



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                                                                  |        |                                                             |           |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                                                                                  |        |                                                             | 2023/24   |
| Subject (*)         | Analytical Chemistry 1                                                                                                                                                                                                                                                           | Code   |                                                             | 610G01011 |
| Study programme     | Grao en Química                                                                                                                                                                                                                                                                  |        |                                                             |           |
| Descriptors         |                                                                                                                                                                                                                                                                                  |        |                                                             |           |
| Cycle               | Period                                                                                                                                                                                                                                                                           | Year   | Type                                                        | Credits   |
| Graduate            | 1st four-month period                                                                                                                                                                                                                                                            | Second | Obligatory                                                  | 6         |
| Language            | SpanishGalicianEnglish                                                                                                                                                                                                                                                           |        |                                                             |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                                                                                     |        |                                                             |           |
| Prerequisites       |                                                                                                                                                                                                                                                                                  |        |                                                             |           |
| Department          | Química                                                                                                                                                                                                                                                                          |        |                                                             |           |
| Coordinador         | Beceiro Gonzalez, Maria Elisa                                                                                                                                                                                                                                                    | E-mail | elisa.beceiro.gonzalez@udc.es                               |           |
| Lecturers           | Beceiro Gonzalez, Maria Elisa<br>Gonzalez Castro, Maria Jose                                                                                                                                                                                                                     | E-mail | elisa.beceiro.gonzalez@udc.es<br>m.j.gonzalez.castro@udc.es |           |
| Web                 |                                                                                                                                                                                                                                                                                  |        |                                                             |           |
| General description | This subject introduces the student in the Analytical Chemistry applying the chemical equilibria to the qualitative and quantitative analysis, establishing the bases of the discipline for the following academic courses. Therefore it exerts a basic role in the full Degree. |        |                                                             |           |

## Study programme competences / results

| Code | Study programme competences / results                                                                    |
|------|----------------------------------------------------------------------------------------------------------|
| A4   | Knowledge of main types of chemical reaction and characteristics of each                                 |
| A7   | Knowledge and application of analytical methods                                                          |
| 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                               |
| A23  | Critical standards of excellence in experimental technique and analysis                                  |
| A24  | Ability to explain chemical processes and phenomena clearly and simply                                   |
| B1   | Learning to learn                                                                                        |
| B2   | Effective problem solving                                                                                |
| B3   | Application of logical, critical, creative thinking                                                      |
| B4   | Working independently on own initiative                                                                  |
| B5   | Teamwork and collaboration                                                                               |
| C1   | Ability to express oneself accurately in the official languages of Galicia (oral and in written)         |
| C6   | Ability to assess critically the knowledge, technology and information available for problem solving     |

## Learning outcomes

| Learning outcomes                                                                        | Study programme competences / results |                |          |
|------------------------------------------------------------------------------------------|---------------------------------------|----------------|----------|
| To apply the foundations of the chemical equilibria in the classical methods of analysis | A4<br>A7<br>A16<br>A24                | B1<br>B2<br>B4 | C1<br>C6 |
| To learn the data handling and present the analytical results                            | A7<br>A16<br>A20                      | B1<br>B2<br>B4 | C1       |



|                                                                                                                            |     |    |    |
|----------------------------------------------------------------------------------------------------------------------------|-----|----|----|
| To understand the qualitative and quantitative aspects of the analysis                                                     | A4  | B1 | C1 |
|                                                                                                                            | A7  | B2 | C6 |
|                                                                                                                            | A20 | B4 |    |
|                                                                                                                            | A21 |    |    |
|                                                                                                                            | A24 |    |    |
| To acquire the basic skill in the laboratory of Analytical Chemistry (basic operations of the classical chemical analysis) | A7  | B1 | C1 |
|                                                                                                                            | A16 | B2 | C6 |
|                                                                                                                            | A17 | B3 |    |
|                                                                                                                            | A19 | B4 |    |
|                                                                                                                            | A20 | B5 |    |
|                                                                                                                            | A21 |    |    |
|                                                                                                                            | A23 |    |    |
|                                                                                                                            | A24 |    |    |

