



Universidad  
de Huelva

Faculty of Experimental Sciences

# GRADE IN CHEMISTRY

## Subject Data

**Name:**

Instrumental Analytical Chemistry

**English name:**

Instrumental Analytical Chemistry

**Code:**

757509201

**Type:**

Compulsory

**Hours:**

	Total	In class	Out class
<b>Time distribution</b>	150	45	105

**ECTS:**

Standard group	Small groups			
	Classroom	Lab	Practices	Computer classroom
6		3		

**Departments:**

Chemistry

**Knowledge areas:**

Analytical Chemistry

**Year:**

Second year

**Semester**

First semester

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## TEACHING STAFF

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<b>Others Data (Tutoring, schedule... )</b>		
<p>Tutoring: Monday 10-11h, Monday 15-17 h, Wednesday 13-14h, Wednesday 15-17h Office: 1.05. 1<sup>st</sup> floor. Center for Research in Sustainable Chemistry-CIQSO</p> <p>Tutoring: Monday 12-14h, Tuesday 12-14 h, Wednesday 12-14h, Office: 07. Module 5, 3<sup>rd</sup> floor. Faculty of Experimental Sciences.</p>		

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### SPECIFIC INFORMATION OF THE COURSE

#### I. Contents description:

##### I.1 In English:

Instrumental analysis: General principles, fundamentals of electroanalysis, electrodes and potentiometry, electroanalytical techniques, optical techniques of analysis, fundamentals and applications of analytical spectrophotometry, fundamentals and applications of atomic spectroscopy, fundamentals and applications of mass spectrometry

##### I.2 In Spanish:

Análisis instrumental: principios generales, fundamentos del electroanálisis, electrodos y potenciometría, técnicas electroanalíticas, técnicas ópticas de análisis, fundamentos y aplicaciones de la espectrofotometría analítica, fundamentos y aplicaciones de la espectroscopia atómica, fundamentos y aplicaciones de la espectrometría de masas.

#### 2. Background:

##### 2.1 Situation within the Degree:

“Instrumental Analytical Chemistry” is a subject of Analytical Chemistry in the Degree of Chemistry. The student have previously studied in the first year “Fundamentals of Analytical Chemistry”, which considers the general analytical process and the study of chemical equilibria and their application in classical methods (gravimetry and volumetric analysis). In “Instrumental Analytical Chemistry” the students deal with modern analytical techniques, involving atomic techniques, electroanalysis and mass spectrometry.

##### 2.2 Recommendations

The students should study first “Fundamentals of Analytical Chemistry”

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### 3. Objectives (as result of teaching):

To provide to the students an overall perspective of instrumental analytical techniques related to molecular and atomic spectroscopy, considering in particular absorption and emission techniques. Electroanalytical techniques will be also described, as well as mass spectrometry and coupled techniques. Applied aspects of the techniques will be considered.

### 4. Skills to be acquired

#### 4.1 Specific Skills:

C3 - Conocer los principios y procedimientos usados en el análisis químico y en la caracterización de los compuestos químicos.

C16 - Conocer las técnicas instrumentales y sus aplicaciones.

C18 - Conocer la metrología de los procesos químicos incluyendo la gestión de calidad.

C19 - Capacidad para organizar, dirigir y ejecutar tareas del laboratorio químico y de producción en instalaciones industriales complejas donde se desarrollen procesos químicos. Asimismo, para diseñar la metodología de trabajo a utilizar.

Q2 - Capacidad de aplicar dichos conocimientos a la resolución de problemas cualitativos y cuantitativos según modelos previamente desarrollados.

Q3 - Competencia para evaluar, interpretar y sintetizar datos e información química.

Q4 - Capacidad para reconocer y llevar a cabo buenas prácticas en el trabajo científico y profesional.

Q5 - Competencia para presentar, tanto en forma escrita como oral, material y argumentación científica a una audiencia especializada.

Q6 - Destreza en el manejo y procesado informático de datos e información química.

P1 - Habilidad para manipular con seguridad materiales químicos, teniendo en cuenta sus propiedades físicas y químicas, incluyendo cualquier peligro específico asociado con su uso.

P2 - Habilidad para llevar a cabo procedimientos estándares de laboratorio implicados en trabajos analíticos y sintéticos, en relación con sistemas orgánicos e inorgánicos.

P3 - Habilidad para la observación, seguimiento y medida de propiedades, eventos o cambios químicos, y el registro sistemático y fiable de la documentación correspondiente.

P4 - Habilidad para manejar instrumentación química estándar, como la que se utiliza para estudios estructurales y separaciones.

P5 - Interpretación de datos procedentes de observaciones y medidas en el laboratorio en términos de su significación y de las teorías que la sustentan.

