(*)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 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

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	Suárez Alonso, María del Pilar			
Lecturers	Suárez Alonso, María del Pilar			
E-mail	psuarez@uvigo.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 2021-22 and 2022-23, 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 to the coordinatorof the course , during the first month after the start 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, F.J. Manuel de Villena Rueda, **Problemas Resueltos de Química Analítica**, 1ª Ed., Síntesis, 2003
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	Fernández Nóvoa, Alejandro			
Lecturers	Fernández Nóvoa, Alejandro González Cabaleiro, Lara Otero Martínez, Clara Tojo Suárez, María Concepción			
E-mail	afnovoa@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	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	0	0	0
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.	10	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.	12.5	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".	7.5	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.	32.5	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.	32.5	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 (66.7% laboratory work, 33.3% 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, 12.5% evaluable exercises, 7.5% self-assessment questionnaires, 65% written tests and 5% practice reports).

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 10% of the qualification of the subject and 5% 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 (66.7% laboratory work, 33.3% 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, 10% laboratory practices and 5% 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	García Bugarín, Mercedes			
Lecturers	Castro Fojo, Jesús Antonio García Bugarín, Mercedes			
E-mail	mgarcia@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. Machine translation into english of the original teaching guide			

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			
Predict the properties of the elements of a group according to his position in the Periodic Table, as well as inside each group	A2 A3	B1 B3 B4	C8 C9	
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.
Practice 1-2	Study of the chemical properties of oxides. Obtaining the dioxide sulfur.
Practice 3-4	Obtaining and chemical behavior of halogens.
Practice 5-6	Obtaining and reactivity of group 16 compounds.
Practice 7	Obtaining and reactivity of group 15 compounds.
Practice 8	Obtaining and reactivity of group 13 compounds.

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 through individual tutorials. In these, an attempt will be made to answer all the doubts that the students have about the subject taught in practices. 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
Lecturing	The resolution by the students of issues dealt with will be valued throughout the masterclasses at the established time / conditions by the teacher.	15	B1 B3 B4
Seminars	The resolution by the students of issues dealt with will be valued throughout the seminars at the time/conditions established by the professor	15	A2 A3 B1 B3 B4 C8 C9 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 B3 B4 C26 D2
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.	25	A2 A3 B1 B3 B4 C8 C9 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.	25	A2 A3 B1 B3 B4 C8 C9 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, master classes and laboratory practices obtained throughout the semester is maintained.

The students who renounce the continuous evaluation will opt for the global evaluation of the subject. To pass the subject through the overall assessment, students must have completed laboratory practices (20%) and take a comprehensive written test (80%) on specific aspects of the content explained in class, seminars and practices. In addition, 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. 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).

Sources of information

Basic Bibliography

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

HOUSECROFT, C.E. Y SHARPE, A. G., **Inorganic Chemistry, 3ª Ed**, Pearson, 2013

SHRIVER & ATKINS, **Química Inorgánica, 4º ed.**, McGraw-Hill, 2008

Complementary Bibliography

RAYNER-CANHAM, G, **Química Inorgánica Descriptiva, 2.ª Ed**, 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

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 Terán Moldes, María del Carmen			
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

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	23	48	71
Laboratory practical	14	5	19
Essay	0	6	6
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.
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 work that will be indicated at the time.

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/maria-beatriz-iglesias-antelo/; https://quimica.uvigo.es/gl/docencia/profesorado/luis-munoz-lopez/; https://quimica.uvigo.es/gl/docencia/profesorado/maria-carmen-teran-moldes/

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/maria-carmen-teran-moldes/
Essay	For preparation of the essay 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/

Assessment

	Description	Qualification	Training and Learning Results			
Flipped Learning	Participation and resolution by the student of all the tasks proposed by the teaching staff in relation to the flipped learning sessions will be evaluated.	15	A2 A5	B1	C17	
Problem solving	As part of the continuous evaluation, participation and resolution by the student of the individual tasks proposed by the teaching staff in the problem solving sessions will be evaluated. Those tasks will conclude with the elaboration of a portfolio and its evaluation.	20	A2 A5	B1	C17	D3
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
Essay	As part of the continuous evaluation, students will carry out group assignments. Those will be global application activities of the knowledge and skills developed in the subject.	20	A2 A5	B1 B2 B3	C17	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 A5	B2 B3	C17	D3
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 A5	B2 B3	C17	D3
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 A5	B2 B3	C17 C25	D3

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, laboratory practical and essay 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

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Complementary Bibliography

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

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

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

Yurkanis Bruice, P., **Fundamentos de Química Orgánica**, 3ª edición, Pearson, 2015

Dobado, J.A.; García, F.; Isac, J.I., **Química Orgánica. Ejercicios comentados**, Garceta, 2012

