



## (\*)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 establishment of the University 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 not the pioneering spirit of the chemists in research or 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>

## (\*)Grao en Química

### Subjects

#### Year 3rd

Code	Name	Quadmester	Total Cr.
V11G200V01501	Structural Determination	1st	6
V11G200V01502	Chemical engineering	1st	9
V11G200V01503	Analytical chemistry II	1st	9
V11G200V01504	Organic chemistry II	1st	6
V11G200V01601	Analytical chemistry 3	2nd	6
V11G200V01602	Biological chemistry	2nd	9
V11G200V01603	Physical chemistry III	2nd	9
V11G200V01604	Inorganic chemistry II	2nd	6



IDENTIFYING DATA				
Structural Determination				
Subject	Structural Determination			
Code	V11G200V01501			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish Galician			
Department				
Coordinator	Álvarez Rodríguez, Rosana			
Lecturers	Álvarez Rodríguez, Rosana Castro Fojo, Jesús Antonio Rodríguez de Lera, Angel			
E-mail	rar@uvigo.es			
Web				
General description	The subject devotes to learning the application of the methods used in the structural determination of chemical compounds			

Competencies	
Code	
A1	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
A2	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
A4	Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
C4	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: Basics and tools for solving analytical problems and characterization of chemical substances
C8	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main techniques for structural determination, including spectroscopy
C12	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: structural features of chemical elements and their compounds, including stereochemistry
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C24	Recognize and analyze new problems and plan strategies to solve them
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D7	Apply theoretical knowledge in practice
D8	Teamwork
D9	Work independently
D12	Plan and manage time properly
D13	Make decisions
D14	Analyze and synthesize information and draw conclusions
D15	Evaluate critically and constructively the environment and oneself
D16	Develop an ethical commitment

Learning outcomes	
Expected results from this subject	Training and Learning Results
Describe the fundamental concepts of the methods for structural elucidation	A1 C4 C8 C12

Analyse the information that the different methods offer on the molecular structure elucidation, and understand their advantages and limitations.	A2 A3	C8 C12 C20	D3 D4 D7 D8 D9 D14
Predict the basic features of a given spectrum for a particular compound.	A2 A3	C4 C8 C12 C20	D3 D4 D7 D9 D14
Design the rational process to obtain key structural information of a chemical compound.	A2 A3	C4 C8 C24	D3 D4 D7 D9 D13 D14
Determine the molecular structure of a simple compound from the analysis of its spectroscopic data (IR, UV, MS, NMR, etc.).	A2 A3 A4	C4 C8 C12 C19 C20	D1 D3 D4 D5 D7 D9 D12 D14 D16
Understand the information provided by the different methods of X-ray diffraction.	A2 A3	C4 C12	D3 D4 D9 D13 D14 D15 D16
Observe the presence of defects and disorder in solids.	A1	C4	

## Contents

### Topic

Chapter 1. Obtaining general data of a chemical compound.	Combustion Analysis: empirical formula. Qualitative analysis. Point and space symmetry Optical Properties.
Chapter 2. Electronic and photoelectronic spectroscopy.	Determination of the chromophore groups. Effect of conjugation. Study of the valence shell MOs.
Chapter 3. Structural determination of crystalline samples.	Applications and limitations of the diffractometric techniques in structural determination. Three-dimensional determination of the molecular structure. Defects and disorders in crystalline solids.
Chapter 4. Vibrational Spectroscopy.	Determination of the presence of characteristic functional groups. Other applications in structural determination.
Chapter 5. Mass Spectrometry.	Determination of the molecular mass. Ionisation techniques. Detection methods. Fragmentation reactions. Isotopic patterns. Interpretation of the mass spectra.
Chapter 6. NMR Spectroscopy.	Monodimensional experiments. Structural information from the chemical shift. Double irradiation experiments. Dynamic NMR: equilibria in solution. Two-dimensional experiments. Homo- and Heteronuclear Correlation spectroscopy.

## Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	13	26	39

Troubleshooting and / or exercises	24	48	72
Practical tests, real task execution and / or simulated.	3	15	18
Jobs and projects	1	20	21

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

## Methodologies

	Description
Master Session	The theoretical classes will be devoted to the presentations of the basis of the different techniques that are most relevant for the interpretation of the data from the structural point of view (relationships between spectra and structures).
Troubleshooting and / or exercises	The classes of small groups will be devoted to solve exercises or problems that allow at the end of each chapter to obtain appropriate information of the corresponding techniques.

## Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	Students may consult any doubt with the teaching staff of the subject in mentoring time.
Tests	Description
Jobs and projects	Students may consult any doubt with the teaching staff of the subject in mentoring time. In addition, students will be called individually or in small groups for mentoring of the work proposed.

## Assessment

	Description	Qualification	Training and Learning Results
Troubleshooting and / or exercises	In the different classes (lectures, seminars) the students will be given handouts with problems and/or exercises that will be used for their evaluation. Learning outcomes: (1). Describe the fundamental concepts of the methods for structural determination. (2). Analyse the information that, on the molecular structure, provide the different methods and understand their main limitations. (3). Predict the basic features of a particular spectrum for a given compound. (4). Describe the information supplied by the different methods of X-ray diffraction. (5). Observe at the microscopic level the presence of defects and disorder in the surface of solids.	20	A1 C4 D7 A2 C8 D8 A3 C12 D13 C19 D15 C20 C24
Practical tests, real task execution and / or simulated.	There will be two short tests of about 1 hour duration in which the students will be asked to obtain structural information from experimental data (spectra and other physical data). The first tests covers chapters 1-3, and the second chapters 4-6. Learning outcomes: (1). Analyse the information that, on the molecular structure, provide the different methods and understand their main limitations. (2). Predict the basic features of a particular spectrum for a given compound. (3) Design the basic process to obtain a particular structural information of a compound. (4). Describe the information supplied by the different methods of X-ray diffraction. (5). Solve the molecular structure of a simple compound from its spectra (UV, IR, MS, NMR, X-Ray, etc).	45	A1 C8 D3 A2 C12 D7 A3 C19 A4 C20 C24
Jobs and projects	The students will carry out a small project proposed by the professors of multidisciplinary spectroscopic nature. The results will be presented as a written report following the format of a scientific article. In addition, they might be asked to present the results orally. Learning outcomes:(1). Solve the molecular structure of a simple compound from its spectra (UV, IR, MS, NMR, X-Ray, etc).	35	A1 C4 D1 A2 C8 D4 A3 C12 D5 A4 C19 D9 C20 D12 C24 D14 D16

## Other comments on the Evaluation

To pass the course the students must handle the professor the following material: - A minimum of 80% of the handouts and homework proposed in the seminar classes.

- All the short tests.
- The final report.

To pass the course at the end of the quarter the students will be required to get a minimum of 5 points (on the basis of 10)

in the final mark. Besides, it is indispensable to obtain in the evaluation of the different parts of the course the following minima: - 30% of the total value in each one of the short tests.

- 40% of the total value in the group of the handouts.

- 40% of the total value in the final report.

In the event the minima is not reached, the student record will show the balanced mark of the short tests.

For students that complete less than 20% of the total work scheduled, the records will not show, in agreement with the current legislation and, the quotation NOT PRESENTED. In any case, the presentation to one of the short tests, will imply the qualification of the course.

The students that fail at the end of the quartet will have to pass a final exam at the end of the academic year (June, July). Said proof will have a value of 45% of the final mark and will replace the results of the short tests. A minimum of 30% of the total value of the exam will be required to pass the course. The qualifications of the handouts and the project report are non-recoverable. In case the minima established in each part is not reached, the qualification will be FAILED. Once the minima is passed a global mark equal or higher than 5.0 (on the basis of 10) will be required to pass the course.

The final qualification of the students that pass the course will be normalised to 10 points.

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### Sources of information

Williams, D.H., Fleming, I., **Spectroscopic Methods in Organic Chemistry**, 6<sup>a</sup>,

Hammond, Christopher, **The Basics of crystallography and diffraction**,

Pavia, D.L., Lampman, G.M., Kriz, G.S., Vyvyan, J.R., **Introduction to Spectroscopy**, 5<sup>a</sup>,

Pretsch, Ernő, **Structure determination of organic compounds : tables of spectral data**, 4a,

Clayden, Jonathan, **Organic Chemistry**, 2a,

Web site: [www.spectroscopynow.com](http://www.spectroscopynow.com)

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### Recommendations

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

Geology: Geology/V11G200V01205

Chemistry: Chemistry I/V11G200V01105

Chemistry: Chemistry 2/V11G200V01204

Numerical methods in chemistry/V11G200V01402

Physical chemistry I/V11G200V01303

Physical chemistry II/V11G200V01403

Inorganic chemistry I/V11G200V01404

Organic chemistry I/V11G200V01304

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#### Other comments

The students have to remember that to reach the competitions of the matter is indispensable to have purchased previously the following results of learning:

- ☐ Determination of the formal state of oxidation of a tie it to me inside a compound
  - ☐ Structures of the main functional groups in organic chemistry
  - ☐ Representation by means of structures of Lewis of organic substances
  - ☐ three-dimensional Structure of the organic substances in accordance with the model of orbital hybrid
  - ☐ Representation of reactions by means of diagrams of arrows
  - ☐ basic Concepts of spectroscopy
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<b>IDENTIFYING DATA</b>				
<b>Chemical engineering</b>				
Subject	Chemical engineering			
Code	V11G200V01502			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Domínguez Santiago, Angeles			
Lecturers	Canosa Saa, Jose Manuel Domínguez Santiago, Angeles González de Prado, Begoña			
E-mail	admiguez@uvigo.es			
Web				
General description	<p>This subject is an introduction to Chemical Engineering, where the knowledge gained in the previous Chemistry degree courses is related to Chemical industry processes. The main goal is to enable the students to learn the basic knowledge about material and energy balances so that they can apply it to the design of separation processes such as distillation or liquid-liquid extraction.</p> <p>This subject gives the basis to understand other subjects such as Environmental Chemistry, Food Chemistry and Industrial Chemistry.</p>			

