal Chemistry**, 7th, Oxford University Press, 2023

N. K. Dunlap, **Medicinal Chemistry**, 1st, Garland Science, 2018

C. Rostron, **Drug Design and Development**, Oxford University Press, 2020

A. Delgado, C. Minguillón, J. Juglar, **Introducción a la Química Terapéutica**, 2ª, Diaz de Santos, 2003

E. Stevens, **Medicinal Chemistry: The Modern Drug Discovery Process**, 1st, Pearson Advanced Chemistry, 2013

Complementary Bibliography

C. Avendaño, **Introducción a la Química Farmacéutica**,

C. G. Wermuth, D. Aldous, P. Raboisson, D. Rogman, **The practice of Medicinal Chemistry**, 4th, Elsevier, 2015

J. M. Beale Jr, J. H. Block, **Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry**, 12th, Wolters Kluwer, 2011

Recommendations

Subjects that it is recommended to have taken before

Biology: Biology/V11G201V01101
Biochemistry/V11G201V01201
Organic chemistry I/V11G201V01205
Organic chemistry II/V11G201V01210
Organic Chemistry III: Concerted, Radical and Photochemical Reactions/V11G201V01305
Organic Chemistry IV: Design of Organic Synthesis/V11G201V01310
Stereoselective Synthesis of Bioactive Compounds/V11G201V01405

IDENTIFYING DATA				
Computing Techniques for Chemistry				
Subject	Computing Techniques for Chemistry			
Code	V11G201V01415			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Otero Martínez, Nicolás			
Lecturers				
E-mail				
Web	http://moovi.uvigo.gal/			
General description	The subject "Computational Techniques in Chemistry" aims to introduce students to the use of advanced computer tools, based on free software, beyond office automation packages already used during the previous courses of the degree, thus expanding skills for work and/or or research. The subject is divided into four blocks in which the general aspects of the GNU/Linux operating system and how to install it, creation of documents in LaTeX with chemical applications, Fortran and Python will be considered. The students will be taught combining small theoretical sessions together with practical examples that the students will verify in situ, and always supervised by the professors responsible for the subject. The evaluation will consist of carrying out some written tasks (programs and documents in LaTeX) with a weight of 50% together with the preparation of reports explaining how the aforementioned tasks have been implemented (with a weight of 30%) and systematic observation of the work done during the practical sessions in a presentation at the end of the course (20%). There will also be the possibility of not using continuous evaluation with a written exam whose weight will be 100% if requested. English Friendly subject: International students may request from the teachers: a) resources and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B3	Ability to manage information
C37	Acquire basic knowledge of programming and be able to use appropriate computer packages to solve problems of chemical interest
D1	Ability to solve problems

Expected results from this subject	Training and Learning Results			
Python/Fortran program creation		B1 B2	C37	D1
Utilization of a distribution of the GNU/Linux operative system	A1 A5			
Preparation of presentations and/or text documents with *LaTeX		B2 B3	C37	

Contents
Topic

GNU/Linux operative system	- Installation of a distribution. - Graphic environment. - Introduction to the command line. - Installation of programs. - Installation and configuration of an integrated development environment.
Introduction to LaTeX	- Structure of the documents. - Common elements of all types of documents or classes. - Tools for technical texts. - Presentations (Beamer). - Applications for chemicals.
Python 3	- Structure of the source code of the programs and fundamentals of Python. - Variables and strings. - Type of data. - Syntax and basic commands. - Programming some practical examples.
Modern Fortran	- Structure of the source code of the programs and fundamentals of Fortran. - Variables and arrays. - Syntax and basic commands. - Programming some practical examples.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	12	12	24
Problem solving	12	27	39
Practices through ICT	14	28	42
Autonomous problem solving	12	27	39
Essay	2	4	6

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

Methodologies

	Description
Lecturing	Theoretical classes given through an on-screen presentation (available to students on the Moovi platform). In these classes the basic contents will be introduced, emphasizing the most important and difficult issues. Practical examples will be shown.
Problem solving	Aimed at solving problems and/or tasks and discussing them. The necessary material will be provided through the Moovi platform.
Practices through ICT	Application from what is discussed in the lecture and in the problem solving sessions to more general, but related, cases to the subject. Through the Moovi platform, the practice scripts and the work rules in the laboratory will be provided.
Autonomous problem solving	(*)Destinados á resolución de tarifas que integren os contados dados e exerciten as competencias a adquirir. A través da plataforma Moovi proporcionarase o material necesario.

