



## IDENTIFYING DATA

### Chemistry: Chemistry

|                   |  |                 |      |            |
|-------------------|--|-----------------|------|------------|
| Subject           | Chemistry:<br>Chemistry  |                 |      |            |
| Code              | V12G770V01109  |                 |      |            |
| Study programme   | PCEO Grado en Ingeniería Mecánica/Grado en Ingeniería en Electrónica Industrial y Automática |                 |      |            |
| Descriptors       | ECTS Credits   | Choose          | Year | Quadmester |
|                   | 6  | Basic education | 1st  | 2nd        |
| Teaching language | Spanish<br>Galician<br>English   |                 |      |            |
| Department        |  |                 |      |            |

|                     |  |  |  |  |
|---------------------|--|--|--|--|
| Coordinator         | Cruz Freire, José Manuel   |  |  |  |
| Lecturers           | Alonso Gómez, José Lorenzo<br>Álvarez Álvarez, María Salomé<br>Bolaño García, Sandra<br>Bravo Bernárdez, Jorge<br>Cruz Freire, José Manuel<br>Díez Sarabia, Aida María<br>Iglesias Antelo, María Beatriz<br>Mejjide Fernández, Jéssica<br>Moldes Moreira, Diego<br>Nóvoa Rodríguez, Ramón<br>Otero Martínez, Nicolás<br>Ramos Berdullas, Nicolás<br>Rey Losada, Francisco Jesús<br>Salgado Seara, José Manuel<br>Vecino Bello, Xanel |  |  |  |
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| General description | This is a basic subject, common for all levels of the industrial fields studies. At the end of the course the students will have a basic knowledge about the principles of general chemistry, organic chemistry and inorganic chemistry, and its application to Industry. This knowledge will be further applied and expanded in other areas of the studies.   |  |  |  |

## Skills

|      |  |
|------|--|
| Code |  |
|------|--|

## Learning outcomes

|   |                               |
|---|-------------------------------|
| Expected results from this subject  | Training and Learning Results |
| Knowing the chemical bases of industrial technologies. Specifically, the student will gain basic knowledge of general, organic and inorganic chemistry and their applications in engineering. This will allow the student to apply the basic concepts and fundamental laws of chemistry. Due to theoretical-practical training, the student will be able to effectively carry out lab experiments and to solve basic chemistry exercises. |                               |

## Contents

## Topic

|  |   |
|--|---|
| 1. Atomic theory and chemical bonding                                    | 1.1 Atomic theory:<br>Particles of the atom: Electron, proton et neutron. Characteristics of the atom: Atomic number and Atomic mass. Isotopes. Stability of the nucleus: Radioactivity (natural and artificial). Evolution of the atomic theory.<br>1.2. Chemical bonding:<br>Definition. Intramolecular bonding: Covalent bonding and ionic bonding. Polyatomic molecules: hybridization and delocalization of electrons.<br>Intermolecular bonding: Types of intermolecular forces.  |
| 2. States of aggregation: Solids, gases, pure liquids and solutions      | 2.1. Solid state:<br>Introduction. Classification of solids: amorphous solids, molecular crystals and liquid crystals, Covalent crystals and ionic crystals.<br>2.2. Gaseous state:<br>Characteristics of the gas phase. Ideal gases: Equation of state. Real gases: Equation of state. Properties of gases.<br>2.3. Liquid state:<br>Characteristics of the liquid phase: physical properties (density, surface tension, viscosity). Changes of state. Phase diagram. Solutions: colligative properties  |
| 4. Chemical equilibrium: in gas phase, acid-base-base, redox, solubility | (4.1. Chemical equilibrium:<br>Concept of Equilibrium. Equilibrium Constant. Types of equilibrium. The Le Chatelier Principe.<br>4.2. Acid-base Equilibrium:<br>Definition of acid and base. Autoionization of water. Ionic Product. Concept of pH and pOH. Strength of acids and bases: Polyprotic acids. Amphoters. pH calculation. Acid-base titration. Buffer solutions.<br>4.3. Redox equilibrium:<br>Concept of oxidation, reduction, oxidising agent, reducing agent. Balance of redox reactions in acid and alkaline media. Redox titration. Electrochemical cells: basic concepts and redox potential. Thermodynamics of electrochemical reactions: Gibbs Energy and cell Potential. Nernst Equation. Faraday's Laws.<br>4.4 Solubility equilibrium:<br>Soluble salts: Hydrolysis. Sparingly soluble salts: solubility and solubility product. Factors affecting solubility. Fractional Precipitation. Complex Salts: Definition, properties, dissociation and importance. |
| 5. Chemical kinetics   | 5.1. Basic Concepts:<br>Reaction Rate. Reaction Order. Kinetic Constant. Rate Equation.<br>5.2. Determination of the Rate Equation:<br>Initial rate method. Integrated Rate Laws.<br>5.3. Factors affecting the Reaction Rate.  |
| 6. Basic principles of Organic Chemistry                                 | 6.1. Fundamentals of Organic formulation and functional groups:<br>6.1.1. Structure of the organic compounds: Alkanes, alkenes and alkynes. Aromatic Hydrocarbons.<br>6.1.2. Alcohols and phenols.<br>6.1.3. Ethers.<br>6.1.4. Aldehydes and ketones.<br>6.1.5. Esters.<br>6.1.6. Carboxylic acids and derivatives.<br>6.1.7. Amines and nitro-compounds.   |
| 7. Basic principles of Inorganic Chemistry.                              | 7.1. Metallurgy and the Chemistry of Metals:<br>Abundance of metals. Nature of the metallic bond, properties. Theory of the Conduction Band: conducting materials, semiconductors and superconductors. Metallurgical processes: iron and steel.<br>7.2. Non-metallic elements and their compounds:<br>General properties. Hydrogen. Carbon. Nitrogen and phosphorous. Oxygen and sulphur. Halogens.   |
| 8. Applied Electrochemistry  | 8.1. Applications of the Nernst equation: Determination of pH, Equilibrium constant, solubility product.<br>8.2. Electrochemical cells: types of cells. Concentration Cells. Electric Conductivity in electrolytes. Electrolysis Cells.<br>8.3. Industrial Processes of electrolysis: electrodeposition (electroplating), electrometallurgy, electrolysis chlorine-caustic soda. Fuel cells.  |

