Subject Guide

1. Information about the subject

SUBJECT	Basic Operations in the Laboratory and Informatic Tools	**CODE**	GQUIMI01-1-002
EDUCATIONAL OFFER	Bachelor´s Degree in Chemistry	**CENTER**	Facultad de Química
TYPE	Core	**N° TOTAL CREDITS**	6.0
PERIOD	Second Semester	**LANGUAGE**	Spanish English

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2. Context

This is the first experimental course of the Degree in Chemistry and it is part of the subject Chemistry of the Degree Basic Module. The course objective is to provide adequate chemistry laboratory skills to all the students. Therefore, it is essential to more advance experimental courses.

The course contents are deeply related to those of the “General Chemistry” course, which provides the theoretical foundations in Chemistry. In a lesser but significant extent, it is also related to the Physics, Mathematics, Biology and Geology first year courses of the Degree Basic Module. **It is noteworthy** that passing both the “Basic Laboratory Operations and Computing Tools” and “General Chemistry” courses is required to enrol for any of the second year courses of the Degree in Chemistry. Therefore, “Basic

Laboratory Operations and Computing Tools" is referred as a "key" course. **Attendance to all course classes is compulsory**. Different areas of Chemistry will be involved in the course.

3. Requirements

Since it is a first year course, no administrative requirements are needed. However, previous experience in Chemistry and Chemistry laboratory courses is very advisable. Many of the concepts provided in the course are also taught in the "General Chemistry" course.

4. Competencies and learning results

General objectives:

1. Rationalization and analysis abilities; being capable of effectively solving specific problems; proper communication in English; independent learning; environmental awareness; critical thinking; team work (CG-1,2,9,12,17,18).
2. Achieve a computing background related to chemistry (CG-3).
3. Acquire basic skills in TIC (CG-20).

Specific objectives:

1. Acquire a basic knowledge of the terminology, nomenclature, guidelines and units used in Chemistry; relate macroscopic properties with those of atoms and individual molecules; understand the factors controlling the different chemical properties of the elements and identify the different states of matter; describe the different types of chemical reactions and make use of the principles of thermodynamics (CE-1,2,3,4,5,7).
2. Solve problems using mathematic models; acquire the needed abilities to evaluate, interpret and analyse chemical information; handle safely chemical reagents, instrumentation and any other devices used in Chemistry; monitor chemical properties; rationalize data extracted from observation; using deductive and inductive methods; recognise and interpret chemical processes; calculate and analyse errors from data; present and defend scientific reports in written and oral forms (CE-20,22,24,25,27,32,33,34,35,36).

Learning outcomes.

The learning outcomes must include the following aspects:

Identify and be familiarized with all the equipment commonly used in a Chemistry laboratory. Learn how to prepare solutions and the different ways to express and determine (via titration) their concentration. Distinguish between exothermic/endothermic processes attending to the experimental observations and making use of the enthalpy concept. Determine the heat of a certain reaction from the variation in temperature observed. Outline and apply the Le Châtelier principle to predict equilibrium shifts in systems altered by an external perturbation. Define the concept of reaction rate (speed of a reaction) and explain the factors controlling it: temperature and reagents concentration. Formulate first and second order kinetic equations and their integers. Understand the concept of solubility product for a certain substance and do the calculations needed to determine the common ion and salt effects. Determine the dissociation constant

of a weak acid from an acid-base titration curve. Know what substances behave as strong/weak electrolytes. Differentiate between strong and weak electrolytes from electric conductivity data. Understand the concept of optic activity and its application for kinetic studies. Be familiar with the use of polarizers for optic activity measurements. Balance redox reactions and predict their spontaneity. Synthesise simple inorganic compounds. Understand the concept of phase change and its role in the purification of solids and liquids. Use crystallization as a basic process for the purification of salts. Distinguish between polar/apolar compounds for extraction processes. Know and make use of health and safety rules in a chemistry laboratory, understand chemical reagents labelling and where to dispose used chemicals. Handle appropriately all the equipment, reagents, instrumentation and techniques commonly used in a Chemistry laboratory. Make use of theoretical and experimental knowledge acquired to measure physicochemical properties. Carry out standard laboratory procedures involved in analysis and synthesis of organic or inorganic compounds, rationalizing the information extracted from observation and data (CE-30). Be familiarized with the computing tools needed to draw chemical compounds structures and draft experimental results. Prepare written reports of the experimental work carried out and the results achieved.

