Bachelor´s Degree in Chemistry

Subject Guide

1. Information about the subject

SUBJECT	Chemistry of the Representative Elements	**CODE**	GQUIMI01-2-006
EDUCATIONAL OFFER	Bachelor´s Degree in Chemistry	**CENTER**	Facultad de Química
TYPE	Compulsory	**N° TOTAL CREDITS**	6.0
PERIOD	Second Semester	**LANGUAGE**	Spanish

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LECTURERS	**EMAIL**	
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2. Context

The course “Chemistry of the Representative Elements” is taught in the second term, second year of Degree in Chemistry. It is integrated in the fundamental module, within the “Inorganic Chemistry” general subject. It is a theoretical course aimed to provide the student with a general understanding of the preparation, structure, bonding and reactivity of both the main-group elements (s and p-block elements) and their more important compounds. It is assumed that the students have assimilated properly the ideas and methods developed in previous courses such as “General Chemistry” and “Concepts and Models in Inorganic Chemistry”. Is should be noted that passing this course is a pre-requisite for the course “Experiments in Inorganic Chemistry I” and also very recommended before undertaking “Chemistry of the Transition Elements”.

This subject is fully taught (lectures, seminars and group tutorial sessions) by Dr. Miguel A. Ruiz, a Professor of Inorganic Chemistry within the inorganic chemistry area of the “Departamento de Química Orgánica e Inorgánica de la Universidad de Oviedo”

3. Requirements

To take this course, it is mandatory that the student has passed the courses “General Chemistry”, and “Basic Laboratory Operations and Information Technology Tools”. In addition, as stated above, it is strongly recommended to have a good knowledge of the subject “Concepts and Models in Inorganic Chemistry”, which is developed in the first term of the same academic year.

4. Competencies and learning results

General Competences:

- Show synthetic and analytical abilities (CG-1).
- Solve problems in an effective way (CG-2).
- Properly handle information (CG-6).
- Develop ability to speak and write correctly in English (CG-8).
- Develop self-learning abilities (CG-9).
- Develop critical thinking (CG-17).
- Develop group-working abilities (CG-18).

Specific competences:

Knowledge:

- Get a good knowledge of the chemical terms, nomenclature, international rules and units (CE-1)
- Relate macroscopic properties with atomic and molecular characteristics (CE-2).
- Recognize the periodical properties of the chemical elements (CE-3).
- Describe the main types of chemical reactions and characteristics (CE-5).
- Get a good knowledge of the representative elements, their compounds, earth distribution, preparation, structure and reactivity (CE-9).

Skills:

- Exhibit knowledge and understanding of the essential facts, concepts, principles and theories related to Inorganic Chemistry (CE-19).
- Solve both qualitative and quantitative problems following models previously developed (CE-20).
- Get the ability to assess, interpret and synthesize chemical information (CE-22).
- Correctly use the inductive and deductive methods in the context of Inorganic Chemistry (CE-32).

Learning outcomes:

- Access, select and use chemical information in an efficient way.
- Know, understand and explain the bonding ability of the representative elements and their more stable oxidation states.
- Know, understand and explain the main periodical trends in the chemistry of the representative elements.
- Know, understand and explain the general methods to obtain the representative elements, their structures, bonding and general reactivity.
- Know, understand and explain the synthesis, structure, bonding and reactivity of the main combinations of representative elements with hydrogen, halogens and oxygen.
- Know, understand and explain the preparation and uses of large-scale inorganic chemicals based on representative elements.
- Know, understand and explain inorganic chemical reactions involving representative elements.

5. Contents

The contents of this course is organized by groups of the periodic table, starting from group 17 and moving leftwards up to group 12, after a short introductory lecture. This organization is different from the one used in the parallel course taught in Spanish, but the overall contents of both courses are equivalent to each other.

1. **Introduction**. Organization of the course. Context of the subject. Commodity chemicals. Contents of the course.

2. **Hydrogen**. Abundance and isotopes. Laboratory, industrial production and uses. Activation of the H2 molecule. Synthesis, structure and reactivity of binary combinations: saline, metallic and covalent hydrides. Acidity of binary combinations. Acidity of oxoacids. The hydrogen bond.

3. **The halogens**. Atomic and molecular properties. Production and uses of the elements. General reactivity. General aspects of the synthesis, structure and reactivity of halides of the representative elements. Production and uses of hydrogen halides. Interhalogenated compounds.

Halogen oxides. Oxoacids and oxoanions.

4. **Oxygen**. Atomic properties of oxygen within the group 16 elements. Dioxygen and ozone. General reactivity of O2. General aspects of the synthesis, structure and reactivity of binary oxides of the representative elements. Water and hydrogen peroxide. Ternary combinations: Mixed oxides, oxohydroxo compounds, and hidroxo compounds.

5. **The chalcogens**. Atomic properties. Production and uses of the elements. Structure and general reactivity of the elements. Hydrogen chalcogenides. Metal chalcogenides. Chalcogen halides. Oxohalides. Oxides. Oxoacids and oxosalts.

6. **Nitrogen**. Atomic properties of nitrogen within the group 15 elements. Uses and general reactivity of the N2 molecule. Binary combinations with hydrogen: Ammonia, hydrazine and hydrazoic acid. Nitrogen halides. Nitrogen oxides: N2O, NO and NO2. Oxoacids and oxosalts.

7. **The heavier group 15 elements**. Atomic properties. Production and uses of the elements. Structure and general reactivity of the elements. Hydrides. Halides. Oxides. Oxoacids and oxosalts.

8. **Carbon**. Atomic properties of carbon within the group 14 elements. Allotropes of carbon: Graphite, diamond, fullerenes and graphene. Graphite compounds. Fullerene compounds. Carbides. Molecular combinations of carbon. Carbon halogenides. Carbon oxides: CO and CO2. Carbonates. Organometallic complexes.