|   |  |
|---|--|
| 9. Corrosion and treatment of Surfaces        | <p>9.1. Basic principles of Corrosion: the corrosion cell.</p> <p>9.2. Corrosion of metals.</p> <p>9.3. Corrosion rate.</p> <p>9.4. Types of Corrosion.</p> <p>9.5. Protection against Corrosion:<br/>Design considerations for Corrosion protection. Cathodic protection: sacrificial anodes and impressed current. Organic Coatings. Metallic coatings.</p>  |
| 10. Electrochemical sensors                   | <p>10.1. Fundamentals.</p> <p>10.2. Typology and function.</p> <p>10.3. Conductivity Sensors.</p> <p>10.4. Potentiometric Sensors.</p> <p>10.5. Ion Selective electrodes. pH sensors.</p> <p>10.6. Sensors for gases in solution.</p> <p>10.7. Enzyme-based sensors: Biosensors.</p> <p>10.8. Amperometric and voltammetric sensors.</p> <p>10.9. Applications of sensors: medicine, industry, environment.</p>      |
| 11. Petroleum and derivatives. Petrochemistry | <p>11.1. Physicochemical characteristics of petroleum (oil).</p> <p>11.2. Physicochemical characteristics of natural gas.</p> <p>11.3. Conditioning and uses of natural gas.</p> <p>11.4. Drilling and crude oil extraction.</p> <p>11.5. Fractioning of oil.</p> <p>11.6. Cracking, alkylation, reforming and isomerisation of hydrocarbons.</p> <p>11.7. Treatment of sulphurous compounds and refining units.</p> |
| 12. Carbon: Carbochemistry                    | <p>(12.1. Formation of carbon.</p> <p>12.2. Types of carbons and their constitution.</p> <p>12.3. Technological uses of carbon.</p> <p>12.4. Pyrogenation of carbon.</p> <p>12.5. Hydrogenation of carbon.</p> <p>12.6. Direct liquefaction of carbon. Gasification.</p>   |

### Planning

|   | Class hours | Hours outside the classroom | Total hours |
|---|-------------|-----------------------------|-------------|
| Lecturing   | 32          | 45                          | 77          |
| Problem solving   | 10          | 12                          | 22          |
| Laboratory practical                                    | 5.4         | 7.6                         | 13          |
| Autonomous problem solving                              | 0           | 25.5                        | 25.5        |
| Objective questions exam                                | 1           | 0                           | 1           |
| Problem and/or exercise solving                         | 3           | 0                           | 3           |
| Report of practices, practicum and external practices 1 |             | 7.5                         | 8.5         |