P6 - Capacidad para realizar valoraciones de riesgos relativos al uso de sustancias químicas y procedimientos de laboratorio.

#### 4.2 General, Basic or Transversal Skills:

Competencias Generales:

CG1 - Que los estudiantes hayan desarrollado y demostrado poseer habilidades de aprendizaje y conocimientos procedentes de su campo de estudio, siendo capaces de aplicarlos en su trabajo, interpretando datos relevantes para emitir juicios de temas de diversa índole pudiendo transmitirlos a un público tanto especializado como no especializado

Competencias básicas:

CB1 - Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.

CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio.

CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética.

CB4 - Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado

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como no especializado.

CB5 - Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía.

B1 - Capacidad de análisis y síntesis.

B2 - Capacidad de organización y planificación.

B5 - Capacidad para la gestión de datos y la generación de información/conocimiento.

B6 - Resolución de problemas.

B8 - Trabajo en equipo.

B9 - Razonamiento crítico.

B10 - Capacidad de aprendizaje autónomo para el desarrollo continuo profesional.

B11 - Sensibilidad hacia temas medioambientales.

### 5. Training Activities and Teaching Methods

#### 5.1 Training Activities:

- Theory and exercises group.
- Laboratory group.

#### 5.2 Teaching Methods::

- In-person classes for theoretical and exercises of the subject, using teaching resource such as PowerPoint presentations and videos.
- Laboratory practices in small groups: experiments, collection of results, discussion, conclusions in a final report.

#### 5.3 Development and Justification:

### 6. Detailed Contents

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The following sections of topics and the corresponding lessons are:

Topic 1. Introduction to Instrumental Analytical Chemistry

Lesson 1. Introduction to Instrumental Analytical Chemistry

Lesson 2. Calibration of instrumentation

Topic 2. Molecular Spectroscopy and applications

Lesson 3. Interaction between electromagnetic radiation and matter

Lesson 4. Molecular absorption spectroscopy

Lesson 5. Molecular emission spectroscopy

Topic 3. Atomic Spectroscopy and applications

Lesson 6. Atomic absorption spectroscopy

Lesson 7. Atomic emission spectroscopy

Topic 4. Mass spectrometry and applications

Lesson 8. Mass spectrometry

Topic 5. Electrochemistry and electrochemical techniques

Lesson 9. Electrodes and potentiometry

Lesson 10. Electrogravimetry and coulometry

Lesson 11. Polarography

Laboratory practices:

1. Spectrophotometric analysis of chromogenic chemical species.
2. Determination of metals by flame atomic absorption spectroscopy.
3. Determination of metals by flame atomic emission spectroscopy.
4. Potentiometric titrations.
5. Potentiometry using ion-selective electrodes: pH, fluoride, ammonium.

## 7. Bibliography

### 7.1 Basic Bibliography:

- D.A. Skoog, J.F. Holler, S.R. Crouch, Principles of Instrumental Analysis, 7th ed., Cengage Learning (2018)
- D.C. HARRIS, Quantitative Chemical Analysis, 9th ed., Freeman (2016)
- J.T. Watson, Introduction to Mass Spectrometry, 3rd edition, Lippincott-Raven (1997)

### 7.2 Additional Bibliography:

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None

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### 8. Systems and Assessment Criteria

#### 8.1 System for Assessment:

The system of assessment is described in each of the examinations convocatory.

#### 8.2 Assessment Criteria and Marks:

##### 8.2.1 Examinations Convocatory I

The Convocatory I will consists of 3 trials, following these criteria:

- Exam of theoretical and practical questions. A minimum grade of 4.5 over 10 in this exam is necessary to obtain the final grade.
- Report of laboratory practices. The results obtained and reported by the students in the laboratory will be graded.
- Test exam of the laboratory practices.

Requirements: Is mandatory to perform the laboratory practices and to hand the reports to the teacher.

The final grade of the subject will be calculated as:

70% of the grade of the Final Exam of theoretical and practical questions,  
20% of the grade of the Report of laboratory practices,  
10% of the Test Exam of the laboratory practices.

To pass the subject, the final grade has to be 5 or higher, on a scale of 10.

The final grade will consider the student's non-compliance of the basic rules of behavior and operation, approved by the Centre Board, that the university community must follow at the Experimental Science Faculty

##### 8.2.2 Examinations Convocatory II

The Convocatory II will consist of 3 trials, following these criteria:

- Final Exam of theoretical and practical questions. A minimum grade of 4.5 over 10 in this exam is necessary to obtain the final grade.
- Report of one laboratory practice. The results obtained and reported by the students in the laboratory will be graded. Note: If the student has previously done the lab practices within the established period and has delivered the Reports, graded equal or higher than 5 on scale of 10, this grade will considered
- Test Exam of the laboratory practices. Note: If the student has previously done the test of lab practices within the established period with a grade equal or higher than 5 on scale of 10, this grade will considered.