9. **The heavier group 14 elements**. Atomic properties. Production and uses of the elements. Structure and general reactivity of the elements. Hydrides. Halides. Oxides. Silicates: Structures and uses.

10. **Metallurgy**. Steps of the metallurgical process. Initial treatments. Pyrometallurgical oxide reductions: Ellingham diagrams and general methods. Examples of pyrometallurgical processes: Industrial production of Na, Al, Ti and Fe.

11. **Boron**. Atomic properties of boron within the group 13 elements. Generation, structures and general reactivity of elemental boron. Metal borides. Boranes: structure and bonding. Diborane and tetrahydroborate salts. Boron halides. Oxides. Oxoacids and oxosalts.

12. **The heavier group 13 elements**. Atomic properties and uses of the elements. General reactivity. Aluminium hydride and tetrahydroaluminate salts. Halides. Oxides and hydroxides.

13. **The Group 12 Elements**. Atomic properties. Production and uses of the elements. General reactivity. Halides. Oxides and hydroxides.

6. Methodology and working plan

The course will be developed during the second term of the academic year by using *lectures (expositive sessions)*, *seminars* and *group tutorial sessions* according to the distribution shown below, in the days fixed by the official calendar set by the School of Chemistry. In expositive sessions, Dr. Ruiz will present the main ideas concerning the preparation, structure, bonding and reactivity of the main-group elements and their most important compounds, by following the contents list of section 5. Overhead projections will be routinely used, as well as the black board. Regular assistance to these sessions is highly recommended. In seminars, Dr. Ruiz will solve some representative exercises and questions related to the contents discussed in lectures, and will also solve and discuss any doubts or additional questions raised by the students. The exercises will be given in advance to the students, who are expected to work on them previous to each seminar. In the group tutorial sessions, each student will solve exercises on site, and will also provide solved exercises (assigned to him in advance). Students might be asked to present and explain these solved exercises to the group. Group discussion around all these exercises will be promoted.

All exercises to be considered in seminars and group tutorial sessions, as well as all graphic material used in expositive sessions, along with any other complementary information, will be available on the web at the "Campus Virtual de la Universidad de Oviedo".

		ON-SITE WORK						**PERSONAL WORK**			
Contents item	***Total hours***	*Lectures (CE)*	*Seminars (PA)*	*Group tutorial sessions (TG)*	*External activities*	*Evaluation sessions*	***Total***	*Group work*	*Individual work*	**Total**	
1	0.5	0.5					0.5				

2	21	6	1				7		14	14	
3	24	7	1	1			9		15	15	
4	18	5	1				6		12	12	
5	12.5	4	0.5				4.5		8	8	
6	13.5	4	0.5	1			5.5		8	8	
7	10	3	1				4		6	6	
8	9	3	0				3		6	6	
9	10.5	3	0.5	1			4.5		6	6	
10	6.5	2	0.5				2.5		4	4	
11	9.5	3	0.5				3.5		6	6	
12	4.5	1	0.5				1.5		3	3	
13	3.5	0.5		1			1.5		2	2	
Total	**150**	**42**	**7**	**4**	**4**	**3**	**60**		**90**	**90**	

Types	Hours	%	Total

On site	Lectures	42	70	60
	Seminars	7	11,66	
	Group tutorial sessions	4	6,66	
	External activities	4	6,66	
	Exams	3	5	
Personal work	Group work	0	0	90
	Individual work	90	100	
	Total	150		

7. Evaluation of the student's learning results

Evaluation of student learning in the ordinary call will be made on the basis of a written exam at the end of semester (80%) and participation of the student in the group tutorial sessions (20%). To pass the course, the student needs to get a minimum mark of 4 out of 10 in the written exam, and the final mark will be calculated as (80A+20B)/100, where A and B are the marks corresponding to the written exam and the group tutorial sessions, respectively.

Evaluation of student learning in the extraordinary calls will be made on the basis of a single written exam. To pass the course, the student needs to get a minimum mark of 5 out of 10 in this exam.

NOTE: The minimum mark in written exams will not be given if the answers contain serious mistakes involving:

1. Formulation of chemical compounds
2. Balance of chemical reactions, particularly red-ox reactions.
3. Basic concepts, such as valence of the elements, use of thermodynamic functions, chemical equilibria, acid-base and redox reactions, solubility, description of molecular and non molecular structures, and distinction between ionic, covalent and metallic substances.

8. Resources, bibliography and complementary documentation

All on-site activities will make use of the overhead projector. This graphic material will be uploaded in the Virtual Campus platform, along with any other documents containing additional information of potential utility, as well as series of exercises to be used in seminars and in group tutorial sessions.

Although some more specific sources might be suggested in particular cases, the titles listed below are recommended reference books for this course:

- "Chemistry of the Elements" by N. N. Greenwood and A. Earnshaw. 2nd edition. Elsevier, Oxford, 1997.
- "Advanced Inorganic Chemistry" by F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann. 6th edition. Wiley, New York, 1999.
- "Inorganic Chemistry" by A. F. Hollemann, E. Wiberg and N. Wiberg. Academic Press, New York, 2001.
- "Química Inorgánica, Vol I, Elementos Representativos" by G. A. Carriedo. Editorial Síntesis, Madrid, 2015.
- "Inorganic Chemistry, 6th Ed.", by M. Weller, T. Overton, J. Rourke and F. Armstrong. Oxford University Press, 2014. (formerly authored by D. F. Shriver and P. W. Atkins).

- "Inorganic Chemistry, 4th Ed.", by C. E. Housecroft and A. G. Sharpe. Pearson, 2012