| Teaching Guide | | | | |
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| Identifying Data | | | | 2020/21 |
| Subject (*) | Chemistry Laboratory 2 | | Code | 610G01032 |
| Study programme | Grao en Química | | | |
| Descriptors | | | | |
| Cycle | Period | Year | Type | Credits |
| Graduate | 2nd four-month period | Second | Obligatory | 6 |
| Language | Spanish | | | |
| Teaching method | Face-to-face | | | |
| Prerequisites | | | | |
| Department | Química | | | |
| Coordinador | Soto Ferreiro, Rosa Maria | E-mail | rosa.soto.ferreiro@udc.es | |
| Lecturers | Ojea Cao, Vicente<br>Prieto Blanco, Maria del Carmen<br>Ruiz Pita-Romero, Maria<br>Soto Ferreiro, Rosa Maria | E-mail | vicente.ojea@udc.es<br>m.c.prieto.blanco@udc.es<br>maria.ruiz.pita-romero@udc.es<br>rosa.soto.ferreiro@udc.es | |
| Web | | | | |
| General description | The aim of the subject is the practical learning for the experimental determination of basic physicochemical properties and structural elucidation by application of spectrometric, spectroscopic and electrochemical techniques | | | |

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| Contingency plan | 1. Modifications to the contents: no changes are made.<br><br>2. Methodologies<br>*Teaching methodologies that are maintained: all (guest lectures / keynote speeches, seminars, workshops and laboratory practices).<br><br>*Teaching methodologies that are modified: all the methodologies are adapted to the hybrid or non-face-to-face modality through Moodle and Teams and the programming established in the coordination calendar of the Center is maintained.<br>- In the standard operations practices the student will elaborate a previous work report from the self-explanatory materials available in Moodle.<br>The mixed objective/subjective test will consist of an individual manuscript exam, carried out asynchronously through Moodle and, it will be performed in advance during the school period if the coordination with the other subjects allows it.<br>- In the physicochemical characterization practices, self-explanatory materials will be provided through Moodle (PowerPoint presentations with audio and explanatory videos, practice scripts adapted to virtual teaching and individual "practical cases") that will allow the student to carry out a previous work of preparation and a work "on-line" related to the practices.<br>The practical test will consist of an "on-line" test on the previous work and that related to the practices.<br>In both cases, laboratory experiences that have not been carried out in person or on-line will not be evaluated. Competency A26 (carrying out standard procedures in laboratories involved in analytical and synthetic work, in relation to organic and inorganic compounds) should be reinforced in subsequent courses.<br><br>3. Mechanisms for personalized attention to students: personalized monitoring will be carried out at the request of the students and, as far as possible, during the hours established for tutoring, through email, the Moodle platform or the TEAMS tool. For students with part-time dedication or specific learning modalities or diversity support, personalized attention will be provided within the flexibility allowed by coordination schedules and material and human resources.<br><br>4. Modifications in the evaluation: the contributions to the final qualification of the evaluable methodologies are modified as follows: mixed test (30%), workshops (15%), standard operations practices (5%), physicochemical characterization practices (40%), and practical test (10%).<br><br>*Evaluation observations: all the observations included in the teaching guide are maintained.<br><br>5. Modifications to the bibliography or webgraphy: no modifications are made, all the necessary materials will be available in Moodle or through access to the electronic resources available in the Library of the Center. |

| Study programme competences / results | |
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| Code | Study programme competences / results |
| A1 | Ability to use chemistry terminology, nomenclature, conventions and units |
| A7 | Knowledge and application of analytical methods |
| A9 | Knowledge of structural characteristics of chemical and stereochemical compounds, and basic methods of structural analysis and research |
| A10 | Knowledge of chemical kinetics, catalysis and reaction mechanisms |
| A12 | Ability to relate macroscopic properties of matter to its microscopic structure |
| A14 | Ability to demonstrate knowledge and understanding of concepts, principles and theories in chemistry |
| A15 | Ability to recognise and analyse new problems and develop solution strategies |
| A16 | Ability to source, assess and apply technical bibliographical information and data relating to chemistry |
| A17 | Ability to work safely in a chemistry laboratory (handling of materials, disposal of waste) |
| A19 | Ability to follow standard procedures and handle scientific equipment |
| A20 | Ability to interpret data resulting from laboratory observation and measurement |
| A21 | Understanding of qualitative and quantitative aspects of chemical problems |