<b>Competencies</b>	
Code	
C1	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: Major aspects of chemical terminology, nomenclature, units and unit conversions.
C16	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: principles and procedures in chemical engineering
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C21	Recognize and implement good scientific practices for measurement and experimentation
C22	Process and perform computational calculations with chemical information and chemical data
C23	Present oral and written scientific material and scientific arguments to a specialized audience
C25	Handle chemicals safely, considering their physical and chemical properties, including the evaluation of any specific risks associated with its use
C27	Monitor, by observation and measurement of physical and chemical properties, events or changes, and document and record them in a consistent and reliable way
C28	Interpret data derived from laboratory observations and measurements in terms of their significance and relate them to the appropriate theory
C29	Demonstrate skills for numerical calculations and interpretation of experimental data, with special emphasis on precision and accuracy
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D6	Use mathematics, including error analysis, estimates of orders of magnitude, correct use of units and data representations
D7	Apply theoretical knowledge in practice
D8	Teamwork
D9	Work independently
D10	Work at a national and international context
D12	Plan and manage time properly
D13	Make decisions
D14	Analyze and synthesize information and draw conclusions
D15	Evaluate critically and constructively the environment and oneself

<b>Learning outcomes</b>		
Expected results from this subject	Training and Learning Results	
Know the different unit systems.	C1 C19	D7

Interpret the flow charts of chemical processes.	C16 C19 C20	
Differentiate the steady, non-steady, continuous and batch operations	C16 C19 C20	D3 D7 D9
Know and know how to apply the mass and energy balances in steady or not steady processes, with or without chemical reaction and with recycle, purge and bypass streams	C16 C19 C20	D3 D9
Know and know how to apply the mass, energy and momentum conservation laws	C16 C19 C20	D3 D7 D9
Pose and solve the design equations to the ideal chemical reactors.	C16 C20 C23	D3 D4 D5
Differentiate the heat transfer mechanisms	C16 C19 C20	D3 D4 D6 D7 D9
Calculate the heat transferred by conduction and convection in simple systems and the heat transferred in shell and tube type heat interchanger.	C16	D4
Identify the different operation units and their application.	C16 C19 C20	D7
Elaborate and interpretate vapour-liquid, liquid-liquid and gas-liquid flow diagrams.	C21 C22 C23 C25 C27 C28 C29	D1 D6 D8 D10 D12 D13 D14 D15
Solve mass balances for flash and batch distillation, liquid-liquid and solid-liquid extraction and absorption.	C21 C22 C23 C25 C27 C28 C29	D6 D8 D10 D12 D13 D14 D15
Determine the number of theoretical stages in separation units for simple mixtures.	C16 C19 C20	D7
Carry out and monitor separation processes in operation units at laboratory level.	C21 C22 C23 C25 C27 C28 C29	D1 D6 D8 D12 D13 D14 D15
Determine experimentally some properties of interest from the point of view of transport phenomena: viscosity, coefficients of convection, density.	C16 C20 C21 C22 C23 C25 C27 C28 C29	D1 D4 D5 D7 D8 D10 D12 D13 D14 D15

Work with continuous and batch chemical reactors at laboratory level.

C16  
C21  
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D12  
D13  
D14  
D15

## Contents

Topic	
Subject 1. Introduction to Chemical Engineering	Origin, concept and evolution of the Chemical Engineering. Discontinuous and continuous operation. Stationary and non stationary state. Cocurrent and countercurrent operations. Classification of the unit operations. Systems of units.
Subject 2. Mass and energy balances	General equation of balance. Mass balances in systems without chemical reaction in stationary and non stationary state. Recycle, purge and bypass. Mass balances in systems with chemical reaction in stationary and non stationary state. Energy balances. Energy balances in systems with chemical reaction in stationary state.
Subject 3. Design of ideal reactors	Speed of reaction. Ideal reactors: batch stirred tank reactor, continuous stirred tank reactor and plug flow reactor
Subject 4. Heat transfer	Mechanisms of heat transfer. Heat transfer through flat walls, cylindrical and spherical. Heat exchangers.
Subject 5. Distillation	Vapour-liquid equilibria. Phase diagrams for binary mixes. Simple and flash distillation. Multistage distillation
Subject 6. Liquid-liquid extraction	Liquid-liquid equilibrium for binary and ternary systems: binodal curve and distribution coefficients. Liquid-liquid extraction in cocurrent and countercurrent contact.
Laboratory sessions	Experimental determination of some properties of interest from the point of view of the design of basic operations: viscosity, coefficients of convection, density. Operation with chemical reactors at lab scale. Experimental determination of phase equilibrium curves. Analysis of the capacity of extraction of several solvents in a process of solid-liquid extraction.

## Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	13	30	43
Troubleshooting and / or exercises	25	50	75
Laboratory practises	40	3	43
Autonomous troubleshooting and / or exercises	0	10	10
Presentations / exhibitions	5	5	10
Tutored works	1	10	11
Short answer tests	2	8	10
Long answer tests and development	3	20	23

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

## Methodologies

	Description
Master Session	During these classes (one hour per week) the teacher will explain the most relevant aspects of the subject. The students will have the available documentation on Tem@.
Troubleshooting and / or exercises	There will be a set of exercises of each subject available for the students. Some of these exercises will be solved in class and other ones will be solved by each student and presented to the teacher in order to be corrected.
Laboratory practises	Laboratory sessions will last 3.5 hours. The experimental procedure will be available for the students and they will have to write a report for each session.
Autonomous troubleshooting and / or exercises	The students will have to solve some exercises and questions and they will have to present them to the teacher before the deadline.
Presentations / exhibitions	The students will have to make an oral presentation related to the theoretical bases, experimental procedure, obtained results and conclusions for some of their laboratory sessions.

Tutored works	The students will have to write an individual report about one subject related to Chemical Engineering. The teacher will indicate them the main points of the subject that they will have to develop and the recommended literature.
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### Personalized attention

Methodologies	Description
Troubleshooting and / or exercises	In the assigned hours of tutoring the professor will solve any doubts regarding the subject
Autonomous troubleshooting and / or exercises	In the assigned hours of tutoring the professor will solve any doubts regarding the subject
Tutored works	In the assigned hours of tutoring the professor will solve any doubts regarding the subject

### Assessment

	Description	Qualification	Training and Learning Results	
Laboratory practises	The qualification will depend on the laboratory work and the laboratory report made by the students. Laboratory sessions are mandatory.	10	C21 C22 C23 C25 C27 C28 C29	D1 D6 D8 D10 D12 D13 D14 D15
Autonomous troubleshooting and / or exercises	The students will have to deliver, in the terms indicated, the problems proposed of each subject.	5	C1 C16 C19 C22	D3 D7 D9
Presentations / exhibitions	The students will make an oral presentation related to laboratory work.	5	C16 C20 C23	D4 D5 D7 D8 D14
Tutored works	The students will realise, and will deliver in the date indicated, an individual work on a subject proposed to the start of course.	5	C1 C16 C20 C23	D1 D3 D14
Short answer tests	They will realise two short exams, one about the subjects 1 and 2 and another one about the subjects 3 and 4.	20	C1 C16 C19	D1 D6 D7 D9
Long answer tests and development	At the end of the course the students have to do an exam related to all the subjects.	55	C1 C16 C19	D1 D6 D7 D9

### Other comments on the Evaluation

Short and long exams. They will realise two short exams along the term. In the final exam, all topics will be evaluated and it is necessary to reach a minimum of 3 out of 10 points to take into account the other elements of evaluation. In case of not reaching the minimum note, the final qualification will be the one obtained in the long exam. Laboratory sessions. The laboratory sessions (lab work and report) and the oral presentation are mandatory and they are 15% of the final qualification. It is indispensable to have a minimum grade of 5 out of 10 points in this section. 50% or more laboratory sessions non-attendance means not to pass the course, independently of the results obtained in the other elements of evaluation. The participation of the student in any of the exams (short exams and long exam), two or more laboratory sessions or the delivery of 20% or more of the works required by the professor, involves the condition of "presented" and the obtention of a qualification. June final exam. A long exam of all the matter that will suppose 75% of the qualification will be done. The students will keep the grades of obtained in laboratory sessions, oral presentation, autonomus exercises and tutored work obtained along the course.

### Sources of information

Calleja y otros, **Introducción a la Ingeniería Química**, 1999,

R.M. Felder, **Principios elementales de los procesos químicos**, 2003,

C.J. Geankoplis, **Procesos de transporte y principios de procesos de separación**, 2007,

W.L. McCabe, J.C. Smith y P. Harriot, **Operaciones unitarias en Ingeniería Química**, 2007,

José Felipe Izquierdo y otros, **Introducción a la Ingeniería Química. Problemas resueltos de balances de materia y energía**, 2015,

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## Recommendations

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IDENTIFYING DATA				
<b>Analytical chemistry II</b>				
Subject	Analytical chemistry II			
Code	V11G200V01503			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Leao Martins, Jose Manuel			
Lecturers	González Romero, Elisa Leao Martins, Jose Manuel			
E-mail	leao@uvigo.es			
Web	<a href="http://quimica.uvigo.es/decanatoquimica/guias-docentes.html">http://quimica.uvigo.es/decanatoquimica/guias-docentes.html</a>			
General description	Global knowledge of Analytical Instrumental Techniques and its applications.			

