COURSE DATA

Data Subject	
Code	36465
Name	Environmental Physical Chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	15 - Physical Chemistry Applied	Optional

Coordination

Name	Department
PEREZ PLA, FRANCISCO	315 - Physical Chemistry

SUMMARY

Kinetic study of the chemical interactions between pollutants and between them and the environment, applying concepts of homogeneous and heterogeneous catalysis. Study reactive processes induced by sunlight and products involving natural contaminants and excited states. Applications.

The Environmental Physical Chemistry is a 4.5 credit elective course that is taught during the first semester of the 4th year of the grade. The course describes the main chemical-physical processes related to air pollution, water and soil. Specifically, the chemistry of the atmosphere, photochemical interactions between anthropogenic and natural contaminants, the transfer of pollutants between different environmental compartments, physical chemistry of water, and pollution processes in natural water are studied. As applications, we address some environmental problems even under intense public debate such as: acid rain, the greenhouse effect and it relationship to global warming, and ozone depletion in the stratosphere.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It would be advisable to have th basic knowledge outlined below. This knowledge has been acquired during the study of the subjects of Physical Chemistry (I, II and III) and Chemistry I and II.
(a) Photochemistry: primary and secondary photophysical processes. Photochemical processes.
(b) Organic Chemistry: properties of functional groups: alkanes, alkenes, alkynes, aromatics, oxygenated organic compounds and nitrogen.
(c) Physical Chemistry: Partition coefficients, absorption spectra, rate law, reaction

OUTCOMES

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Demonstrate knowledge of the principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules.
- Solve qualitative and quantitative problems following previously developed models.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Relate chemistry with other disciplines.
- 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.

- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning outcomes of the subject Applied Chemistry Physics that allow to acquire both specific knowledge of Chemistry, cognitive skills and competencies and general competences recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK document (ECTN) for thel Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject of Environmental Physical Chemistry related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Environmental Physical Chemistry that contemplate the learning outcomes EUROBACHELOR®
The principles of thermodynamics and their applications to chemistry	Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6).
The principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules	Demonstrate knowledge of the principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules..(CE5).
The kinetics of chemical change, including catalysis; the mechanistic interpretation of chemical reactions	Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry..(CE6).
The nature and behaviour of functional groups in organic molecules	Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4) Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties

	and applications..(CE7). Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Environmental Physical Chemistry that contemplate the learning outcomes EUROBACHELOR®
Competences to present and argue scientific issues orally and in writing to a specialized audience.	Relate chemistry with other disciplines.(CE26). Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate. (CG6). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4).
Ability to calculate and process data, related to information and chemistry data.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them.(CE15).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Environmental

	Physical Chemistry that contemplate the learning outcomes EUROBACHELOR®
Ability to apply practical knowledge to solve problems related to qualitative and quantitative information.	Solve problems effectively..(CG4). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Solve problems effectively.CG4).
Competences in information management, in relation to primary and secondary sources, including information retrieval through on-line searches.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Ability to analyse materials and synthesize concepts.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). 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..(CB3).

Skills related to information technology such as word processing, spreadsheet, recording and storage of data, internet use related to the subjects.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
Interpersonal skills to interact with other people and get involved in team work.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).
Competences in oral and written communication, in one of the main European languages, in addition to the language of the country of origin.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community. (CT1). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to know in this subject how to apply the knowledge learned to guarantee an inclusive, equitable, and quality education and promote learning opportunities for everyone (SDG 4).

To acquire a special sensitivity for sustainable management of water (SDG 6), raw materials and energy sources (SDG 7), as well as for an environmentally friendly and sustainable development (SDGs 11 , 12, 13, 14 and 15), in addition to being able to design, select and/or develop efficient chemical products, processes and/or analytical methodologies (SDG 7) that minimize their impact on the environment (SDGs 14 and 15), using alternative raw materials and reducing wastes (SDG 11).

DESCRIPTION OF CONTENTS

1. The terrestrial atmosphere.

Introduction. Our environment: Earth. Hydrosphere. Genesis and evolution of the atmosphere. Atmosphere structure. Composition of the atmosphere. Energy balance. Mass transfer:. Thermodynamics of the atmosphere. Humidity: Dew point. Air Movements: adiabatic. Vertical Stability and instability. Inversions

2. Photochemical characteristics of components of the troposphere.

Photochemistry: fundamentals, primary and secondary photochemical processes. Intensity and distribution of sunlight in the troposphere. Evaluation photolysis rates. Absorption spectrum and photochemistry of tropospheric O2. Absorption and photochemistry other tropospheric components. Photolytic sources of hydroxyl radicals. Formation of other primary radicals. Uni- and ter-molecular processes

3. Introduction to the atmospheric chemistry

Air pollution system. Concentration units. Primary and secondary pollutants. SO2. CO. NOx. COV. Particles. Radiation scattering from aerosols and visibility. Dispersion of pollutants: Meteorology. Air quality criteria. Pollution indoors. Radioactivity and radon.

