

**Chemical Balance and Instrumentation**

Code: 102846  
ECTS Credits: 9

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	2	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

### Contact

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### Use of Languages

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

### Teachers

Jordi Gené Torradella

### Prerequisites

It is recommended to know inorganic formulation. It is highly recommended to have understood and to know how to put into practice the chemical equilibrium part of the subject Chemistry (1st year).

### Objectives and Contextualisation

Chemical Equilibrium and Instrumentation is part of the general subject Chemistry for Environmental Sciences. The main objectives are to be able to interpret the fundamentals of most environmental problems, mainly in aquatic environments, as well as to recognize the methods of analysis of environmental samples. The specific objectives are the following:

- Know the most important chemical fundamentals about the different equilibrium reactions in aqueous and their application and consequences to the environment.
- Acquire basic knowledge of the classical and current techniques used in the analysis of the main environmental compounds.
- Develop the necessary skills to solve chemical equilibrium and instrumentation problems related to environmental cases.
- Develop the necessary skills to work in a laboratory.

### Competences

- Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
- Analyze and use information critically.

- Collect, analyze and represent data and observations, both qualitative and quantitative, using secure adequate classroom, field and laboratory techniques
- Demonstrate adequate knowledge and use the most relevant environmental tools and concepts of biology, geology, chemistry, physics and chemical engineering.
- Demonstrate concern for quality and praxis.
- Demonstrate initiative and adapt to new situations and problems.
- Learn and apply in practice the knowledge acquired and to solve problems.
- Quickly apply the knowledge and skills in the various fields involved in environmental issues, providing innovative proposals.
- Work autonomously

## Learning Outcomes

1. Adequately convey information verbally, written and graphic, including the use of new communication and information technologies.
2. Analyze and use information critically.
3. Apply chemical knowledge to solve problems in a quantitative or qualitative nature relating to the environment.
4. Demonstrate concern for quality and praxis.
5. Demonstrate initiative and adapt to new situations and problems.
6. Develop work type chemical analysis from previously established procedures.
7. Handle tools and equipment in chemical laboratories standards of environmental control.
8. Identify the chemical processes in the surrounding environment and evaluate them properly and originally.
9. Interpret data from databases or by experimental measures, including the use of computer tools, identify the meaning and relate behavior in environmental systems.
10. Learn and apply in practice the knowledge acquired and to solve problems.
11. Make correct assessments of health risks and environmental and socioeconomic impacts associated with chemicals and the chemical industry.
12. Observe, recognize, analyze, measure, and so properly and safely represent chemical processes applied to environmental sciences.
13. Safe handling of chemicals, taking into account their physical and chemical properties.
14. Work autonomously

## Content

### I. Introduction to environmental chemical analysis

Unit 0.- Stoichiometric relations of chemical reactions. Equilibrium conditions of a reversible reaction. Equilibrium constant  $K_{eq}$  by a reaction. Relative importance of direct or inverse reactions according to the magnitude of the equilibrium constant. Reaction ratio,  $Q_{eq}$ . Principle of Le Châtelier.

Unit 1.- Water chemistry and environment. Analytic chemistry. The analytical process Methods of analysis: classical methods and instrumental methods. Parameters of analytical quality. Calibration and standards.

### II. Acid-base equilibrium in the environment. Determination of environmental parameters by classical methods.

Unit 2.- Acids and bases according to Brönsted and Lowry. Water autoionization Definition of pH. Electrolytes Relative strength of an acid-base pair: acidity and basicity constants. Prediction of acid-base reactions. Calculation of the pH of an acid or a base. Solubility of gases in water: pH of rainwater and acid rain. Buffer solutions. Calculation of the pH of salts.

Unit 3.- Introduction to volumetric analysis techniques. Titrations of acids or bases; Titration curves, equivalence point and end point. Acid-base indicators. Application of titrations to environmental parameters.

III. Solubility equilibrium of poorly soluble solids and complexation in the environment. Determination of environmental parameters by classical methods.

Unit 4.- Solubility and Kps. Limestone waters; solubility and Kps of  $\text{CaCO}_3$ . Variation of solubility of  $\text{CaCO}_3$  with pH. Methods of determination of chlorides (salinity). Methods of fractionated precipitation.

Unit 5.- Complexes: Lewis acids and bases. Complexes equilibrium. Complexes and acidity. Complexation titrations. Determination of water hardness. Complexing reactions in natural waters.

IV. Oxidation-reduction equilibrium. Determination of environmental parameters by classical methods.

Unit 6.- Redox reactions: characteristics and definitions. Electrochemical cells Measurement of the potential (f.e.m.) of a cell. Standard electrode potential. Prediction of a redox reaction. Nerst equation.

Unit 7.- Redox titrations. Determination of Chemical Oxygen Demand (COD) and environmental significance.

V. Instrumental methods of analysis applied to environmental samples

Unit 8.- Calibration of the method. Calibration with external patterns. Linear regression by least squares. Calibration using the standard addition method.

