27214 - Inorganic Chemistry II

Información del Plan Docente

Academic Year	2017/18
Faculty / School	100 - Facultad de Ciencias
Degree	452 - Degree in Chemistry
ECTS	12.0
Year	3
Semester	Annual
Subject Type	Compulsory
Module	---

1.General information

1.1.Introduction

The course *Inorganic Chemistry II* is included in the core module of the Chemistry degree. It is an annual compulsory subject with a workload of 12 ECTS including: interactive lectures (7 ECTS), problem-solving sessions and seminars (2 ECTS), and laboratory sessions (3 ECTS).

The program of the course includes the study of the chemistry of coordination compounds, solid state chemistry and transition metal chemistry. In addition, some advanced current topics in Inorganic Chemistry are presented. The course entails a practical part to be developed at the laboratory, where the synthesis and characterization of several inorganic compounds will be carried out, introducing the students in the use of experimental advanced techniques.

1.2.Recommendations to take this course

To have a passing grade in the Basic module is strongly recommended. The completion of the *Inorganic Chemistry I* and *Introduction to the Chemical Laboratory* courses is required to take this course.

1.3.Context and importance of this course in the degree

Inorganic Chemistry is one of the four fundamental areas of the Chemistry. The Inorganic Chemistry subject has been divided in two courses included in the core module (modulo fundamental) , *Inorganic Chemistry I* and *Inorganic Chemistry II* , which are lectured in the second and third year , respectively, of the Chemistry degree.

The content items of the *Inorganic Chemistry I* comprise the fundamentals of Inorganic Chemistry, and the chemistry of the main groups elements and their compounds. The *Inorganic Chemistry II* course deals with Coordination Chemistry, the chemistry of transition metals and their compounds, solid state chemistry and some frontier topics in Inorganic Chemistry.

1.4.Activities and key dates

The information about schedules, calendars and exams will be available at the notice board and website of the Sciences Faculty, https://ciencias.unizar.es/calendario-y-horarios . The laboratory sessions will be performed during the second

four- month term period, the schedule and the laboratory will be announced well in advance on the website for the course on the platform Moodle, https://moodle2.unizar.es/add .

2.Learning goals

2.1.Learning goals

The student must know and utilize the main information resources in Inorganic Chemistry.

The student must know the structure of the coordination compounds and relate the stereochemistry and bonding mode with the spectroscopic and magnetic properties.

The student must be able to relate the structural and electronic properties of inorganic solids with their properties.

The student must know the main synthetic methodologies and characterization techniques of inorganic solids.

The student must know and utilize the chemical bonding models and theories to explain and reasonably predict the chemical properties of inorganic compounds.

The student must know the chemistry of transition metal, of lanthanides and actinides, and their compounds.

The student must identify the major on-going research topics in Inorganic Chemistry.

The student must analyse, solve and discuss critically problems and questions on the structure and reactivity of inorganic compounds applying the theoretical contents developed in the course.

The student must know and execute correctly the different experimental procedures to carry out the synthesis and characterization al inorganic compounds.

The student must be able to realize reports where he organizes, describes and validates the experimental work applying the scientific method.

2.2.Importance of learning goals

Chemistry studies the matter and its transformations. The scientific advances can be related to current social welfare, as his impact in our daily life is very well known: medicines, agrochemicals, new materials, etc. Inorganic Chemistry occupies a central position into Chemistry since it approaches the study of all the elements and his compounds, except those organic compounds based on carbon. Thus, the Chemistry graduates require an in-deep knowledge in Inorganic Chemistry in order to be able to develop their professional career in the future.

3.Aims of the course and competences

3.1.Aims of the course

The subject and its expected results aim to the following objectives:

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The subject intends to deepen the knowledge of the students in the field of Inorganic Chemistry in order to enable them to relate bonding, structure and properties of inorganic chemicals and to give them a general overview of the current state of knowledge. The study is centred in coordination chemistry, solid state chemistry and transition metal elements and compounds, both form a theoretical an experimental point of view. Some frontier topics will be included.

3.2.Competences

Working knowledge about Inorganic Chemistry bibliographical sources.

Understand the chemistry of the elements, particularly the transition elements, based on their periodic properties.

Show a good knowledge about the main kind of compounds of transition metal elements, its obtention, structure and reactivity.

Relate the structure and bonding of coordination compounds with their properties.

Relate the structure of different types of solids and their properties.

Work autonomously in the Inorganic Chemistry laboratory.

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The student must show that has achieved the expected learning results by the following assessment activities:

1. Seminars and problem classes (5%): Evaluation will be carried out by checking problem assignments, applied questions and related activities.
2. Laboratory Sessions (15%): Laboratory work will be graded according the quality of experimental work, question answering, laboratory notebook or reports and the result of a final written exam related to the contents of the experimental sessions. If the laboratory part is passed (with a mark equal or above 5) the mark will be valid for both examination calls (June and September). If the laboratory part is failed the student should take an exam in regard to the contents of the laboratory sessions (either in June or September) whose mark will be a 15% of the global mark.
3. Theoretical contents. There will be a partial examination at the end of the first quarter and a final examination during the global evaluation period at the end of the second quarter. The first partial examination will be valid as a partial mark for the final exam of June. In June, the students with a mark of 5 or above in the first partial test will take only the part of the final examination covering the contents of the second half of the course. The final mark will be the mean of both partial examinations. Those who did not pass the first partial examination must take the whole global examination and the final mark will be that of the exam, which should be 5 or above in order to pass the course.