Competencies	
Code	
C4	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: Basics and tools for solving analytical problems and characterization of chemical substances
C8	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main techniques for structural determination, including spectroscopy
C17	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories in: metrology of chemical processes including quality management
C18	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: principles of electrochemistry
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C21	Recognize and implement good scientific practices for measurement and experimentation
C22	Process and perform computational calculations with chemical information and chemical data
C23	Present oral and written scientific material and scientific arguments to a specialized audience
C25	Handle chemicals safely, considering their physical and chemical properties, including the evaluation of any specific risks associated with its use
C26	Perform common laboratory procedures and use instrumentation in synthetic and analytical work
C27	Monitor, by observation and measurement of physical and chemical properties, events or changes, and document and record them in a consistent and reliable way
C28	Interpret data derived from laboratory observations and measurements in terms of their significance and relate them to the appropriate theory
C29	Demonstrate skills for numerical calculations and interpretation of experimental data, with special emphasis on precision and accuracy
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D6	Use mathematics, including error analysis, estimates of orders of magnitude, correct use of units and data representations
D7	Apply theoretical knowledge in practice
D8	Teamwork
D9	Work independently
D12	Plan and manage time properly
D13	Make decisions
D14	Analyze and synthesize information and draw conclusions
D15	Evaluate critically and constructively the environment and oneself
D17	Develop concern for environmental aspects and quality management

Learning outcomes	
Expected results from this subject	Training and Learning Results

Justify the basic principles of the instrumental analysis and his field of application in base to the characteristics of the *analito and of application	C4	D1 D3 D6 D9 D12
Appropriated instrumental technique selection depending the phisycocochemicals properties of the analytes.	C4 C19 C20 C22	D1 D4 D6 D9 D12 D13
Description the quality parameters of an analytical method.	C4 C17 C19 C29	D1 D3 D4 D5 D6 D9
Adavances in principles of: internal standard, external standard addition, standard solutions preparation, calibration and its applications in different instrumentl equipments.	C19 C21 C25 C26 C27 C28 C29	D1 D3 D4 D5 D6 D7 D8 D12 D13 D14
Estimation, interpretation and understand the different calibrations parameters of an instrumental method.	C17 C19 C20 C21 C26 C28 C29	D3 D4 D5 D6 D7 D8 D9 D12 D13 D14
Spectroscopic, electrochemical and separation (chromatographic and electrophoretic) techniques basis and its applications	C4 C8 C18 C19	D1 D3 D4 D7 D8 D9 D14
Instrumental equipment description and its functions required for spectroscopic, electrochemical measurements and separations techniques.	C4 C8 C18 C21 C26 C27	D1 D3 D4 D7 D9 D12 D13
Classify and proposes different applications fields of spectroscopic, electrochemical techniques and separation	C4 C8 C18 C19 C23	D1 D3 D4 D7 D8 D9 D13 D14

Implementation and application of spectroscopic and electrochemical techniques to carry out the determination of different analytes	C4	D1
	C18	D4
	C19	D5
	C21	D6
	C23	D7
	C25	D8
	C26	D12
	C27	D13
	C28	D14
	C29	D15
Implementation and application of chromatographic techniques with different detection modes for the separation, identification and quantification of different analytes		D17
	C4	D1
	C21	D4
	C23	D5
	C25	D6
	C26	D7
	C27	D8
	C28	D12
	C29	D13
		D14
		D15
		D17

## Contents

Topic	Subject (QAII) description
General Introduction	
1-Introduction to the instrumental technicians	Introduction Classification of the instrumental techniques Quality parameters Instrumental methodology analysis Calibration Molecular absorption spectrophotometry UV-VIS: Principles, Instrumentation and applications
2- Luminescent techniques	Basic principles Relation between fluorescence intensity and concentration Instrumentation Applications
3- Atomic Absorption Spectrometry	Basic principles Atomization systems, Flame, graphite furnace, hydrides generation and cold steam. Instrumentation Applications
4- Emission Atomic Spectrometry	Basic principles Emission sources. Flame and plasma. Plasma-Mass coupling Applications
5- Electroanalytical Techniques	Basic principles Classification Potentiometry: Ion Selective Electrode Voltammetry Conductimetry Coulometry Applications
6- Chromatographic methods	Basic principles Chromatographic modes Gas Chromatography Instrumentation Applications
7- Liquid Chromatography	Liquid chromatography: Normal, reverse phase and ionic Instrumentation Applications
8- Electrophoretic Techniques	Principles High resolution capillary Electrophoresis basic and theory Electrophoretic Techniques Classification Instrumentation Applications

<b>Planning</b>			
	Class hours	Hours outside the classroom	Total hours
Troubleshooting and / or exercises	26	26	52
Laboratory practises	45.5	7	52.5
Master Session	26	26	52
Reports / memories of practice	0	38	38
Short answer tests	2	4	6
Long answer tests and development	3.5	10.5	14
Practical tests, real task execution and / or simulated.	3.5	7	10.5
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

<b>Methodologies</b>	
	Description
Troubleshooting and / or exercises	Following the master classes, seminars be dedicated to solving problems / exercises, which aims are to finding the comprehension level of the students on issues developed. The exercises will be develop in small groups in seminars session followed a general discussion, later the student will have individual proposes exercises to solve individually. The seminars are aimed at strengthening the knowledge acquired in the lectures class, Practical analytical issues and related to the content of the subject will be discussed.
Laboratory practises	The laboratory practical sessions have a fundamental part in the teaching of the subject. On the one hand, they are essential for understanding theoretical concepts; and also allows the students to introduce on analytical methodology practical concepts, as well to understand the norms and rules of scientific work, individual and work group concept in laboratory including report writing.
Master Session	Lecture sessions will develop during 60 minutes. The teacher provides a global vision of each agenda item, stating the main contents of each. Classes are held interactive way with the students, using online learning materials (Tem @ platform) and adequate literature.

<b>Personalized attention</b>	
Methodologies	Description
Troubleshooting and / or exercises	
Laboratory practises	
Tests	Description
Reports / memories of practice	

<b>Assessment</b>				
	Description	Qualification	Training and Learning Results	
Troubleshooting and / or exercises	The teacher will monitor the exercises given to students in seminars class. Scientific publication, pratical situations will be discussed in seminars sessions and supervised by the teacher	10	C4 C8 C18 C29	D1 D6
Laboratory practises	The teacher will monitor the experimental work done by students in the lab sessions. It is REQUIRED to attend practical laboratory sessions to pass the course. Students who do not perform laboratory practices are considered FAIL throughout the cycle of evaluation of the course.	15	C20 C21 C25 C26 C27 C28	D4 D7 D8 D13
Reports / memories of practice	The student will prepare lab reports, which reflects the work performed in the laboratory. These reports must be submitted by the deadline and will be corrected by the teacher.	10	C17 C19 C20 C28 C29	D1 D4 D6 D7 D14
Short answer tests	The theoretical/practical short test will be used during semester evaluation. This test is not eliminatory and will contribute 10% of the final grade for the course.	10	C4 C8 C18 C19	D1 D3 D6

Long answer tests and development	The exam (the test) will be performed at the end of the semester and contains a theoretical and theoretical-practical aspects. For compensation of subject , students must achieve at least 4.0 minimum score (4.0 minimum score in each part of the test).  ATTENTION: 3.0 is the minimal requirement in the final results achieve by the student for each long test corresponding to each teacher participate in the subject in order to carry out the weighting of overall examination. If you do not get this rating, the end result is FAIL	45	C4 C8 C17 C18 C19	D1 D3 D6 D9
Practical tests, real task execution and / or simulated.	Laboratory test for each student will be made to assess their skills in the development of an experiment. This test is performed at the end of the lab sessions	10	C20 C21 C25 C26 C27 C28 C29	D1 D6 D7 D9

### Other comments on the Evaluation

Omission of ALL activities proposed for the evaluation of the subject (Not participated all evaluation activities) for the evaluation of the subject will be considered as NOT PRESENTED (NO EVALUATION).  
Attendance at laboratory practices class is mandatory and eliminatory. If the participation in these activities is less than 80%, TOTAL results in subject evaluation will be FAIL (SUSPENSO); in this case, the final official result will be the value only obtained for laboratory evaluation

### Sources of information

Douglas A. Skoog, F. James Holler, Stanley R. Crouch, **Principios de análisis instrumental**, 6ª,  
Lucas Hernández Hernández, Claudio González Pérez, **Introducción al análisis instrumental**, 1ª,  
Satinder Ahuja, Neil D. Jespersen, **Modern instrumental analysis**, 1ª,  
James W. Robinson, Eileen M. Skelly Frame, George M. Frame, **Undergraduate instrumental analysis**, 6ª,  
Donald T. Sawyer; William R. Heineman; Janice M. Beebe, **Chemistry Experiments for Instrumental Methods**, 1ª,  
Rouessac, Annick Rouessac, **Chemical Analysis: Modern Instrumentation Methods and Techniques**, 6ª,

### Recommendations

#### Subjects that continue the syllabus

Analytical chemistry 3/V11G200V01601

#### Subjects that are recommended to be taken simultaneously

Structural Determination/V11G200V01501  
Chemical engineering/V11G200V01502  
Organic chemistry II/V11G200V01504

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

Chemistry, physics and biology: Integrated laboratory I/V11G200V01103  
Chemistry, physics and geology: Integrated laboratory II/V11G200V01202  
Chemistry: Chemistry I/V11G200V01105  
Chemistry: Chemistry 2/V11G200V01204  
Numerical methods in chemistry/V11G200V01402  
Analytical chemistry I/V11G200V01302

<b>IDENTIFYING DATA</b>				
<b>Organic chemistry II</b>				
Subject	Organic chemistry II			
Code	V11G200V01504			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	Spanish			
Department				
Coordinator	Gómez Pacios, María Generosa Fall Diop, Yagamare			
Lecturers	Fall Diop, Yagamare Gómez Pacios, María Generosa			
E-mail	yagamare@uvigo.es ggomez@uvigo.es			
Web				
General description	Machine translation into english of the original teaching guide The course Organic Chemical II is designed to deepen in the knowledge of the properties and reactivity of functional groups. After the study of nucleophilic substitution and elimination reactions, the reactivity of bi-functional carbonylic compounds will be approached. Finally, the radical and peryclic reactions will be studied.			

