COURSE DATA

Data Subject	
Code	33077
Name	Chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1104 - Degree in Environmental Sciences	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
1104 - Degree in Environmental Sciences	115 - Chemistry	Basic Training

Coordination

Name	Department
OCHANDO GOMEZ, LUIS E.	315 - Physical Chemistry

SUMMARY

The course **Chemistry** is a basic subject that is taught quarterly within the *Module I: General Scientific basis*, in the first semester of the first year of the **Environmental Sciences** degree. It comprises a total of 6 credits. With this subject it is intended that the student deepens in those knowledge of Chemistry acquired in previous chemical courses (like 2º Bachillerato) and that, in certain aspects, completes them. This knowledge and skills will establish the essential foundations so that the student can later approach the study of the different branches of environmental science, which involved the chemical phenomenon.

The course has a mixed theoretical-experimental character, so the theoretical components are added those of a practical nature, both solving numerical issues as the performance of laboratory work in which the concepts and techniques studied, familiarizing the student with the material and human environment of work in the laboratory.

The basic lines contained in the program of the subject are articulated around the fundamental concepts in chemistry, covering what we normally know as General Chemistry. In particular it is intended that the student dominates the concepts and practices in chemical stoichiometry exercises, that knows the principles that regulate the kinetic and thermodynamic aspects of a chemical transformation and that dominates the concept of chemical equilibrium, deepening in the more relevant as acid-base, oxidation-

reduction and precipitation. As the subject is integrated into the graduate degree in environmental sciences, teachers of the same approach to understand that the chemical phenomena under study should be specifically oriented towards aspects related to environmental sciences.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

In order to successfully pass the subject, it is imperative that the student possesses a number of previous knowledge. These skills include:
- Nomenclature and basic chemical formulation both inorganic and organic.
- Adjustment of chemical reactions.
- Elementary stoichiometric calculations.
- Mathematical algebra.
- Management of logarithms and exponentials.

OUTCOMES

1104 - Degree in Environmental Sciences

- Have capacity for analysis and synthesis and for critical reasoning.
- Be able to communicate orally and in writing.
- Have problem-solving skills, be able to apply knowledge to practice and show motivation for quality.
- Be able to work in a team.
- Master basic general knowledge in the branch of science.
- Be aware of the time and space dimensions of environmental processes.
- Be able to integrate experimental evidence found in field and/or laboratory studies with theoretical knowledge.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Learn to work safely in the laboratory.

LEARNING OUTCOMES

- Know the basic laws of stoichiometry, as well as the key concepts associated with it.
- Calculate the quantities of matter involved in a chemical reaction.
- Know the most used concentration units in solid, liquid, and gaseous mixtures.
- Understand the concepts of energy, work, temperature, heat, specific heat and heat capacity.
- Calculate the energy involved in the exchange of heat between systems.
- Understand the concepts of enthalpy, standard enthalpy of formation and standard enthalpy of combustion.
- Obtain the reaction enthalpy.
- Know the laws of Thermodynamics.
- Understand the concepts of entropy and free energy.
- Know the criteria of spontaneity and equilibrium and how to apply them to the changes that occur in nature.
- Know the different ways of expressing the equilibrium constant.
- Know the Le Chatelier's Principle and be able to apply it to predict the evolution of systems.
- Calculate the amounts of reagents and products in equilibrium.
- Know the factors that determine the concentration of dissolved gases in water at equilibrium.
- Determine the concentration of dissolved gases in water.
- Identify and justify the acid-base character of various types of substances and solutions.
- Understand the concepts of pH, acid-base strength, buffer solution, indicator and acid-base titration, alkalinity and be able to explain its utility by chemical reasoning.
- Determine the pH of a solution.
- Identify and justify the acid-base character of the different media, aquous, terrestrial and atmospheric, and understand the implications that pH has on the environment.
- Understand the concepts of saturated solution, solubility and solubility product.
- Determine the solubility of an ionic solute.
- Know what factors influence solubility.
- Understand the implications of solubility in the soil evolution and the treatment of pollutants.
- Know the concepts involved in a redox reaction.
- Balance oxidation-reduction (redox) reactions.
- Understand the keys of the redox process through the operation of a galvanic cell.

- Draw up a diagram of a galvanic cell, indicating all the relevant information.
- Calculate the electromotive force of a galvanic cell from the reduction potentials.
- Use a table of reduction potentials to establish the spontaneity of a reaction.
- Know the dependence of the electromotive force of a galvanic cell with the concentration, the Nernst equation.
- Calculate the electromotive force under non-standard conditions.

