COURSE DATA

DATA SUBJECT

Code: 34193
Name: Physical Chemistry I
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Facultat de Química	2	Second quarter
1934 - Double Degree Program in Chemistry-Chemical Engineering	Facultat de Química	2	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1110 - Degree in Chemistry	Physical Chemistry	COMPULSORY
1934 - Double Degree Program in Chemistry-Chemical Engineering	Segundo curso	COMPULSORY

COORDINATION

SANCHEZ DE MERAS ALFREDO

SUMMARY

Physical Chemistry I is an obligatory subject taught in the second half of the second year of the grade studies in Chemistry. The course has a total of 4.5 ECTS credits.

This course aims, essentially, to deepen the knowledge of Chemistry and Physics that the students should have obtained in the previous year and to learn how to apply them to chemical processes. In this way, this course establishes the necessary grounds for the successful study of the future courses of Physical Chemistry as well as a support of reference for all disciplines of the Chemistry grade.

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), as well as to sustainable and environmentally compatible development (SDGs 11, 12, 13, 14 and 15)

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 achieve success in the subject, the students should have basic knowledge on:
Nomenclature and formulation chemistry, both inorganic and organic.
Adjustment of chemical reactions.
Stoichiometric calculations.
Basic knowledge of acid-base reactions, precipitation and redox.
Basic knowledge of batteries and the Nernst equation.

COMPETENCES / LEARNING OUTCOMES

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Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.

Act autonomously in learning, making well-founded decisions in various contexts, forming judgements based on experimentation and analysis, and applying knowledge to new situations.

Address new problems and propose strategies to solve them.

Collaborate effectively in work teams, assume responsibilities and leadership roles, and contribute to collective improvement and development.

Communicate effectively both orally and in writing, adapting to the context and audience.

Contribute to the design, development and implementation of solutions that respond to social demands, using the Sustainable Development Goals as a reference.

Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.

Demonstrate both inductive and deductive reasoning skills.

Demonstrate critical and self-critical thinking, considering professional ethics, moral values and social implications of the different activities carried out throughout the degree.

Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.

Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.

Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.

Demonstrate knowledge of the main types of chemical reaction and their main characteristics.

Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.

Demonstrate the ability to adapt to new situations.

Demonstrate the ability to analyse, synthesise and reason critically.

Describe the characteristics and behaviour of the different states of matter and the theories used to explain them.

Develop capacity for analysis, synthesis and critical thinking.

Develop sustainable and environmentally friendly methods.

Distinguish between the qualitative and quantitative aspects of chemical problems.

Evaluate, interpret and synthesise chemical data and information.

Express ideas correctly, both orally and in writing, in any of the official languages of the Valencian Community.

Identify chemical processes in everyday life.

Identify the main types of chemical reactions and their associated key characteristics.

Implement sustainable and environmentally friendly methodologies.

Interpret the relationship between the variation in the characteristic properties of chemical elements and the Periodic Table.

Learn autonomously.

List the principles of quantum mechanics and apply them to the description of the structure and properties of atoms and molecules.

Propose creative and innovative solutions to complex situations or problems in the field, addressing diverse professional and social needs.

Recognise and analyse new problems and plan strategies to solve them.

Recognise and evaluate chemical processes in daily life.

Relate chemistry to other disciplines.

Relate chemistry with other disciplines.

Relate theory and experimentation.

Relate theory to experimentation.

Show inductive and deductive reasoning ability.

Solve problems effectively.

Solve problems effectively.

Solve qualitative and quantitative problems following previously developed models.

State the principles of thermodynamics and kinetics and their application in chemistry.

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.

Understand and analyse, from the perspective of the degree programme, social inequalities based on sex and gender; integrate gender-sensitive approaches into problem-solving and solution design.

Understand the qualitative and quantitative aspects of chemical problems.

Use chemical terminology, nomenclature, conventions and units correctly.

DESCRIPTION OF CONTENTS

1. Formal kinetics

Introduction. Complex reactions: reversible reactions, competitive reactions, consecutive reactions. Reaction mechanisms. Molecularity. Limiting-step approximation. Steady-state approximation. Influence of temperature on reaction rate. Variation of rate constant with temperature. Catalysis.

2. Open systems and changes in composition. Partial molar properties and chemical potential

Introduction. Properties of the Gibbs function (free energy). Dependence of the Gibbs function with the temperature. Dependence of the Gibbs function with the pressure. Thermodynamic description of mixtures. Quantities (properties) partial molar. Partial molar Gibbs function or chemical potential. Material balance. Gibbs-Duhem equation. Relation between partial molar quantities. Thermodynamic functions of mixing. Chemical potential of ideal gas and ideal gas mixtures.

3. Simple applications of material equilibrium

Changes of state of pure substances and Thermodynamics of ideal solutions. Concepts of phase and component. Phase rule. Phase diagrams of one component systems. Examples. Phase equilibrium. Stability of the phases, curves of chemical potential versus T. Dependence curves of chemical potential versus T with pressure. Clapeyron equation. Variation of equilibrium pressure with temperature. Solid-liquid equilibrium. Equilibrium liquid / gas. Equilibrium solid / gas.

4. Colligative properties. Activity coefficients

Chemical potential of liquids (solutions). Ideal solutions, Raoult's law. Thermodynamic properties of solutions. Dilute ideal solutions: Henry's law. Thermodynamic properties. Colligative properties. The common feature of colligative properties. Lowering of the vapor pressure. Boiling point elevation. Freezing point depression. Osmotic pressure. Real solutions: activities and activity coefficients. The activity of the solvent. Symmetric Convention (I). The activity of the solute. Asymmetric Convention (II). Conventions, scales and reference states. Determination of activities and activity coefficients. Determination of activity coefficients from measurements of vapor pressure. Determination of activity coefficients from colligative properties. Gibbs-Duhem-Margules. Excess thermodynamic functions.

