VNIVERSITAT DE VALÈNCIA

Course Guide
36450 Analytical Chemistry I

COURSE DATA

Data Subject	
Code	36450
Name	Analytical Chemistry I
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	2	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	6 - Analytical Chemistry	Obligatory

Coordination

Name	Department
GARRIGUES MATEO, SALVADOR	310 - Analytical Chemistry

SUMMARY

Analytical Chemistry I is the first course in the subject area of Analytical Chemistry on the degree in Chemistry. As such, it is the starting point for the teaching of Analytical Chemistry and of great importance for addressing the later courses related to that area.

This course introduces the basic concepts related to the analytical process, basic operations, analytical properties and the expression of results. Students become aware of what Analytical Chemistry represents today and how it contributes to today's society.

Following an introduction to sample treatment and preparation, the course focuses on classical analytical techniques and in particular on reactions in solution, i.e. volumetric and gravimetric analysis. The contents of General Chemistry II on chemical equilibrium will therefore prove extremely useful for completing this course. Moreover, the contents of Analytical Chemistry I will be reinforced on Laboratory of Analytical Chemistry I, which students will complete in the next semester.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Basic knowledge: Nomenclature and formulation. Stoichiometric calculations. Basis of equilibria in solution. Identifying acid-base and redox characteristics of species. Accuracy and precision. Basic mathematical and statistical calculations. Types of errors. Propagation of uncertainty. Significant digits.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Solve problems effectively.
- 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 types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.
- 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.
- Recognise and analyse new problems and plan strategies to solve them.
- Evaluate, interpret and synthesise chemical data and information.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Relate chemistry with other disciplines.
- 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 developed the learning skills needed to undertake further study with a high degree of autonomy.
- 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 (RD 1393/2007) // NO CONTENT (RD 822/2021)

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Analytical Chemistry that allow to acquire specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Analytical Chemistry I related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Analytical Chemistry I that contemplate the learning outcomes EUROBACHELOR®
The major types of chemical reaction and the main characteristics associated with them.	Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4)
The principles and procedures used in chemical analysis and the characterisation of chemical compounds.	Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8) Understand the qualitative and quantitative aspects of chemical problems..(CE24).

COMPETENCES AND COGNITIVE SKILLS
The learning process should allow the degree graduates to demonstrate:

	Competences of the subject Analytical Chemistry I that contemplate the learning outcomes EUROBACHELOR®
Ability to demonstrate knowledge and understanding of the facts, concepts, principles and fundamental theories related to the topics mentioned above.	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry..(CE13).
Ability to apply this knowledge and understanding to the solution of common qualitative and quantitative problems.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Competences for the evaluation, interpretation and synthesis of information and chemical data.	Evaluate, interpret and synthesise chemical data and information..(CE16). Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).
Ability to calculate and process data, related to information and chemistry data.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Analytical Chemistry I that contemplate the learning outcomes

	EUROBACHELOR®
Ability to apply practical knowledge to solve problems related to qualitative and quantitative information.	Solve problems effectively..(CG4). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Solve problems effectively..CG4).
Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf	Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.(CG10). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). 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. (CB3).

These learning outcomes should ensure that on successful completion of Analytical Chemistry I students will be able to:

- Define the concept of Analytical Chemistry.
- Explain the role of Analytical Chemistry in its current context.
- Define and use basic concepts such as analyte, interferent, sample, technique, method, procedure, and protocol, etc. appropriately.
- Define and classify the main analytical properties.
- Relate the analytical properties with the methods and analytical results.
- Describe and distinguish between the various steps in an analytical process and assess their relevance.
- Describe and justify the basis of the sampling techniques.
- Describe and justify the principles behind the basic operations in the treatment of analytical samples.
- Define and distinguish between systematic and random errors and describe their relationship with the analytical properties.
- Express an analytical result correctly.
- Describe the fundamentals of classical qualitative analysis and justify its analytical interest.
- Define the scope of volumetric methods and describe their rationale, highlighting the features the reactions must have if they are to be used in these methods.
- Describe the fundamentals of direct and back titrations, highlighting the differences in the experimental procedures.
- Construct linear predominance diagrams of acid-base and complex formation systems.
- Carry out the necessary calculations in order to draw titration curves for acid-base, complex formation, precipitation and oxidation-reduction systems.
- Calculate the side-reaction coefficients and conditional constants, together with their influence on the titration curves.
- Describe the features that primary and secondary standards should have.
- Select the appropriate chemical indicator and calculate the titration error.
- Explain the basis for the main applications in volumetric analysis.
- Determine the analyte concentration in a sample by titrimetric analysis.
- Describe the features that must be met in a chemical reaction if it is to be used in gravimetric analysis.
- Describe the steps involved in a gravimetric procedure.
- Describe the characteristics of the precipitates and the factors that influence a gravimetric procedure.
- Explain the basis for the main applications of gravimetric analysis.
- Determine the analyte concentration in a sample obtained by gravimetric analysis.