Personalized assistance

Methodologies	Description
Lecturing	The student needing help will have the possibility of attend to "special tutorial sessions to solve doubts, mainly following the schedules indicated previously. To optimize the time, it is convenient that the student contacts with the professor with previously enough.
Practices through ICT	The student needing help will have the possibility of attend to "special tutorial sessions to solve doubts, mainly following the schedules indicated previously. To optimize the time, it is convenient that the student contacts with the professor with previously enough.
Problem solving	The student needing help will have the possibility of attend to "special tutorial sessions to solve doubts, mainly following the schedules indicated previously. To optimize the time, it is convenient that the student contacts with the professor with previously enough.
Autonomous problem solving	

Assessment

	Description	Qualification	Training and Learning Results
Problem solving	The students will give all the written work made in the session, such as creation of documents in LaTeX and Fortran/Python source code.	20	B1 C37 D1 B2

Practices through ICT	The students will give all the written work made in the session, such as creation of documents in LaTeX and Fortran/Python source code.	30	A1 A5	B1 B3	C37	D1
Autonomous problem solving	(*)Presentación da resolución de tarefas complexas que integren o coñecementos e competencias da materia.	30	A1	B1	C37	D1
Essay	The students will present the results of their practices made using LaTeX and explaining the design of his applications of Fortran/Python.	20	A1 A5	B1 B2 B3	C37	D1

Other comments on the Evaluation

Sources of information

Basic Bibliography

Jay LaCroix, **Learn Linux TV**, Youtube, 2022

Complementary Bibliography

Jay LaCroix, **Mastering Ubuntu Server : explore the versatile, powerful Linux Server distribution Ubuntu 22.04 with this comprehensive guide**, 4, Packt Publishing Limited, 2022

Richard Blum, Christine Bresnahan, **Linux command line and shell scripting bible**, 3, John Wiley & Sons, 2015

Collaboratively writing open-content textbook, **LaTeX**, https://en.m.wikibooks.org/wiki/LaTeX, 2022

J. Mulero, J.M. Sepulcre, **LATEX con palabras clave**, Publicacions de la Universitat d'Alacant, 2016

Collaboratively writing open-content textbook, **Python Programming**, https://en.m.wikibooks.org/wiki/Python_Programming,

Python 3 Tutorial, https://www.tutorialspoint.com/python3/,

Alberto Cuevas Álvarez, **Python 3**, RA-MA Editorial, 2016

David Beazley, Brian K. Jones, **Python Cookbook**, 3, O'Reilly, 2013

Fortran Tutorial, https://www.tutorialspoint.com/fortran/index.htm,

Collaboratively writing open-content textbook, **Fortran**, https://en.m.wikibooks.org/wiki/Fortran,

Michael Metcalf, John Reid, Malcolm Cohen, **Modern Fortran Explained (Numerical Mathematics and Scientific Computation)**, 4, Oxford University Press, 2011

William H. Press, Brian P. Flannery, Saul A. Teukolsky, William T. Vetterling, **Numerical Recipes in Fortran 77: The Art of Scientific Computing**, 2, University Press, 1992-1996

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109

IDENTIFYING DATA

Theory of Organic Reactions

Subject	Theory of Organic Reactions			
Code	V11G201V01417			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	Spanish			
Department				
Coordinator	Vaz Araújo, Belén			
Lecturers	Vaz Araújo, Belén			
E-mail	belenvaz@uvigo.es			
Web				
General description	This subject aims to deepen the knowledge of all aspects related to reactivity in Organic Chemistry and reaction mechanisms. Emphasis will be placed on factors affecting the stabilities of reaction intermediates, chemoselectivity and stereoselectivity. This knowledge will allow students to predict and justify chemical behaviors. English Friendly Program: Foreign students may request from the teaching staff: a) material and bibliographical references in English for the follow-up of the subject; b) attend tutorials in English; c) assessment tests in English.			

Training and Learning Results

Code	
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B5	Ability to adapt to new situations and to make decisions
C44	Know the main methods for the study of organic reactions mechanisms
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English

Expected results from this subject

Expected results from this subject	Training and Learning Results			
Understanding the principles and theories related to the main types of chemical reactions and their characteristics.	A4 A5	B5	C44	D3
Knowing the methods of studying the mechanism of an organic reaction.	A4 A5	B5	C44	D3
Knowing the methods to study and propose reaction intermediates.	A4 A5	B5	C44	D3
Rigorously apply the corresponding safety and healthy standards in the laboratory, as well as the proper treatment of the waste generated		B5	C44	D2 D3
Collect data and write in the laboratory notebook, in a clear, concise and rigorous way, the experiments carried out and the conclusions drawn.	A4 A5	B5		D2 D3