- Know how to apply oxidation-reduction concepts to processes of environmental interest such as the optimization of energy resources (fuel cells) or the electrochemical treatment of pollutants.
- Know the parameters indicating the redox characteristics of water.
- Understand the concepts of rate of a chemical reaction, rate expression, specific rate constant, order of reaction, the half-life and the activation energy.
- Match the rate of a reaction with factors such as concentration, temperature, or the presence of catalysts.
- Know the Arrhenius equation and the concept of activation energy.
- Express the rate of a reaction.
- Express the rate constant with the appropriate units for different orders of reaction.
- Understand the concepts of reaction mechanism, elementary process, rate-determining step, intermediate, molecularity and stationary state.
- Apply kinetic concepts to processes related to the environment such as photochemical, radiactive processes, or the elimination of pollutants.

Given that part of the course consists in carrying out practices in the laboratory, this will allow the students to acquire skills in:

- The handling and the usual material and basic operations in a chemistry laboratory.
- Waste treatment, safety measurements and first aid in the laboratory.
- The determination of the alkalinity of a water.
- The determination of the total hardness of a water.
- The deionization of water by ion exchange.
- The elimination of residual chlorine in a chlorinated water by adsorption with activated carbon.
- Studying the behavior of the reducing power of some metals.
- The construction of galvanic cells.
- Soil cleaning by electrolysis.
- The analysis of the obtained results.
- The development of a laboratory journal.

DESCRIPTION OF CONTENTS

1. INTRODUCTION

- Introduction to Chemistry.
- Concept and importance of chemistry in the environment.

2. CHEMICAL REACTIONS AND STOICHIOMETRY

- Chemical reaction and chemical equation.
- Balance of chemical equations.
- The concept of mole.
- Unit systems and their use in calculations.
- Environmental concentration, usual concentration units in solution and in the atmosphere.
- Exercises of stoichiometry applied to environmental processes: environmental pollution in water, air and soil; biological treatment of pollutants, BOD; toxicity limit, LD50; hardness of water.

3. THE ENERGY OF CHEMICAL REACTIONS

- Energy and its environmental consequences.
- Temperature, heat and energy. Specific heat and heat capacity.
- First Law of Thermodynamics. Law of conservation of energy.
- Enthalpy. Standard enthalpy of formation and combustion.
- Calculation of reaction enthalpies. Hess' Law
- Exercises related to the efficient use of energy: biofuels, atmospheric processes.
- Entropy. Second and third law of thermodynamics.
- Entropy and the environment.
- Free energy. Criterion of spontaneity and equilibrium.
- Coupled reactions: implications of free energy variation in bio-geo-chemical cycles

4. THE EQUILIBRIUM IN CHEMICAL REACTIONS

- The ideal law of Chemical Equilibrium.
- The equilibrium constant in ideal gas systems.
- Factors affecting the Equilibrium Constant. Le Chateliers Principle.
- Exercises of gaseous equilibria applied to reactions of environmental interest.
- Gas solubility equilibria in water. Importance of oxygen and dissolved CO2 in aquatic life.

5. ACID-BASE REACTIONS

- Importance of acids, bases and salts in the environment.
- Aqueous solutions, water as solvent.
- The nature of acids, bases and salts.
- Dissociation of acids, bases and salts in water.
- Self-ionization of water. The pH Scale.
- Strength of acids and bases. Ionization constants.
- Dissociation of salts in water. Acid and basic salts.
- Water alkalinity. Acid-base titration Indicators.
- pH regulation of a solution. Buffer solutions.
- Importance of the pH in the different media: the pH of the waters of the seas and lakes saturated with CO2; acid rain; ion exchange and pH of soil.
- Exercises to calculate pH in acid-base processes related to the environment.

6. PRECIPITATION REACTIONS

- Solubility of solid solutes in water.
- The Solubility Product.
- Factors that affect solubility.
- Equilibria involving solubility reactions in the environment:
- Salinity.
- Softening of waters.
- Solubility of minerals in water.

- Treatment of pollutants.
- Solubility exercises.

7. ELECTROCHEMICAL REACTIONS

- Oxidation-reduction reactions and their impact on the environment.
- Oxidation-reduction reactions: concept of oxidant and reductant. Balancing Oxidation-Reduction equations.
- Voltaic or galvanic cells.
- Electromotive force of a galvanic cell. Electrode potentials (reduction potential).
- Dependence of electromotive force with concentration. Nernst equation.
- Redox reactions in the aqueous environment. Scale pE. pE-pH diagrams
- Electrochemical water treatment.
- Electrochemical soil treatment.
- Oxidation-reduction exercises applied to processes of environmental importance.

8. THE RATE OF CHEMICAL CHANGE

- Rate of chemical reaction.
- Factors affecting the rates of chemical reactions.
- Rate dependence with concentration: the rate expression.
- Rate constants. Units.
- Integrated equations of simple kinetics.
- The half-life of a reaction.
- Influence of temperature on the reaction rate. Arrhenius equation.
- Catalysis. Importance of catalysts in the conservation of the environment.
- Reaction mechanisms. Approximations of rate-determining step and steady state.
- Exercises of reaction mechanisms applied to reactions of environmental interest.
- Kinetics of reactions of environmental interest:
- Chain reactions.
- Photochemical processes.
- Kinetics of radioactive decay.
- Persistence or half-life of pollutants.

