Intermediate Inorganic Chemistry

CHEM 3510

Spring 2018

Tuesday/Thursday: 12:00 – 12:50 pm

ESLC 053

Professor Yujie Sun
Office: Widtsoe 345
Phone: 435 – 797 – 7608
Email: yujie.sun@usu.edu (preferable way to contact me)
Office Hour: appointment via email

Textbook: "Inorganic Chemistry", 6th Edition, Shriver, Weller, Overton, Rourke, Armstrong, Oxford University Press, 2014.

Prerequisites: CHEM 1220 or equivalent; CHEM 2310, CHEM 2315

Grading: total of 500 points with 10 possible extra credit points for taking the Gain Score Assessment Tests. Points are distributed as follows:

9 In-Class Quizzes (the lowest score will be dropped):	80 pts
Midterm #1 (2/8, 12:00 – 1:20 pm)	100 pts
Midterm #2 (4/3, 12:00 – 1:20 pm)	100 pts
Comprehensive Final Exam (5/3, 11:30 am – 1:20 am)	200 pts
Total points:	480 pts
Extra Gain Score Assessment Test	20 pts

Tentative Grading Scale
(Brackets could be lowered but not be raised):

A–/A	90 – 100%
B–/B/B+	80 – 89%
C–/C/C+	70 – 79%
D/D+	60 – 69%
F	< 60%

Course Objectives/ Goals:

CHEM 3510 is designed to take students from the introductory principles of chemistry to a broader and deeper level of understanding of inorganic chemistry across the periodic table. The CHEM 3510 course is organized in concert with the CHEM 3520 laboratory course (offered concurrently).

Course Design:

I will be utilizing Canvas management system for CHEM 3510.

Materials for the class (*e.g.*, Powerpoint files, notes, overheads, practice problems, practice problem solutions, sample exams, and other materials) will be available through Canvas. **I recommend that you download and print the appropriate Powerpoint files before lecture and use them to take notes in class.

Quizzes: Quizzes will be given on selected dates and will consist of 3 – 4 short questions that are relevant to the topics discussed in lectures going back to the previous quiz or exam. The question(s) are likely to be related to the practice problems available for each lecture on Canvas. There will be total of 9 quizzes during the semester, each worth 10 points. The lowest quiz score will be dropped at the end of the semester and the scores of the remaining 8 quizzes will be added together to give the final overall quiz score. Each quiz will be given promptly at the start of class and you will be given ~15 minutes to answer the question(s). There will be no make-up quizzes.

"Gain-Score" Assessment Tests: Two short tests (~15 min) will be given – one at the beginning of the semester and one at the end. These short tests are given to assess your ability to apply, analyze, and synthesize information that is delivered throughout the course. These questions are not designed to test you specific knowledge of the subject, but rather how to apply this knowledge. You will receive 20 credit points for simply taking each "gain-score" assessment test, regardless of performance.

Missed Exam Policy: If a student misses, or will miss an exam, due to illness or family emergency, the student should speak to Dr. Sun as soon as possible. Make-up exam will be offered if the absence is supported by appropriate documentation (e.g. note from physician or parent).

CHEM 3510 Class Schedule (Spring 2017)

Class	Date	Topic	Chapter
1	1/9	Lewis structures and valence bond theory	2.1-6
2	1/11	Molecular orbital, structure and bond properties	2.7-10, 13-16
3	1/16	Structure of simple solids	3.1-3, 18-20 **Quiz 1**
4	1/18	Acid/base chemistry	4.1, 6-9
5	1/23	Molecular symmetry, elements and point groups	6.1
6	1/25	Character tables	6.2 **Quiz 2**
7	1/30	Introduction to coordination compounds	7.1-15
8	2/1	Periodic trends	9.1-9 **Quiz 3**
9	2/6	Review session for Midterm #1	
10	2/8	**Midterm #1 (12:00 pm – 1: 20 pm)**	
11	2/13	Group 13/14/15 elements	13.1-3; 14.1-3; 15.1-3
12	2/15	Group 16/17/18 elements	16.1-3; 17.1-3; 18.1-3
	2/20	Monday schedule	**No class**
13	2/22	The d-block elements	19.3-12 **Quiz 4**
14	2/27	Crystal field theory; ligand field theory	20.1-2
15	3/1	Electronic spectra	20.3-7 **Quiz 5**
		Spring break	No class
16	3/13	Ligand substitution reactions	21.1-9
17	3/15	Redox reaction and photochemical reactions	21.10-15 **Quiz 6**
18	3/20	No class, ACS conference	
19	3/22	**Midterm #2 (12:00 pm – 1: 20 pm)**	
20	3/27	Organometallic chemistry: bonding, ligands	22.1-17
21	3/29	Organometallic chemistry: compounds, reactions	22.18, 19, 21-26 **Quiz 7**
22	4/3	Physical techniques in inorganic chemistry I	8.1-8
23	4/5	Physical techniques in inorganic chemistry II	8.9-17
24	4/10	Materials chemistry	24.1, 11-12, 22-26
25	4/12	Nanomaterials, nanostructures, and properties	24.27-30 **Quiz 8**
26	4/17	Homogeneous catalysis	25.1-9
27	4/19	Heterogeneous catalysis	25.10-17 **Quiz 9**
28	4/24	Review session for Final	
29	4/26	Review session for Final	
30	**5/1**	**Final (11:30 am – 1:20 pm)**	**Comprehensive**

Withdrawal Policy and "I" Grade Policy: The administration of Chem 3510 will adhere strictly to the academic regulations stipulated in the most recent Schedule of Classes and the USU General Catalog. Withdrawal from the course will follow official USU procedures. Students are required to complete all courses for which they are registered by the end of the semester. In some cases, a student may be unable to complete all of the coursework because of extenuating circumstances, but not due to poor performance or to retain financial aid. The term 'extenuating' circumstances includes: (1 incapacitating illness which prevents a student from attending classes for a minimum period of two weeks, (2) a death in the immediate family, (3) financial responsibilities requiring a student to alter a work schedule to secure employment, (4) change in work schedule as required by an employer, or (5) other emergencies deemed appropriate by the instructor.