Contents

Topic	
1. Thermodynamics and Kinetics of Organic Reactions	Thermodynamic stability. Chemical kinetics. Coordinate diagrams of reaction. Transition state theory. Arrhenius equation. Reaction rate expressions. Kinetic control and thermodynamic control. Hammond's postulate. Curtin□Hammett principle.
2. Methods for the study of Organic Reactions	Applications of chemical kinetics to the study of the mechanisms of reaction. Kinetic isotope effects. Effect of substituents. Hammett correlations.
3. Acid and base catalysis of organic reactions	Acidity and basicity in organic compounds. Specific acid catalysis. General acid catalysis. Basic catalysis.
4. Frontier Orbitals	Fukui postulate. Klopman-Salem Equation.
5. Reaction Intermediates	Radicals. Carbenes. Carbocations. Carbanions. Structure and stability of these intermediates, generation and reactivity. Reaction intermediates detection. Stereochemistry and reaction mechanisms.

Practice 1	Effect of sterics and electronics on the aldol condensation reaction. Hammett correlation.
Practice 2	Study of the primary isotope effect in the oxidation of 1-phenylethanol

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	36	60
Seminars	11	24	35
Laboratory practical	14	14	28
Problem and/or exercise solving	1	8	9
Presentation	1	4	5
Problem and/or exercise solving	1	12	13

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

Methodologies	
	Description
Lecturing	The subject material will be previously provided through the Moovi platform. The teaching staff will present the contents of the subject in a structured manner. Possible doubts arising at the time of the presentation may be clarified during these presentations.
Seminars	The concepts introduced in the master sessions will be worked on through problems and questions formulated by the teaching staff. In addition, the students will work on the concepts learned in class and will solve problems and additional exercises that will be evaluated.
Laboratory practical	The laboratory work will be developed in 4 sessions of 3.5 hours. Students will have to prepare a laboratory notebook with the experiments carried out, where the conclusions derived from the experimental work will also be collected. Additionally, students will answer a series of questions about the work done in the laboratory.

Personalized assistance	
Methodologies	**Description**
Lecturing	The teacher will clarify the doubts and questions that arise during the exposition of the topics, related to the subject.
Seminars	The teaching staff will explain and resolve the questions raised by the students in relation to the exercises and problems solved in the seminar sessions.
Laboratory practical	The teaching staff will supervise and guide the development of the experiments proposed in the lab sessions. In addition, special attention will be paid to compliance with safety and healthy measures in the laboratory.
Tests	**Description**
Problem and/or exercise solving	Before each evaluation test (short tests and final exam) the teaching staff will dedicate the necessary time to answer the students' questions related to the subject.
Presentation	The teacher will supervise and guide the development of the work for its subsequent presentation in a seminar session.
Problem and/or exercise solving	

Assessment					
	Description	Qualification	Training and Learning Results		
Seminars	As part of the continuous evaluation, the participation and the resolution of the exercises proposed by the teaching staff in the classroom will be evaluated. The resolution of exercises and additional problems will also be evaluated, similar to those resolved during the seminar sessions, and which will be proposed through the Moovi platform.	20	A4 A5	C44	D3

Laboratory practical	1. It is mandatory to carry out the laboratory practices, as well as to follow the healthy and safety standards in the laboratory and the collection of residues to obtain the PASS condition. 2. In addition, it will be evaluated (20%): - the laboratory notebook - the resolution of the questions raised in relation to the practices carried out. 3. In order for students to pass the subject, they must obtain the PASS mark in the laboratory practice work.	20	A5	B5	C44	D2 D3
Problem and/or exercise solving	Two tests will be carried out: The first test on the contents of the first topics, which will mean 20% of the final grade. A minimum grade of 2.5 points out of 10.0 in this test will be required to pass the subject. In the event that the minimum required in any of the tests (first or second) is not exceeded, the final grade obtained in the subject will be the weighted grade of the global evaluation test.	20	A4 A5	B5	C44	D3
Presentation	The students will analyze and explain the research results collected in a recent research article related to the subject of the course in a seminar session. The ability to synthesize and understand the work presented will be valued, as well as the questions that are asked about the other works of the students.	10	A4 A5	B5	C44	D3
Problem and/or exercise solving	Two tests will be carried out: The second test on ALL THE CONTENTS OF THE SUBJECT, which will mean 30% of the final grade. A minimum grade of 4.0 points out of 10.0 in this test will be required to pass the subject. In the event that the minimum required in any of the previous tests is not exceeded, the final grade obtained in the subject will be the weighted grade of the global evaluation test.	30	A4 A5	B5	C44	D3

Other comments on the Evaluation

MINIMUM REQUIREMENTS: The identification of serious conceptual errors will lead to an assignment of specific activities aimed at acquiring those skills. These activities will be evaluated as part of the 20% corresponding to deliverables.