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

### Methodologies

|                            | Description  |
|----------------------------|--|
| Lecturing                  | Presentation by the faculty member of the theoretical content of the subject using audiovisual media.  |
| Problem solving            | Activity in which problems and/or exercises related to the subject will be formulated. Students should develop appropriate solutions by applying formulas or algorithms to manage the available information and interpret the results.   |
| Laboratory practical       | Activities of application of the theoretical background to specific situations, aimed to the acquisition of basic skills related to the subject. Will be developed in the laboratories or computer rooms of the center in which subject is given. Those rooms will be equipped with the necessary specialized equipment. |
| Autonomous problem solving | Activity in which the teacher formulates problems and/or exercises related to the subject, and the student must develop the analysis and resolution in an autonomous way.  |

### Personalized assistance

| Methodologies        | Description  |
|----------------------|--|
| Lecturing            | Any doubt related with the contents given in the mater sessions will be clarified.         |
| Problem solving      | Any doubt related with the problems resolved in the seminars of problems will be answered. |
| Laboratory practical | Any doubt related with the laboratory practices will be answered.                          |

### Assessment

| Description   | Qualification | Training and Learning Results  |
|---|---------------|--|
| Autonomous problem solving                            | 10            | Students must solve independently, and periodically submit problems or exercises formulated by the faculty member. The results and the procedure followed in the execution will be evaluated. According to current legislation, the final grade will be numeric and between 0 and 10.  |
| Objective questions exam                              | 40            | The purpose of these tests, which will be carried out in the date of the official announcement of examinations, is to assess the level of theoretical knowledge acquired by students in classroom sessions. Written tests are multiple choices, multiple responses, in which students can achieve a numerical score between 0 and 10, according to current legislation.  |
| Problem and/or exercise solving                       | 40            | The evaluation of the knowledge gained by students in seminars will be through a written exam, in the official announcement of examinations, in which the student must solve 4 or 5 problems related to the subject under study. The exam will be graded according to the current legislation, with a numerical final grade between 0 and 10.  |
| Report of practices, practicum and external practices | 10            | After each laboratory session, the student should answer an oral question or prepare a detailed report including aspects such as objective and theoretical foundations, procedure followed, materials used, results and interpretation. The aspects considered in the evaluation are the content of the report, the understanding of the work done, the ability of summarising, quality of presentation, and the personal contribution. The final score, between 0 and 10, will be the average of the marks obtained in the various reports made and/or writing or oral test that could be done for each practice. |

### Other comments on the Evaluation

The final exam, consisting of two different parts, a test-type quiz for theory content and a set of exercises, will be considered for the final score weighting only when they were rated greater than or equal to 4. Although the average score could be equal or greater than 5, if the qualification of any of the parts of the final exam be lower than 4, the final score will be the lowest mark obtained in the final exam (which is the one that does not permit to calculate the average mark). The attendance to any lab session or any seminar test means that the student is being evaluated and therefore a qualification of [not presented] is no longer possible.

The marks of continuous evaluation (seminars test and lab experiments) and the marks of final exam higher than 5 (test quiz or exercises) obtained in the first call will be kept for the second call.

Those students that obtain officially the renunciation to the continuous evaluation will be evaluated by the final exam, to be held in the official date for the two calls. The final qualification will consist of a 50% of exercises and a 50% of theory (test-type) exam. A rate equal to or greater than 4 in both parts is necessary in order to pass the exam.

Ethical commitment:

The student is expected to present an adequate ethical behavior. If an unethical behavior is detected (copying, plagiarism, unauthorized use of electronic devices, and others) it is considered that the student does not meet the requirements for passing the subject. In this case, the final grade in the current academic year will be FAIL (0.0 points).

The use of electronic devices during the assessment tests will be not permitted. Introducing an unauthorized electronic device into the examination room, will be considered as a FAIL (0.0 points) in the current academic year.

### Sources of information

#### Basic Bibliography

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#### Complementary Bibliography

Atkins, P. y Jones, L, **Principios de Química. Los caminos del descubrimiento**, Ed. Interamericana,

