Teaching Guide				
Identifying Data				2022/23
Subject (*)	Inorganic Chemistry 4		Code	610G01024
Study programme	Grao en Química			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Third	Obligatory	6
Language	SpanishGalician			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Rodríguez Rodríguez, Aurora		E-mail	aurora.rodriguez@udc.es
Lecturers	Esteban Gomez, David Platas Iglesias, Carlos Rodríguez Rodríguez, Aurora Señaris Rodriguez, Maria Antonia		E-mail	david.esteban@udc.es carlos.platas.iglesias@udc.es aurora.rodriguez@udc.es m.senaris.rodriguez@udc.es
Web				
General description	DESCRIPTION: Preparation and characterization of inorganic compounds: Coordination compounds and non-molecular solids. CONTEXT: The course is fitted in the sixth semester of the Degree in Chemistry (3rd year), and is closely related to the subject of the fifth semester "Inorganic Chemistry 3." The two fields set up the module "Advanced Inorganic Chemistry", which will provide an adequate education to students in the fields of Coordination Chemistry and Solid State Chemistry.			

Study programme competences	
Code	Study programme competences
A1	Ability to use chemistry terminology, nomenclature, conventions and units
A3	Knowledge of characteristics of the different states of matter and theories used to describe them
A4	Knowledge of main types of chemical reaction and characteristics of each
A6	Knowledge of chemical elements and their compounds, synthesis, structure, properties and reactivity
A9	Knowledge of structural characteristics of chemical and stereochemical compounds, and basic methods of structural analysis and research
A14	Ability to demonstrate knowledge and understanding of concepts, principles and theories in chemistry
A15	Ability to recognise and analyse new problems and develop solution strategies
A16	Ability to source, assess and apply technical bibliographical information and data relating to chemistry
A17	Ability to work safely in a chemistry laboratory (handling of materials, disposal of waste)
A18	Risk management in relation to use of chemical substances and laboratory procedures
A19	Ability to follow standard procedures and handle scientific equipment
A20	Ability to interpret data resulting from laboratory observation and measurement
A21	Understanding of qualitative and quantitative aspects of chemical problems
A22	Ability to plan, design and develop projects and experiments
A23	Critical standards of excellence in experimental technique and analysis
A24	Ability to explain chemical processes and phenomena clearly and simply
A26	Ability to follow standard laboratory procedures in relation to analysis and synthesis of organic and inorganic systems
B1	Learning to learn
B2	Effective problem solving
B3	Application of logical, critical, creative thinking
B4	Working independently on own initiative
B5	Teamwork and collaboration
B7	Effective workplace communication

C1	Ability to express oneself accurately in the official languages of Galicia (oral and in written)
C2	Oral and written proficiency in a foreign language
C3	Ability to use basic information and communications technology (ICT) tools for professional purposes and learning throughout life
C7	Acceptance as a professional and as a citizen of importance of lifelong learning
C8	Understanding role of research, innovation and technology in socio-economic and cultural development

Learning outcomes			
Learning outcomes	Study programme competences		
To identify problems associated with the synthesis and structural characterization of metal complexes and inorganic solids, and plan strategies to solve them.	A6 A15		
To know and handle the literature on the structure, bonding, synthesis, reactivity, characterization, properties and applications of coordination compounds and non-molecular solids.	A16	B1 B4	C2
To understand and to carry out standard procedures for the synthesis and characterization of inorganic compounds, and to use scientific instrumentation for their characterization.	A17 A19 A26		
To plan, design and carry out the synthesis and characterization of coordination compounds and non-molecular solids.	A15 A22	B5	
To understand and explain the processes observed in the Inorganic Chemistry Laboratory.	A1 A18 A20 A21 A23 A24	B2 B3 B4 B7	C1 C7
To understand the important contribution that the research in Inorganic Chemistry has on the socio-economic and cultural progress of society.			C8
To manage properly the waste generated in a laboratory devoted to the synthesis and characterization of inorganic compounds.	A17 A18 A23		
To prepare a laboratory notebook that gathers all relevant information making the necessary calculations.	A1 A15 A18 A20 A21 A23 A24	B3 B4 B7	C1 C3
To know the structure of coordination compounds and molecular crystalline solids and to apply the techniques required for structure determination.	A9	B2 B4	
To prepare and present reports on the work and results obtained in a laboratory of inorganic chemistry .	A1 A3 A4 A9 A14 A20	B3 B4 B7	C1 C3

Contents	
Topic	Sub-topic
Preparation of Coordination Compounds	Methods for the preparation of metal complexes. Solvent effects. Speciation diagrams.