CONDITION OF PRESENTED: The participation of the student in any of the acts of evaluation of the subject will imply the condition of presented and, therefore, the assignment of a grade. Attendance at practical laboratory classes, handing in assignments and/or exercises proposed by the teaching staff, or taking a test will be considered acts of evaluation.

EVALUATION IN JULY: the grade obtained by the students during the course in problem solving, laboratory practices and assignments will be maintained. A test will be carried out on all the theoretical contents of the subject that will account for 50% of the final grade and that will replace the marks of the written tests. It will be necessary to achieve a minimum of 4 points out of 10 in this test to pass the subject and to take into account the rest of the evaluation elements. In case of having a grade of PASS in the laboratory work and having obtained a grade lower than 5 out of 10 in the evaluation of the practices, a written test of the experimental part will be done, which will mean 20% of the final grade.

STUDENTS OF 2nd AND LATER REGISTRATION: Students who have been evaluated with PASS in the laboratory work in a previous course, will be awarded the mention of PASS in the follow-up of the laboratory work in the current academic year, not being necessary to carry out the experiments again. However, a written test of the experimental part must be taken to obtain the qualification corresponding to the experimental part of the subject in the current academic year.

NON-CONTINUOUS ASSESSMENT OPTION: Students who wish not to opt for continuous assessment must request it during the first three weeks of the course from the subject coordinator. To pass the subject, you must complete the Laboratory Practices, obtain a grade of PASS in the work developed in the laboratory and a grade equal to or greater than 5 points out of 10 in the evaluation of the laboratory notebook and the questions related to the practices made. In addition, you must obtain at least 5 points out of 10 in a test in which all the contents of the subject will be evaluated. In this case, the final mark will be a maximum of 2 points for laboratory practices and a maximum of 8 points for the written test.

Sources of information

Basic Bibliography

J. Clayden, N. Greeves, S. Warren., **Organic Chemistry**, Oxford University Press, 2012

Complementary Bibliography

Felix A. Carroll., **Perspectives on Structure and Mechanism in Organic Chemistry**, Wiley, 2010

Francis A. Carey, Richard J. Sundberg, **Advanced Organic Chemistry : Part A: Structure and Mechanisms**, Springer, 2007

Recommendations

Subjects that it is recommended to have taken before

Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Organic chemistry I/V11G201V01205
Organic chemistry II/V11G201V01210
Physical Chemistry V: Chemical Kinetics/V11G201V01308
Organic Chemistry III: Concerted, Radical and Photochemical Reactions/V11G201V01305
Organic Chemistry IV: Design of Organic Synthesis/V11G201V01310

IDENTIFYING DATA				
Immunochemistry				
Subject	Immunochemistry			
Code	V11G201V01419			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Simón Vázquez, Rosana			
Lecturers				
E-mail				
Web	http://https://www.uvigo.gal/es/universidad/administracion-personal/pdi/rosana-simon-vazquez			
General description	The subject of *Inmunoquímica has like aim contribute a basic knowledge on the operation of the immune system, and deepen in the use of his components for the development of technicians of *inmunodetección. Between his components stand out the antibodies, some skilled proteins in recognising numerous types of different molecules, so much of biological origin as of synthetic origin. The antibodies allow to develop diverse technicians of analysis, diagnostic and therapy by means of his union to other molecules like enzymes, particles or drugs, or even of free form. His extraordinary capacity of detection is used in fields very diverse (medicine, chemical and pharmaceutical industry, agriculture, marine field, etc.). In this subject will review also the chemistry of the components of the immune system, with the aim to know the extraordinary capacities of this system to protect us in front of pathogens, or in front of other illnesses like the cancer.			

Training and Learning Results	
Code	
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
B2	Organization and planning capacity
B4	Ability for analysis and synthesis
C49	Acquire sufficient knowledge, skills and abilities for the practice of immunochemistry in different fields
D1	Ability to solve problems
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English
D5	Ability to develop their professional activity based on respect for fundamental rights and equal opportunities, within the framework of professional ethics and ethical commitment

Expected results from this subject	Training and Learning Results			
Identify the cellular and molecular components involved in immune responses.	A3	B2	C49	D1
Understand the diversity of immune system receptors.	A4	B4		D3
Identify the interactions between immune system receptors and their ligands and understand their complexity.				D5
Understand the different methodologies for obtaining antibodies for subsequent use in the laboratory and/or therapy.				
Understand and manage concepts, terminology, and scientific instrumentation.				
Understand the theoretical and technical aspects of various immunochemical assays.				
Develop a procedure to carry out an immunochemical technique in the laboratory.				
Apply knowledge and technology related to Immunochemistry in aspects related to the production, analysis, and diagnosis of biological and/or chemical processes and resources.				
Apply Immunochemistry knowledge to isolate, identify, handle, and analyze specimens and samples of biological and/or chemical origin, as well as to characterize their constituents.				
Communicate a critical analysis of a scientific work in writing and orally regarding the application of immunochemical techniques in different fields.				