Requirements: Is mandatory to perform the laboratory practices and to hand the reports to the teacher.

The final grade of the subject will be calculated as:

80% of the grade of the Final Exam of theoretical and practical questions,  
10% of the grade of the Report of laboratory practices,  
10% of the Test Exam of the laboratory practices.

To pass the subject, the final grade has to be 5 or higher, on a scale of 10.

The final grade will consider the student's non-compliance of the basic rules of behavior and operation, approved by the Centre Board, that the university community must follow at the Experimental Science Faculty.

##### 8.2.3 Examinations Convocatory III



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The Convocatory III will consist of 3 trials, following these criteria:

- Final Exam of theoretical and practical questions. A minimum grade of 4.5 over 10 in this exam is necessary to obtain the final grade.
  - Report of one laboratory practice. The results obtained and reported by the students in the laboratory will be graded. Note: If the student has previously done the lab practices within the established period and has delivered the Reports, graded equal or higher than 5 on scale of 10, this grade will be considered.
  - Test Exam of the laboratory practices. Note: If the student has previously done the test of lab practices within the established period with a grade equal or higher than 5 on scale of 10, this grade will be considered.
- Requirements: It is mandatory to perform the laboratory practices and to hand the reports to the teacher.

The final grade of the subject will be calculated as:

80% of the grade of the Final Exam of theoretical and practical questions,

10% of the grade of the Report of laboratory practices,

10% of the Test Exam of the laboratory practices.

To pass the subject, the final grade has to be 5 or higher, on a scale of 10.

The final grade will consider the student's non-compliance of the basic rules of behavior and operation, approved by the Centre Board, that the university community must follow at the Experimental Science Faculty.

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### 8.2.4 Extraordinary Convocatory

The Extraordinary Convocatory will consist of 3 trials, following these criteria:

- Final Exam of theoretical and practical questions. A minimum grade of 4.5 over 10 in this exam is necessary to obtain the final grade.
- Report of one laboratory practice. The results obtained and reported by the students in the laboratory will be graded. Note: If the student has previously done the lab practices within the established period and has delivered the Reports, graded equal or higher than 5 on scale of 10, this grade will be considered.
- Test Exam of the laboratory practices. Note: If the student has previously done the test of lab practices within the established period with a grade equal or higher than 5 on scale of 10, this grade will be considered.

Requirements: It is mandatory to perform the laboratory practices and to hand the reports to the teacher.

The final grade of the subject will be calculated as:

- 80% of the grade of the Final Exam of theoretical and practical questions,
- 10% of the grade of the Report of laboratory practices,
- 10% of the Test Exam of the laboratory practices.

To pass the subject, the final grade has to be 5 or higher, on a scale of 10.

The final grade will consider the student's non-compliance of the basic rules of behaviour and operation, approved by the Centre Board, that the university community must follow at the Experimental Science Faculty.

### 8.3 Single Final Evaluation:

To have the right for the Single Final Evaluation, the student must indicate it to the teacher responsible of the subject. The student has to do it within the first two weeks of the teaching period or within the first two weeks after enrollment in the subject, using the corresponding application form of the Faculty. Choosing the Single Final Evaluation will imply explicitly to lose the chance of taking the Continuous Evaluation, without possibility of changing the procedure of examination. As in the Continuous Evaluation, the final grade will consider the student's non-compliance of the basic rules of behavior and operation approved by the Centre Board that the university community must follow at the Experimental Science Faculty.

The single Final Evaluation of the Ordinary Proposal will consist of 3 trials:

- Final Exam of theoretical and practical questions. A minimum grade of 4.5 over 10 in this exam is necessary to obtain the final grade.
- Report of one laboratory practice. The results obtained and reported by the students in the laboratory will be graded. Note: If the student has previously done the lab practices within the established period and has delivered the Reports, graded equal or higher than 5 on scale of 10, this grade will be considered.
- Test Exam of the laboratory practices. Note: If the student has previously done the test of lab practices within the established period with a grade equal or higher than 5 on scale of 10, this grade will be considered.

Requirements: It is mandatory to perform the laboratory practice and to hand the report to the teacher.

The final grade of the subject will be calculated as:

- 70% of the grade of the Final Exam of theoretical and practical questions,
- 20% of the grade of the Report of the laboratory practice,
- 10% of the Test Exam of the laboratory practices.

To pass the subject, the final grade has to be 5 or higher, on a scale of 10.

The final grade will consider the student's non-compliance of the basic rules of behavior and operation, approved by the Centre Board, that the university community must follow at the Experimental Science Faculty.