4. Kinetics and mechanism of the main tropospheric reactions.

Introduction: Reactions of alkanes. Reactions of alkyl, and alkoxide alkyl-peroxide. Reactions of alkenes. Criegee intermediates reactions. Reactions of alkynes. Reactions of aromatic hydrocarbons. Reactions of oxygenated organic compounds. Tropospheric reactions of nitrogen-containing constituents: inorganic, organic. Tropospheric ozone: Potential photochemical ozone creation. Sulfurous and photochemical smog pollution.

5. Acid rain and transport models

Introduction. SO2 oxidation rate in the troposphere. Homogeneous gas phase reactions. Aqueous phase reactions. Heterogeneous reactions on solid surfaces. Oxidation of NO2 to nitric acid. Comparison and contrasts between sulfuric and nitric acids. Influence of Meteorology. Dynamics of Environmental Chemistry: Models of transport and acid rain. Acid mists. Ecological effects.

6. Greenhouse effect and global warming.

Introduction. Mechanism of the greenhouse effect. Gases that contribute to the greenhouse effect. CO2. Water vapor. Methane. Oxides of nitrogen. Chlorofluorocarbons. Ozone. Aerosols. Comparison of greenhouse gases. Global warming potentials. Kyoto Protocol and predictions on Global Climate Change. Reducing greenhouse gas emissions.

7. Chemistry of the stratosphere: The ozone layer.

Stratosphere: the ozone layer. Non-catalytic mechanism of formation and destruction of ozone. Catalytic ozone destruction processes. Role of chlorine and bromine in ozone destruction. Interaction of tropospheric and stratospheric chemistry. Polar stratospheric clouds. General mechanism of formation of "holes". Ozone depletion potentials. Montreal Protocol. Effects of the decrease in the ozone layer.

8. Introduction to the Chemistry of the Hydrosphere

Introduction. Hydrosphere: Water Cycle. Physical-chemical properties of water. Physical-chemical properties of aquatic systems. Salinity. Temperature in aquatic systems: Thermal stratification. Gases in aquatic systems.

9. Processes in aquatic systems.

Equilibria of CO2 in aquatic systems. Equilibria in pure and saline water. Equilibria in natural systems. Alkalinity and hardness of natural waters. Redox processes: pE-pH diagrams. Photosynthesis. Electronic transmission and phosphorylation. Photo-independent reactions. Illumination and nutrients. Redox processes in natural systems: bacteria as catalysts. Other photochemical processes in aquatic systems: direct, indirect and heterogeneous.

10. Pollution of natural waters.

Classification of pollutants. Nutrients, sediments and eutrophication. Waste requiring oxygen. Pathogens. Metals: general, mercury. Bio-accumulation: Ecological Vision, thermodynamic and kinetic approaches. Oil. Persistent Organic Products. Inorganic products. Thermal pollution. Radioactive materials.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of individual work	40,00	0
Preparation of evaluation activities	22,00	0
Preparing lectures	8,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the subject is carried around the lectures and tutorials.In the lectures, which provides an overview of the subject, the key concepts are emphasized for propercompression and indicates the resources that are necessary for in-depth study of the subject. The tutorials are seminars in which it will study in depth a key concept bysolving a complex numerical problem. In the first part of the seminar, the teacher will pose the problem.Then the students, individually or in groups, will get the solution based on the theory explained. Once thetask is achieved, the teacher will give a reasoned solution, allowing self-assessment by students. If theconcept reviewed presents social debate, there will be a brief discussion according to the results.

EVALUATION

First and second call.

The evaluation of the course will be conducted according to the following criteria:

(a) attendance and participation in classes and seminars: 5%.

(b) Conduct a final questionnaire: 50%

(c) Performing tasks proposed during the course: 45%

NOTE. The guest reviews have the following characteristics:

(a) consist of both theory and practical issues.

(b) be conducted individually.

(c) the teacher will be given 15 days after the last class of the course.

(d) the course will not be approved if there is the final questionnaire.

(e) The minimum that must be obtained from the questionnaire will be 4 points out of 10 for to average out the attendance note and the proposed tasks. Below 4, the course will be suspended.

REFERENCES

Basic

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Additional

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