Contents
Topic

Subject 1. Historical introduction. Principles of Immunochemistry.	1.1. Discovery and identification of molecular components such as antibodies, receptors and antigen. 1.2. Development of techniques such as agglutination/precipitation, neutralization, lysis by the complement system, which allowed the characterization and understanding of the immunological reaction. 1.3. The relevance of transplants and allergy for the development of Immunology.
Subject 2. Components of the immune system. Basic concepts.	2.1. Membrane receptors and soluble molecules. 2.2. Cells.
Subject 3. Introduction to Cellular Immunology	3.1. Main cells of the immune system and their function. 3.2. Phenotype and cellular differentiation. 3.3. The clusters of differentiation (CDs) as markers of cellular populations.
Subject 4. Basic concepts of Immunochemistry and Immunogenetics	4.1. Antibodies. 4.2. Receptors involved in the immune response. 4.3. Concept of antigen, hapten and immunogen. 4.4. Antibody-antigen and TCR-peptide-MHC interaction. 4.5. Principles of the genetic diversity of receptors.
Subject 5. Immunoassay concepts	5.1. Obtaining of antibodies in the laboratory. 5.2. Purification and scaling techniques. 5.3. Chemical modification of antibodies.
Subject 6. Immunochemistry tecniques	6.1. Homogeneous techniques. Precipitation Agglutination Complement. Quantification of components 6.1. Heterogeneous techniques. Principles of colorimetry, fluorescence, chemiluminescence and radioactivity. Visualization techniques: optics, fluorescence, electronic, confocal ELISA: direct, indirect, competitive , sandwich EIA, RIA Western Blot and Dot Blot Immunoprecipitation Immunofluorescence Enzymatic techniques: Immunohistochemistry / Immunocytochemistry
Subject 7. Immunoassays in the pharmaceutical industry	7.1. Importance in the development of medicines and clinical aspects.
Laboratory practices	1) Agglutination technique 2) Antigen-antibody conjugation 3) ELISA 4) Dot Blot 5) Cell separation by density gradient centrifugation

Planning			
	Class hours	Hours outside the classroom	Total hours
Lecturing	24	46	70
Seminars	12	10	22
Laboratory practical	14	4	18
Objective questions exam	2	25	27
Laboratory practice	0	5	5
Problem and/or exercise solving	0	8	8
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Lecturing	The professor will present the basic foundations and principles of Immunochemistry. The aim of the theoretical classes is for the student to acquire a basic understanding of the fundamental principles of Immunology and their possible application in analysis, diagnosis, and therapy.
Seminars	The seminars will consist of exercises, debates, or tasks that reinforce the knowledge acquired during the lectures. Additionally, practical cases and problems will be included for students to test their knowledge.
Laboratory practical	The laboratory work is aimed at achieving competence and application in immunochemical techniques.

Personalized assistance

Methodologies	Description
Lecturing	The master sessions will be participatory. Personalized attention will be provided by the teachers responsible for each topic in the corresponding weekly tutoring hours.
Seminars	The seminars will be participatory. The responsible professor will be available to solve doubts related with the exercises or any theoretical or practical content.
Laboratory practical	The responsible professors will provide personalised supervision to each student during laboratory practicals and will give the necessary support for the understanding of the aims, methodology, techniques and interpretation of results.

