Universitat Autònoma de Barcelona

2019/2020

Chemical Balance and Instrumentation

Code: 102846
ECTS Credits: 9

Degree	Type	Year	Semester
2501915 Environmental Sciences	OB	2	1

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 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 quality 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. The buffer system H_2CO_3 / HCO_3^-. Calculation of the pH of salts. CO_2 / Carbonate systems: pH of seawater and other natural waters. pH control in chlorinated water. Alkalinity and acidity of water.

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

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

Unit 4.- Limestone waters; solubility and Kps of $CaCO_3$. Variation of $CaCO_3$ solubility with pH. Concentration of ions in natural waters. Solubility of $CaCO_3$ and "stability" of water; Langelier index (IL), corals and microplankton. Methods of determination of chlorides (salinity). Methods of fractionatedprecipitation.

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

IV. Oxidation-reduction equilibrium. Determination of quality 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 (reduction potential). Prediction of a redox reaction. Nerst equation. Constant equilibrium of a redox reaction.

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

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): determination of pH and other ions in aqueous solutions. Amperometric methods. Determination of dissolved oxygen (DO) and environmental significance. 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. Applications: determination of chlorine and determination of total organic carbon (TOC). Atomic spectroscopic techniques: atomic absorption (flame and graphite furnace) and atomic emission (flame photometry and ICP).

Unit 11.- Introduction to the separation techniques of environmental compounds. Concept and fundamentals of chromatography. Classification. Elution. 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, supported with additional material, classes of problems and practices.

Some 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 in the classroom in the form of problems to be solved cooperatively and others individually.

The laboratory practices are mandatory.

DIRECTED ACTIVITIES

Theoretical classes	50h	Lectures
	3-4 /week	Temas 0-5: Mar Puyol Bosch
		Temas 6-11: Jordi Gené Torrabadella

Exercises	18h 1/week	Exercise discussion and solving
Laboratory practices	6 days (3,5 h/session) Attendance and delivery of laboratory reports is compulsory.	Laboratory practices in pairs
SUPERVISED ACTIVITIES		
Tutorials	mariadelmar.puyol@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
Exercises 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	
Laboratory practices	21	0.84	
Master classes, supported by power point	50	2	
Type: Supervised			

Tutoring	13	0.52
Type: Autonomous		
Problem solving	36	1.44
Reading scripts (practices)	11	0.44
Study	49	1.96

Assessment

1. EXAMINATIONS:

A) Partial exams: Two written partial exams (35% each) on the concepts of theory and problems (eliminate matter).

Minimum note of 3.5 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 exams (each partial or global exam)

In order to attend to these exams, 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 3.5 is necessary to avoid making the Second Change exams.

A minimum note of 4 as the average of the partial exams is required to average with other activities: 4.0.

2. EVALUATION ACTIVITIES (10%)

Delivery of problems, test tests in the classroom and group work.

3. PRACTICES (20%)

a. Reports of practices and attitude (50%)

b. Test (50%)

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Activity in the classroom	10%	5	0.2	2, 3, 10, 5, 6, 8, 9, 12, 1, 14
Laboratory practices (60% exam, 40% reports)	20%	16	0.64	3, 10, 5, 4, 11, 8, 9, 7, 13, 12, 14
Written test (1st partial)	30-40%	3	0.12	2, 3, 10, 6, 8, 12
Written test (2nd partial)	30-40%	3	0.12	2, 3, 10, 6, 8, 12

Bibliography

1.-"Química General". Ralph Petrucci, Wiliam Harwood, Geoffrei Herring. Prentice-Hall (Pearson) 10a Edició, 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.