



Course guide

320005 - Q - Chemistry

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: MARGARITA MORILLO CAZORLA
ESTER GUAUS GUERRERO

Others: MARGARITA MORILLO CAZORLA-JORGE MACANÁS DE BENITO- XAVIER COLOM FAJULA -
ESTER GUAUS GUERRERO- TZANKO TZANOV-GEMMA MOLINS DURAN-ROGER CURCOLL
MASSANES-MARTA GUADAYOL GALLEGUO -JUDIT CRESPIERA PORTABELLA-EVA RAMON
PORTES-GUADALUPE BARAJAS LOPEZ

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Generical:

CG03-INDUS. Knowledge in basic and technological subjects that enable them to learn new methods and theories and provide them with versatility to adapt to new situations.

Basic:

CB02. That students can apply their knowledge to their work or vocation in a professional manner and possess the competencies typically demonstrated through the development and defense of arguments and problem-solving within their field of study.

CB1. That students have demonstrated possession and understanding of knowledge in a field of study that is based on general secondary education, and is typically found at a level that, while supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

TEACHING METHODOLOGY

- Face-to-face lecture sessions

Lectures are given using digital presentations. Presentations will be made available to students on the Virtual Campus before classes begin to help them follow them. Assessment will be based on mid-semester examinations.

- Face-to-face practical work sessions

During practical work sessions, students work individually or in small groups of 2-3 on problems and questions under the lecturer's supervision. A collection of problems will be made available on the Digital Campus, some of them will be solved in class and other realization is recommended to promote self-learning. Students will be available Moodle questionnaires for each topic that will be used to evaluate the subject.

- Face-to-face laboratory work sessions

Students work in pairs during laboratory sessions. Guidelines for practicals will be made available to students on the Digital Campus at the start of the course. Students must hand in a report for each practical. Marks will be based on the work carried out in the laboratory, the reports handed in and related Moodle questionnaires. Assessment will be based on: the work done in the lab, reports and associated questionnaires. It has a public rubric for evaluation of laboratory practices.

LEARNING OBJECTIVES OF THE SUBJECT

On completion of the course, students should be able to:

- Correctly use and interpret the language and basic concepts of Chemistry.
- Recognise the structure of matter and relate it to the physical and chemical properties of organic and inorganic substances.
- Apply stoichiometric calculations and chemistry equilibrium to solve problems.
- Recognise the equipment and apply basic techniques of the chemistry laboratory.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	15,0	10.00
Hours small group	15,0	10.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

TOPIC 0: INTRODUCTION

Description:

- 0.1. Introduction to the subject.
- 0.2. Assignment of tasks.
- 0.3. Introduction to laboratory, safety rules and various manipulation techniques.

Specific objectives:

For students to:

- Understand objectives and assessment method for the subject.
- Be assigned tasks for the subject.
- Understand the main manipulation techniques used in the laboratory.
- Understand the main safety rules observed in the laboratory.

Related activities:

L1. The chemistry laboratory. Introduction to the laboratory, the safety rules and various manipulation techniques. Assignment of tasks.

Questionnaires Moodle.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 6h

Theory classes: 1h

Laboratory classes: 2h

Self study : 3h

TOPIC 1. INTRODUCTION TO CHEMISTRY. ATOMIC STRUCTURE AND THE PERIODIC TABLE: PERIODIC PROPERTIES.

Description:

TOPIC 1A:INTRODUCTION TO CHEMISTRY.

1. Basic concepts.
2. Substances properties.
3. Measurement of substances. Gases. Liquids (pure liquids and solutions).

TOPIC 1B. ATOMIC STRUCTURE AND THE PERIODIC TABLE: PERIODIC PROPERTIES

1. The atom. Atomic theories.
2. Quantum numbers.
3. Electronic configurations.
4. The periodic table. The relationship between electron configuration and position in the periodic table.
5. Periodic properties.
6. Types of bonds. Substances types.

Specific objectives:

For students to:

- Apply appropriate magnitudes of measurement for a particular matter and composition.
- Understand the structure of the periodic table.
- Relate the position of elements in the periodic table with their properties.
- Identify the kind of bond between two elements.

Related activities:

P1. Periodic properties. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises and problems related to the topic. Individual continuous assessment.

L4. Preparation of solutions. Measurement of densities.

Questionnaires Moodle

Partial exam 1.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 13h

Theory classes: 4h

Practical classes: 2h

Laboratory classes: 2h

Self study : 5h

TOPIC 2. INORGANIC SUBSTANCES.

Description:

- 2.1. Elementary substances.
- 2.2. Binary compounds.
- 2.3. Polyatomic compounds.

Specific objectives:

- Understand the language of chemistry and the families of inorganic compounds.