Assessment

	Description	Qualification	Training and Learning Results
Objective questions exam	A FINAL WRITTEN EXAM will be conducted, accounting for 40% of the final grade for the course. In this mandatory exam, the fundamental contents of the course (lectures, laboratory practicals, and seminars) will be evaluated through OBJECTIVE QUESTIONS (multiple choice and/or short answer).	40	A3 B2 C49 D1 A4 B4 D3 D5
Laboratory practice	The skills and competencies acquired during the laboratory practicals will be CONTINUOUSLY ASSESSED through the presentation of reports, multiple-choice and short-answer questions, or problem-solving. The evaluation of the practicals will account for 30% of the final grade.	30	A3 B2 C49 D1 A4 B4 D3 D5
Problem and/or exercise solving	The work and participation in the seminars will be CONTINUOUSLY ASSESSED, as well as the student's ability to solve problems and exercises. This part will account for 30% of the final grade.	30	

Other comments on the Evaluation

Attendance at all in-person activities is MANDATORYto PASS the course (except for duly justified absences). To pass the course, atleast a 5 out of 10 must be obtained on the final written exam. If the finalwritten exam is not passed, the student's grade will be the one obtained in thefinal written exam. Non-attendance at the final written exam will be consideredas not attended. In subsequent sessions, the failed student will only need totake the Final Exam, with the grade obtained in the Continuous Assessment(Laboratory practicals and Seminars) being retained.

ATTENDANCE AT PRACTICALS AND ASSESSMENT:

An attendance of less than 75% of the practicalsessions, even if justified, will result in a failing grade for the course. Inthat case, students would have to undergo a single exam to pass the course, inthe form of a written test consisting of two parts:

-70% theoretical part.

-30% practical part.

To pass the course, at least a 5 out of 10 must beobtained on the single exam. The final grade, in this case, will be 70% of thegrade of the single exam and 30% of the grade of the seminars.

Sources of information

Basic Bibliography

Complementary Bibliography

Wild D., **The Immunoassay Handbook. Theory and applications of ligand binding, ELISA and related techniques.**, 4ª, Elsevier, 2013

Carlberg C., Velleuer E., **Molecular Immunology: How Science Works**, 1ª, Springer, 2022

Álvarez Vallina, L, **Anticuerpos Monoclonales. Realidades y perspectivas**, Editorial Complutense S.A, 2004

Álvarez-Vallina L., González-Fernández A., Magadán Mompó S. et al., **Immunotechnology and its applications**, Ediuno, 2022

Greenfield E. A., **Antibodies: A Laboratory Manual**, Cold Spring Harbor Laboratory Press, 2014

Campos Ferrer A., Muñoz Ruiz C., Rubio Pedraza G., **Manual de Prácticas de Inmunología**, Masson, 2004

Recommendations

Subjects that it is recommended to have taken before

Biology: Biology/V11G201V01101
Biochemistry/V11G201V01201

IDENTIFYING DATA				
Internships				
Subject	Internships			
Code	V11G201V01981			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Lavilla Beltrán, María Isela Peña Gallego, María de los Ángeles			
Lecturers	Lavilla Beltrán, María Isela			
E-mail	isela@uvigo.es mpena@uvigo.es			
Web	http://quimica.uvigo.es/index.php/practicas-en-empresas.html			
General description	The aim of this matter is that the students carry out a stay in a company with the end to make tasks related with the professional field of the Chemistry. By means of the realisation of internships periods in companies the students will be able to apply the knowledges and competitions adquired during his studies, to complement and reinforce his training and to facilitate his incorporation to the labour market.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B5	Ability to adapt to new situations and to make decisions
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English
D4	Incorporate criteria of sustainability and environmental commitment into the professional exercise. Acquire skills in the equitable, responsible and efficient use of resources
D5	Ability to develop their professional activity based on respect for fundamental rights and equal opportunities, within the framework of professional ethics and ethical commitment
D6	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and professional practice with the aim of achieving a more just and equal society

Expected results from this subject	Training and Learning Results		
Perform tasks to test the critical and reflexive capacity.	A1 A3 A4 A5	B1 B2 B5	D2 D3 D4 D5 D6
Take decisions and put in practice the capacity of analysis and synthesis in the resolution of practical problems.	A1 A3 A4 A5	B1 B2 B5	D2 D3 D4 D5 D6

Contents
Topic
The students will integrate in the company organization and will coordinate with the members of the work group assigned.

The students will make activities related to the exert of the profession and with the knowledges and the competences of his studies.
The activities made by the students will be supervised and evaluated by the academic tutor and the company tutor.

Planning			
	Class hours	Hours outside the classroom	Total hours
Practicum, External practices and clinical practices	0	120	120
Report of practices, practicum and external practices	0	30	30
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Practicum, External practices and clinical practices	Students develop activities in a context related to the exercise of a profession, during a certain period, performing the functions assigned and foreseen in the internship proposal.

