CHE 332: Inorganic Chemistry Fall 2018

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Course Meetings: Classroom: MWF 11:30 AM-12:30 PM in Olin 123
Laboratory: Thursday 12:40-3:40 PM in Young 205

Office Hours: MW 2:00-3:30 PM, TTh 9:30-11:00 AM and by appointment.
Feel free to stop by my office outside of office hours; if I'm busy, we can make a plan to meet when mutually convenient. If I'm not around, the best way to contact me is email. You can expect a response within 24 hours, though I may be a little slow on the weekends.

Course Description:

In this course we will explore the rest of the periodic table—those elements not encountered in organic chemistry. We will start by discussing how atoms bond, and then apply our bonding models to transition metal chemistry. Additionally, the role of transition metal chemistry in biology, catalysis, and materials will be overviewed. Prerequisites include **CHE 241: Organic Chemistry** I and **CHE 361: Quantum Chemistry and Spectroscopy**

Students who complete this course will be able to:

1. Use concepts from quantum theory to explain periodic trends in atomic and chemical properties
2. Use symmetry and group theory to explain the spectroscopy and reactivity of molecules and complexes
3. Predict electronic structure and properties in metallic systems with reference to molecular orbital theory, crystal field theory, and ligand field theory. Apply and understand the limitations of each of these bonding models.
4. Interpret kinetic or spectroscopic data in terms of metal complex structure, bonding, or reactivity
5. Use coordination chemistry principles to describe the varied roles of metals in biological systems
6. Apply organometallic reactions to industrially useful catalytic cycles.

Course Materials:

Miessler, Fischer and Tarr. (2013) *Inorganic Chemistry*, 5th Ed. Pearson Prentice Hall.
Laboratory notebook, goggles, scientific (or graphing) calculator

If you are looking for additional resources, check these out from the library or ask to loan my copy:

Huheey et al. *Inorganic Chemistry: Principles of Structure and Reactivity*, Harper-Collins.
Cotton *Chemical Applications of Group Theory*, Wiley Interscience.
Crabtree *The Organometallic Chemistry of the Transition Metals*, Wiley Interscience.
Lippard and Berg *Principles of Bioinorganic Chemistry*, University Science Books.

Class Meeting Ground Rules:

The daily class format will consist of a pre-class assignment, an in-class activity, and a few suggested problems. Bring your textbook and a calculator to each class. At the beginning of class, all cell phones, pagers, and laptops should be silenced. Attendance will be recorded for each class meeting. If you miss class, it is your responsibility to recover what you missed. In the event of inclement weather, I will communicate with you via email by 10 AM about the status of our class meeting and/or any alternative instructions. Please check your email. As a student at Centre College, I expect you to follow the honesty policy set forth in the *Student Handbook*. Academic dishonesty, including submitting others' work as your own or using unauthorized sources during an exam, will be reported to the Associate Dean.

Grading: Your learning gains will be quantified based on the following:

Assignment Category	Weight
Pre-class assignment participation	3%
Quizzes	12% (3% each)
Exams	45% (15% each)
Laboratory	20%
Final exam	20%

Students scoring in the following percentage ranges will be given *at least* the letter grade below.

A	93.3 – 100.0	B+	87.0 – 89.9	C+	77.0 – 79.9	D	60.0 – 69.9
A-	90.0 – 93.2	B	83.3 – 86.9	C	73.3 – 76.9	U	< 60.0
		B-	80.0 – 83.2	C-	70.0 – 73.2		

Note: You must attempt all assignment categories in order to pass this class. For example, you cannot skip the final exam and plan to get 80%. Also, given that successful completion of the laboratory portion is integral to meeting the goals of the course, those who fail to pass the laboratory portion (>60.0%) will receive a "U" for the class.

Pre-class Assignments: Before each class period, you will be assigned a reading assignment from your textbook (or other resource) and an accompanying response administered through Moodle. The purpose of the assignment is for you to prepare for our class time and reflect on what you do not understand from your reading. Your answers to my questions will also help guide our time in class. Your responses will be graded only on completion of a reasonable and coherent attempt, not on correctness. If you are more honest, I can be more helpful. =Feel free to look at the questions before reading and to discuss your answers with your classmates. These responses must be submitted by 7:00 AM the morning of class.

Suggested Problems: Homework problems will not be graded for this class, but suggested problems and their solutions are available on Moodle. The solutions for all of the problems in the textbook are also available on Moodle.