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| A23 | Critical standards of excellence in experimental technique and analysis |
| A26 | Ability to follow standard laboratory procedures in relation to analysis and synthesis of organic and inorganic systems |
| B2 | Effective problem solving |
| B3 | Application of logical, critical, creative thinking |
| B4 | Working independently on own initiative |
| C1 | Ability to express oneself accurately in the official languages of Galicia (oral and in written) |
| C3 | Ability to use basic information and communications technology (ICT) tools for professional purposes and learning throughout life |

| Learning outcomes | | | |
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| Learning outcomes | Study programme competences / results | | |
| Perform standard laboratory operations for the preparation, separation and purification of organic compounds, materials handling safely, reagents and waste. | A1<br>A9<br>A12<br>A14<br>A15<br>A16<br>A17<br>A20<br>A21<br>A23<br>A26 | B2<br>B3<br>B4 | C1 |
| Applying spectroscopic and spectrometric techniques in determining the structure of organic compounds. | A1<br>A9<br>A14<br>A15<br>A16<br>A21 | B2<br>B3<br>B4 | C1<br>C3 |
| Application of electrochemical and spectroscopic techniques for the determination of the basic physicochemical properties of the compounds | A1<br>A7<br>A10<br>A17<br>A19<br>A23<br>A26 | B2<br>B4 | C1<br>C3 |
| Being able to apply electrochemical and spectroscopic techniques for the determination of basic physicochemical properties of the compounds. | A14<br>A15<br>A20<br>A21 | B2<br>B3 | C1 |

| Contents | |
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| Topic | Sub-topic |
| 1. Standard laboratory operations. | Preparation, separation and purification of chemical compounds |
| 2. Spectrometric techniques for determining molecular structure | Application of the 1H and 13C NMR, mass spectrometry, and infrared spectroscopy for structural determination. Characteristics frequency of the main functional groups. Tables of additivity. |

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| 3. Electrochemical and spectroscopic techniques for the physicochemical characterization of compounds. | Quantitative applications of electrochemical (potentiometry and conductimetry) and spectroscopic techniques : determination of reaction rates, equilibrium constants, molar masses, stoichiometry of the complexes, application of the Generalized Beer Law |

| Planning | | | | |
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| Methodologies / tests | Competencies / Results | Teaching hours (in-person & virtual) | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech | A1 A9 A21 B3 | 4 | 0 | 4 |
| Seminar | A1 A9 A14 A15 A16 A21 B3 C1 C3 | 3 | 4.5 | 7.5 |
| Workshop | A1 A9 A14 A15 A16 A21 B2 B3 B4 C1 C3 | 10 | 15 | 25 |
| Laboratory practice | A1 A7 A10 A12 A14 A16 A17 A19 A20 A21 A23 A26 B3 B4 C1 | 39 | 65.5 | 104.5 |
| Practical test: | A1 A7 A14 A15 A17 A19 A20 A21 A23 A26 B2 B3 B4 | 2 | 2 | 4 |
| Mixed objective/subjective test | A1 A9 A14 A15 B2 B3 | 2 | 2 | 4 |
| Personalized attention | | 1 | 0 | 1 |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. | | | | |