Unit 9.- Electrical methods. Potentiometric methods of analysis. Reference electrodes. Ion Selective Electrodes (ESI). Amperometric methods. Determination of dissolved oxygen (DO) and Determination of biochemical oxygen demand (BOD) and environmental significance.

Unit 10.- Interaction of electromagnetic radiation - matter. Optical analysis techniques: classifications. Absorption and emission of radiation: spectra. Law of Lamber-Beer. Molecular absorption spectroscopic techniques: UV-Vis and IR. Fundamentals and instrumentation. Environmental applications. Atomic spectroscopic techniques: atomic absorption and atomic emission.

Unit 11.- Introduction to the separation techniques of environmental compounds. Concept, fundamentals and classification of chromatography. Chromatographic parameters. Qualitative and quantitative analysis. Calibration with internal standard. Gas chromatography (GC). Liquid chromatography (HPLC).

## Methodology

The subject will be developed through theoretical classes (lectures), supported with additional material, classroom practices and laboratory practices.

Some case problems will be developed by the students and others will be carried out by the teachers on the blackboard.

Self-evaluation activities will be carried out either in or out of the classroom, to be solved cooperatively or individually.

The laboratory practices are mandatory.

### ***DIRECTED ACTIVITIES***

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Theoretical classes (lectures)	50h	Lectures
	3-4 /week	Units 0-5: Cristina Palet Ballús
		Units 6-11: Jordi Gené Torradabella

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Classroom practices	18h	Classroom practices. Problem discussion and solving
	1/week	

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Laboratory practices	6 days  (3,5 h/session)  Attendance and delivery of laboratory reports are compulsory.	Laboratory practices
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### ***SUPERVISED ACTIVITIES***

Tutorials	<a href="mailto:cristina.palet@uab.cat">cristina.palet@uab.cat</a> <a href="mailto:jordi.gene@uab.cat">jordi.gene@uab.cat</a>	Tutorials for exercises solving and understanding of theoretical concepts
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### ***AUTONOMOUS ACTIVITIES***

Study	Making schemes and summaries and understanding of concepts
Problem case solving	Problem approach and solving
Laboratory guides reading	Comprehensive reading of practice guides
Laboratory reports writing	Making reports of laboratory practices

## **Activities**

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom practices	18	0.72	2, 3, 10, 5, 4, 9, 12, 1, 14
Laboratory practices	21	0.84	2, 3, 5, 4, 6, 11, 9, 7, 13, 12, 1, 14
Lectures	50	2	2, 5, 4, 11, 8, 12, 1, 14
Type: Supervised			
Tutoring	13	0.52	
Type: Autonomous			
Laboratory guides reading (practices)	11	0.44	

Problem solving	36	1.44
Study	49	1.96

## Assessment

### 1. EXAMINATIONS:

A) Partial exams (50%): Two written *partial exams* (25% each) on the concepts of theory and problems (eliminate matter).

Minimum note of 3.0 of each partial to be able to pass by partial exams.

1st partial exam Themes 0-5

2nd Partial Exam Themes 6-11

B) Second Chance exam (each partial or global exam)

In order to attend to this exam, the student has had previously been evaluated by 2/3 of the continuous evaluation activities.

Partial exams can be done separately.

A minimum score of 3.0 of these exams (before or after the second chance exam) is necessary to be able to do a weighted average with other activities.

### 2. EVIDENCE LEARNING AND FORUM (35%)

There will be group or individual self-assessment activities in and out of the classroom (30%).

Participation in the Virtual Campus Forum (5%).

### 3. LABORATORY PRACTICES (15%)

a. Reports of practices and attitude (7.5%)

b. Exam (7.5%)

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evidence of learning + Forum virtual campus	35 %	14	0.56	2, 3, 10, 5, 6, 8, 9, 12, 1, 14
Laboratory practices (50% exam, 50% reports)	15 %	7	0.28	3, 10, 5, 4, 11, 8, 9, 7, 13, 12, 14
Written test (1st partial)	25 %	3	0.12	2, 3, 10, 6, 8, 12
Written test (2nd partial)	25 %	3	0.12	2, 3, 10, 6, 8, 12

## Bibliography

1.-"Química General". Ralph Petrucci, William Harwood, Geoffrey Herring. Prentice-Hall (Pearson) 10a Edición, 2011. ISBN: 9788483226803

2.- V.L. Snoeyink i D. Jenkins, Química del agua, Ed. Limusa, México, 1995.

3.- C. Baird, Química Ambiental, Ed.Reverté, (2001)

4.-"Equilibrios iónicos y sus aplicaciones analíticas" Manuel Silva, José Barbosa. Ed. SINTESIS, 2002. ISBN: 9788497560252

5.- "Anàlisi química quantitativa" D.C. Harris Ed. Reverté, traducció de la 6a edició, 2006.

ON-LINE BIBLIOGRAPHY:

QUÍMICA GENERAL 10ed

[Carey Bissonnette](#) , [F. Geoffrey Herring](#) , [Jeffrey D. Madura](#) y [Ralph H. Petrucci](#)

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