Related activities:

Self-directed learning with the support of prepared materials via the Digital Campus, followed by exercises related to the topic.
Individual continuous assessment.
Questionnaires Moodle.
Partial exam 1.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)
CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 8h

Self study : 8h

TOPIC 3. IONIC AND METALIC SOLIDS.

Description:

- 3.1. States of matter. Solid state.
- 3.2. Ionic solids.
- 3.3. Metallic solids.

Specific objectives:

For students to:

- Identify the type of bond that two elements will form.
- Grade the strength or intensity of bonds between different pairs of elements.

Related activities:

P3. Physical properties of inorganic substances. Physical properties of organic substances. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises related to the deduction of properties on the basis of structure. Individual continuous assessment.

L2. Structure-property relationships. Experimental determination of physical properties of unknown substances in order to identify their structure. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle

Partial exam 1.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)
CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 16h

Theory classes: 3h

Practical classes: 1h

Laboratory classes: 1h

Self study : 11h

TOPIC 5. COVALENT BOND. COVALENTS AND MOLECULAR SUBSTANCES.

Description:

4.1. Covalent Bond.

4.2. Covalent solids.

4.3. Molecular substances.

Lewis structures. Molecular geometry (VSEPR method). Polarity of molecules. Intermolecular forces. Physical properties of organic and inorganic compounds.

Specific objectives:

For students to:

- Compare the intensity bond between different elements.
- Construct Lewis structures.
- Describe molecular geometry using the VSEPR method.
- Identify the presence of molecular dipole moment.
- Approximately deduce the general physical properties of any substance.
- Compare and establish gradations in the physical properties of different substances.

Related activities:

P4. Lewis structures. Molecular geometry and polarity. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises and problems related to the topic. Students will use molecular models. Individual continuous assessment.

L2. Structure-property relationships. Experimental determination of physical properties of unknown substances in order to identify their structure. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle

Partial exam 1.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 16h

Theory classes: 4h

Practical classes: 2h

Laboratory classes: 1h

Self study : 9h

TOPIC 5. ORGANIC COMPOUNDS.

Description:

- 5.1. The carbon atom.
- 5.2. Hydrocarbons.
- 5.3. Compounds with functional groups.

Specific objectives:

For students to:

Understand the language of chemistry and the families of organic compounds.

Related activities:

Self-directed learning with the support of prepared materials via the Digital Campus, followed by exercises related to the topic.
Individual continuous assessment.

Questionnaires Moodle.

Partial exam 2.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 12h

Self study : 12h

TOPIC 6. CHEMICAL REACTIONS: STOICHIOMETRY.

Description:

- 6.1. Chemical equations. Balancing.
- 6.2. Stoichiometric calculations. Limiting reagents. Yield.
- 6.3. Thermochemistry.
- 6.4. Speed of a chemical reaction.
- 6.5. Chemical equilibrium. Le Chatelier principle.

Specific objectives:

For students to:

- Balance chemical equations.
- Detect the presence of limiting reagents.
- Determine the quantities of reactants and products involved in a reaction.
- Apply stoichiometric calculations to determine yield, purity, composition, etc.
- Use equilibrium constants to describe systems at equilibrium
- Use the equilibrium constant expressed in terms of partial pressures (K_p) and relate it to K_c
- Recognize the factors that affect equilibria and predict the effects of a change.
- Understand the terminology of thermodynamics, and the meaning of the signs of changes.
- Use Hess's Law to find the enthalpy change for a reaction.
- Understand how the spontaneity of a process is related to Gibbs free energy.
- Express the rate of a chemical reaction in terms of changes in concentrations of reactants and products with time.
- Describe the experimental factors that affect the rates of chemical reactions.
- Use the concept of order of a reaction.
- Apply the method of initial rates to find the rate-law expression for a reaction.

Related activities:

P6. Balancing chemical reactions. Stoichiometric calculations. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises and problems related to the topic. Individual continuous assessment.

L3. Determination of the purity and composition of samples. Experimental determination. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle.

Partial exam 2.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 22h

Theory classes: 6h

Practical classes: 3h

Laboratory classes: 3h

Self study : 10h

TOPIC 7. ACID BASE REACTIONS.

Description:

- 7.1. Acids and bases. Definitions.
- 7.2. Self-ionization of water. pH scale
- 7.3. Relative strength of acids and bases. Hydrolysis.
- 7.4. pH calculation of solutions.
- 7.5. Buffer solutions.
- 7.6. Neutralization. Volumetric. Titration curves.
- 7.7. Acidic and basic oxides.
- 7.8. Acid rain.

