Universitat Autònoma de Barcelona

2022/2023

Chemical Balance and Instrumentation

Code: 102846
ECTS Credits: 9

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	2	1

Contact

Name: Cristina Palet Ballus
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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 Gene Torrabadella

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.- Mass and ion charge balances. Acids and bases according to Brönsted and Lowry: pH, acidity and basicity constants. Prediction of acid-base reactions. Calculation of the pH of an acid/base system: very weak systems, buffer solutions, polyprotic systems, ampholytes, salts of acid/basic hydrolysis.

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 $CaCO_3$. Variation of solubility of $CaCO_3$ with pH. Methods of determination of chlorides (salinity).

Unit 5.- Complexes: Lewis's 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

Theoretical classes (lectures)	50h 3-4 /week	Lectures Cristina Palet Ballús Jordi Gené Torrabadella
Classroom practices	18h 1/week	Classroom practices. Problem discussion and solving

Laboratory practices	20h 5 days (4 h/session) Attendance, wear a lab coat and delivery of laboratory reports are compulsory.	To attend the Practical Laboratory Classes, the student mustjustify having passed the Safety Test in the teaching laboratories that he will find in the "Security" space of the moodle of the Faculty of Sciences. For safety reasons, if this test has not been passed or you are not wearing a lab coat, access to the laboratory will not be allowed. Carrying out laboratory practices and writing and delivering the practice reports for each session.
SUPERVISED ACTIVITIES		
Tutorials	cristina.palet@uab.cat jordi.gene@uab.cat	Tutorials for exercises solving and understanding of theoretical concepts
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

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Classroom practices	18	0.72	2, 3, 10, 5, 4, 9, 12, 1, 14
Laboratory practices	20	0.8	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	50	2

Assessment

1. EXAMINATIONS:

A) Partial exams (60%): Two written *partial exams* (30% each) on the concepts of theory and problems (eliminate matter).

Minimum note of 4.0 of each partial to be able to pass by partial exams.

1st partial exam Themes 0-5 (always depending on the academic calendar)

2nd Partial Exam Themes 6-11 (always depending on the academic calendar)

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 for the second chance.

A minimum score of 4.0 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 (25%)

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

3. LABORATORY PRACTICES (15%)

Mandatory attendance.

The Practice Reports will be valued, as well as the work and attitude in the laboratory.

A minimum score of 4.0 is necessary to be able to do a weighted average with other activities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evidence of learning	25 %	14	0.56	2, 3, 10, 5, 6, 8, 9, 12, 1, 14
Laboratory practices	15 %	7	0.28	3, 10, 5, 4, 11, 8, 9, 7, 13, 12, 14
Written test (1st partial)	30 %	3	0.12	2, 3, 10, 6, 8, 12
Written test (2nd partial)	30 %	3	0.12	2, 3, 10, 6, 8, 12

Bibliography

1.- Ralph Petrucci, Wiliam Harwood, Geoffrei Herring, *Química General*, 10a Edició, Editorial: Prentice-Hall (Pearson), 2011. ISBN: 9788483226803

2.- Daniel C. Harris, *Anàlisi química quantitativa*, Traducció 6a ed., Editorial: Reverté, 2006.

3.- Daniel C. Harris, Charles A. Lucy, *Quantitative Chemical Analysis*, 10th ed., Editorial: MacMillan Learning, 2020.

4.- C. Baird, *Química Ambiental*, Editorial: Reverté, 2001.

5.- Manuel Silva, José Barbosa, *Equilibrios iónicos y sus aplicaciones analíticas*, Editorial: SINTESIS, 2002. ISBN: 9788497560252

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Ralph H. Petrucci, F. Geoffrey Herring, Jeffry D. Maduray, Carey Bissonnette. Ed. Pearson, 11 ed., Madrid, 2017.

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ANÁLISIS QUÍMICO CUANTITATIVO

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Software

Microsoft Excel will be used.