Structural determination of coordination compounds (I)	Chemical analysis. Mass spectrometry. Molar conductivity. Dipolar moments. Vibrational spectroscopy. NMR spectroscopy. Questions and exercises.
Structural determination of coordination compounds (II): Electronic Absorption Spectroscopy	Introduction. Selection rules. Origin of the bands: Ligand-ligand bands, charge transfer bands and d-d bands. Spectroscopic terms and electronic states. Tanabe-Sugano diagrams. Analysis of electronic spectra and applications in structure determination. Questions, problems and exercises.
Structural determination of coordination compounds (III): magnetic properties	Diamagnetism and paramagnetism. Effective magnetic moment. Spin and orbital contributions. Applications in structure determination. Questions, problems and exercises.
Methods of preparation of non-molecular solids	Strategies for the preparation of crystalline non-molecular solids. Main synthesis methods: ceramic method, ?soft? chemistry methods (co-precipitation, decomposition of nitrates, sol-gel method, intercalation reactions?), solvothermal method.
Methods for Characterization of non-molecular solids	General overview of the different diffractometric techniques (X-ray, electron and neutron diffraction), with emphasis on crystal powder X-ray diffraction. Spectroscopic techniques. Thermal methods. Electronic microscopy (scanning and transmission electron microscopies).
Preparation and Characterization of Coordination Compounds	Selection of the synthesis conditions. Selection of materials (reagents, solvents, instrumentation, glass equipment...). Assessment of the risks associated with the experiment and its prevention. Experimental procedure for the synthesis. Use of instrumental techniques for structural elucidation. Interpretation of the structural elucidation results. Preparation of a laboratory notebook. Preparation and presentation of a final report.
Preparation and Characterization of crystalline non-molecular solids	Selection of the synthesis conditions. Selection of materials (reagents, solvents, instrumentation, glass equipment...). Assessment of the risks associated with the experiment and its prevention. Experimental procedure for the synthesis. Use of auxiliar software for structural elucidation. Interpretation of the structural elucidation results. Preparation of a laboratory notebook. Preparation and presentation of a final report.

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A1 A6 A9 A15 A20 A21 A24 B1 B2 B3 B7 C7 C8	10	30	40
Laboratory practice	A1 A3 A4 A6 A15 A16 A17 A18 A19 A20 A22 A23 A26 B1 B3 B4 B5 B7 C1 C2	34	0	34
Seminar	A1 A9 A12 A14 A15 A16 A20 A21 A24 B1 B2 B3 B4 B5 B7 C1 C2	4	20	24

Supervised projects	A1 A3 A4 A6 A9 A14 A15 A16 A20 A21 A22 A24 B3 B4 B7 C1 C2	2	28	30
Oral presentation	A1 A14 A16 A24 B3 B4 B7 C1 C3	1	8	9
Mixed objective/subjective test	A1 A6 A9 A14 A20 A21 A24 B2 B3 C1 C2	2	0	2
Summary	A1 A20 A24 B4 C3	0	10	10
Personalized attention		1	0	1
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	**Description**
Guest lecture / keynote speech	Lectures: oral presentations of the topics 1-6 of ?Contents? section. These sessions involve also the active participation of the students and a continuous exchange of ideas between lecturer and students.
Laboratory practice	Laboratory practices (topics 7-8 in "Contents"): student's work in the laboratory, under the tutoring of the teacher. Students will synthesize and characterize coordination compounds and crystalline non-molecular solids.
Seminar	Seminars: sessions in small groups to solve problems and exercices related with the topics of the lectures. They also serve as a "feed-back" to the lecturer to assess the progress of students.
Supervised projects	The students must prepare the experiments, prior to start the work at the laboratory, using the literature. This process will be guided and supervised by the laboratory instructor.
Oral presentation	Group sessions to present the work done during the laboratory practice. Each student must summarize his/her work in a short time (around 5 minutes) and discuss it with the audience.
Mixed objective/subjective test	Written test that will include questions and numerical problems related to the contents of the course.
Summary	Each student must provide the laboratory notebook at the end of the laboratory practice, as well as brief report of each experiment, which will be evaluated and corrected by the laboratory instructor.

