COURSE DATA

Data Subject	
Code	34184
Name	General chemistry II
Cycle	Grade
ECTS Credits	6.0
Academic year	2016 - 2017

Study (s)

Degree	Center	Acad. year	Period
1108 - Degree in Chemistry	Faculty of Chemistry	1	Second term

Subject-matter

Degree	Subject-matter	Character
1108 - Degree in Chemistry	1 - Chemistry	Basic Training

Coordination

Name	Department
POU AMERIGO, ROSENDO	315 - Physical Chemistry

SUMMARY

The subject General Chemistry II is intended for students to deepen the knowledge of chemistry that they acquired during upper secondary education. This way, this course will serve to establish the necessary grounds for the successful further study of the different branches of the discipline. While the subject General Chemistry I focuses on the description of subject area, the guiding thread of General Chemistry II is the study of chemical reactions. Thus, topics such as the energy of reactions, kinetics or material equilibrium and its various types will be addressed. The main objectives are:

- To homogenise the prior knowledge of chemistry acquired by students in previous years.
- To establish solid bases so that they can successfully complete more advanced subjects.
- Students should acquire the basic terminology of chemistry and use it properly, expressing the ideas with the precision needed in a scientific context, knowing the conventions and using the units correctly.
- Students should develop their skill to set up and solve numerical problems in chemistry and interpret the results obtained.
- Students should be capable of looking for and selecting information in the context of chemistry and of presenting it appropriately in an oral way.
- To promote their skills for teamwork.

- To encourage among students those values and attitudes that must be inherent in the scientific activity.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Nomenclature and chemical formulation, both inorganic and organic.
Balancing of chemical equations.
Elementary stoichiometric calculations.
Identification of the acid-base nature of common compounds.
Obtaining of oxidation states of the elements that constitute the chemical species.
Calculation of derivatives and simple integrals.
Correct use of logarithms and exponentials.

OUTCOMES

1108 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- 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.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- 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.

- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Evaluate, interpret and synthesise chemical data and information.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- 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.
- 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

At the end of the course, the student must be able to:

- Distinguish between open, closed and isolated systems, between intensive and extensive variables, and between isobaric, isothermal, isochoric, adiabatic, cyclical, reversible and irreversible processes.
- Define state function and indicate which thermodynamic properties are state functions and which are not.
- Correctly employ the sign convention for the transfer of energy as heat or work.
- Calculate the gas expansion/compression work, both against a constant external pressure, in vacuo, and along a reversible isothermal process.
- State the first law of thermodynamics and use it to calculate transfers of energy.
- State Hess’s law and use it to calculate reaction enthalpies and/or internal energy changes.
- Define standard state, standard enthalpy of reaction, standard enthalpy of formation and standard enthalpy of combustion of a substance, indicating, for the latter two, the corresponding reactions and under which conditions they are carried out.
- Obtain the enthalpy of reaction and the internal energy change from standard enthalpies of formation data.
- Define specific heat and molar heat capacity and make use of these concepts to calculate the variation of enthalpies of reaction with temperature.
- State the second law of thermodynamics and use it to interpret the direction of changes in nature.
- Calculate entropy changes in expansions/compressions of ideal gases and in phase changes.