| Methodologies | |
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| Methodologies | Description |
| Guest lecture / keynote speech | In the first class a general presentation of the subject will be carried out: objective, contents and organization of the subject. In later sessions the basic notions of instrumentation, calibration and fundamentals of mass spectrometry will be explained. |
| Seminar | General aspects of the application of spectrometric and / or spectroscopic techniques in the structural determination. |
| Workshop | Resolution of practical cases of structural determination. The proposed problems will be solved, elaborating strategies that require the integration of data coming from the different spectroscopic techniques for the structural elucidation. Use of computer programs for the estimation of NMR data. Previously to some sessions, students must submitt (through Moodle) for some of the proposed problems. |
| Laboratory practice | The students will carry out the preparation, separation and structural determination of compounds (in the Standard Operations Laboratory) and will use electrochemical and spectroscopic techniques for the experimental determination of properties of compounds (in the Physicochemical Characterization Laboratory). In both Laboratories the students will develop the programmed experiences and should elaborate laboratory reports including the data obtained and their discussion, as well as the answers to the questions raised to deepen the understanding of the experiments carried out. The reports of the standard operations practices will be submitted through Moodle. |
| Practical test: | Realization of a practical test and resolution of questions in the laboratory, about the contents of the practices on characterization of physicochemical properties. Students will have an advanced opportunity to perform the practical test, once they have completed Physicochemical Characterization Laboratory. |
| Mixed objective/subjective test | The mixed test will include problems about structural elucidation from spectrometric and or spectroscopic data, analogous to those solved during the workshops |

| Personalized attention |
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| Methodologies | Description |
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| Laboratory practice<br>Workshop | The student will have the help of the teacher during tutorials (in addition to the classroom activities) for the resolution of doubts and questions that may arise in the preparation of laboratory practices, reports on the problems of structural determination or on the work to be done in the Laboratories of standard operations or characterization of physicochemical properties. |

| Assessment | | | |
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| Methodologies | Competencies / Results | Description | **Qualification** |
| Laboratory practice | A1 A7 A10 A12 A14 A16 A17 A19 A20 A21 A23 A26 B3 B4 C1 | The organization, attitude and activity developed by the students during the laboratory sessions will be valued, as well as the corresponding laboratory reports, which must be submitted for evaluation. | 40 |
| Mixed objective/subjective test | A1 A9 A14 A15 B2 B3 | The mixed test will consist of problems about structural determination, analogous to those solved in the workshops. | 30 |
| Practical test: | A1 A7 A14 A15 A17 A19 A20 A21 A23 A26 B2 B3 B4 | A practical test with questions about the practices covering the characterization of physicochemical properties will be held in the laboratory. Students will have an advanced opportunity to perform the practical test, once they have completed the physicochemical characterization practices | 20 |
| Workshop | A1 A9 A14 A15 A16 A21 B2 B3 B4 C1 C3 | The attitude and work carried out by the student during the problem solving sessions will be assessed. Solutions and reports submitted by the students will also be evaluated. | 10 |

| Assessment comments |
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Laboratorio de Química 2 (LQ2) is an experimental curse and the attendance to all the evaluation activities is mandatory. For this reason, all the students will be graded in all activities with the flexibility that the coordination schedules and the material and human resources allow. To pass LQ2, it is necessary to obtain in the workshop, the mixed test, the practical text and the laboratory practices (corresponding to either the standard operations or the characterization of physicochemical properties) a note equal to or greater than 4 on 10. Therefore, students with a global grade equal to or greater than 5 who have not reached the qualification of 4 in any evaluable activity will be graded as not pass (grade of 4.5). Students who had not attended to the activities required to reach 25% of the global grade will receive the unpresented qualification. The students who have not reached the qualification of 4 in the advanced opportunity for the practical test will have to repeat it in the first or the second opportunity.

Regarding to the second opportunity of evaluation: (1) The qualifications of the laboratory practices (corresponding to either the standard operations or the characterization of physicochemical properties) will be preserved at the second opportunity. (2) The qualifications obtained for the practical test and mixed test in the second opportunity will substitute to those obtained in the the corresponding tests of the first opportunity. (3) The qualification obtained for the workshops could be preserved in the second opportunity or, in an alternative way, students could perform an optional exercise to evaluate the activities developed in the workshops during the course. (4) The students evaluated in the second opportunity will only be eligible for the Honored Grade (Matrícula de Honor) if the maximum number of these grades for the corresponding course has not been covered in full at the first opportunity.

The teaching-learning process, including the evaluation, refers to a complete academic course and, therefore, will start again with a new academic year, including all the activities and evaluation procedures that are schedulled for that course.