5. Contents

Module A: Safety and security; Laboratory Equipment

1. **Safety and security**: Risks and hazards in the chemistry laboratory. Chemical exposure hazards. Glassware manipulation hazards. Risk assessment: Electrocution, fire, and explosion. Laboratory protection guidelines: Basic rules. Safety and security rules. Acting in case of accident. Chemical waste management.
2. **Laboratory equipment:** Measuring mass: grain scales, analytical scales. Volumetric equipment and general glassware. Heaters. Thermometers. Filtration, traditional and vacuum. Distillation equipment. Conductimeters, Polarimeters, pH-meters, and spectrophotometers.

Module B: Information Technology Tools.

1. **Statistical treatment of information**: Estimating experimental errors. Accuracy and precision. Writing out experimental results: Significant figures. Conventions. Using significant figures.
2. **Computational tools used in chemistry:** Basic office tools: word processors, spreadsheets. Numerical and algebraic computer packages. Introduction to problem solving strategies. Data representation. Chemical information: molecular representations. Internet as a chemical information store.

Module C: Basic Laboratory Operations.

1. Common physical operations :

a. Extraction and precipitation. Application of the acid-base properties to the extraction. Distillation of solvents at atmospheric pressure. Distillation of solvents by rotary evaporation. Purification by vacuum distillation. Purification by recrystallization. Filtration and drying. Stoichometric

calculations. Methods of purification.

2. Thermodynamic and kinetic aspects of chemical reactions:

a.Thermochemistry. Endothermic and exothermic processes. Enthalpy. Heat of dissolution. Heat of dilution. Chemical equilibrium. Le Chatelier´s Principle

b.Rate of a Chemical Reaction. Equation and rate constant. Order of a reaction. Rate of a reaction and concentration of reagents. The effect of temperature on reaction rates.

3. Analytical procedures and applications of the equilibriums to chemical analysis.

a. Materials frequently used in a chemical laboratory: weight, volume measurement and preparation of solutions.

b. Introduction to chemical equilibria: titrations.

c. Introduction to chemical equilibria: gravimetries.

4. Reactivity.

1. Redox reactions. Effect of the concentration. Nernst´s equation and passivation phenomenon.

5. Synthesis of simple compounds

1. Application of redox reactions to the synthesis of simple compounds.
2. Preparation of compounds that require appropriate reaction conditions, followed by their isolation and purification.

6. Methodology and working plan

The methodology used is mainly based on teamwork and/or the individual's work in the laboratory. Each experiment will follow these steps:

1. Individual study of the general scheme of the experiment base on the guide that is provided.
2. Explanation and discussion between the teacher and students about operational aspects and essential theoretical concepts or those having some additional difficulty.
3. Execution of the experiment by students under the supervision of the professor. Answers to the

questions posed in the experiments guide must be included.

4. It is recommended the preparation of a laboratory report which should contain the work that was done and the results that were obtained, as well as new new theoretical concepts, calculations using the results obtained, bibliographic information such as reference citations, and conclusions.

	In-class	Out-of-class	TOTAL
Laboratory work	70	35	105
Seminars	14	14	28
Examinations and assessments	3	14	17
TOTAL	88	62	150

For the methodology of joint activities, refer to the student guide.

7. Evaluation of the student's learning results

Topics	Criteria	Method	Percentage
Concepts and calculations	Knowledge of theoretical concepts, experimental methods and mass balances.	Exam	60%
Laboratory work	Active participation in the development of the experiment. - Answers to questions raised by the professor during the development of the experiment.	From the laboratory notes, students will write (or will complete) a laboratory report. The teacher will review and evaluate the criteria accomplished (detailed on the left), as well as the laboratory skills and answers the students provide to questions posed during laboratory	30%

	-Interest, attention and care given to the lab work. Each experiment must take into account the following: -organization of the experiment. -Correct use of nomenclature, agreements and units. -Detailed analysis of the results. -Conclusions of the work. -Appropriate literature citations.	experiments..	
Joint activities	See student-guide for joint activities	See student-guide for joint activities	10%

To pass the course, the student must obtain at least 4 out of 10 points in each of the three aspects evaluated (concepts and calculations, laboratory and join activities). When the student does not pass the course in June two scenarios can be considered: (1) If the student fails the written exam, the student will be evaluated again in July, while keeping the grades obtained previously in the other two topics (laboratory and join activities); or (2) If the student fails the laboratory work, a practical exam will be given in July, while keeping the grades obtained previously (exam and joint activities). In either case, the percentage of each evaluated topic will remain as listed in the table above. Other extraordinary calls will have the same system of evaluation that the call for July.