9. LABORATORY (SESSION 1): INTRODUCTION TO WORK IN THE CHEMICAL LABORATORY

- Safety rules.
- Material, instrumentation.
- Preparation of solutions

10. LABORATORY (SESSION 2): TITRATION. DETERMINATION OF THE ALKALINITY AND HARDNESS OF A WATER

- Acquire skill in the titration technique.
- Determine the alkalinity of a water.
- Determine the total hardness of a water.

11. LABORATORY (SESSION 3): DEIONIZATION AND SOFTENING OF WATERS BY IONIC EXCHANGE

- Water deionization: exchange of cations for H+ and exchange of anions for OH-.
- Water Softening: Exchange of Ca2+ and Mg2+ ions by Na+.

12. LABORATORY (SESSION 4): OXIDATION-REDUCTION REACTIONS

- Study of the behavior of some metals against an acid solution (HCl).
- Construction of galvanic cells.
- Soil cleaning by electrolysis.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	45,00	100
Laboratory practices	12,00	100
Tutorials	3,00	100
Preparation of evaluation activities	30,00	0
Preparing lectures	20,00	0
Preparation of practical classes and problem	30,00	0
Resolution of online questionnaires	10,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the course is structured around five topics:

1.-Theory sessions

In these sessions a global vision of the treated subject will be offered and will be focused on those key concepts for its understanding. Likewise, the student will be indicated the most recommendable resources for the subsequent preparation of the subject in depth.

2.- Sessions of questions and problems

This section includes sessions dedicated to the resolution of numerical problems as well as those dedicated to solving simple test-type questions, designed to reinforce the concepts introduced in theory sessions. In the sessions dedicated to the resolution of numerical problems the student will be explained a series of problems-type, so that the student acquires the necessary tools to solve analogous problems.

As for the sessions dedicated to the questions, the teacher will select from each lesson, and solve in class, some standard questions from which the student will be able to solve analogous questions. The student will have the solutions to these issues, so you can perform your self-assessment and check the level reached in understanding the concepts covered in each topic.

3.- Tutorials

The tutorials will be mainly work sessions, about questions and problems of the subject, supervised by the teacher. Students will be distributed in groups of 16. Each student will participate in three sessions of one hour spread throughout the course. In them, the teacher will guide students on all the elements that make up the learning process, both in terms of global approaches and specific issues. For these sessions, students will receive a list of questions and problems that will help them to strengthen their knowledge and exercise in each of the aspects discussed in class sessions. These exercises will be delivered resolved on the date indicated by the teacher. The teacher will return them properly corrected. Some of the issues raised in the tutoring sessions will be done online in the Virtual Classroom or in self-evaluating questionnaires, which the student must complete in a time and manner previously established by the teacher.

4.- Practical laboratory work

The laboratory sessions will be developed in groups of sixteen students that will have the advice of a teacher present at all time. The students will work in pairs in the elaboration of simple chemical experiences. Before the sessions the students will have information about the operations and experiences that they will perform and they will have to answer some preliminary questions to the work in the laboratory. The responsible professor will comment on the characteristics of the experience at the beginning of the session, highlighting the need to understand the theoretical concepts included in it and to elaborate a laboratory notebook in which all the aspects of the experience that make it are collected. understandable and reproducible. After the development of the laboratory work, supervised by the teacher, the students must collect in a report the results of the experience and answer, in the laboratory, a series of questions about it. These questions will be handed over to the teacher (or to do online) and will serve for the evaluation of the students. In a coordinated way, the professors of the subject will be able to decide the elaboration of detailed memories of the experiences.

5.- Seminars

Six hours of seminars will be scheduled throughout the semester. The objective of this type of session is:a) Review of basic concepts (especially formulation and stoichiometric calculations). The experience of previous years has made it possible to observe the diversity in the level of chemistry with which students enter this degree (there is a high percentage of students who have not completed the Chemistry subject in the second year of Bachillerato). Three or four of the hours dedicated to seminars

will be at the beginning of the semester with the aim of trying to homogenize those basic concepts indicated.

Integrated problem solving. Resolution of real cases from various points of view of an environmental chemist, where different aspects or chemical concepts can converge, not exclusive to a specific topic of the program.