DESCRIPTION OF CONTENTS

1. Introduction to Analytical Chemistry

Introduction to analytical chemistry. Definition of Analytical Chemistry. Basic terminology. Analytical properties. Classification of analytical methods. Classical Qualitative Analysis Steps of the analytical process.

2. Analytical Sampling and Sample Treatment

Analytical sampling and sample treatment. Definition. The importance of representativeness in the sampling. Basic operations of sampling (in solid, liquid and gaseous states). Basic operations of sample treatment in Analytical Chemistry: dissolution, leaching, wet and dry mineralization, liquid-liquid extraction, solid-phase extraction, distillation, evaporation, filtration, centrifugation, precipitation, masking and derivatisation.

3. Introduction to Classical Quantitative Analysis

Introduction to classical quantitative analysis. Classification. Fundamentals of volumetric analysis. Requirements of the reactions used in titrimetric analysis. Titration curves. Equivalence point and end point. Titration error. Primary and secondary standards (preparation, standardization and conservation). Direct, indirect and back titrations. Evaluation and expression of results.

4. Fundamentals of Gravimetric Analysis: Gravimetries

Fundamentals of gravimetric analysis. Principles. Gravimetric factor. Characteristics of the precipitates. Basic steps of gravimetric analysis based on precipitation. Applications.

5. Acid-base Titrimetric Analysis

Acid-base titrimetric analysis. Introduction. Titration curves. End point detection: acid-base indicators. Selecting the indicator. Error assessment. Applications.

6. Titrimetric Analysis Based on Complex Formation

Titrimetric analysis based on complex formation. Introduction. Effect of the medium on the titration curve: influence of side reactions, calculation of side-reaction coefficients and conditional constant. Titration curves. End point detection: metallochromic indicators. Selecting the indicator. Error assessment. Applications.

7. Titrimetric Analysis Based on Precipitation

Titrimetric analysis based on precipitation. Introduction. Effect of the medium on the titration curve. Titration curves. End point detection. Error assessment. Applications.

8. Redox Titrimetric Analysis

Redox titrimetric analysis. Introduction. Effect of the medium on the titration curve. Titration curves. End point detection: redox indicators. Selection of the indicator. Error assessment. Applications.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Study and independent work	40,00	0
Preparation of evaluation activities	22,00	0
Preparing lectures	8,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course will be taught using the following methods:

- Lectures
- Participatory classes
- The solving of exercises
- Conferences and/or Seminars
- Information searches
- Problem-based learning
- Analyses and case studies

The course will comprise lectures on theoretical concepts, problem-based learning sessions, group tutorials and seminars.

The lectures will present an overview of each topic on the course. The problem-based learning sessions will provide the basis for solving problems related to the theoretical contents. Outside the classroom, students will answer questions and solve problems set by the lecturer in order to consolidate the knowledge they have acquired.

In the tutorials, students will discuss practical analytical problems and their ability to solve these problems will be evaluated. The tutorials will also allow students to raise any queries they have in relation to the questions and problems set by the lecturer.

In the seminars, practical cases related to the contents of the lectures will be explained.

In the programmed conferences where current topics will be tackled, at the end of the session, the students will answer a test with questions related to the content of the talk.

Students will also be able to raise their queries about the questions and problems set by the lecturer and submit their work for evaluation on these matters throughout the course.

EVALUATION

The following system of evaluation will be used:

- Written, oral or practical examinations.
  - Continuous assessment of each student-based classroom activity, student participation, and the student's degree of involvement in the teaching-learning process.

Learning will be evaluated by taking into account all the aspects stipulated in the Methodology section of this syllabus. Students who do not attend class regularly must choose mode B.