The final mark for the course, in the first call, will be the best of:

- Mark = Seminars (5%) + Laboratory (15%) + Theoretical exam (80%)
- Mark = Lab (15%) Theoretical exam (85%)

In September (2 nd . Call) all the students should take the complete exam covering the whole course. The final mark will be:

- Mark= Lab (15%) + Theoretical exam (85%)

The number of official examination calls per registration and their use will be subjected to the statements of the

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Regulation of Permanence in Master Studies and Regulation of the Learning Assessment (http://www.unizar.es/ice/images/stories/calidad/Reglamento%20Evaluacion.pdf). The latest document will also regulate the general design and scoring criteria of the assessment activities, as well as the exam schedules and timetable for the post-examination review.

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The course has been designed with this structure:

1. Classroom lectures (7 ECTS)
2. Seminars and problems (2 ECTS)
3. Laboratory teaching (3 ECTS)

5.2.Learning tasks

The program offered to the student in order to get the results covers the following activities:

Classroom lectures in Inorganic Chemistry (7 ECTS)

Seminar: Problem solving, questions and singular topics (2 ECTS)

Laboratory sessions (3 ECTS)

- Synthesis of inorganic compounds by means of the usual lab techniques, including gas obtention and handling and introduction to inert atmosphere techniques.
- Tests and measurements related to the identification of those compounds.

Tutorials. The students will have 6 h. weekly for consult.

5.3.Syllabus

1.- Introduction to transition metal chemistry.

The *d* -block transition metals: general aspects. Occurrence, abundance, extraction and applications. Physical properties. Electronic configurations. Periodic trends in the chemical properties. Relativistic effects. Lanthanide contraction. Transition metal compounds: representative examples.

2.- Structure of coordination compounds.

Basic concepts. Polydentate ligands and design of complexes. Electronic characteristics of ligands. Ligands and electrons.

3.- Stereochemistry of coordination compounds.

Stereoisomerism. Describing configuration in coordination compounds. Chirality in coordination compounds. Optical activity. Resolution of enantiomers.

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4.- Electronic structure of coordination compounds.

Ligand field theory. Molecular orbital theory. Molecular orbitals for octahedral complexes with s bonding, octahedral complexes with s and p bonding. Molecular orbitals for tetrahedral and square-planar complexes. Ligand field stabilization energy: structural and thermodynamic effects. The 18-electron rule. Electronic spectra and magnetism in coordination compounds.

5- Stability of coordination compounds.

Thermodynamic stability of coordination compounds. Factors influencing the stability of coordination compounds. The Irwing-Williams series. Hard and soft (Lewis) acids and bases. Steric effects. Chelate and macrocyclic effects. Stabilization of unusual oxidation states.

6- Synthesis and reactivity of coordination compounds.

Classification of the reactions. Kinetic stability of the coordination compounds. Substitution reactions on octahedral complexes. Stereochemistry in substitution reactions. Substitution reactions on square planar complexes. Trans influence and trans effect. Electron transfer reactions. Isomerization reactions. Reactions on coordinated ligands.

7.- Electronic structure of solids.

Electrons in solids. Band theory: crystal orbitals, bands of energy, density of states and Fermi level. Electronic structure of one-dimensional solids: Peierls distortion. Electronic structure of ionic and covalent solids, and metals.

8.- Electrical properties of solids.

Electronic conductivity. Semiconductors. Photoconductivity. p-n junctions: applications. Semiconductor compounds isoelectronic with silicon. Electronic structure and properties of inorganic solids: transition metal oxides and sulphides. Low-dimensionality solids: polyacetylene, KCP, graphite. Superconductivity.

9.- Crystal defects, non-stoichiometric solids and solid solutions.

Imperfections in solids. Defects classification. Point defects. Solid solutions. Ionic conductivity. Solid electrolytes. Non-stoichiometric solids. Extended defects.

10.- Preparation of solid materials.

Solid state reactions. Thermodynamic control: phase diagrams. Kinetic control. Synthetic methods. Intercalation reactions. Vapour-phase transport deposition. Thin film preparation techniques.

11.- Transition metal compounds: halides.

Transition metal halides: binary halides, hydrated halides and halide clusters. The multiple metal-metal bond. Synthesis of transition metal halide compounds. Reactivity of transition metal halide compounds.

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12.- Transition metal compounds: oxides and molecular oxohalides.

Structure and properties of binary oxides. Synthesis and reactivity of transition metal oxides. Mixed oxides: spinels, perovskites and ilmenite. Properties.

13.- Lanthanides and actinides elements.

The *f* -block elements. General aspects and chemical behaviour. Oxidation numbers. Lanthanide and actinide chemistry. Applications.

5.4.Course planning and calendar

The information about schedules, calendars and exams is available at the website of the Sciences Faculty, https://ciencias.unizar.es/calendario-y-horarios. The presentation of practical works will be done according to the scheduled to be announced well in advance.

The students will be provided with diverse teaching material either at reprography or through the University's web tool: https://moodle2.unizar.es/add.

5.5.Bibliography and recommended resources

The updated bibliography of the course is accessible at the Web page of the library:

https://psfunizar7.unizar.es/br13/egSolotexto.php?codigo=27214