University Standards of Academic Integrity – "The Honor System": Each student has the right and duty to pursue his or her academic experience free of dishonesty. The Honor System is designed to establish the higher level of conduct expected and require o all Utah State University students.

The Honor Pledge. To enhance the learning environment at Utah State University and to develop student academic integrity, each student agrees to the following Honor Pledge: "I pledge, on my honor, to conduct myself with the foremost level of academic integrity." A student who lives by the Honor Pledge is a student who does more than not cheat, falsify, or plagiarize. A student who lives by the Honor Pledge espouses academic integrity as an underlying and essential principle of the Utah State University community; understands that each act of academic dishonesty devalues every degree that is awarded by this institution; and is a welcomed and valued member of Utah State University.

Grievance Process (Student Code): Students who feel they have been unfairly treated (in matters other than (i) discipline or (ii) admission, residency, employment, traffic, and parking – which are addressed by procedures separate and independent from the Student Code) may file a grievance through the channels and procedures described in the Student Code.

Plagiarism: Plagiarism includes knowingly "representing, by paraphrase or direct quotation, the published or unpublished work of another person as one's own in any academic exercise or activity without full and clear acknowledgment. I also includes the unacknowledged used of materials prepared by another person or agency engaged in the selling of term papers or other academic materials." The penalties for plagiarism are severe. They include warning or reprimand, grade adjustment, probation, suspension, expulsion, withholding of transcripts, denial or revocation of degrees and referral to psychological counseling.

Sexual Harassment: Sexual harassment is defined by the Affirmative Action/Equal Employment Opportunity Commission as any "unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature." If you feel that you are a victim of sexual harassment, you may talk to or file a complaint with the Affirmative Action/Equal Employment Opportunity Office located in Old Main, Room 161, or call the AA/EEO Office at 797–1266.

Students with Disabilities: The Americans with Disabilities Act states: "Reasonable

accommodation will be provided for all persons with disabilities in order to ensure equal participation within the program." If a student has a disability that will likely require some accommodation by the instructor, the student must contact the instructor and document the disability through the Disability Resource Center (797−2444), preferably during the first week of the course. Any request for special consideration relating to attendance, pedagogy, taking of examinations, etc., must be discussed with and approved by the instructor. I cooperation with the Disability Resource Center, course materials can be provided in alternative format, large print, audio, diskette, or Braille.

Learning Objectives

Students emerging from CHEM 3510 should be able to:

1. Predict atomic properties based on periodic trends of effective nuclear charge.
2. Apply atomic trends to predict relative sizes of ions.
3. Describe small molecules and ions in terms of valence bond models.
4. Describe homonuclear small molecule bonding in terms of sigma and pi symmetry molecular orbitals.
5. Use bonding theory to predict what specifically happens when a molecule is oxidized or reduced.
6. Describe electronegativity and polarity in heteronuclear small molecules.
7. Describe the bonding in heteronuclear diatomic molecules using molecular orbital theory.
8. Define and provide examples of isoelectronic molecules.
9. Predict molecular shapes using the VSEPR model.
10. Distinguish between symmetry operations and symmetry elements.
11. Understand character tables
12. Assign point groups for small molecules.
13. Discuss the range of transition metal complex structural types known.
14. Define a coordination complex and factors that influence coordination equilibria and thermodynamic stability.
15. Describe characteristic properties of transition metal complexes including variable oxidation states and coordination numbers.
16. Use crystal field theory to predict the electronic configurations and magnetic features of simple octahedral, tetrahedral, and square planar coordination complexes and determine crystal field stabilization energies.
17. Explain the fundamental nature of the colors possible in transition metal complexes.
18. State the spin and Laporte selection rules for electronic transitions.
19. Write the ground state term symbol for a transition metal ion.
20. Suggest physical methods that can be used to characterize inorganic compounds.
21. List kinetically labile versus inert metal complexes.
22. Describe dissociative, associative, and interchange mechanisms for transition metal ligand substitution reactions.
23. Interpret activation parameters in terms of possible mechanisms.
24. Describe the mechanism of ligand substitution in square planar metal complexes.
25. Define inner-sphere vs outer-sphere electron transfer reactions.
26. Describe how CO binds to a transition metal center.
27. Give examples and describe the bonding of other ligands typically found in "organometallic" complexes.

28. Determine whether an organometallic complex follows the 18-electron rule.
29. Predict the products of selected organometallic reactions.
30. Write mechanisms for the industrial applications of homogeneous catalysis.
31. Describe and calculate Madelung constants for simple ionic compounds.
32. Discuss how ionic bonding is affected by ion charges and Madelung factors.
33. Describe solid materials via lattice and unit cell
34. Distinguish the difference in electronic structures of insulator, metal, and semiconductor
35. Describe aspects of how metal ions are transported and stored in biological systems.
36. Elaborate the functions of metal centers in in biological systems.
37. Compare/contrast acid/base definitions (Bronsted, Arrhenius, Lewis).
38. Provide brief descriptions of the chemistry of main group elements.
39. List the common synthetic methods of solid-state materials
40. Discuss the synthesis and characterization of selected nanomaterials