EVALUATION

The assessment of student learning will be carried out in three different sections:

1. Continuous evaluation (30%)
2. Practical laboratory work (20%)
3. Exam (50%)

1.- Continuous evaluation (30%)

In the first place, a continuous evaluation of the progress and the work developed throughout the course will be carried out, which pretends to be, above all, a formative evaluation. In this section, the following will be taken into account: (a) active participation in the scheduled tutorials in the calendar (3 sessions in the four-month period) where some online questionnaires will be scheduled and in-class examples of problems or standard questions will be carried out; (b) all those activities so that the student works autonomously (multiple choice tests, additional numerical problems, etc.). At least one questionnaire will be scheduled at the end of each program topic, and in those topics where are the most gaps, an additional one to complement the consolidation of the contents. Quantitatively, each section described will compute 10% and 20%.

2.- Practical laboratory work (20%)

The practical work of laboratory will suppose 20% of the global note. This section includes:

- Preliminary questions before the laboratory sessions, that student must be solve online at Aula Virtual. The objective is to prepare the experience.
- The laboratory work itself, for whose evaluation the teacher will take into account the student's ability in the laboratory as well as their interest and attitude.
- The laboratory notebook: the order, clarity, accuracy, rigor and quantity of the information collected on the experiences carried out will be assessed.
- The knowledge reached by the students through the questions they must answer and deliver to the teacher (or to do online) at the end of each experience.

3.- Exam (50%)

Finally, the knowledge and skills acquired will also be assessed through an exam, which will contribute 50% to the final note.

This exam may consist of three types of questions:

- Multiple-choice questions (test type) about the contents of the subject.
- Short answer questions, about a certain concept or with some simple numerical calculation.
- Questions that involve a broader development, with several subsections, in which the student must demonstrate their knowledge of the concepts covered in the subject and their ability to apply them to specific situations that arise. These questions will be supplemented with simple numerical problems.

To pass the course the student must obtain a global note equal to or greater than five (5)***. It is important to note that at least a minimum score of 4 points out of 10 will be required in each of the three blocks cited to average and calculate the final grade for the course.***

Second call.

Students who do not pass on the first call must sit the exam on the second call, keeping the mark of the other sections (continuous assessment and laboratory), which are considered “non-recoverable”. The same percentages and requirements are maintained as in the first call.

Convocation advance.

To request the advance notice of this subject, the student must take into account that he / she must have completed the compulsory activities indicated in the teaching guide of the subject (laboratory work). According to article 10 of the Regulation of Evaluation and Qualification of the University of Valencia (ACGUV 108/2017), the block of continuous evaluation is exempt, so that the evaluation will be carried out based on the following two sections:

1. Practical laboratory work (20%)

2. Exam (80%)

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ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

The contents initially indicated in the teaching guide are maintained.

Workload and temporary teaching planning

Regarding the workload: The different activities described in the Teaching Guide are maintained with the intended dedication.

Regarding the temporary teaching planning: The material to follow the theory/tutoring/classroom-seminar classes allows to continue the temporary teaching planning both in days and schedule, whether the teaching is face-to-face in the classroom or not.

Teaching Methodology

Regarding the theory classes and regulated tutorials: The theory classes and classroom tutoring will tend to the maximum possible attendance, and we have been informed that there is a classroom large enough to meet the sanitary restrictions that limit the capacity and distance between students.

Regarding the laboratory practice sessions: Regarding the laboratory classes, there will be a maximum attendance, respecting the rules of distance and occupation of spaces set by the academic authorities. In the General Chemistry laboratory of the Faculty of Chemistry, since it receives students from eight different grades, some sessions have had to be planned in which the introduction to the practice, the discussion of the previous questions, and the explanation of the procedure and precautions to take into account, will be previously made in a non-face-to-face way (of the four sessions planned in the teaching guide, the first will be 100% face-to-face, but the rest will consist of 1 non-face-to-face hour + 2 face-to-face hours).

Regarding the seminar/teamwork sessions: The planning provided in the Teaching Guide is maintained. In the event that the health authorities recommend stopping giving face-to-face classes, the development of teamwork could continue, taking advantage of the Virtual Classroom tools, even the defense of teamwork could be done without problems through videoconference, or with recorded presentations.

The methodology used for non-face-to-face classes shall be:

1. Synchronously using virtual classroom tools (Teams, Blackboard ...)

2. Asynchronously using recorded power-point presentations, recorded videos, or other virtual classroom tools.

3. Resolution of exercises and questionnaires

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the course, they will be replaced by non-face-to-face sessions following the established schedules and using the tools of the virtual classroom.

Evaluation

The evaluation system described in the Teaching Guide of the subject in which the different evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained (it should be noted that 50% of the grade is made up of continuous assessment).

If there is a closure of the facilities for health reasons affecting the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final grade of the subject will remain unchanged, as set out in this guide.

References

The literature recommended in the Teaching Guide is maintained since it is accessible, and it is complemented by notes, slides and problems uploaded to the Virtual Classroom as material of the course.