<b>Competencies</b>	
Code	
A1	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
A2	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
C2	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: types of chemical reactions and its main characteristics
C8	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main techniques for structural determination, including spectroscopy
C10	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: properties of aliphatic, aromatic, heterocyclic and organometallic compounds
C11	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: nature and behavior of functional groups in organic molecules
C12	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: structural features of chemical elements and their compounds, including stereochemistry
C13	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main synthetic routes in organic chemistry, including interconversions of functional groups and the formation of carbon-carbon and carbon-heteroatom bonds
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C23	Present oral and written scientific material and scientific arguments to a specialized audience
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D8	Teamwork
D9	Work independently
D12	Plan and manage time properly
D13	Make decisions
D14	Analyze and synthesize information and draw conclusions

## Learning outcomes

Expected results from this subject	Training and Learning Results		
Explain the reactivity of the organic compounds through the different mechanisms of reaction: replacement, elimination, addition and addition-elimination.	A1 A2 A3 A5	C2 C10 C11 C12 C13	D1 D3 D4 D5 D9 D12 D13 D14
Describe in detail the mechanisms of transformation of the organic compounds using the formalism of arrows.		C2 C11	D1 D3 D4 D5 D8 D9 D12 D13 D14
Complete diagrams of reaction of organic compounds adding reactive and/or the conditions of reaction.		C2 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Propose sequences of simple reaction.		C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Differentiate, according to the conditions of reaction and the *sustratos used, the mechanisms of replacement *nucleófila *SN1 and *SN2.		C2 C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Apply the processes of replacement *nucleófila on carbons *sp3 in the obtaining of organic compounds with simple links.		C2 C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
*Predecir The possible competition between the processes of replacement *nucleófila and elimination for a *sustrato given.		C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14

Apply the reactivity of *enoles and *enolatos.	C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Apply the processes of elimination in the preparation of organic compounds with multiple links.	C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Apply the reactivity of the composed alpha-*dicarbonílicos (*enolización, acidity, *alquilación in alpha, *alquilación in beta, *descarboxilación) in organic synthesis.	C10 C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Design the synthesis of compounds *bifuncionales using the reaction of condensation *aldólica, the reaction of *Reformatsky and the condensation of *Claisen.	C11 C12 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Apply the reaction of *Knoevenagel and the procedures of synthesis *acetilacética and synthesis *malónica.	C11 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Design the synthesis of derivatives of the compounds *carbonílicos alpha,beta-*insaturados by means of reactions of addition 1,2 and 1,4.	C11 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14
Apply the basic reactivity of the organic radicals.	C2 C11 C13	D1 D3 D4 D5 D8 D9 D12 D13 D14

Apply the reactions \*pericíclicas to the organic synthesis.

C2  
C11  
C13  
D1  
D3  
D4  
D5  
D8  
D9  
D12  
D13  
D14

(\*)Characterize \*compuestos organic \*sencillos from \*sus \*datos espectroscópicos.

C8  
C11  
C19  
C20  
C23  
D1  
D3  
D4  
D5  
D8  
D12  
D13  
D14

## Contents

### Topic

1. Nucleophilic substitution reactions	Bimolecular nucleophilic substitutions (SN2). Unimolecular nucleophilic substitutions (SN1). Kinetic, mechanisms, stereochemistry aspects. SN2 and SN1 competition. Transformations of functional groups through SN2 and SN1 processes.
2. Elimination Reactions.	Reactions of elimination. Bimolecular Elimination (E2). Unimolecular Elimination (E1). Base conjugated unimolecular elimination (E1cB). Intramolecular elimination (Ei). Mechanisms. Substitution and elimination competition. Application of elimination reactions in organic synthesis.
3. Oxidation-reduction reactions.	Oxidation-reduction reactions. Oxidation reactions of alcohols. Oxidation reactions of carbonyl compounds. Oxidative rupture of alkenes and alkynes. Reduction of aldehydes and ketones. Reduction of carboxylic acids, esters and nitriles.
5. Radical reactions.	Structure, stability and reactivity of radicals. Halogenation of alkanes. Radical addition of HBr to alkenes. Radical halogenation of allylic and benzylic systems. Polymerization of alkenes.
4. Reactivity in alpha position of carbonyl compounds.	Reactivity in alpha position of carbonyl groups. Enols and enolates: general reactivity. Reactions of ketones and esters enolate anions. Enolate anion reactions with carbonyl compounds: aldol, Claisen, Dieckmann and Reformatsky reactions.
5. Bifunctional Compounds.	Reactivity of 1,2-Bifunctional compounds: pinacol rearrangement, benzoin condensation, acyloin condensation, benzyl acid rearrangement, enolization. Reactions of beta-dicarbonyl compounds: malonic synthesis, acetoacetic ester synthesis, Knoevenagel reaction. Reactions of alpha-beta unsaturated carbonyl compounds: reactions with electrophiles, reactions with nucleophiles, carbanion addition (Michael reaction), Robinson annulation.
6. Pericyclic reactions.	General characteristics. Classification. Electrocyclic reactions. Cycloaddition reactions. Sigmatropic reactions. Diels-Alder reaction. 1,3-Dipolar cycloadditions.

## Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	2	2	4
Master Session	26	31	57
Seminars	24	45	69
Short answer tests	3	6	9
Long answer tests and development	3	8	11

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

## Methodologies

	Description
Tutored works	The student, of individual form or in group, will prepare a short exhibition on a subject *relacionado with the matter. This activity includes the research of information, editorial and presentation of the work.

Master Session	The sessions *magistrales will consist in the exhibition by part of the professor of the fundamental appearances of each subject. Before each session, the student will have to work the material that the professor will facilitate him through the platform FEAR, related with the content that will treat in each session.
Seminars	The students, with the support of the professor, will resolve exercises and questions previously proposed in Bulletins, related with the theoretical contents. A selection of the exercises will be delivered regularly to the professor for his evaluation.

### Personalized attention

#### Methodologies Description

Seminars	The professors will devote a time to attend the needs and queries of the students related with the study and the resolution of exercises on the subjects linked with the matter. The day of the presentation the professors will inform on his time availability for this.
Tutored works	The students will realise a work on a subject that *eligirán of a series proposed by the professors, once finalised, in hours of seminar will expose it and will answer to the questions that formulate him the professors and/or the students. The professors will be able to *asesorar to the student in the election and development of the subject, in the distribution, *busqueda bibliographic and presentation

### Assessment

Description		Qualification	Training and Learning Results	
Tutored works	It will value the preparation and presentation of a work on a subject proposed by the professor related with the theoretical content of the *asignatura.	5	C2 C8 C10 C11 C12 C13 C19 C20 C23	D1 D3 D4 D5 D9 D12 D13 D14
Seminars	In the classes of seminar will value the participation and the resolution of the previously proposed problems by the professor. A selection of the exercises will be resolved individually in the classroom and delivered regularly to the professor for his evaluation.	10	C2 C8 C10 C11 C12 C13 C19 C20 C23	D1 D3 D4 D5 D8 D9 D12 D13 D14
Short answer tests	They will realise two proofs of short answer: the first when finalising the Subject II and the second when finalising the Subject IV. The first will constitute 20% of the total qualification, and the second 15%.	40	C2 C8 C10 C11 C12 C13 C19 C20 C23	D1 D3 D4 D5 D9 D12 D13 D14
Long answer tests and development	It will consist in a global proof on all the contents of the matter. It will be necessary to reach a minimum of 4 points on 10 in this proof to surpass the matter and to take into account the rest of the elements of evaluation. It will realise when finalising he *cuatrimestre.	45	C2 C8 C10 C11 C12 C13 C19 C20 C23	D1 D3 D4 D5 D9 D12 D13 D14

### Other comments on the Evaluation

#### IMPORTANT NOTES:

1. In the long proof final will evaluate the whole of the \*asignatura. It will be necessary to reach in this proof a minimum of 4 points on 10 to surpass the matter and to take into account the rest of the elements of evaluation.

2. A selection of the exercises of the bulletins will be resolved individually in the classroom and delivered regularly to the professor for his evaluation. Those students that by fault of assistance to class, do not deliver a minimum of 80% of these exercises, will not be able to present to the final proof.

CONDITION OF PRESENTED/To: The participation of the student in any one of the proofs written will involve the condition of presented/to and therefore the allocation of qualification.

EVALUATION IN THE ANNOUNCEMENT OF JULIO:

1. Punctuation obtained by the student during the course: Máximo 3.0 points.

It will keep the qualification obtained by the student during the course in works \*tutelados (maximum 0.5 points), proofs of short answer (maximum 2.5 points).

2. Proof written: Máximo 7.0 points.

It will realise a proof of long answer on all the contents of the matter to which will assign a maximum of 7.0 points on 10.

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#### **Sources of information**

Vollhardt, K.P.C. y Schore, N.E., **Química Orgánica**, 5ª,

Wade, L.G., **Química Orgánica**, 5ª,

Yurkanis Bruice, P., **Química Orgánica**, 5ª,

Ege, S., **Organic Chemistry: Structure and reactivity**, 5ª,

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#### **Recommendations**

##### **Subjects that continue the syllabus**

Organic chemistry III/V11G200V01704

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##### **Subjects that are recommended to be taken simultaneously**

Structural Determination/V11G200V01501

Chemical engineering/V11G200V01502

Analytical chemistry II/V11G200V01503

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

Chemistry: Chemistry I/V11G200V01105

Chemistry: Chemistry 2/V11G200V01204

Organic chemistry I/V11G200V01304

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IDENTIFYING DATA				
<b>Analytical chemistry 3</b>				
Subject	Analytical chemistry 3			
Code	V11G200V01601			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Bendicho Hernández, José Carlos			
Lecturers	Bendicho Hernández, José Carlos Lavilla Beltrán, María Isela			
E-mail	bendicho@uvigo.es			
Web	http://faitic.uvigo.es			
General description	<p>"Machine translation into english of the original teaching guide" -</p> <p>This matter provides to the students the knowledge on important and actual aspects on Analytical Chemistry (Chemometrics; Trace Analysis; Automatism and sensors), especially those regarding strategies that have allowed the evolution of the conventional methodologies to improve the quality of the analytical information. Students will be able to complement his training by means of the integration of the knowledge of Analytical Chemistry taken previously, specially the contents in Analytical Chemical II (introduction to the instrumental analysis). This will allow them to tackle the resolution of analytical problems in different areas of interest (environment, feeding, industry, clinic etc.).</p>			