Personalized assistance	
Methodologies	**Description**
Practicum, External practices and clinical practices	The subject coordinator will resolve any doubts on a personalised basis
Tests	**Description**
Report of practices, practicum and external practices	The academic tutor will resolve any queries on a personalised basis

Assessment			
	Description	Qualification	Training and Learning Results
Practicum, External practices and clinical practices	The qualification will take into account the performance evaluation of the student made by the company tutor and the monitoring made by the academic tutor.	80	
Report of practices, practicum and external practices	When concluding the practices, the students will have to deliver to his academic tutor a final memory to be evaluated.	20	

Other comments on the Evaluation

* This matter will be ruled by the established in the Normative of External Practices of the Degree in Chemistry.

* The academic tutor will make the global evaluation of the external practices (**Annex V**) considering:

(70%) The report made by the company tutor (**Annex IV**) in which it will value elements related with the practices made by the student as punctuality, assistance, responsibility, capacity of work in groups and integration in the company, quality of the work made, etc.

(20%) The memory that students must elaborated at the conclusion of the internship period in which they will have to appear, among others, a concrete and detailed description of the tasks performed and the departments within the company to which the student was assigned, a relation of the problems proposed and the procedure followed for his resolution, the level of integration inside the company and the relations with the personnel and a critical reflection about the education received during the degree studies and its adequation for the realization of external practices. The memory will have a minimum extension of 10 and a maximum of 20 pages of A4 size, including cover, index and annexes. Mminimum margins of 2 cm, size of letter of 12 points, simple leading and paragraph justification are recommended. Tables and figures will appear numbered consecutively along the text and must include a brief heading to describe its content.

(10%) The assessment of the academic tutor (**Annex V**) of the aptitude and attitude showed by the student during the development of the activities made.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations

IDENTIFYING DATA				
Final Year Dissertation				
Subject	Final Year Dissertation			
Code	V11G201V01991			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	18	Mandatory	4th	2nd
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	Peña Gallego, María de los Ángeles			
Lecturers				
E-mail				
Web	http://quimica.uvigo.es/traballo-fin-de-grao.html			
General description	According to the memory of the Degree in Chemistry of the University of Vigo, the End of Degree project is a mandatory subject of 18 credits ECTS in the second term of the fourth course. The objective of the subject is to offer the students the opportunity to apply the knowledges, skills and competences adquired during the Degree studies. The TFG is an original work that each student will do individually under the supervision of one or two tutors. TFG subjects can correspond to experimental and/or theoretical works and/or of bibliographic reviews on subjects related with the contains in the Degree in Chemistry. The final stage of the TFG will consist in a written report and its public presentation. English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A2	Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
A5	Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
B1	Ability for auronomous learning
B2	Organization and planning capacity
B3	Ability to manage information
B4	Ability for analysis and synthesis
B5	Ability to adapt to new situations and to make decisions
C1	Ability to know and understand essential facts, concepts, principles and theories related to Chemistry
C2	Use correctly chemical terminology, nomenclature, conversions and units
C3	Recognize and analyze chemical, qualitative and quantitative problems, proposing strategies to solve them through the evaluation, interpretation and synthesis of data and chemical information
C4	Use computer tools properly to obtain information, process data, perform computational calculations and calculate matter properties
C5	Present material and scientific arguments in oral and written form to a specialized audience
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C7	Distinguish the main types of chemical reactions and their characteristics
C8	Know the characteristic properties of the elements and their compounds, including the relations between groups and their variations in the periodic table
C9	Know the structural aspects of chemical elements and their compounds, including stereochemistry
C10	Know the characteristics of the different states of matter and the theories used to describe them
C11	Know the principles of Thermodynamics and its applications in Chemistry
C12	Know the kinetics of chemical change, including catalysis and reaction mechanisms
C13	Know the principles and applications of electrochemistry
C14	To know the principles of quantum mechanics and its application in the description of the structure and properties of atoms and molecules