- Give a qualitative interpretation of entropy from a microscopic point of view.
- State the third law of thermodynamics.
- Calculate entropies of reaction at different temperatures on the basis of molar standard entropies and heat capacities.
- Predict the conditions in which a reaction will be spontaneous, estimating the sign of the change of the Gibbs free energy.
- State the general condition of chemical equilibrium.
- Obtain the reaction quotient and use it to determine the direction of a chemical reaction.
- Write the expressions of the equilibrium constant in ideal gaseous systems and in heterogeneous systems, both in terms of pressures and of concentrations; point out the relationship between them and obtain such constants from thermodynamic magnitudes (DHº and DSº).
- Calculate the quantities of the different substances of a system when the equilibrium is reached, by using both partial pressures and concentrations.
- Determine the variation of the equilibrium constant with temperature, both from a qualitative and a quantitative point of view, making use of the Van't Hoff's equation.
- Predict and justify the shifting of a chemical equilibrium when it is disturbed.
- Distinguish between homogeneous and heterogeneous systems and define the concept of phase.
- Name the phase transitions between solids, liquids and gases.
- Justify the change of the boiling points of pure substances with pressure.
- Draw the phase diagram of a pure substance and extract information (stable phases, equilibrium regions, phase transitions in processes, and singular points).
- Characterise an ideal solution and an ideal diluted solution, both from a microscopic and a phenomenological point of view, identifying the laws they obey and using them correctly in simple calculations.
- Construct and interpret P-x and T-x diagrams of binary solutions.
- Determine colligative properties of nonelectrolyte solutions.
- Justify the acid, basic or amphoteric properties of compounds by applying the Arrhenius, Brönsted-Lowry, and Lewis models.
- Classify different acids, basis and salts according to the pH of their aqueous solutions.
- Define buffer solution, buffer capacity, acid reserve, alkaline reserve and explain how to prepare buffer solutions.
- Solve simple acid-base numerical problems by employing the expressions of the equilibrium constants and the balances of matter and charge.
- Define the concepts of coordination compound complex, ligand, number of coordination and chelate, and classify ligands.
- Name and write chemical formulas for simple coordination compounds and represent the three-dimensional structures of complexes in a suitable form.
- Write the expressions of the constants of complex-ion equilibria, indicating the meaning of the successive constants and the constants inversion.
- Describe the effect of simultaneous reactions on the main complex-ion equilibrium.
- Calculate the concentrations at equilibrium in simple problems of formation of complexes by using the constants of all the equilibria involved as well as the metal and ligand balances.
- Establish the relationship between the ionic salts solubility and the solubility product.
- Predict whether the mixture of two solutions will cause the precipitation of a solid or not.
- Predict and justify the effect that several properties have on the solubility of a salt: temperature, the effect of the common ion, a change of pH or the formation of complex ions, and define the concept of conditional solubility and conditional solubility product.
- Calculate the concentrations at equilibrium in simple problems of solubility.
- Distinguish between galvanic batteries and electrolytic cells.

- Balance oxidation-reduction reactions, both in acid and in basic solution.
- Use a table of redox potentials to predict whether a reaction will take place between two species or not, identifying the oxidising and reducing agents.
- Draw the scheme of a galvanic battery providing electric current, indicating anode and cathode, polarity of the electrodes, brief notation of the battery, direction of the flow of electrons and ions, half-reactions and exact global reaction.
- Describe the meaning of the Nernst’s equation and calculate how the electromotive force is modified when the concentrations change.
- Establish the relationship between the electromotive force of a battery, the change of the Gibbs free energy and the equilibrium constant.
- Describe the characteristics of the main types of batteries: dry batteries, button batteries, lead batteries, nickel - cadmium batteries, and fuel cells.
- Describe what the phenomenon of corrosion is, the chemical processes involved, how it is affected by pH, and methods to prevent it (painting, galvanization, and cathode protection).
- Identify the properties that appear in a rate equation.
- Write, for simple zeroth-, first-, and second-order kinetics, the integrated equations, the expression of the half-life time, and the units of the rate constant, and use them in simple problems.
- Obtain the order and the rate constant of chemical reactions from experimental information, both with the method of the initial rates, and with the method of the integrated equations.
- Define mechanism of reaction, elementary process and molecularity, and identify reaction steps in a mechanism.
- Employ the approach of the rate-limiting step to establish whether or not a mechanism proposed for a chemical reaction is compatible with the available kinetic information.
- Identify the properties that appear in the Arrhenius equation, explain its meaning and use it to calculate the variation of the rate constant with temperature.
- Describe what a catalyst is, how it works and which types of catalysis exist.
- Carry out a minor team project (its preparation will not require more than 12-14 hours per student) while contributing actively to the setting of an effective communication system, to the accurate distribution of tasks and to the definition of a decision-making mechanism, a planning and a self-assessment system. Carry out the tasks assigned promptly and properly, while contributing novel ideas and assuming shared responsibility in the results.
- Lead the team’s work effectively by promoting initiatives, stimulating work, convening and leading members proactively, appropriately managing any conflicts that may arise, and building team spirit at all times.
- Give a short oral presentation (not exceeding 5 minutes per student) in an appropriate manner as regards formal aspects, presentation and content.
- Justify scientific facts or opinions with rational arguments in an appropriate and rigorous manner.
- Obtain, analyse, select, manage, synthesise and present scientific information in an appropriate manner by using the correct bibliographic sources and information and communication technologies.
- Solve new problem situations that may arise related to those aspects studied during the course.
- Relate and explain the chemical content addressed in the course with phenomena of everyday life and/or of environmental interest, and be able to explain them.
- Interpret simple sentences written in English on the topics studied.

DESCRIPTION OF CONTENTS

1. THE ENERGY OF THE CHEMICAL REACTIONS

Basic concepts. Systems, variables and processes.- Energy, heat and work. The first law of thermodynamics.- Enthalpy.- Heat of reaction. Hesss law. - Standard enthalpy of formation.- Heat capacity.- Variation of the enthalpy of reaction with temperature. Kirchhoffs equation.