Specific objectives:

For students to:

- Identify acidic and basic substances.
- Grade and compare the strength of organic and inorganic acids and bases.
- Predict the possible reaction between two acidic and/or basic substances and their products.
- Determine the concentration of an acid or a base by titration.
- Identify the species which prevails at a given pH
- Understand the autoionization of water
- Understand the pH and pOH scales and how they are used
- Use ionization constants for weak monoprotic acids and bases
- Describe how polyprotic acids ionize in steps
- Apply acid-base equilibrium concepts to salts and discuss the concept of hydrolysis
- Recognize buffer solutions
- Carry out calculations related to buffer solutions and their action
- Describe what species are present at various stages of titration curves

Related activities:

P7. Acids and bases. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises and problems related to the topic. Individual continuous assessment.

L5. Acid-base titration. Experimental determination. Continuous assessment of two-student teams. Laboratory reports.

L7. Synthesis of an organic compound. Application of the reactivity of organic compounds in the synthesis of a compound of industrial and/or environmental interest. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle.

Partial exam 2.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 25h

Theory classes: 5h

Practical classes: 3h

Laboratory classes: 4h

Self study : 13h

TOPIC 8. REDOX REACTIONS.

Description:

- 8.1. Redox reactions. Definitions.
- 8.2. Standard reduction potential. Electrochemical series.
- 8.3. Nernst equation.
- 8.4. Standard E i K relation.
- 8.5. Batteries.
- 8.6. Corrosion.
- 8.7. Electrolysis.

Specific objectives:

For students to:

- Identify oxidising and reducing substances.
- Grade and compare the strength of oxidising and reducing substances.
- Predict the possible redox reaction between two substances and their products.
- Identify and understand the various types of batteries.
- Predict the products of electrolysis.
- Apply stoichiometric calculations to electrolysis.

Related activities:

P8. Redox reactions. Solubility and complex formation. Presentation of the topic to the entire class with the support of prepared materials via the Digital Campus, followed by exercises and problems related to the topic. Individual continuous assessment.

L6. Redox reactions. Electrolysis. Experimental determination and demonstration. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle

Partial exam 2.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 18h

Theory classes: 4h

Practical classes: 2h

Laboratory classes: 2h

Self study : 10h

TOPIC 9. PRECIPITATION REACTIONS.

Description:

- 9.1. Introduction.
- 9.2. Solubility and solubility product.
- 9.3. Common ion effect on solubility.
- 9.4. Conditions for the substances precipitation and to solubilize precipitates.
- 9.5. Solubility and pH.
- 9.6. Precipitate dissolution.

Specific objectives:

- Understand the concepts of solubility and solubility product. Use Ksp's in chemical calculations.
- Apply the rules of general solubility in water to the possible formation of precipitates and to redissolved precipitates.
- Relate the structure of organic compounds with their solubility in different solvents.
- Describe some methods for dissolving precipitates.

Related activities:

P9. Solubility and precipitation. Resolution of exercises and problems linked to the themes, after the exhibition in large group and with the support of previously prepared and available in Campus Digital materials. Individual continuous assessment.

L3. Determination of the purity and composition of samples. Experimental determination and demonstration. Continuous assessment of two-student teams. Laboratory reports.

Questionnaires Moodle

Partial exam 2.

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 14h

Theory classes: 3h

Practical classes: 2h

Self study : 9h

ACTIVITIES

(ENG) ACTIVITAT 1. FACE TO FACE CLASS. (CONTINGUTS 1, 3, 4, 6, 7, 8 I 9)

Description:

Face to face class.

Specific objectives:

Those of the corresponding topics.

Material:

MS PowerPoint presentations.

Delivery:

Moodle questionnaires. Exams.

Related competencies :

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Full-or-part-time: 52h

Theory classes: 26h

Self study: 26h

ACTIVITY 2. PRACTICES (CONTENTS 1, 3, 4, 6, 7, 8 and 9)

Description:

Face to face problems class.

Specific objectives:

Those of the corresponding topics.

Material:

Presentations MS PowerPoint, problems collection. Moodle questionnaires.

Delivery:

Moodle questionnaires. Exams.

Related competencies :

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Full-or-part-time: 30h

Practical classes: 15h

Self study: 15h

(ENG) ACTIVITAT 3. QÜESTIONARIS MOODLE. (CONTINGUTS TOTS)

Description:

Evaluation and autoevaluation questionnaires .

Specific objectives:

Those of the corresponding topics.

Material:

Presentations MS PowerPoint, problems collection. Moodle questionnaires.

Delivery:

Moodle questionnaires (10% global qualification).

Related competencies :

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Full-or-part-time: 28h

Self study: 28h

ACTIVITY. LABORATORY (CONTENTS 0, 1, 3, 4, 6, 7, 8 AND 9)

Specific objectives:

Those of the corresponding topics.