Herranz Agustín, C, **Química para la ingeniería**, Ediciones UPC,

McMurry, J.E. y Fay, R.C, **Química General**, Ed. Pearson,

Herranz Santos, M.J. y Pérez Pérez M.L., **Nomenclatura de Química Orgánica**, Ed. Síntesis,  
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Sancho, J. y col., **Metalurgia Extractiva II: Procesos de obtención**, Ed. Síntesis,  
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Calleja, G. y col., **Introducción a la Ingeniería Química**, Ed. Síntesis,  
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Pingarrón, J.M. y Sánchez Batanero, P., **Química Electroanalítica. Fundamentos y Aplicaciones**, Ed. Síntesis,  
Ramos Carpio, M. A., **Refino de Petróleo, Gas Natural y Petroquímica**, Ediciones UPM,  
Vian Ortuño, A., **Introducción a la Química Industrial**, Ed. Reverté,  
Herrero Villén, M.A., Atienza Boronat, J.A., Nogera Murray, P. y Tortajada Genaro, L.A., **La Química en problemas. Un enfoque práctico**, Ediciones UPV,  
Quiñoa ,E., **Cuestiones y ejercicios de química orgánica: una guía de estudio y autoevaluación**, Ed. McGraw Hill,  
Llorens Molina, J.A., **Ejercicios para la introducción a la Química Orgánica**, Ed Tébar,  
Sánchez Coronilla, A., **Resolución de Problemas de Química**, Ed. Universidad de Sevilla,  
Brown, L.S., Holme, T.A., **Chemistry for engineering students**, Brooks/Cole Cengage Learning, 3rd ed.,

## Recommendations

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

Physics: Physics 1/V12G350V01102

Mathematics: Algebra and statistics/V12G350V01103

Mathematics: Calculus 1/V12G350V01104

### Other comments

It is recommended that students have taken and passed the subject of ""Chemistry"" in second baccaulaureate or, alternatively, passed a specific test of access to the Degree.

## Contingency plan

### Description

=== EXCEPTIONAL PLANNING ===

=== EXCEPTIONAL MEASURES SCHEDULED ===

Given the uncertain and unpredictable evolution of the health alert caused by COVID-19, the University of Vigo establishes extraordinary planning that will be activated at the time that the administrations and the institution itself determine it based on safety, health and responsibility criteria and guaranteeing teaching in a non-classroom or partially classroom setting. These already planned measures guarantee, at the required time, the development of teaching in a more agile and effective way, as it is known in advance by the students and teachers through the standardized tool and institutionalized teaching guides or syllabus.

=== ADAPTATION OF THE METHODOLOGIES ===

All the teaching methodologies explained in the syllabus are maintained, but the lectures will be performed by means of the Remote Campus of the University of Vigo.

If the lab practices could not be developed in person, the theoretical content will be explained by Remote Campus.

Moreover, some videos recorded by the teachers will be provided, so that the student could see the procedure that should be done. Then, the students will be provided with experimental data, so that they can complete the corresponding lab report.

Office hours could be carried out in different modalities: in person, by email or through the virtual offices at the Remote Campus of the University of Vigo.

=== ADAPTATION OF THE EVALUATION ===

Modification of the evaluation tests:

Autonomous problem solving: the student must periodically deliver the problems or exercises formulated by the teacher; this topic increase their weight in the grade from 10% to 30%.

Problem solving and / or exercises: The final problem exam, to be held on the official dates set by the EEI, reduces its weight in the final grade, from 40% to 20%. The test will be graded with a final numerical grade between 0 and 10.

Multiple choice test: The final theory exam will be carried out on the official dates set by the EEI; it will be a multiple-choice test; it reduces its weight in the final grade from 40% to 20%. The test will be graded with a final numerical grade between 0 and 10.

Lab Practices report: The qualification of the laboratory practices maintains a weight of 10% in the final grade.

Autonomous resolution of theory questionnaires: These new continuous assessment tests are added; the student must carry out theory multiple-choice tests, which will have a weight of 20% in the final grade.

Considering that some students could be unable to do some test of continuous assessment, two possible procedures of qualification will be considered. The selected one will be the most favorable for each student in the two calls. The two procedures of weighing are:

a) Final score = theory exam x 0.2 + problem exam x 0.2 + continuous evaluation problems x 0.3 + continuous evaluation theory x 0.2 + lab practice x 0.1

b) Final score = theory exam x 0.5 + problem exam x 0.5

A grade greater than or equal to 4.0 in both the final theory exam and in the problem exam will be required in order to pass the subject in both weighting systems.

For the second call, the continuous evaluation grades obtained throughout the course are maintained, as well as the scores equal to or greater than 5.0 of the multiple-choice tests or problems exam obtained in the first call.

Those students who officially obtain the renounce of continuous assessment will do, on the official exam date of the two calls, a problem exam and a theory multiple-choice test, which will be weighted by 50% each of them in their grade. A grade greater than or equal to 4.0 in each exam will be a requirement.

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