## Competencies

Code	
A1	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
A2	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
C4	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: Basics and tools for solving analytical problems and characterization of chemical substances
C8	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main techniques for structural determination, including spectroscopy
C17	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories in: metrology of chemical processes including quality management
C18	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: principles of electrochemistry
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C22	Process and perform computational calculations with chemical information and chemical data
C24	Recognize and analyze new problems and plan strategies to solve them
C29	Demonstrate skills for numerical calculations and interpretation of experimental data, with special emphasis on precision and accuracy
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D6	Use mathematics, including error analysis, estimates of orders of magnitude, correct use of units and data representations
D7	Apply theoretical knowledge in practice
D8	Teamwork
D9	Work independently
D12	Plan and manage time properly
D13	Make decisions
D14	Analyze and synthesize information and draw conclusions
D17	Develop concern for environmental aspects and quality management

## Learning outcomes

Expected results from this subject	Training and Learning Results		
1. Select and apply distinct technical *quimiométricas to the resolution of practical cases and justify the utilisation of the same.	A1 A2 A3	C17 C19 C20 C22	D1 D3 D5 D6 D7 D9 D13 D14 D17
2. Use the experimental design like tool for the optimisation of an analytical method.	A1	C17 C19 C22	D1 D3 D5 D6 D7 D9 D13 D14
4. Justify the utilisation of the Chemometrics in the quality of the results. Describe how implements a system of quality in a laboratory of control of analytical.	A1 A2	C4 C17 C19 C20 C29	D1 D3 D5 D6 D7 D8 D9 D14 D17
3. Evaluate and interpret the analytical results of systems *multicomponentes and *multivariables.	A1 A2 A3	C4 C17 C20 C22	D1 D3 D5 D6 D7 D8 D9 D13 D17
6. Recognise the different methods of treatment of sample as well as evaluate his possibilities in the resolution of diverse analytical problems inside the field of the analysis of trace.	A1 A2	C4 C19 C20	D1 D3 D4 D7 D9 D12 D13 D14 D17
5. Describe the planning of the sampling and the factors that take part in him for the analysis of trace.	A1	C4 C17 C24	D1 D3 D4 D6 D7 D9 D12 D13 D17
7. Compare and value the different methods of existent extraction in the actuality, like the extraction by fluent *supercríticos, in solid phase, *microextracción, etc.	A1 A2	C4 C19 C20	D1 D3 D8 D9 D12 D14 D17
8. Describe the analytical methodology and instrumentation as well as know the applications of technicians of general use in analysis of trace like the voltammetry of *redisolución *anódica, spectrometry of atomic absorption with atomisation *electrotérmica, spectrometry of masses with source of plasma and the different attachments between the chromatography and the spectrometry of masses.	A1	C4 C8 C18 C19	D1 D3 D4 D8 D9

9. Classify the different types of automatic systems and *miniaturizados, establishing his advantages and inconvenient, modalities and applications more notable and of immediate future. Justify the automation in the different stages of the analytical process.	A1 A2	C4 C17 C20	D1 D3 D4 D5 D8 D9 D17
10. Explain the foundations of the sensors and *biosensores chemical, as well as his more important applications. Explain and value the importance of the utilisation of the sensors for the fast and reliable obtaining of analytical information.	A1 A2 A3	C4 C17 C20	D1 D3 D4 D8 D9 D12
11. Describe the characteristics of the continuous automatic analysers, discontinuous and *robotizados. Know the phenomena of dispersion in continuous analysers of injection in flow and of sequential injection, as well as the form to characterise them.	A1	C4 C17 C19 C20	D1 D3 D4 D5 D8 D9 D14 D17
12. Explain the construction of analytical tools in miniature and his applications.	A1	C4 C17 C19	D1 D3 D4 D5 D9 D12 D14

## Contents

### Topic

SUBJECT 1. Analysis of trace	Concept and importance of the analysis of trace. Sources of pollution in the laboratory. Experimental methods in analysis of trace. Sampling. Methods of decomposition in analysis of trace inorganic. Methods of extraction in analysis of trace organic. Technicians selected of analysis of trace.
SUBJECT 2. Automation	Automation in the laboratory of analysis: generalities. Automatic analysers. Discontinuous analysers, continuous and *robotizados. Analysers of injection in flow and flow *segmentado: characteristics. Phenomena of dispersion. Characteristics of the signal of injection in flow. Technicians of gradient. Analysers of sequential injection. Instrumentation and applications.
SUBJECT 3. Sensors and *biosensores chemical	Concept of sensor. Components of a chemical sensor. Classification. Sensors and *biosensores. Elements of recognition. Types of *transductores. (*Bio)Electrochemical and optical sensors. Applications of interest. Miniaturisation of analytical systems.
SUBJECT 4. Introduction to the Chemometrics	Definition and historical evolution of the Chemometrics. The chemometrics in the different stages of the analytical process. Basic statistical concepts. Parameters that estimate the central value and the dispersion: parametric and no parametric. Properties of the variance and the average. Expression of analytical results.
SUBJECT 5. Basic chemometrics: comparison of analytical results	Test of significance. Proofs of hypothesis: structure of the proofs of hypothesis. Errors type I and II. Probability. Rejection of anomalous results. Parametric proofs of comparison of two variances. Parametric proofs of comparison of two averages. Comparison of several half *muestrales by means of *ANOVA of a road. Control of the accuracy and precision over time: charts of control. Proofs no parametric.
SUBJECT 6. The quality in the analytical laboratories: *cualimetría.	Introduction to the *cualimetría: quality and chemometrics. Quality and analytical properties: validation of analytical methods. *Trazabilidad. Generic approximation to the quality. Systems of quality: Norms ISO. Accreditation and certification of the laboratories.

## Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	13	26	39
Tutored works	0	9	9

Master Session	26	52	78
Short answer tests	2	4	6
Short answer tests	2	4	6
Long answer tests and development	4	8	12

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

Methodologies	
	Description
Seminars	In the classes of seminar will reinforce the learning of the *temario explained during the sessions *magistrales, carrying out the resolution of numerical problems and theoretical exercises-practical. The professor will propose, of regular form, different problems/exercises that will be resolved of individual form by the student and delivered for his evaluation.
Tutored works	It will provide to the student a series of articles published in magazines of education in Chemistry and related with the contents of the matter. Once studied the article, the student will have to answer to a questionnaire of questions provided by the professor.
Master Session	The professor will develop the contents of the program from the proportionate material to the student through the platform FEAR. In the sessions *magistrales, the professor will present the fundamental appearances of the matter that will have to complement by means of the bibliography recommended.

## Personalized attention

Methodologies	Description
Master Session	The professor will resolve the doubts of personalised way on any one of the activities proposed (masterclasses, seminars, works *tutelados, resolution of problems/exercises and proofs). To such end, the professor will inform the available schedule in the presentation of the matter.
Seminars	The professor will resolve the doubts of personalised way on any one of the activities proposed (masterclasses, seminars, works *tutelados, resolution of problems/exercises and proofs). To such end, the professor will inform the available schedule in the presentation of the matter.

## Assessment

	Description	Qualification	Training and Learning Results
Seminars	In the classes of seminar, the professor will resolve part of the problems/exercises, leaving others to be resolved by the student. The delivery of the problems/exercises resolved is compulsory. To be able to evaluate is activity, the student will have to carry out at least 75% of the deliveries. Besides it will be necessary to obtain a minimum punctuation of 3 on 10 points so that the qualification of this activity can add to the rest of elements of evaluation.	10	A1 C4 D6 A2 C8 D7 A3 C17 D9 C18 D12 C19 D14 C20 C22
Tutored works	The realisation of the works is compulsory. So that this activity can be evaluated, the student will have to carry out at least 75% of the deliveries. Besides it will be necessary to obtain a minimum punctuation of 3 on 10 points so that the qualification of this activity can add to the rest of elements of evaluation.	5	A1 C4 D1 A2 C8 D3 A3 C17 D4 C18 D5 C19 D7 C20 D8 C24 D9 D14 D17
Short answer tests	It will effect a first short proof on the subjects 1, 2 and 3, roughly to half of the *cuatrimestre. The short proof will be able to consist in questions of short answer, problems and ask type test. The presentation to this proof *inhabilita to the student to obtain the qualification of no presented.	20	A1 C4 D1 A2 C8 D6 A3 C17 D7 C18 D9 C19 D12 C20 D13 D14
Short answer tests	It will effect a second short proof on the subjects 4, 5 and 6 to the end of the *cuatrimestre. The short proof will be able to consist in questions, problems and exercises. The presentation to this proof *inhabilita to the student to obtain the qualification of no presented.	25	A1 C4 D1 A2 C17 D6 A3 C19 D7 C20 D9 C22 D12 C24 D13 D14

Long answer tests and development	Compulsory final examination. It will consist in a global proof of the *temario that will include problems, exercises and ask type test. It will be necessary to obtain 3 points on 10 in this examination so that the qualification can add to the one of the rest of elements of evaluation.	40	A1 C4 D1 A2 C8 D6 A3 C17 D7 C18 D9 C19 D12 C20 D13 C22 D14 C24
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### Other comments on the Evaluation

The participation of the student in any one of the activities evaluated (deliveries of problems and exercises, proofs of short answer) \*inhabilita to the student to obtain the qualification of NO PRESENTED.&\*ANNOUNCEMENT OF JULIO:The qualification in this announcement will be formed by two components:1. Punctuations obtained by the student during the course (maximum 5 points)&\*they will keep the qualifications in the works \*tutelados (maximum 0.5 points), problems/exercises resolved (maximum 1 point) and short proofs (maximum 3.5 points).2. Global written proof of the contents of the matter (maximum 5 points)This proof will include problems, exercises and ask type test. To be able to approve in this announcement, the student has to obtain at least 3 points on 10 in this proof.The presentation to this proof \*inhabilita to the student to obtain the qualification of NO presented.