Related competencies :

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Full-or-part-time: 36h

Laboratory classes: 15h

Self study: 21h

ACTIVITY 5. PARTIAL EXAM 1 (CONTENTS 1, 2, 3, 4 and optionally on the part of the T6)

Description:

Test partial levels T1-T4 (and optionally on the part of the T6) that will take place in the middle of semester.

Specific objectives:

Those of the corresponding topics.

Material:

Presentations MS PowerPoint, problems collection. Moodle questionnaires.

Delivery:

Face to face exam (35% final qualification)

Related competencies :

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

Full-or-part-time: 2h

Theory classes: 2h

ACTIVITY 6. PARTIAL EXAM 2 (CONTENTS 5, 6, 7, 8 and 9)

Description:

Test partial levels T5-T9 that will take place in the end of semester.

Material:

Presentations MS PowerPoint, problems collection. Moodle questionnaires.

Delivery:

Face to face exam (35% final qualification)

Related competencies :

CE04-INDUS. Ability to understand and apply the principles of basic knowledge of general chemistry, organic and inorganic chemistry, and their applications in engineering. (Basic training module)

CENG4-DIDP. Basic knowledge of general, organic, and inorganic chemistry and their applications in engineering. (Basic training module).

Full-or-part-time: 2h

Theory classes: 2h

ACTIVITY 7. EXAM OF RECONDUCTION (OF PARTIAL 1)

Description:

Unsatisfactory results of the first examination may be redirect through a written exam, which will take place the same day of the second test. This exam can be accessed by all students enrolled who have a partial 1 mark

Full-or-part-time: 2h

Theory classes: 2h

GRADING SYSTEM

- Oral and written tests: 70 % (35 % 1st examination, 35 % the 2nd test)
- Laboratory sessions: 20%
- Other deliveries: 10% (Application/Questionnaires)

Unsatisfactory results of the first test may redirect through a written test, which will take place the same day of the second exam. This exam can be accessed by all students enrolled who have a partial 1 mark

EXAMINATION RULES.

Necessary condition to overcome the subject is performing laboratory practices and presenting corresponding reports. The use of coat and safety glasses is required in the laboratory.

BIBLIOGRAPHY

Basic:

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- Sales i Cabré, Joaquim, autor; Vilarrasa i Llorens, Jaume.. Introducció a la nomenclatura química: inorgànica i orgànica [on line]. 5a ed. Barcelona: Reverté, 2003 [Consultation: 13/05/2022]. Available on : <https://web-p-ebshost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=4a702db9-5af2-4eae-bdb5-0ae5b499e473%40redis&vid=0&format=EB>. ISBN 9788429193206.
- Whitten, Kenneth W. [et al.]. Química general. 5a ed. Madrid: McGraw-Hill, 1998. ISBN 8448113861.
- Chang, Raymond. Fundamentos de química. México: McGraw-Hill, 2011. ISBN 9786071505415.
- Reboiras, M. D. Química: la ciencia básica. Madrid: International Thomson Editores, 2006. ISBN 8497323475.
- Atkins, P. W. Principios de química: los caminos del descubrimiento. 3a ed. Buenos Aires: Médica Panamericana, 2006. ISBN 9500600803.
- Petrucci, Ralph H. Química general: principios y aplicaciones modernas [on line]. 11a ed. Madrid: Pearson Prentice Hall, 2017 [Consultation: 11/05/2022]. Available on : https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6751. ISBN 9788490355336.

Complementary:

- Quiñoá, Emilio. Nomenclatura y representación de los compuestos orgánicos: una guía de estudio y autoevaluación [on line]. 2a ed. Madrid: McGraw-Hill, 2005 [Consultation: 11/05/2022]. Available on : https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=4081. ISBN 8448143639.
- Whitten, Kenneth W. [et al.]. General chemistry. 7th ed. Brooks Cole, 2003. ISBN 9780534408602.
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- Masterton, William L. Química: principios y reacciones. 4a ed. Madrid: Thomson, 2003. ISBN 8497321006.
- Kotz, John C. Química y reactividad química. 5a ed. México: International Thomson, 2003. ISBN 9706863079.
- Silberberg, Martin S. Química general. 2a ed. México: McGraw-Hill, 2002. ISBN 9701035283.
- Chang, Raymond. Principios esenciales de química general. 4a ed. Madrid: McGraw-Hill, 2006. ISBN 8448146263.

RESOURCES

Hyperlink:

- <http://upcommons.upc.edu/video/handle/2099.2/1241>. Videoteca UPC >Grup de Recursos per a la Didàctica de la Química >Materials docents
<http://upcommons.upc.edu/video/handle/2099.2/1241>