Students with part-time dedication will be evaluated with the criteria previously explained. Students with academic exemption from attendance or specific modalities of learning or support for diversity may be evaluated only through laboratory practices (standard operations and physical-chemical characterization), practical test and mixed test, both in the first as in the second opportunity (they will have dispensation of attendance to the workshops, corresponding to 10% of the global qualification). For those students who took advantage of the workshop attendance waiver, the mixed test will contribute to 40% of the overall score. The attendance to the laboratory practices is mandatory and the students will be graded with all the flexibility that the coordination schedules and the material and human resources available can offer. In the case of exceptional, objectivable and adequately justified circumstances, the responsible professor could exempt a student from attending the process of continuous evaluation of laboratory practices. The student who is in this circumstance must pass a specific examination (corresponding to 100% of the grade) precluding any doubt about the achievement of the knowledge, skills and competences of the subject.

**Sources of information**

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|---|---|
| **Basic** | - Mª Ángeles Martínez Grau; Aurelio G Csákÿ. (2001). Técnicas experimentales en síntesis orgánica . Ed. Síntesis<br>- José Ramón Pedro; Gonzalo Blay (2010). 200 Problemas de determinación estructural de compuestos orgánicos. Ed. Vision Libros, Madrid<br>- K. Peter C. Vollhardt; Neil S. Schore (2008). Espectroscopia de resonancia magnética nuclear, Espectroscopia de infrarrojo y Espectrometría de masas. Capítulos 10 y 11 en: Química Orgánica, Estructura y Función. 5ª Ed. Ediciones Omega<br>- L. G. Wade, Jr. (2012). Espectroscopia de infrarroja y espectrometría de masas, Espectroscopia de resonancia magnética nuclear. Capítulos 12 y 13 en: Química Orgánica, volumen 1. 7ª Ed. Pearson<br>- Jonathan Clayden; Nick Greeves; Stuart Warren. (2012). Determining organic structures; 1H NMR: proton nuclear magnetic resonance. Capítulos 3 y 13 en: Organic Chemistry . 2nd Ed. Oxford University Press<br>- Andrade Garda, J. M.; Carlosena Zubieta, A.; Gómez Carracedo, M. P.; Maestro Saavedra, M. A.; Prieto (2017). Problems of instrumental analytical chemistry. A hands-on guide. World Scientific<br>- Castro, A. R.; Moreno Bondi, M. C.; Simonet Suau, B. M. (coords) (2012). Técnicas espectroscópicas en química analítica. Vol I: Aspectos básicos y espectrometría molecular. Síntesis<br>- Espenson, J. H. (2002). Chemical Kinetics & Reaction Mechanisms.. 2ª ed, McGraw-Hill.<br>- Connors, K .A. ( 1987). Binding Constants. The Measurement of Molecular Complex Stability. Wiley & Sons: New York<br>- Levine, I. N. (2004). Fisicoquímica . 5ª ed., McGraw-Hill, Madrid.<br>- Gavira Vallejo, J. M.; Hernanz Gismero, A. (2007). Técnicas fisico-químicas en medio ambiente. UNED<br>- Skoog, D. A; Holler, F. James; Nieman, Timothy A. (2001). Análisis químico cuantitativo. Reverté |
| **Complementary** | |

| Recommendations |
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| **Subjects that it is recommended to have taken before** |
| General Chemistry 1/610G01007 |
| General Chemistry 2/610G01008 |
| General Chemistry 3/610G01009 |
| Chemistry Laboratory 1/610G01010 |
| Analytical Chemistry 1/610G01011 |
| Physical Chemistry 1/610G01016 |
| Inorganic Chemistry 1/610G01021 |
| Organic Chemistry 1/610G01026 |
| **Subjects that are recommended to be taken simultaneously** |
| Analytical Chemistry 2/610G01012 |
| Physical Chemistry 2/610G01017 |
| Inorganic Chemistry 2/610G01022 |
| Organic Chemistry 2/610G01027 |
| **Subjects that continue the syllabus** |
| Instrumental Analytical Chemistry 1/610G01013 |
| Instrumental Analytical Chemistry 2/610G01014 |
| Advanced Analytical Chemistry and Chemometrics/610G01015 |
| Physical Chemistry 3/610G01018 |
| Intermediate Organic Chemistry/610G01028 |
| Experimental Organic Chemistry/610G01029 |
| Advanced Organic Chemistry/610G01030 |
| **Other comments** |
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(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.