Universitat de Lleida

DEGREE CURRICULUM

PHYSICAL CHEMISTRY

Coordination: CANTERO GOMEZ, MARIA ROSA

Academic year 2023-24

PHYSICAL CHEMISTRY 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>PHYSICAL CHEMISTRY</td></tr>
<tr><td>Code</td><td>102344</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Common branch in industrial engineering programs - Igualada</td><td>2</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
<tr><td>Not informed</td><td>2</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>CANTERO GOMEZ, MARIA ROSA</td></tr>
<tr><td>Department</td><td>INDUSTRIAL AND BUILDING ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>60 h lectures (40 %)
90 h Autonomous work (60 %)</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan</td></tr>
<tr><td>Distribution of credits</td><td>3 theoretical credits
3 practical credits</td></tr>
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PHYSICAL CHEMISTRY 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CANTERO GOMEZ, MARIA ROSA	rosa.cantero@udl.cat	6	

Subject's extra information

Continuous work is required throughout the semester in order to achieve the objectives of this subject. It is highly recommended that students visit the Virtual Campus associated with the subject on a frequent basis.

Learning objectives

- Capacity to understand the thermodynamic relationships.
- Capacity to calculate reaction heats.
- Capacity to use the Gibbs free energy and to solve chemical equilibrium problems.
- Capacity to apply the knowledge acquired about thermodynamics of the solutions.
- Capacity to interpret the phase diagrams of multicomponent systems.
- Capacity to perform electrochemistry calculations.
- Capacity to explain the chemistry of surfaces and their applications.
- Capacity to critically analyze and synthesize the concepts acquired.
- Capacity to use the knowledge acquired to solve engineering problems related to physicochemical contents.
- Capacity to reason and analyze the results obtained from the problems worked on, thus deepening critical thinking.

Competences

Basic competences

- **B01.** That students have demonstrated to possess and understand knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply knowledge coming from the vanguard of his/her field of study.
- **B02.** That students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- **B03.** That students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
- **B04.** That students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
- **B05.** That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

General competences

- **CG3.** To synthesize basic and technological subjects, which enable them to learn new methods and theories, and provide them with versatility to adapt to new situations.
- **CG4.** To solve problems with initiative, make decisions, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Chemical Engineering.

- **CG5.** To carry out measurements, calculations, valuations, appraisals, surveys, studies, reports, work plans and other analogous work.
- **CG10.** To work in a multilingual and multidisciplinary environment.

Specific competences

- **CE2.** To conceptualize and command the fundamental concepts about the general laws of mechanics, thermodynamics, fields and waves and electromagnetism and their application to solve problems in engineering.
- **CE7.** To conceptualize applied thermodynamics and heat transmission. To recognize the basic principles and their application to solving engineering problems.

Transversal competences

- **CT1.** To develop a proper understanding and oral and written expression of Catalan and Spanish.
- **CT3.** To implement new technologies and technologies of information and communication.
- **CT5.** To apply essential notions of scientific thinking.

Subject contents

1. Thermochemistry

1.1. Standard states of pure substances

1.2. Standard enthalpy of reaction

1.3. Standard enthalpy of formation

1.4. Determination of reaction enthalpies

1.5. Temperature dependence of reactions heats

2. Free energy and chemical equilibrium

2.1. Free energy

2.2. Standard Gibbs energy of reaction

2.3. Thermodynamic relationships

2.4. Dependence of free energy with respect to pressure

2.5. The Gibbs energy of a reaction mixture

2.6. Relationship between ΔG^{o} and the equilibrium constant

2.7. Temperature dependence of the free energy and the equilibrium constant

2.8. Displacements in chemical equilibrium

2.9. Heterogeneous equilibrium

3. Solutions

3.1. Solution composition

3.2. Partial molar quantities

- 3.3. Ideal solutions
- 3.4. Ideal diluted solutions
- 3.5. Non-ideal solutions
- 3.6. Colligative properties
- 3.6.1. Vapor pressure lowering
- 3.6.2. Freezing point depression and boiling point elevation
- 3.6.3. Osmotic pressure