### Sources of information

G. Ramis Ramos; M.C. Álvarez Coque, **Quimiometría**, Síntesis,  
J.C. Miller; J.N. Miller, **Estadística y Quimiometría para Química Analítica**, Prentice-Hall,  
R. Compañó Beltrán; R. Ríos Castro, **Garantía de calidad en los laboratorios analíticos**, Síntesis,  
C. Cámara, **Toma y tratamiento de muestras**, Síntesis,  
R. Cela, **Técnicas de separación en Química Analítica**, Síntesis,  
S. Mitra, **Sample preparation techniques in analytical chemistry**, Wiley,  
B.R. Eggins, **Chemical sensors and biosensors**, Wiley,  
C. Cámara, **Análisis químico de trazas**, Síntesis,  
L. Hernández, **Introducción al análisis instrumental**, Ariel,  
K.A. Robinson, **Análisis Instrumental**, Prentice-Hall,  
Skoog, **Principios de Análisis Instrumental**, McGraw-Hill,  
Kellner, **Analytical Chemistry**, Wiley-VCH,  
Valcárcel, **Automatización y miniaturización en Química Analítica**, Springer,

### Recommendations

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

Analytical chemistry I/V11G200V01302  
Analytical chemistry II/V11G200V01503

IDENTIFYING DATA				
Biological chemistry				
Subject	Biological chemistry			
Code	V11G200V01602			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	2nd
Teaching language	Spanish			
Department				
Coordinator	Valverde Pérez, Diana			
Lecturers	Pérez Cid, Benita Silva López, Carlos Suarez Alonso, Maria del Pilar Valverde Pérez, Diana			
E-mail	dianaval@uvigo.es			
Web				
General description	Introductory course of Biochemistry, global and integrated knowledge of the molecular mechanisms responsible of biological processes.			
Competencies				
Code				
A1	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			
A2	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			
C4	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: Basics and tools for solving analytical problems and characterization of chemical substances			
C15	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories in: chemistry of biological molecules and their processes			
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature			
C21	Recognize and implement good scientific practices for measurement and experimentation			
C23	Present oral and written scientific material and scientific arguments to a specialized audience			
C25	Handle chemicals safely, considering their physical and chemical properties, including the evaluation of any specific risks associated with its use			
C26	Perform common laboratory procedures and use instrumentation in synthetic and analytical work			
C27	Monitor, by observation and measurement of physical and chemical properties, events or changes, and document and record them in a consistent and reliable way			
C28	Interpret data derived from laboratory observations and measurements in terms of their significance and relate them to the appropriate theory			
D1	Communicate orally and in writing in at least one of the official languages of the University			
D3	Learn independently			
D4	Search and manage information from different sources			
D5	Use information and communication technologies and manage basic computer tools			
D7	Apply theoretical knowledge in practice			
D8	Teamwork			
D9	Work independently			
D12	Plan and manage time properly			
D13	Make decisions			
D14	Analyze and synthesize information and draw conclusions			
D15	Evaluate critically and constructively the environment and oneself			
Learning outcomes				
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	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Identify and recognise the properties and chemical reactivity of the diverse types of biomolecules	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Recognise the distinct biological activities of the diverse types of biomolecules	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Define the kinetical enzymatic of reactions catalized by enzymes as well as their general mechanisms	A1 A3	C4 C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Recognise the distinct types of inhibition of the enzymatic activity and his quantification	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Relate the vitamins with the corresponding coenzymes of enzymatic reactions	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15

Explain the concept of Bioenergy. Importance of endergonic and exergonic process in the biological systems	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Enumerate the main structural appearances of the ATP that determine his paper in the transfer of energy. Describe the cycle of the ATP.	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Distinguish the metabolic roads of the biomolecules, as well as their interrelationships and regulation	A1 A3	C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Explain the fundaments of the current technics of proteomics and molecular biology in relation with the isolation, separation, purification, determination, identification and manipulation of proteins and nucleic acids	A1 A2 A3	C4 C15	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Apply experimentally some basic technicians in Biochemistry	A1 A2 A3	C4 C15 C19 C21 C23 C25 C26 C27 C28	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15
Distinguish the main operations involved in the commercial production of biomolecules, as well as his foundations	A1 A2 A3 A5	C15 C21 C23 C25 C26 C27 C28	D1 D3 D4 D5 D7 D8 D9 D12 D13 D14 D15

Recognise the possible practical applications of biomolecules, with special emphasis in the characteristic operational conditions	A1	C15	D1
	A2	C19	D3
	A3	C21	D4
	A5	C23	D5
		C25	D7
		C26	D8
		C27	D9
		C28	D12
			D13
			D14
			D15
Justify the application of the distinct instrumental technics in the analysis of biomolecules	A2	C4	D1
	A3	C15	D3
		C19	D4
		C21	D5
		C23	D7
		C25	D8
		C26	D9
		C27	D12
		C28	D13
			D14
Distinguish analytical protocols of application of the previously mentioned technis to the analysis of biomolecules in diverse areas (clinical, pharmaceutical, biomedical, etc.)	A1	C4	D1
	A2	C15	D3
	A3	C19	D4
	A5	C21	D5
		C23	D7
		C25	D8
		C26	D9
		C27	D12
		C28	D13
			D14
			D15

## Contents

Topic	
1.Biomolecules	Carbohydrates: Classification and structure. Lipids: Classification and structure. Biological functions of the lipids. Proteins: Structure and configuration of the proteins. Relation structure - function. Nucleic Acids: Structure and function.
2.Biocatalisis	Nomenclature and classification of the enzymes Enzymatic Kinetics Mechanisms of the enzymatic reactions Effect of the temperature in the enzymatic reaction and inhibition Quantification of the enzymatic activity. Allosteric enzymes
3.Vitamins and coenzymes	Structure and role in metabolic reactions
4.Metabolism of glucides	Degradative Metabolism of glucides: glycolysis. Metabolic crossroad of pyruvate. Degradative Oxidation of acetil-CoA. Respiratory chain and oxidative phosphorylation. Oxidative Route of the pentoses phosphate. Gluconeogenesis. Metabolism of glycogen.
5. Metabolism of lipids	Degradation of lipids: oxidation of fatty acids . Biosynthesis of fatty acids.
6. Metabolism of proteins	Proteolisis. Degradation of amino acids. Destination of the ion ammonium. Biosynthesis of amino acids.
7.Metabolism of nucleotides	Degradation of nucleic acids and nucleotides. Biosynthesis of nucleotides.

## 8.Experimental methods in Biochemistry

Technics for synthesis and isolation of biomolécules  
 Separation, determination and identification of proteins  
 Determination and quantification of lipids  
 Determination and quantification of glycogen  
 Evaluation of the enzymatic activity. Effect of the temperature and inhibition  
 Polymerase chain reaction.  
 Utilisation of restriction enzymes

### Planning

	Class hours	Hours outside the classroom	Total hours
Seminars	13	19.5	32.5
Laboratory practises	45.5	68.25	113.75
Troubleshooting and / or exercises	3	3	6
Master Session	26	26	52
Short answer tests	6	9	15
Practical tests, real task execution and / or simulated.	2.3	3.45	5.75

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

### Methodologies

	Description
Seminars	They formulate , they argue and they resolve questions, related with the matter.
Laboratory practises	They will propose questions practise, to resolve in the laboratory.
Troubleshooting and / or exercises	Activity in which they formulate problems and/or exercises related with the matter. The student has to develop the suitable or correct solutions by means of the realisation of routines, the application of formulas or algorithms, the application of procedures of transformation of the available information and the interpretation of the results. It is used to employ as I complement of the magistral lesson.
Master Session	Exhibition by the professor of the contents on the matter object of study, theoretical bases and/or guidelines of a work, exercise or project to develop by the student.

### Personalized attention

Methodologies	Description
Seminars	The professor will resolve the doubts of the students for the good development of the activities proposed
Laboratory practises	The professor will resolve the doubts of the students for the good development of the activities proposed
Troubleshooting and / or exercises	The professor will resolve the doubts of the students for the good development of the activities proposed

### Assessment

	Description	Qualification	Training and Learning Results
Seminars	It will value the participation in the seminars and in the discussions that propose in him	20	C4 C15 C19 C23 D3 D4 D8 D12 D14 D15
Laboratory practises	It will value the assistance to practise them, the development of the same, the delivery of a memory of practise.	35	A1 A2 A3 A5 C15 C19 C21 C25 C26 C27 C28 D3 D7 D9 D12 D13 D14
Short answer tests	They will realise 2 controls with a value of 15% each one of the proofs and a final examination .	45	A1 A3 C4 C15 D1 D3 D4 D9 D12 D14

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### Other comments on the Evaluation

The note of the controls will have eliminatory character, as long as it reach the minimum value of 5.&nbsp;To surpass the matter the professor has to have in time and form of a minimum of 80% of the work requested to the student. It will be necessary to take out a 5 in the theoretical proofs of the matter to be able to take into account the rest of the elements of evaluation in the matter. In case of not reaching the necessary minimum, the final note will be the note that appears in the final examination. The no realisation of any control along the course and the no assistance to the final examination will be considered how no presented. The final qualification of the students approved will be able to be normalised, so that the qualification but high will be of until 10 points. The professor will realise a follow-up of the experimental work realised by the student in the sessions of laboratory; as well as of the fascicle/ inform elaborated. The assistance to practices is compulsory. An inferior assistance to 75% of the practical sessions supposes the qualification of suspense in the matter. For the evaluation of Julio will realise one tests writing that will be he 45% of the evaluation of the matter, will keep the qualification obtained so much in practices as in seminars.