5. Phase equilibria of binary systems

Introduction. Phase diagrams for binary solutions. Diagrams vapor pressure-composition. Temperature-composition diagrams. Representation of the distillation. Distillation of real solutions: azeotrope. Distillation of immiscible liquids.

6. Electrolyte solutions

Electrolyte solutions. Introduction. Electrolyte solutions. Chemical potential of a composite electrolyte. Chemical potential of an electrolyte. Determination of activity coefficients of electrolytes. The practical osmotic coefficient of solvent. Determination of ionic activity coefficient from measurements of colligative properties. Empirical behavior of solutions of electrolytes. Debye-Hückel model for electrolyte solutions.

7. Chemical equilibrium

Introduction. Spontaneous chemical reactions. The minimum Gibbs function. Thermodynamic condition for chemical equilibrium. Affinity. Chemical balance in a mixture of ideal gases. Equilibrium constants based on concentrations and mole fractions. Variation of equilibrium constant with temperature and pressure. Le Chateliers principle. Chemical equilibria in real gases. Fugacity of a real gas. Chemical equilibrium in ideal non-electrolyte solutions. Actual chemical balance in non-electrolyte solutions. Heterogeneous equilibrium. Ionic equilibria (solutions of electrolytes). Ionization equilibria of weak acids. Solubility equilibria.

8. Electrochemical equilibrium

Electrochemical equilibrium. Electrode potential. Electrochemical potential properties. Types of electrodes. Electromotive force. Thermodynamics of a stack. Measurement of thermodynamic quantities from the potential difference between electrodes of a battery. Liquid junction potential. Applications of the FEM as d: activity coefficient, pK, solubility product, and predicting the spontaneity of redox reactions and metal corrosion.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Tutorials	7,00
Theory	38,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	30,00
Preparation of lessons	21,50
Preparation for assessment activities	16,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

Development of the course is structured around three areas: theoretical and practical classes, seminars and other activities in the non-attending hours. Theoretical and practical classes will give an overview on the topic and will have an impact on those key concepts for understanding it. It will also provide more recommended resources for further preparation of the subject in depth.

In some sessions the student will explain a number of problems-type through which learn to identify the essential elements of the approach and solve the problems posed by this issue. In other sessions, however, ownership will pass completely into the hands of the student, as it will be he who will face similar problems and more complex. Students are allocated to groups and the teacher will guide them and help.

With respect to tutorials, there will be 7 sessions in the semester. In them, the teacher will guide students on all elements of the learning process, both in regard to global approaches as to specific issues. Also, students will receive them a list of questions and additional problems that will reinforce their knowledge and exercise in each of the matters covered in the class sessions. The student must submit unresolved issues and questions that the Professor indicates.

EVALUATION

The following assessment systems will be used:

- Tests consisting of Written, Oral and/or Practical Exams.
- Evaluation of group tutorial sessions, seminars, preparation of assignments and/or oral presentations. Due to their nature these activities can not be evaluated again.
- Continuous assessment of each student based on face-to-face activities, participation and degree of involvement in the teaching-learning process. Due to their nature these activities can

not be evaluated again.

The assessment of student learning will take into account all the aspects set out in the methodology section of this teaching guide.

Modality A

FIRST CALL

The final grade will consist of:

The exam (70%), which will consist of a series of theoretical questions and numerical problems, which will deal with the basic concepts taught in class. The exam will be the same for all groups. Continuous assessment (30%), which includes assessment tests carried out throughout the course in the form of multiple or brief choice tests, the evaluation of group tutorial sessions, through the completion and/or delivery of exercises and questions, and the continuous assessment of each student based on participation and degree of involvement in the teaching-learning process. **Only in exceptional cases and within the period established by the professors, may modality A be waived.**

The minimum grade of the written exam must be equal to or greater than 4.5 out of 10 in order to average with the grade of the continuous assessment. The minimum overall grade to pass the subject is 5.0 out of 10.

Modality B

This modality will only be accepted in those very exceptional cases in which the teacher has accepted the student's application.

FIRST CALL

The final grade will consist of the exam (90%) and the continuous assessment activities (10%). The minimum grade of the written exam must be equal to or greater than 4.5 out of 10 in order to average with the grade of the continuous assessment. The minimum overall grade to pass the subject is 5.0 out of 10.

The default modality will be A. Accessing modality B will require a justification of the non-possibility of attending face-to-face activities and approval by the professor who teaches the subject.

SECOND CALL

In the second call, students will take an exam consisting of a series of theoretical questions and numerical problems, which will deal with the basic concepts taught in class. The exam will be the same for all groups. The final grade, including the continuous assessment, will be carried out using the same weighting as in the first call. The minimum overall grade to pass the subject is 5.0 out of 10.

Final Warning

The copying or manifest plagiarism of any task that is part of the evaluation will make it impossible to pass the subject, then submit to the appropriate disciplinary procedures.

It should be noted that, in accordance with article 13 d) of the University Student Statute (RD 1791/2010, of December 30th), "*it is the duty of a student to refrain from using or cooperating in fraudulent procedures in assessment tests, in the work carried out or in official documents of the University*".

REFERENCES

- ENGEL, T., REID, P. Química Física. Pearson Addison Wesley, 2006. ISBN 9788478290772
- ATKINS, P., DE PAULA, J. Química Física. 8ª ed. Editorial Médica Panamericana, 2008. ISBN 9789500612487
- LEVINE, I.N. Fisicoquímica. 5ªed. MacGraw-Hill, 2004. ISBN 9788448137861 (v. 1) ISBN 9788448137878 (v. 2)