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

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 40% of the final mark, and the second to the remaining 60%. 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	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Bendicho Hernández, José Carlos			
Lecturers	Bendicho Hernández, José Carlos Pena Pereira, Francisco Javier Pérez Cid, Benita			
E-mail	bendicho@uvigo.gal			
Web				
General description	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. 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 21-22 and 22-23 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 B4 C6 D1 A3

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 and those who wish to raise their grade 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 edition 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 edition 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	Fernández Nóvoa, Alejandro González Cabaleiro, Lara Hervés Beloso, Juan Pablo López Fernández, Iago Otero Martínez, Clara 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 0-15%	15	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%.	35	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%.	35	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	García Bugarín, Mercedes García Martínez, Emilia Pérez Lourido, Paulo Antonio			
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 an introduction to the study of transition and internal transition metals (d and f blocks).			

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			
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, individually or in a group that does not exceed 3 people, will prepare a bibliographic search work on a topic related to some part of the subject. For the elaboration of the work, the students will take the course "Search and management of information for an academic work" specially prepared by the Library staff and available in Moovi. The grade achieved in this course together with the grade for the work done 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	For the preparation of the work, the students will have the supervision of the teaching staff of the subject. Orientation sessions may be held in person or by telematic means such as email, virtual classroom, etc. under the modality of prior appointment. In addition, they must take the course "Search and management of information for academic work" whose estimated duration is 6 hours, specially designed by Library staff and which will be available to them on the Moovi tele-learning platform. Students who obtain a pass grade in this course will obtain a certificate issued by the Library. The qualification obtained in this course together with that of the search work carried out 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 people 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 will carry out a bibliographic search, on a topic proposed by the teaching team that will be related to one of the topics covered in the subject. It can be individual or in groups of no more than three people. To carry out this work, the students will take the course specially designed by library staff: "Search and management of information for an academic paper", which will be available on the Moovi platform. Students who achieve the pass rating will receive a certificate issued by the Library. The grade for this course together with the grade for the work will constitute the score 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 3. It is necessary to achieve a score equal to or greater than 5 out of 10 to pass the subject.	18	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 4 to 11. It is necessary to achieve a score equal to or greater than 5 out of 10 to pass the subject.	37	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

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 Iglesias Antelo, María Beatriz Sánchez Sanz, Irene 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 alpha-dicarbonyl 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
Laboratory practical	28	8	36
Presentation	0	6	6
Problem and/or exercise solving	1	4	5
Problem and/or exercise solving	1	8	9
Problem and/or exercise solving	1	4	5
Essay	0	6	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	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.
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.
Presentation	The students, grouped into teams, must make a presentation on a topic assigned by the teacher. This activity will be graded.

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.eres/gl/docencia/profesorado/maria-magdalena-cid-fernandez/ https://quimica.uvigo.eres/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/ https://quimica.uvigo.eres/gl/docencia/profesorado/marta-teijeira-bautista/
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/
Presentation	The teaching staff will attend in a personalized way the queries of the students related to the preparation of the presentation. 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**
Essay	Teachers will attend to the queries of the students related to the proposed works, 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/
Problem and/or exercise solving	Teachers will attend to the queries of the students related to the proposed works, 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.eres/gl/docencia/profesorado/maria-beatriz-iglesias-antelo/ https://quimica.uvigo.eres/gl/docencia/profesorado/marta-teijeira-bautista/

Assessment							
	Description	Qualification	Training and Learning Results				
Lecturing	Participation and the resolution of individual tasks proposed by the teaching staff in the master sessions will be valued.	10	A1 A5	B5	C17 C18	D1	
Problem solving	The participation and resolution of the exercises proposed by the teacher will be evaluated.	15	A1 A5	B5	C17 C18	D1 D3	
Laboratory practical	The assistance to the practical classes of laboratory is compulsory. The work of laboratory will be evaluated as APTO or NO APTO. The following aspects will be evaluated: the previous or later work, the development of the experimental work and the lab notebook. In order for the students to pass the subject, a qualification of APTO in laboratory practices must be reached.	0		B5	C17 C18 C26 C28	D1	
Presentation	The students will realize a presentation in formal group. It will be an activity of application of the knowledges/skills developed in the subject.	10	A1 A5		C17 C18	D3	
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	
Essay	The students will elaborate an essay related to the content of the subject. It will comply with the parameters specified by the teacher.	10		B5	C17 C26 C28	D1	

Other comments on the Evaluation

In this subject, BASIC learning outcomes that will be necessary to achieve to pass will be defined.

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

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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 essay (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 lectures/problem solving, laboratory practices and assignments/exhibitions 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 this test 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 exceeded. 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

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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

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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