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### Sources of information

Stryer L., Berg J. M. & Tymoczko J. L., **Bioquímica**, Editorial Reverté 7ª edición,  
Lehninger, Nelson D. L. & Cox M. M., **Principios de Bioquímica**, Editorial Omega 4ª edición,  
McKee and McKee, **Bioquímica**, Ediciones McGraw Hill 5ª edición,  
Vollhardt, K.P.C., Schore, N.E., **Química Orgánica**, 5ª,  
Andreas Manz, Nicole Pamme, Dimitri Lossifidis, **Bioanalytical Chemistry**, Imperial College Press,  
Victor A. Gault and Neville H. McClenaghan, **Understanding Bioanalytical Chemistry: principles and Applications**, Wiley Blackwell,  
Feduchi, Blasco, Romero, Yañez, **Bioquímica**, Panamericana,  
John Kuriyan, Boyana Konforti, David Wemmer, **The Molecules of Life**, Garland Science,

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### Recommendations

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

Analytical chemistry I/V11G200V01302  
Organic chemistry I/V11G200V01304  
Organic chemistry II/V11G200V01504

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IDENTIFYING DATA				
Physical chemistry III				
Subject	Physical chemistry III			
Code	V11G200V01603			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	9	Mandatory	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Bravo Díaz, Carlos Daniel			
Lecturers	Bravo Díaz, Carlos Daniel Fernández Nóvoa, Alejandro			
E-mail	cbravo@uvigo.es			
Web	<a href="http://fatic.uvigo.es/">http://fatic.uvigo.es/</a>			
General description	The matter provides training in applications of Physical Chemistry of great importance, like Chemical Kinetics, including Catálisis, surface phenomena, Macromolecules and Colloids as well as some foundations of Electrochemistry.			

### Competencies

Code	
C7	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: kinetics of change, including catalysis and reaction mechanisms
C14	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules
C19	Apply knowledge and understanding to solve basic problems of quantitative and qualitative nature
C20	Evaluate, interpret and synthesize data and chemical information
C21	Recognize and implement good scientific practices for measurement and experimentation
C22	Process and perform computational calculations with chemical information and chemical data
C23	Present oral and written scientific material and scientific arguments to a specialized audience
C26	Perform common laboratory procedures and use instrumentation in synthetic and analytical work
C27	Monitor, by observation and measurement of physical and chemical properties, events or changes, and document and record them in a consistent and reliable way
C28	Interpret data derived from laboratory observations and measurements in terms of their significance and relate them to the appropriate theory
C29	Demonstrate skills for numerical calculations and interpretation of experimental data, with special emphasis on precision and accuracy
D1	Communicate orally and in writing in at least one of the official languages of the University
D3	Learn independently
D4	Search and manage information from different sources
D5	Use information and communication technologies and manage basic computer tools
D6	Use mathematics, including error analysis, estimates of orders of magnitude, correct use of units and data representations
D7	Apply theoretical knowledge in practice
D8	Teamwork
D9	Work independently
D14	Analyze and synthesize information and draw conclusions
D15	Evaluate critically and constructively the environment and oneself

### Learning outcomes

Expected results from this subject	Training and Learning Results	
Explain the hypotheses, the consequences and the fundamental results of the Molecular Kinetic Theory of the gases	C7	D1
	C14	D3
	C19	D4
	C23	D9
Describe the general mechanism of the process of transport and *particularizarlo for the transport of distinct physical properties. Comprise the origin of the ionic conductivity. Know apply this knowledge to the determination of thermodynamic parameters like constants of balance, coefficients of activity or others like molar conductivities limit.	C7	D1
	C14	D3
	C19	D4
	C23	D9

Define with precision, all the basic concepts in Kinetic Chemical, and know the distinct methods of analysis of data to obtain equations of speed.	C7 C19 C23	D1 D3 D4 D9
Establish the kinetic behaviour of complex reactions and apply the most usual approximations in kinetic chemical. Obtain equations of speed of complex processes from the corresponding mechanisms. Distinguish between complexes of Arrhenius and van't Hoff and know realise a kinetic treatment-formal general for both cases.	C7 C14 C19	D1 D3 D4 D9
Describe the foundation of the distinct experimental techniques available for the kinetic study of the chemical reactions.	C20 C27 C28	D1 D3 D4 D9
Be able to carry out the analysis of kinetic data, including the ones of complex reactions and relate the same with the mechanisms of reaction.	C7 C19 C27	D1 D3 D4 D7 D9
Explain the fundamental hypotheses of the distinct theories on the chemical change, as well as the results and the limitations of each one of them (Theory of Collisions and Theory of the State of Transition and know apply them like tool in the analysis of kinetic results).	C7 C14 C19	D1 D3 D4 D9
Describe the distinct types of *catálisis, explain the mechanism of the reactions *catalizadas and apply it to concrete cases. Know *particularizar said kinetic treatment-formal to the distinct types of *catálisis	C7 C19	D1 D3 D4 D9
Know the basic structure of the *interfase energised and his applications to the study of the stability of the colloids and of the processes in the *interfases *electrónicas.	C7 C14 C19	D1 D3 D4 D9
Explain the principles that govern the phenomena of adsorption on solid surfaces and distinguish the types. Comprise the origin of the distinct isotherms of adsorption and know apply them to concrete problems.	C14 C19	D1 D3 D4 D9
Explain the nature and structure of the macromolecules in dissolution and the most representative models for his description.	C14 C19	D1 D3 D4 D9
Describe with clarity the nature and the distinct types of systems *coloidales. Comprise the basic appearances of the thermodynamic treatment of the macromolecular dissolutions.	C14 C19	D1 D3 D4 D9
Describe the foundation of the experimental techniques more important for the determination of the structure of *macromoléculas and systems *coloidales.	C14 C27	D1 D3 D4 D9
Describe the structure and explain the causes of the stability of the systems *coloidales as well as recognise his chemical importance.	C14 C19	D1 D3 D4 D9
Know the basic appearances of the structure of the *interfase *electrónica, the origin of the distinct types of *sobrepotencial and his application.	C7 C14 C19	D1 D3 D4 D9
Apply the distinct basic techniques in the field of the kinetic for the determination, between others, of equations of speed and energies of activation. Determine experimentally properties associated to the phenomena of transport and superficial and the structure of the macromolecules and systems *coloidales.	C19 C20 C21 C22 C26 C27 C28 C29	D1 D4 D5 D6 D7 D8 D9 D14 D15

## Contents

### Topic

(*)Phenomena of transport	(*)Kinetic theory of the gases. Phenomena of transport no electrical. Phenomena of electrical transport: conductivity
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(*)Phenomena of surface	(*)Superficial tension. Structure of the solid surfaces. Adsorption on solid surfaces. *Fisisorción And *quimisorción: models. The *interfase energised.
(*)Kinetical formal	(*)Speed of reaction and equations of speed. Analysis of data. Kinetical analysis of complex reactions. Mechanisms. Influence of the temperature in the speed of reaction.
(*)Experimental methods in Kinetical Chemical	(*)Transformation of the equations of speed. Conventional technicians. Experimental technicians for the study of fast reactions.
(*)Theoretical interpretation of the speed of reaction.	(*)Theory of collisions for reactions *bimoleculares. Theory of the state of transition.
(*)Macromolecules.	(*)Structure of the macromolecules. Structural models. Characterisation of macromolecules.
(*)Colloids.	(*)Classification of the systems *coloidales. Synthesis and characterisation of colloids. Stability of systems *coloidales.
(*)Catálisis.	(*)General mechanism of the *catálisis. *Catálisis *homogénea. *Catálisis Heterogeneous.
(*)Kinetical *electródica.	(*)Stages of a process *electródico. *Sobrepotenciales. *Sobrepotencial Of transfer of load. *Sobrepotencial Of diffusion. *Sobrepotenciales Of reaction and crystallisation. Experimental technicians.
(*)Practical.	(*)Experiences of Kinetical Chemical including *Catálisi, Phenomena of Transport, Electrochemical Macromolecules and Colloids.

## Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	26	0	26
Seminars	13	65	78
Laboratory practises	45.5	32.5	78
Short answer tests	1	5	6
Short answer tests	1	5	6
Long answer tests and development	3	15	18
Reports / memories of practice	0	6	6
Troubleshooting and / or exercises	0	7	7

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

## Methodologies

	Description
Master Session	Lesson by the method *expositivo *desarrollada in a classroom. They can pose simple exercises *directamentamente related *on the explanation.
Seminars	Approach, analysis and discussion of problems and questions of some complexity.
Laboratory practises	Practices of laboratory in the usual format

## Personalized attention

Methodologies	Description
Master Session	Resolution of doubts on the proportionate explanations in classes.
Seminars	Resolution of doubts on the proportionate explanations in classes.
Laboratory practises	Resolution of doubts on the proportionate explanations in classes of laboratory
Tests	Description
Reports / memories of practice	Resolution of doubts on the preparation and preparation of reports of laboratory.
Troubleshooting and / or exercises	Resolution of doubts on the *problemas and/or questions provided in classes.

## Assessment

	Description	Qualification	Training and Learning Results
Seminars	It values presentation and discussion of exercises *entregables	20	C7 D1 C14 D6 C19 D7 C23 D14

Laboratory practises	Realisation of practices of laboratory; when finalising the practices will realise a short proof on the concepts in which they base the same.	15	C19 C20 C21 C22 C23 C26 C27 C28 C29	
Short answer tests	Qualification of consistent short proof in questions or short problems	10	C7 C14 C19 C23	D1 D7
Short answer tests	Qualification of the second consistent short proof in questions or short problems.	10	C7 C14 C19 C23	D1 D7
Long answer tests and development	Qualification of the final examination. Questions and numerical problems.	40	C7 C14 C19 C23 C28	D1 D7
Reports / memories of practice	Qualification of the report of practices, calculations, presentation of results and discussion of the same.	5	C19 C20 C21 C22 C23 C28 C29	

#### Other comments on the Evaluation

- The assistance to masterclasses, seminars and the realisation of the practices and the delivery of the corresponding reports is compulsory.

The notes of the seminars and practical of laboratory will keep for the second evaluation. Under special circumstances, could require the preparation of "entregables" to improve the qualification obtained during the first evaluation.

The minimum note of the "official" (long) exam will be of 3.8 (in scale 0-10, 1.52 in scale 0-4) and of 3.0 (scale 0-10) in the short ones, so that the final grade will be an average (with the corresponding percentage) of the punctuations of all sections. To pass the topic, the global half punctuation has to be, of course, the same or higher than 5.0. There is not minimum punctuations in other sections, but presentation and discussion of exercises during the seminars will be important.