Attendance to the classroom and experimental sessions is mandatory. Students will not be allowed to attend the experimental sessions with unjustified absences in the Safety block (A.1).

The evaluation of the teaching process will be performed jointly with the rest of the course subjects. Once the June exams will be finished, it will be organized a meeting professors-students (5-6 students in each group) and the students will answer a questionnaire about the course subjects. Later it will be a sharing of responses and a debate between students and teachers. The outcome of the meeting will be a document where the possible actions of improvement will be reflected.

8. Resources, bibliography and complementary documentation

Different texts are recommended for each module. In this way problems with libray loans and/or excessive demand will be minimized. General purpose texts:

- “Química, Curso Universitario”, B.H. Mahan y R.J. Myers. 4ª ed. Ed. Addison Wesley Iberoamericana, 1990 (**8** copies available in the library of the Faculty of Chemistry, 9 copies in the library of the Teaching training school, 1 in the Faculty of Geology, 3 in the Mines School, 1 in Mieres, 10 in the Business and Technology building at the Viesques campus). The original english version (University Chemistry) is available but out of print.
- “Química General: principios y aplicaciones modernas”, R. H. Petrucci, W. S. Harwood ; tr. N. Iza Cabo, C. Pando Ga. Pumarino, Prentice Hall, 1999. Chapter 7 (7.1-7-6). **5** copies avialble in the library of the faculty of chemistry, 3 in the library of the Teaching training school, 3 in Mieres, and 3 in the Business and Technology building at the Viesques campus. The original english version (General chemistry: principles and modern applications) is also available.
- “General Chemistry: principles and modern applications”. R. H. Petrucci, W. S. Harwood ; tr. N. Iza Cabo, C. Pando Ga. Pumarino, Pearson, 2011 (10th ed).
- “Chemical Principles”. P. Atkins, L. Jones, L. Laverman. Ed. W. H. Freeman and Company (NY), 2013 (6th ed.).

Module A:

- “Seguridad en el Laboratorio de Química”, Francisco Javier García Alonso, University of Oviedo press, 2004. No english translation is available. An english source is "Laboratory Safety for Chemistry Students", R. H. Hill, D. Finster, Wiley, 2010.

Module B

- “Informática aplicada a la química”, Josep Planelles Fuster, Universitas, 2002. No english translation. Material in english will be uploaded to ecampus.

Module C:

- “Química General Superior” Masterton, Slowinski, Stanitski. Chapter 12. Chapter 19 (19.1-19.7). There are 8 copies in Chemistry School library, 15 at the Teaching School, 2 in the Biology School, 2 in the Superior Miner School, 2 in the ICE, 4 at the Mieres Campus and 15 in the Technology and Enterprise School at the Viesques Campus.
- “Físicoquímica”, I. Levine, Chapter 16 . There are 26 copies in the Chemistry School library, 1 in the Medical School, 7 in the Technology and Enterprise School at the Viesques Campus and 2 at the Buelga´s House. There is an english version. "Physical Chemistry" I. N. Levine, 6th Ed. McGraw-Hill.
- “Química”, Bailar, Chapter 28 (28.1, 28.2, 28.4, 28.7, 28.9). There are 4 copies in the Chemistry School library, 2 in the Biology School, 2 in the ICE, 2 in the Psychology School and 2 at the Mieres Campus. There is also an english version. "Chemistry", J. C. Bailar, Brace Jovanovich, 1989.
- “Experimentación en Química General” J. Martínez Urreaga, A. Narros Sierra, M.M. de la Fuente García-Soto, F. Pozas Requejo, V. M. Díaz Llorente. Paraninfo, 2006. There are 2 copies in the Technology and Enterprise School library at the Viesques Campus. A possible english source is "Experiments in General Chemistry", R. Wentwordth, B. H. Munk. 10th Ed. Cengage learning, 2012.
- “Organic Laboratoy Techniques”. D. L. Pavía, G. M. Lampman and G. S. Kriz, 3rd Ed. Saunders College Publishing, 1988.

Experimental procedures will be available on ecampus, where any other relevant material and/or information will be uploaded.