Personalized attention	
Methodologies	**Description**
Laboratory practice Seminar Supervised projects Oral presentation	During the "laboratory practice" students will be individually interviewed by the teacher at different stages: i) Interviews prior to the start of the experimental work, once the student completes the literature review and the preparation of the experiments. A positive assessment of this work is required for the student to be allowed to start the experimental work. ii) A personal interview at the end of the laboratory practice to assess the work carried out and to solve possible deficiencies in the training. Moreover, students can ask for additional tuttoring sessions that will take place at the tuttoring hours of the teacher (the timetables will be indicated at the beginig of the course).

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Laboratory practice	A1 A3 A4 A6 A15 A16 A17 A18 A19 A20 A22 A23 A26 B1 B3 B4 B5 B7 C1 C2	Instructor's assessment of lab skills (planning, time management, skill and confidence in practical work) and results of the synthesis and characterization.	15

Seminar	A1 A9 A12 A14 A15 A16 A20 A21 A24 B1 B2 B3 B4 B5 B7 C1 C2	Instructor's assessment of the participation in seminars and lectures (quantity and quality of the participation: questions, resolution of problems and exercises...)	5
Supervised projects	A1 A3 A4 A6 A9 A14 A15 A16 A20 A21 A22 A24 B3 B4 B7 C1 C2	The literature review to prepare the experiments, the results of the experimental work and the conclusions reached will be assessed by personal interview.	25
Oral presentation	A1 A14 A16 A24 B3 B4 B7 C1 C3	In the oral presentation of the "Laboratory practice", the instructor will assess the analysis of the results and the conclusions, and the active participation of the students in the discussion after each presentation.	10
Summary	A1 A20 A24 B4 C3	The laboratory notebook and the reports will also be assessed.	25
Mixed objective/subjective test	A1 A6 A9 A14 A20 A21 A24 B2 B3 C1 C2	A written text including questions and numerical problems related to the contents of the course.	20

Assessment comments

This is a course with an important loading of experimental work. Therefore, attendance to all scheduled classes is mandatory.
First opportunity (June): The maximum score is 10 points, and passing the course requires a minimum of 5 points. In each of the assessed parts, it is required a minimum of 40% of the maximum score posible for that part. The assessment process will start when the student begins the work in the lab. Thus, every student that reaches this stage will obtain a mark even if the different activities of the course, including the laboratory practice, are not completed.
Second opportunity (July): The maximum score is 10 points, and passing the course requires obtaining 5 points. Students will be assessed by an objective mixed test, from which students can obtain up to 2.5 points, and a laboratory practice test (which counts for a maximum of 7.5 points). A minimum of 40% of the maximum score posible for each part is required in order to pass the course. The practical test will consist on the preparation and execution of a laboratory experiment using the same criteria detailed in the "methodology" section, with the exception that the preparation of the experiment will not be tutored. An inappropriate preparation of the experimental work will result in a negative assessment (failed course) before beginning the laboratory work. The student can only do the exam of the laboratory practice in the second opportunity, if he/she has performed the practical training during the course (minimum 75%). If the student obtained a minimum of 4 points in the Laboratory Practice in the first opportunity will not have to perform the laboratory practice test in the second opportunity.
From the time the student begins the preparation of the experiments, or the realization of the objective test, it is considered that accepted to be assessed, and therefore those students that reach these stages will obtain a mark even if the different activities of the course are not completed.
Those students assessed in the second opportunity (July) can be awarded with honors only if the máximum number of students that finish the course with honors is not reached after the first opportunity (June).
NOTE 1: "Part-time Students": First and second opportunities: Attendance to DE and TGR activities is not mandatory but the "mixed test" is required and they have to got a minimum of 5 points (of 10) to pass this activity. Laboratory practice is mandatory and follows the same requirements applied to students at full time.
NOTE 2: Implications
of plagiarism in the qualification: The fraudulent realization of the tests or
other evaluation activities will directly imply the qualification of 0.0 points
in the course in the corresponding call, thus invalidating any grades obtained in all the activities for the extraordinary call, in
accordance with the provisions of the UDC Student Statute (article 35, point 3,
https://www.udc.es/es/normativa/estudantes/estatuto_estudantado/index.html
NOTE 3: December
Early call: The weighting in the evaluation of the different teaching
activities of the students who participate in the December early call, will be
adapted to the new evaluation percentages set out in this guide, if they differ
from each other in both academic courses.