| Contents                             |                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                | Sub-topic                                                                                                                                                                                                                                                                                                                                                                         |
| Chapter 1: Analytical Chemistry      | Definition and scopes<br>Qualitative and quantitative analysis<br>The analytical process<br>Classification of methods and techniques                                                                                                                                                                                                                                              |
| Chapter 2: Titrimetric Methods       | Basic concepts, titrimetric reaction and types of Titrations<br>Primary standards, standard solutions and standardized solutions<br>Equivalence point and detection of the end point<br>Titration curves<br>Errors associated to titrimetric methods                                                                                                                              |
| Chapter 3: Acid-Base Titrations      | Acid-Base titration theory. Titration curves<br>Indicators for acid-base titrations. Selection of an indicator<br>Strong acid versus strong base and vice versa<br>Weak acid versus strong base and vice versa<br>Titration of polyprotic acids or bases and their salts<br>Titration of mixtures of acids or bases<br>Acid-Base titration in nonaqueous solvents<br>Applications |
| Chapter 4: Redox Titrations          | Titration curves<br>Redox indicators and their selection<br>Oxidizing and reducing agents used prior to titration<br>Titrations with oxidizing agents<br>Titrations with reducing agents<br>Determination of organic and inorganic compounds                                                                                                                                      |
| Chapter 5: Complexometric Titrations | Coordination compounds of interest in titrimetric analysis<br>Titration curves and the factors that affect them<br>Metal ion indicators for chelometric titrations<br>Titrations with polyaminocarboxylic acids                                                                                                                                                                   |
| Chapter 6: Precipitation Titrations  | Precipitation reactions of interest in titrimetric analysis<br>Titration curves<br>Titration of mixtures<br>Detection of the end point: Mohr, Volhard and Fajans methods                                                                                                                                                                                                          |



|                                          |                                                                                                                                                                                                                                                                                                           |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chapter 7: Gravimetric Analysis          | Principles of the gravimetric analysis<br>Steps and classification of gravimetric methods<br>Precipitation process. Conditions for analytical precipitation<br>Gravimetry by chemical precipitation. Treatment of precipitates<br>Gravimetry by volatilization and absorption<br>Gravimetric calculations |
| Chapter 8: Evaluation of Analytical Data | Definitions and basic concepts<br>Statistic treatment for indetermined errors<br>The confidence limit<br>Rejection of a result<br>Tests of significance<br>Analytical data how present them                                                                                                               |
| Chapter 9: Qualitative Analysis          | Application of chemical reactions to the qualitative analysis<br>Analytical characteristics of chemical reactions (sensitivity, selectivity and safety)<br>General and specific reagents<br>Analytical characteristics and reagents for metal ions<br>Analytical characteristics and reagents for anions  |
| Module: Laboratory practice              | Acid-Base Titrations<br>Redox Titrations<br>Complexometric Titrations<br>Precipitation Titrations<br>Gravimetric Analysis<br>Evaluation of Analytical Data                                                                                                                                                |

| Planning                                                                                                                        |                                                           |                                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------------------------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies / Results                                    | Teaching hours (in-person & virtual) | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A4 A7 A21 B1                                              | 24                                   | 36                            | 60          |
| Problem solving                                                                                                                 | A7 A16 A20 B1 B2 B4<br>C1                                 | 8                                    | 18                            | 26          |
| Seminar                                                                                                                         | A7 A20                                                    | 2                                    | 0                             | 2           |
| Laboratory practice                                                                                                             | A7 A16 A17 A19 A20<br>A21 A23 A24 B1 B2<br>B3 B4 B5 C1 C6 | 18                                   | 18                            | 36          |
| Short answer questions                                                                                                          | A4 A7 A21 B4                                              | 0                                    | 1.5                           | 1.5         |
| Supervised projects                                                                                                             | A7 A16 A20 B1 B2 B4<br>C1                                 | 0                                    | 3                             | 3           |
| Mixed objective/subjective test                                                                                                 | A4 A7 A20 A21 A24<br>B1 B2 C1 C6                          | 3                                    | 18                            | 21          |
| Personalized attention                                                                                                          |                                                           | 0.5                                  | 0                             | 0.5         |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                                                           |                                      |                               |             |

| Methodologies                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Guest lecture / keynote speech | In the lecture classes the professor will develop the fundamental contents of the program of the subject. To make a good use of these sessions, the student will have to prepare previously the fundamental appearances of the topic to treat, employing the educational material (diagram that reflects the contents of each topic), which will be provided to the student through the Campus Virtual platform. The student also will must read the chapter regarding to the topic to treat in the recommended bibliography |