2. THE DIRECTION OF THE CHEMICAL CHANGE.

Spontaneity. Need for the second law.- Reversibility and spontaneity.- The second law of thermodynamics. Entropy.- Entropy calculations.- Molecular interpretation of the entropy.- Absolute entropies. Third law of thermodynamics.- Change of the entropy of reaction with temperature.- Free energy. Change of the free energy with temperature.

3. THE EQUILIBRIUM IN CHEMICAL REACTIONS

Basic aspects of the chemical equilibrium.- General condition of the chemical equilibrium.- Chemical equilibrium in ideal gas systems.- Heterogeneous equilibria.- Variation of the equilibrium constant with temperature.- Equilibrium response to a change in conditions. Le Châteliers principle.

4. CHANGES OF STATES OF PURE SUBSTANCES.

Basic concepts. Phases and phase transitions.- Phase equilibria in one-component systems. Thermodynamic study.- Pressure/temperature diagrams.

5. SOLUTIONS

Concept of ideal solution. Raoults law.- Thermodynamic study of ideal solutions.- Ideal binary solutions. P-x and T-x diagrams.- Ideal diluted solutions. Henry's law.- Colligative properties.

6. ACID-BASE EQUILIBRIUM

Definitions of acids and bases.- The autoionisation of water. pH scale.- Strength of acids and bases. Equilibrium constants. - Calculation of the pH and the concentrations of all the species at equilibrium.- Hydrolysis.- Buffer solutions.

7. COMPLEX-ION EQUILIBRIA

Definitions and nomenclature.- Equilibrium constants.- Relationship between complex-ion acid-base equilibria. Conditional constants.- Calculation of concentrations at equilibrium.

8. SOLUBILITY EQUILIBRIA

Basic concepts.- Solubility product.- Factors affecting solubility. Conditional solubility.- Calculations at equilibrium.

9. OXIDATION-REDUCTION EQUILIBRIA

Oxidation-reduction reactions.- Thermodynamics of electrochemical systems. Voltaic batteries.- Electromotive force of the batteries (EMF). Electrode potentials.- Dependence of the EMF on concentrations. Nernst equation.- Types of electrodes.- Commercial batteries.- Corrosion.

10. THE RATE OF THE CHEMICAL CHANGE.

Reaction rate.- Dependence of the reaction rate on concentration. Rate equation.- Simple integrated rate laws.- Mechanisms of reaction.- Influence of temperature on the reaction rate. Arrhenius equation.- Catalysis.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of group work	12,00	0
Study and independent work	54,00	0
Preparation of evaluation activities	24,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course will be developed through the following teaching methods:

• Lectures

• Participatory sessions

• Problem solving

• Search of information

• Oral presentations

The first two methodologies will offer an overview of the topic as well as a series of recommended resources for an in-depth further study of the subject.

Problem-solving sessions will serve to explain a set of typical problems, but it will be students themselves who will have to deal with the problems, which will be corrected and analysed later on.

In tutorials the lecturer will guide the students as regards their learning process. For these sessions, students will be given a list of questions and problems that will serve to strengthen their knowledge.

Finally, the presentation of a project is compulsory. The project will involve a search of information and will be prepared in teams and presented to the whole class.

EVALUATION

The following assessment systems will be used, which will contribute to the final mark in the percentages indicated:

• Written, oral and/or practical tests: 70%

• Assessment of group tutoring sessions, seminars, preparation of projects and/or oral presentations: 25%

• Continuous assessment of each student based on classroom activities, participation and degree of involvement in the teaching-learning process: 5%

At the end of the semester, students must sit a final exam that will contribute 70% of the mark and will have two parts: one consisting of theoretical questions and another one consisting of numerical problems. The exam result will be calculated as the average of the marks obtained in each part, taking into account that both marks must be greater than or equal to 4.5. Otherwise, both the exam and the subject will be marked as failed, regardless of the other marks achieved. Official exams will be the same for all groups.

The second assessment item, which will contribute 25%, will be marked based on two components: first, the mark for the team project (10%) and second, the mark for the exercises presented in group tutorials and for the questionnaires (10%). Finally, the continuous assessment of each student will contribute an additional 5%.

Systems and percentages will be identical in the first and second examination sitting. It is therefore not possible to be assessed only through a final exam. Any student who fails at the first attempt must sit the final exam at the second examination sitting and the marks for sections 2 and 3 obtained at the first attempt will be carried forward. However, if the student failed one of these two sections and the lecturer deems it feasible and appropriate, he or she may retake it by carrying out additional activities.

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