Sources of information

Basic	-A. R. West, Basic Solid State Chemistry, John Wiley and Sons, Chichester, 1999, Libro, -D. F. Shriver, P. W. Atkins, C. H. Langford, Química Inorgánica, Editotial Reverté S. A., 1998, Libro, -J. Rivas Gispert, Química de Coordinación, Ediciones Omega S.A., 2000, Libro, -L. Smart, E. Moore, Una introducción a la química del estado sólido, Editorial Reverté, Barcelona, 1995, Libro, -L. Smart, E. Moore, Solid State Chemistry: an Introduction, Taylor & Francis, Third Edition, 2005, Libro, -M.T. Weller, Inorganic Materials Chemistry, Oxford University Press, Oxford, 1999, Libro, -S. F. A. Kettle, Physical Inorganic Chemistry. A Coordination Chemistry Approach, Oxford University Press, 1998, Libro, -D. F. Shriver, P. W. Atkins, C, H. Langford, Química Inorgánica, Editorial Reverté, Barcelona, 1998, Libro, -Dann, Reactions and Characterization of Solids, Royal Society of Chemistry. Cambridge, 2000, Libro,
Complementary	-A. R. West, Solid State Chemistry, John Wiley and Sons, Chichester, 1999, Libro, -A.F. Wells, Structural Inorganic Chemistry, 5th Ed., Oxford Univesity Press, London, 1984, Libro, -D. Nicholls, Complexes and First-Row Transition Elements, McMillan Press , 1979, Libro, -D. Sutton, Espectros Electrónicos de los Complejos de los Metales de Transición, Reverté, Barcelona, 1975, Libro, -N.N. Greenwood, Cristales iónicos, defectos reticulares y no estequiometría, Alhambra, Madrid, 1970, Libro, -Angelici e outros, Syntesis and Techniques in Inorganic Chemistry?. 3ª Ed., University Science Books. Sausalito, 1999, Libro, -Brauer, Química Inorgánica Preparativa, Editorial Reverté, Barcelona, 1958, Libro, -Lever, Inorganic Electronic Spectroscopy. 2ª Ed., Elsevier. Ámsterdam, 1984, Capítulo de libro, -Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, 5ª Ed., Wiley & Sons, New York, 1997, Libro, -Schlessinger, Preparación de Compuestos Inorgánicos en el Laboratorio, Continental, México, 1965, Libro, -W. McCleverty e outros, Comprehensive Coordination Chemistry II, Elsevier-Pergamon, Amsterdam, 2004, Libro, -Wilkinson e outros, Comprehensive Coordination Chemistry, Pergamon Press, Oxford, 1986, Libro, -Cotton e Wilkinson, Química Inorgánica Avanzada?, 4ª Ed., Limusa-Wiley. México, 1986, Libro,

Recommendations
Subjects that it is recommended to have taken before
Physical Chemistry 1/610G01016 Physical Chemistry 2/610G01017 Inorganic Chemistry 1/610G01021 Inorganic Chemistry 2/610G01022 Inorganic Chemistry 3/610G01023
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Advanced Inorganic Chemistry/610G01025 Materials Science/610G01035
Other comments
It is advised that those students who take the "Inorganic Chemistry 4" course have passed "Inorganic Chemistry 3", and have the knowledge and skills associated with ?Inorganic Chemistry 1 and 2 " and" Physical Chemistry 1 and 2.Green Campus Program - Faculty of Sciences To achieve an immediate sustainable environment and comply with point 6 of the "Environmental Declaration of the Faculty of Sciences (2020)", the documentary works carried out in this course:a.- They will be requested mainly in virtual format and computer support.b.- If paper is used:- Plastics will not be used.- Double-sided prints will be made.- Recycled paper will be used.- The preparation of drafts will be avoided.

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.