|                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Problem solving                 | Classes in intermediate groups devoted to the resolution of the bulletins of problems, which previously will have been provided to the student through the Campus Virtual platform, and that the students will have to realise of autonomous form for their resolution and explanation in these classes. Besides, in these sessions any doubts on any appearance related with the lecture sessions will be resolved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Seminar                         | Initial activity, before beginning the laboratory sessions, which consists on 1 session of 2 hours. In this session, the students will be exposed to the educational methodology that will be employed in the practices of laboratory.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Laboratory practice             | <p>6 laboratory sessions of 3 hours of length, in which the student will carry out the application of the theoretical concepts studied in the classroom.</p> <p>Each practice owns a script and a prelaboratory exercise which will be provided to the student (through the Campus Virtual platform) previously to the practice sessions. The realisation of the prelaboratory exercises before starting the laboratory practice is mandatory. The scripts will have questions that the students will have to answer and deliver once finished the practices.</p> <p>During laboratory sessions, and on a simultaneous way to the realisation of the experiments, the student will have to elaborate a fascicle of laboratory that collect the calculations and the experimental procedures. The professor will review the notebook of each student in each laboratory session.</p> |
| Short answer questions          | Exams about the topics of the subject will be carried out employing short answer questions . These exams will be realised employing the Campus Virtual platform.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Supervised projects             | <p>Supervised learning process in small groups (3-4 students) with the aim of helping students to work independently and encouraging students to become responsible for their own learning.</p> <p>The proposed activities will be related with problem solving sessions. The students will work together to solve the tasks assigned by the teacher, with the aim of optimising their learning experience and that of other members of group. The activities will be discussed in a tutelage session.</p>                                                                                                                                                                                                                                                                                                                                                                          |
| Mixed objective/subjective test | Two written exams will be carried out in each one of the two official announcements of January/July. One of them will evaluate the learning of the student by means of questions of theory and applied theory and the other one will consist on the resolution of problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

## Personalized attention

| Methodologies                                                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Laboratory practice<br>Problem solving<br>Supervised projects | <p>The classes of laboratory practice are conceived like activities in small groups in which the student participates directly. In this way both methodologies let personalised attention to the students allowing a better follow-up and orientation.</p> <p>Regarding the supervised projects, for each group of students a tutelage session will be programmed for discussion of the activities and resolution of doubts. Therefore, the teacher will be able to analyse if the process of learning of the student is suitable.</p> <p>Besides, along the term, the students will be able to do use of the schedule of tutelage sessions for asking queries or doubts about the subject.</p> <p>Students with official recognition of part-time dedication and academic assistance waiver regime will be attended in a tutorships regime (by appointment). The realization of laboratory practices and assistance to problem solving sessions will be provided within the flexibility to allow coordinating schedules and material and human resources.</p> |

## Assessment

| Methodologies | Competencies / Results | Description | Qualification |
|---------------|------------------------|-------------|---------------|
|---------------|------------------------|-------------|---------------|

|                                 |                                                           |                                                                                                                                                                                                                                                                                                                                                                     |     |
|---------------------------------|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Laboratory practice             | A7 A16 A17 A19 A20<br>A21 A23 A24 B1 B2<br>B3 B4 B5 C1 C6 | It will be evaluated the suitable realisation of the prelaboratory exercises, the skill in the realisation of the experimental work, the interpretation of the data obtained, as well as the correct realisation of the calculations, the answers to the questions of practices (that they will have to deliver) and the preparation of the notebook of laboratory. | 20  |
| Problem solving                 | A7 A16 A20 B1 B2 B4<br>C1                                 | The work carried out before and during the sessions as well as the attitude and degree of participation of the student in the classes.                                                                                                                                                                                                                              | 5   |
| Mixed objective/subjective test | A4 A7 A20 A21 A24<br>B1 B2 C1 C6                          | Two written exams in each one of the two official announcements of January/July: one of them will consist on questions of theory and applied theory and the another one will consist on exercises focused to the resolution of problems.                                                                                                                            | 60  |
| Supervised projects             | A7 A16 A20 B1 B2 B4<br>C1                                 | The adequate resolution of the proposed projects, the degree of participation of the student in the tutelage session, and the quality of explanation of each activity.                                                                                                                                                                                              | 7.5 |
| Short answer questions          | A4 A7 A21 B4                                              | Exams to be realised through the Campus Virtual platform about the topics of the subject by means of short answer questions.                                                                                                                                                                                                                                        | 7.5 |

#### Assessment comments

To pass the subject two basic requirements are needed:

1.- The realization of laboratory practice is mandatory to pass the subject. 2.-Reach a minimum qualification in the laboratory practice and in each mixed test. This minimum qualification will cannot be lower than 5 (over 10). Note that the subject will not be approved (even when the overall sum exceeds 5) if one of these particular scores do not reach 5. In this case, the subject is failed and the final qualification will be 4.5. In the first and second opportunity, the students who carried out the laboratory practice but the obtained qualification was lower than 5, will have the opportunity to, in addition to the mixed test, perform a specific test related to the laboratory practice. The score of this test will replaced the grade obtained in practice for the overall rating. Students who do not participate on the problem solving, supervised projects and do not carry out the short answer questions will score 0 in these sections. The student will obtain the qualification of No Presented when the student does not attend to the mixed test. In the context of "continuous evaluation" the "second opportunity" is a second opportunity of realisation of the mixed test and a specific test related to the laboratory practice. Therefore, the laboratory practice (except for students who did not get a minimum of 5), problem solving, supervised projects and short answer questions will keep the qualifications obtained along the course, whereas the qualification of the mixed test and a specific test related to the laboratory practice corresponding to second opportunity will substitute to those obtained in the first opportunity. The students evaluated in the "second opportunity" only will be able to opt to Mark Honor if the maximum number of the Honors for the corresponding course has not covered in its whole in the "first opportunity". For students with recognition of a part-time dedication, the evaluation will be carried out under the same criteria.

For students with academic exemption waiver assistance, conducting laboratory practices is mandatory and they will be provided within the flexibility to allow coordinating schedules and material and human resources. On the other hand, assistance to the greatest number of problem solving sessions will be provided, if students can not attend the problem solving sessions, they will make a mentoredwork. Therefore, these students will be evaluated by the qualifications obtained in laboratory practice (20%), in the mixed test (60%), in short answer questions (7.5%) and in the activities of supervised projects-problem solving (12.5%). This will be applied to both opportunities. Regarding fraudulent performance in tests or evaluation activities, the article 11 (section 4b) of the UDC assessment rules relating to the commission of Fraud will be applied: Penalization by obtaining "0" as score in the corresponding academic year whether the fraud is committed at the first or second opportunity.

#### Sources of information

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b> | <p>- SKOOG D.A., WEST D.M., HOLLER F.J. y CROUCH S.R. (2005). Fundamentos de Química Analítica . Madrid, Ed. Paraninfo</p> <p>- SKOOG D. A., WEST D.M. y HOLLER F. J (1997). Fundamentos de Química Analítica . Barcelona, Ed. Reverté</p> <p>- HARRIS, DANIEL C (2007). Análisis Químico Cuantitativo . Barcelona, Ed. Reverté</p> <p>O libro "Análisis Químico Cuantitativo" do autor Daniel C. Harris (Ed. Reverté SA), atópase dispoñible na web da biblioteca da UDC.</p> |
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|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Complementary</b> | <ul style="list-style-type: none"><li>- GUITERAS J. RUBIO R. y FONRODONA G. (2003 ). Curso Experimental en Química Analítica . Madrid, Ed. Síntesis</li><li>- SILVA M. y BARBOSA J. (2002 ). Equilibrios iónicos y sus Aplicaciones Analíticas . Madrid, Ed. Síntesis</li><li>- LÓPEZ CANCIO J.A. (2005). Problemas Resueltos de Química Analítica . Madrid, Ed. Paraninfo</li><li>- YÁÑEZ-SEDEÑO P., PINGARRÓN J.M. y MANUEL DE VILLENA F.J. (2003 ). Problemas Resueltos de Química Analítica . Madrid, Ed. Síntesis</li><li>- BURRIEL MARTI F., LUCENA CONDE F., ARRIBAS JIMENO S. y HERNÁNDEZ MÉNDEZ J. (2001 ). Química Analítica Cualitativa . Madrid, Ed. Paraninfo</li><li>- HARVEY D. (2002). Química Analítica Moderna . Madrid, Ed. McGraw-Hill</li></ul> |
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## Recommendations

### 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

### Subjects that are recommended to be taken simultaneously

### Subjects that continue the syllabus

Analytical Chemistry 2/610G01012  
Instrumental Analytical Chemistry 1/610G01013  
Instrumental Analytical Chemistry 2/610G01014  
Advanced Analytical Chemistry and Chemometrics/610G01015

### Other comments

To register on this subject it is recommended having passed the subject ?Chemical 3? Green Campus Faculty of Sciences Program ? SUSTAINABILITY. To help achieve a sustainable environment and comply with point 6 of the "Environmental Declaration of the Faculty of Sciences (2020)", the documentary works carried out in this subject:

a. They will be requested mainly in virtual format and computer support.

b. If done on paper:

- Plastics will not be used.
- Double-sided printing will be performed.
- Recycled paper will be used.
- The preparation of drafts will be avoided. In accordance with current legislation, compliance with the gender perspective will be ensured, promoting values of respect and equality and avoiding situations of discrimination

(\*)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.