FIRST CALL

Mode A

The final grade will be calculated from the scores obtained in the written examination (70%) and the continuous assessment (30%)

The score on each of these two parts must be at least 4.5 in order to apply the average.

The minimum overall grade to pass the course is 5.0.

Mode B

Students may request to be evaluated solely by an examination of the course contents developed during the lectures, tutorials and seminars. This examination will determine whether the student has acquired the skills and knowledge taught by the lecturer throughout the course.

SECOND CALL

In the second call, the evaluation will be made according to the criteria of the First Call. Students who have opted for Modality A and obtained a grade below 5.0 in the continuous assessment will be evaluated by Mode B.

REFERENCES

Basic

- - SKOOG, D.A.; WEST, D.M.; HOLLER, F.J. Y CROUCH, S.R. Fundamentos de Química Analítica, 8ª edición. Madrid: Thomson-Paraninfo, 2005. ISBN: 9788497323338
- - HARRIS, D.C. Análisis químico cuantitativo, 3ª edición en español. Barcelona: Ed. Reverté, 2007. ISBN 9788429172249
- - BERMEJO, F.; BERMEJO, P. Y BERMEJO, A. Química Analítica general: cuantitativa e instrumental, 7ª edición. Madrid: Paraninfo, 1991. ISBN: 978-84-600-5965-3
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- - BURRIEL, F.; LUCENA, F.; ARRIBAS, S. Y HERNÁNDEZ, J. Química Analítica cualitativa. Madrid: Paraninfo, 2003. ISBN 9788497321402

Additional

- - VALCÁRCEL, M. Principios de Química Analítica. Barcelona: Springer-Verlag Ibérica, 1999. ISBN: 9788407005002
- - KELLNER, R.; MERMET, J.M.; OTTO, M.; VALCÁRCEL, M. Y WIDMER, H.M. Analytical Chemistry:
a modern approach to analytical science, 2ª edición. Winheim: Wiley-VCH, 2004. ISBN: 978-3-527-30590-2
- - SILVA, M. Y BARBOSA, J. Equilibrios iónicos y sus aplicaciones analíticas. Madrid: Síntesis, 2002.ISBN 9788497569293
- - YÁNEZ-SEDEÑO, P.; PINGARON, J.M. Y DE VILLENA, F.J.M. Problemas resueltos de Química Analítica. Madrid: Síntesis, 2003. ISBN: 9788497560719
- - FERNÁNDEZ, P.; MARTÍN-ESTEBAN, A.; PÉREZ-CONDE, C. Y VIDAL, M. Toma y tratamiento de muestras. CÁMARA, C. (ed.). Madrid: Síntesis, 2002. ISBN 9788477389620

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

The contents initially indicated in the teaching guide are maintained.

Workload and temporary teaching planning

Regarding the workload:

The different activities described in the Teaching Guide are maintained with the intended dedication.

Regarding the temporary teaching planning:

The material to follow the theory/tutoring/classroom-seminar classes allows to continue the temporary teaching planning both in days and schedule, whether the teaching is face-to-face in the classroom or not.

Teaching Methodology

Theory courses: Theory classes and classroom tutoring will tend to the maximum possible face-to-face teaching, always respecting the health restrictions that limit the capacity of the classrooms to 50% of their usual occupation. Depending on the capacity of the classroom and the number of students enrolled, some of the students may need to follow the classes synchronously in an auxiliary classroom. If this situation arises, students will attend the main classroom or auxiliary classroom for weekly rotary shifts (preferably in alphabetical order). However, the rotation system will be fixed once the actual enrollment data is known, guaranteeing, in any case, that the percentage of face-to-face teaching of all students enrolled in the subject is the same.

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the course, they will be replaced by non-face-to-face sessions following the established schedules and using the tools of the virtual classroom.

Evaluation

1. The possibility of exam-only evaluation is eliminated.

2. The evaluation system described in the Teaching Guide of the subject in which the various evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained.

If there is a closure of the facilities for health reasons affecting the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final grade of the subject will remain unchanged, as set out in this guide.

References

2.- The literature recommended in the Teaching Guide is maintained since it is accessible, and it is complemented by notes, slides and problems uploaded to the Virtual Classroom as material of the course