4. Multicomponent phase equilibrium

- 4.1. Two-component liquid-vapor equilibrium
  - 4.1.1. Ideal solution at constant temperature
  - 4.1.2. Ideal solution at constant pressure
  - 4.1.3. Non-ideal solutions
- 4.2. Two-component liquid-liquid equilibrium
- 4.3. Two-component solid-liquid equilibrium
- 4.4. Three-component systems

5. Solutions of electrolytes and conductivity

- 5.1. Solutions of electrolytes
- 5.2. Activity coefficients of electrolytes
- 5.3. Electrical conductivity of solutions
- 5.4. Electrolysis
- 5.5. Transport numbers

6. Galvanic cells

- 6.1. Redox processes
- 6.2. Types of electrodes
- 6.3. Galvanic cells
- 6.4. Standard electrode potentials
- 6.5. Thermodynamics of galvanic cells
- 6.6. Concentration cells
- 6.7. Liquid-junction potentials
- 6.8. Applications of emf measurements

7. Surface chemistry

7.1. Introduction

7.2. Surface tension

7.2.1. Young-Laplace equation

7.2.2. Capillarity

7.2.3. Methods for determination of surface tension

7.3. Adsorption of gases on solids

7.3.1. Chemical adsorption

7.3.2. Physical adsorption

7.3.3. Adsorption isotherms

7.3.4. Temperature dependence

7.4. Colloids

7.4.1. Lyophilic colloids

7.4.2. Lyophobic colloids

7.4.3. Sedimentation

7.4.4. Emulsions

7.4.5. Gels

Methodology

- Lectures in which the theoretical concepts of each topic are introduced, illustrating them with examples.
- Problem-solving sessions in which students take an active part in their learning process working in small groups or individually.
- Group work for the study of practical applications related to the contents of the subject.

In-person and online classes will be combined as indicated on the schedule.

Development plan

Week	Methodology	Contents	Lecture hours	Autonomous work hours
1-2	Lecture. Problem solving.	Presentation subject. 1. Thermochemistry	6	9
2-4	Lecture. Problem solving.	2. Free energy and chemical equilibrium	8	12
4-6	Lecture. Problem solving.	3. Solutions	7	11
6-7	Lecture. Problem solving.	4. Multicomponent phase equilibrium	7	11

8	Lecture. Problem solving.	7. Surface chemistry. Presentation group work.	4	7
9		Evaluation. Written test.		
10-11	Lecture. Problem solving. Teamwork.	7. Surface chemistry (continuation). Teamwork.	8	13
12-13	Lecture. Problem solving. Teamwork.	5. Solutions of electrolytes and conductivity. Teamwork.	7	13
13-15	Lecture. Problem solving. Teamwork.	6. Galvanic cells. Teamwork.	9	14
16-19		Evaluation. Written test. Referral exam.		

Evaluation

- **Assessment block 1 (BA1):** Written test, units 1-4 (20% of the final qualification).
- **Assessment block 2 (BA2):** Written test, units 1-7 (50% of the final qualification). In case that the result of BA2 is higher than that of BA1, the result of BA1 will be improved and equalled to BA2 when applying the designated percentages.
- **Assessment block 3**: Individual controls of the problems worked on in group and active participation in the work sessions (15% of the final qualification).
- **Assessment block 4**: Group work for the study of applications (15% of the final qualification).

  Referral exam: Units 1-7. Allows students to obtain up to 70% of the final qualification (equivalent to BA1+BA2).

Students who have the approval to be assessed through **alternative assessment** (see requirements and procedure in the assessment regulations) must carry out the following activities:

- Written test, units 1-7 (85% of the final qualification).
- Work for the study of applications (15% of the final qualification).

  Referral exam: Units 1-7. Allows students to obtain up to 85% of the final qualification.

Bibliography

- Levine, Ira N. *Fisicoquímica*. 5ª ed. Volum 1. McGraw-Hill, 2003. ISBN: 8448137868.
- Levine, Ira N. *Fisicoquímica*. 5ª ed. Volum 2. McGraw-Hill, 2004. ISBN: 8448137876.
- Engel, Thomas; Reid, Philip. *Química Física*. Pearson Addison Wesley, 2006. ISBN: 847829077X.
- Atkins, Peter W. Química Física. 6ª ed. Omega, 1999. ISBN: 8428211817.