#### Sources of information

I.N. LEVINE, **Physical Chemistry**, 6<sup>a</sup>,  
P.W. ATKINS y J. DE PAULA, **Physical Chemistry**, 10<sup>a</sup>,  
T. ENGEL y P.J. REID, **Physical Chemistry**, 3<sup>a</sup>,  
K. J. LAIDLER, **Chemical Kinetics**, 3<sup>a</sup>,  
A. HORTA, **Macromoléculas (2 vols)**, 2<sup>a</sup>,  
S. SENENT, **Química Física II**, 3<sup>a</sup>,  
J. Bertrán y J. Núñez (coords.), **Química Física (2 vols)**, 1<sup>a</sup>,

#### Recommendations

##### Subjects that are recommended to be taken simultaneously

Analytical chemistry 3/V11G200V01601  
Inorganic chemistry II/V11G200V01604

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

Physical chemistry I/V11G200V01303  
Physical chemistry II/V11G200V01403

<b>IDENTIFYING DATA</b>				
<b>Inorganic chemistry II</b>				
Subject	Inorganic chemistry II			
Code	V11G200V01604			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	2nd
Teaching language	Spanish Galician			
Department				
Coordinator	Vázquez López, Ezequiel Manuel			
Lecturers	Carballo Rial, Rosa Vázquez López, Ezequiel Manuel			
E-mail	ezequiel@uvigo.es			
Web	http://fatic.uvigo.es			
General description	This matter presents the most relevant aspects of the Chemistry of the Transition Metals as well as an important class of derivatives known as coordination compounds.			

### Competencies

Code	
C2	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: types of chemical reactions and its main characteristics
C7	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: kinetics of change, including catalysis and reaction mechanisms
C8	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: main techniques for structural determination, including spectroscopy
C9	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: characteristic properties of the elements and their compounds, including group relationships and variations in the periodic table
C12	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: structural features of chemical elements and their compounds, including stereochemistry
C14	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories: relationship between macroscopic properties and properties of individual atoms and molecules, including macromolecules

### Learning outcomes

Expected results from this subject	Training and Learning Results
Classify ligands and coordination compounds, as well as recognize the presence of isomers.	C12
Define the global and steps thermodynamic stability constants of one complex and describe the chelate, macrocyclic and cryptate effects	C2 C14
Deduce the spectroscopic terms for stable electronic configurations of the transition metals in a coordination compound	C9
Construct and interpret a qualitative energy diagram of molecular orbitals in octahedral complexes	C12 C14
Interpret the electronic spectra of octahedral, tetrahedral and square planar complexes of transition metals and rationalize their magnetic behavior	C8 C14 C7
Describe the different mechanisms of substitution and rationalize the various products obtained in substitution reactions in octahedral and square planar complex.	
Describe how you can get metals from their natural resources	C9
Being able to differentiate the behavior between the elements of the first transition series and the second and third.	C9
Predicting the reactivity of the metal oxides, halides and of those of the coordination compounds based on the bond and on the oxidation state of the metal.	C9
Rationalize the thermodynamic stability of coordination compounds, depending on the oxidation state of the metal and the type of ligand.	C9 C12 C14

### Contents

Topic	
Subject 1: Introduction to the Chemistry of the transition metals.	Physical properties. Electronic configuration. multielectronic systems Spectroscopic terms. Reactivity and properties

Subject 2: Coordination chemistry.	Coordination numbers and geometries. Type of ligands. Isomers in coordination chemistry. Nomenclature.
Subject 3: Bonding in the coordination compounds (I):	Crystal field theory. Weak and strong field complexes in octahedral complexes. Tetrahedral square-plane complexes.
Subject 4: Bonding in the coordination compounds (II):	Molecular orbital theory in octahedral complexes. The metal-ligand interaction.
Subject 5: Spectroscopical and magnetic properties in metal complexes.	Energy states. Selection rules. Characteristics of the electronic spectra, Magnetic behavior.
Subject 6: Thermodynamic properties of the coordination compounds.	Stability constants and factors that affect them. Chelate, macrocycle and cryptate effect.
Subject 7: Mechanisms of reaction in coordination compounds.	Substitution reactions of *sustitución in square-plane and octahedral complexes. Electronic transfe.
Subject 8: Chemistry of the transitional metals	Global aspects. Frost diagrams. General methods of obtention and purification of the metals.
Subject 9: Chemistry of the 3 and 5 groups metals.	Extraction and uses. Oxidation states. Representative compounds of titanium: halides, oxides and mixed oxides. Coordination Compounds.
Subject 10: Chemistry of the 5 group metals.	Extraction and uses. Oxidation states. Representative compounds of vanadium: halides, oxides and oxoanions. Coordination Compounds.
Subject 11: Chemistry of the 6 group metals.	Extraction and uses. Oxidation states. Representative compounds of chromium: halides, oxides and oxoanions. Coordination Compounds.
Subject 12: Chemistry of the 7 group metals.	Extraction and uses. Oxidation states. Representative compounds of manganese: halides, oxides and oxoanions. Coordination Compounds. Bioinorganic chemistry of the manganese and technetium.
Subject 13: Chemistry of the 8 group metals.	Extraction and uses. Oxidation states. Representative compounds of iron: halides, oxides and mixture oxides. Coordination Compounds. Bioinorganic chemistry of iron.
Subject 14: Chemistry of the 9 group metals.	Extraction and uses. Oxidation states. Representative compounds of cobalt: halides, oxides and coordination compounds. Bioinorganic chemistry of cobalt.
Subject 15: Chemistry of the 10 group metals.	Extraction and uses. Oxidation states. Representative compounds of nickel: halides, oxides and coordination compounds. Bioinorganic chemistry of platinum.
Subject 16: Chemistry of the 11 group metals.	Extraction and uses. Oxidation states. Representative compounds of copper: halides, óxides and coordination compounds. Bioinorganic chemistry of copper and gold.
Subject 17: Chemistry of the 12 group metals.	Extraction and uses. Oxidation states. Representative compounds of zinc and mercury: halides, oxides and coordination compounds. Bioinorganic chemistry of the elements of the group.

## Planning

	Class hours	Hours outside the classroom	Total hours
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Seminars	26	26	52
Master Session	26	39	65
Short answer tests	2	2	4
Troubleshooting and / or exercises	0	21	21
Long answer tests and development	4	4	8

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

Methodologies	
	Description
Seminars	Seminar classes will be devoted to the resolution of case studies related to the subject as well as the resolution of questions or issues that arise in the development of each topic. Beheld also hold seminars that address issues not taught in other courses but necessary for the progress of the course.
Master Session	The lectures will be devoted to presenting the fundamental aspects.

### Personalized attention

Methodologies	Description
Master Session	Throughout the educational period students can consult any doubts on the matter tutorials or previous appointment.
Seminars	Throughout the educational period students can consult any doubts on the matter tutorials or previous appointment.

Assessment			
	Description	Qualification	Training and Learning Results
Seminars	In the lectures they may ask students to solve simple issues that will have to deliver at that time and will serve for the evaluation. The score will be considered only if the test is long reaches a score of 3 or above on 10 points.	10	C2 C7 C8 C12 C14
Master Session	In the lectures they may ask students to solve simple issues that will have to deliver at that time and will serve for the evaluation. The score will be considered only if the test is long reaches a score of 3 or above on 10 points.	5	C2 C7 C8 C12
Short answer tests	There will be two short tests throughout the school period of 1-2 hours each. The score will be considered only if the test is long reaches a score greater than or equal to 3 points out of 10.	30	C2 C7 C8 C9 C12 C14
Troubleshooting and / or exercises	Throughout the course they ask students to do exercises to perform such work. The solutions must be submitted in a timely manner previously established. It is possible that the teacher ask the student to defend his response delivered before proceeding with the assessment. The score will be considered only if the test is long reaches a score greater than or equal to 3 points out of 10.	15	C2 C7 C8 C9 C12 C14
Long answer tests and development	There will be a test at the end of the semester in which students must resolve all issues related to the presented contents.	40	C2 C7 C8 C9 C12 C14

### Other comments on the Evaluation

Attendance at lectures and seminars is mandatory. The competencies of the subject relating to the competencies of the degree (A1-A3, A5, A10, A12 and A20) will be assessed explicitly in classroom exercises and written tests. The transferable skills will be evaluated implicitly by the qualification of the exercises (B2, B3 and B4).

To pass the course the professor must have time and form of a minimum of 80% of the exercises proposed in the various activities and presences. It is also mandatory for the student to present all written tests planned to pass the course.

Will need a score greater than or equal to 30% of the total value in each of written tests (short and final) and the sum total of the qualifications of the deliverables to the final qualification note the rest of the elements of evaluation (exercises and

short tests). Failure to achieve any of the minimum, in the act appear the result of the tests and weighted exercises in which qualified reached criterion.

A student who performs over 20% of the total planned work or take any of the tests will be graded in accordance with the current regulations and, therefore, may not be in the act of qualifying NOT PRESENTED.

Students who fail the course at the end of the semester will take a written test in the closing period of evaluation in the final month of July. This test will be worth 40% of the mark and replace the test results at the end of the semester. The qualification of the exercises (classroom activities) and short tests are not recoverable.

The final of the students, to be more than 7 points can be normalized so that the highest score can be up to 10 points.

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#### Sources of information

Housecroft, C.E. e Sharpe, A.G., **Inorganic chemistry**, 3<sup>o</sup> Ed.,

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

Housecroft, Catherine E., **The Heavier d-block metals : aspects of inorganic and coordination chemistry**, Oxford : Oxford University Press, 1999,

Atkins, Peter, **Inorganic Chemistry**, Oxford : Oxford University Press, 2010,

Housecroft, C.E. e Sharpe, A. G., **Inorganic chemistry**, 4<sup>o</sup> ed.,

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#### Recommendations

##### Subjects that continue the syllabus

Materials chemistry/V11G200V01702

Inorganic chemistry III/V11G200V01703

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

Chemistry: Chemistry I/V11G200V01105

Chemistry: Chemistry 2/V11G200V01204

Physical chemistry I/V11G200V01303

Physical chemistry II/V11G200V01403

Inorganic chemistry I/V11G200V01404

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