C15	Know the main techniques of structural research, including spectroscopy
C16	Know the relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids, crystals and other materials
C17	Know the nature and behavior of functional groups in organic molecules
C18	Know the properties of aliphatic, aromatic, heterocyclic and organometallic compounds
C19	Know the main synthesic routes in organic chemistry, including the interconversions of functional groups and the formation of carbon-carbon and carbon-heteroatom bonds
C20	Know the structure and reactivity of the main classes of biomolecules and the chemistry of important biological processes
C21	Know mathematical concepts based on previous ones and be able to use them in the different contexts of Chemistry
C22	Know and apply the foundations of Physics necessary to understand the theoretical and practical aspects of Chemistry that need it
C23	Know the principles and procedures of chemical engineering
C24	Know the properties and applications of materials
C25	Safely handle chemical substances, considering their physical and chemical properties, evaluating the risks associated with their use and laboratory procedures and including their environmental repercussions
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
C27	Demonstrate the ability to observe, monitor and measure chemical processes, by systematically and reliably recording them and presenting reports of the work done
C28	Interpret data derived from laboratory observations and measurements in terms of their meaning and relate them to the appropriate theory
C29	Demonstrate ability for numerical calculations and interpretation of experimental data, with correct use of units and estimation of uncertainty
C30	Ability to understand, interpret and adapt the advances in the field of Analytical Chemistry
C31	Know the control processes applied in the analytical laboratories to achieve their correct management and ensure the quality of the results
C32	Acquire basic knowledge on enviromental control and evaluation and agro-food security
C33	Know the metrology of chemical processes, including quality management
C34	Select and use different procedures for obtaining and characterizing nanomaterials and know their potential in the development of new applications
C35	Acquire theoretical and experimental knowledge in advanced aspects of Physical Chemistry
C36	Know the basics and be able to use different quantum mechanical methods to be applied to systems of chemical interest
C37	Acquire basic knowledge of programming and be able to use appropriate computer packages to solve problems of chemical interest
C38	Relate the structural bases of organometallic compounds with their physical, spectroscopic and chemical properties
C39	Select the appropriate techniques and procedures for problems of structural elucidation, synthesis, isolation and purification of organometallic compounds
C40	Acquire knowledge about the variety of roles played by metal ions in Biology. Know the biomolecules that contain metal ions
C41	Evaluate health risk, and environmental and socioeconomic impact of chemical substances
C42	Know synthetic strategies to obtain stereoselectively compounds with biological activity
C43	Know the chemical compounds with therapeutic application
C44	Know the main methods for the study of organic reactions mechanisms
C45	Apply chemical and chemical engineering knowledge to industrial processes
C46	Know the principles and procedures of environmental technology applied to the industry
C47	Know the principles and procedures of industrial health and safety
C48	Be able to determine the behavior of a material
C49	Acquire sufficient knowledge, skills and abilities for the practice of immunochemistry in different fields
C50	Know the concepts of company, institutional and legal framework of companies, and organization and management of companies
D1	Ability to solve problems
D2	Capacity for teamwork
D3	Ability to communicate in both oral and written form in Spanish and / or Galician and / or English
D4	Incorporate criteria of sustainability and environmental commitment into the professional exercise. Acquire skills in the equitable, responsible and efficient use of resources
D5	Ability to develop their professional activity based on respect for fundamental rights and equal opportunities, within the framework of professional ethics and ethical commitment
D6	Ability to understand the meaning and application of the gender perspective in different areas of knowledge and professional practice with the aim of achieving a more just and equal society

Expected results from this subject	
Expected results from this subject	Training and Learning Results

New	A1	B1	C1	D1
	A2	B2	C2	D2
	A3	B3	C3	D3
	A4	B4	C4	D4
	A5	B5	C5	D5
			C6	D6
			C7	
			C8	
			C9	
			C10	
			C11	
			C12	
			C13	
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			C42	
			C43	
			C44	
			C45	
			C46	
			C47	
			C48	
			C49	
			C50	

Contents
Topic
(*)Dado o seu carácter especial, a materia non ten contidos propios.

Planning			
	Class hours	Hours outside the classroom	Total hours
Mentored work	160	256	416
Presentation	0.5	33.5	34
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description

Mentored work	Individual work that each student will make of autonomous form under the supervision of one or two tutors. The allocation of the subject of work will do in accordance with the Rule of the TFG of the Faculty of Chemistry.

Personalized assistance

Methodologies	Description
Mentored work	

Assessment

	Description	Qualification	Training and Learning Results			
Mentored work		30	A1	B1	C1	D1
			A2	B2	C2	D2
			A3	B3	C3	D3
			A4	B4	C4	D4
			A5	B5	C5	D5
					C6	D6
					C7	
					C8	
					C9	
					C10	
					C11	
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					C46	
					C47	
					C48	
					C49	
					C50	

Presentation	70	A1 A2 A3 A4 A5	B1 B2 B3 B4 B5	C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33 C34 C35 C36 C37 C38 C39 C40 C41 C42 C43 C44 C45 C46 C47 C48 C49 C50	D1 D2 D3 D4 D5 D6

Other comments on the Evaluation

TFG is ruled by the norms approved in the Junta de Facultad and published in the web page web of the faculty.
The TFG Commission will do public, with sufficient advance, the criteria of evaluation that will use the tutor and the jury.
The TFG Commission will do public, with sufficient advance, the conditions for the written report and the public defences.
All the information generated by the TFG Commission will be included in the TFE module and/or in the web page of the faculty.

Sources of information

Basic Bibliography

Complementary Bibliography

Recommendations