Quizzes: About every two weeks (see schedule), you will complete a 15 minute quiz at the end of the class period. This quiz will represent the kind of problems you might expect to see on an hour exam. These quizzes are intended for you and me to check your understanding.

Exams: There will be three in-class exams that will last for one hour each. These exams will cover a specific group of chapters and may include questions related to the lab. Both problem-solving and descriptive explanations will be required for success. In-class exams may only be taken during the designated class times; make-up exams will be administered only with an excused absence.

Laboratory: See the laboratory schedule and details below. Bring your lab notebook and a calculator to all lab meetings.

Final Exam: The ACS Foundations of Inorganic Chemistry Exam will be given during the normal final exam period, 8:30-11:30 AM on **Thursday, December 6**. Final exams may not be rescheduled without the consent of the Associate Dean.

Learning Challenges & Disability Accommodations Self Identify, Self Advocate:

If you have a situation, condition, or set of circumstances that may affect your learning and that I should know about, I encourage you to see me in private ASAP and let me know what's going on. Identify any issues and be your own advocate. These may be learning disabilities, medical conditions, or personal situations. Specific examples of concerns you should consider discussing with me: learning disabilities, ASD/Asperger's, susceptible to insulin reaction, susceptible to seizures, a terminal illness in your family, food or housing insecurity. I am happy to try to help as appropriate and can be more helpful the sooner I know.

Students with physical or learning disabilities must take responsibility for obtaining the needed accommodations. The College had designated the Assistant Dean for Advising, Dr. Mary Gulley, in the Office of Academic Affairs as the starting point for the accommodation process. This process should be initiated immediately because relief cannot always be granted immediately and will not be granted after the fact.

Laboratory Guidelines

Lab Learning Goals:

1. Prepare and characterizing coordination complexes and organometallic compounds
2. Make first-hand observations about how inorganic chemistry applies to art, medicinal chemistry, organic synthesis, and solar energy.
3. Communicate experimental results in the format of a short scientific article that includes context, experimental methods, results, and discussion of the importance of the experimental contribution.

Laboratory Schedule

Date	Experiment	Due Dates (% of total grade)
Aug 30	Synthesis and structural identification of $Mo(O)_2(acac)_2$	
Sept 6	Symmetry scavenger hunt	
Sept 13	Antibacterial reactivity of Ag(I) cyanoximate complexes	
Sept 20	Antibacterial reactivity of Ag(I) cyanoximate complexes	$Mo(O)_2(acac)_2$ paper due
Sept 27	Antibacterial reactivity of Ag(I) cyanoximate complexes	Peer review due
Oct 4	Synthesis and magnetic properties of metal acetylacetonate complexes	Revised $Mo(O)_2(acac)_2$ paper due (7%)
Oct 11	*Fall break! No lab!*	
Oct 18	Synthesis and magnetic properties of metal acetylacetonate complexes	Silver antibacterials paper due (3%)
Oct 25	Synthesis and magnetic properties of metal acetylacetonate complexes	
Nov 1	Chemistry of photography	
Nov 8	Iron cross-coupling catalysis	$M(acac)_3$ paper due
Nov 15	Iron cross-coupling catalysis	Peer review due
Nov 20	*No lab!*	Revised $M(acac)_3$ paper due (7%)
Nov 27	Dye-sensitized solar cells	Iron-cross coupling paper due (3%)

Safety Guidelines: Safety is very important to me. At times, the materials used in this laboratory will pose serious health and safety risks. Per College policy, you must complete (refresh) the safety quiz on Moodle before the second meeting of this lab. In addition, the following behaviors are expected of students in CHE 332 lab:

- Goggles are to be worn at all times while in Y205.
- Gloves are to be worn while working with chemicals.
- Gloves NOT to be worn out of Y205 or while using instruments or computers. Gloves are always assumed to be contaminated with chemicals, even when they are clean.
- Hands should be washed with soap and water before leaving Y205.
- Long pants and closed top shoes (not ballet flats) should be worn while in the laboratory. Hair longer than shoulder-length should be tied up and back.

Laboratory Expectations

Before lab meeting period:

- Read the lab handout on Moodle. You should have a copy of it with you in lab, either paper or electronic. I recommend printing at least the essential pages because you may not want your computer or tablet close to the lab bench for concerns about chemical contamination.
- Complete the pre-lab assignment, as indicated. This will usually include stating the goal(s) of the experiments and preparing a table to reagents (including appropriate mass or volume) but may require a different activity.

During the lab meeting period:

- You know what to do. Lab starts on time, but I may need to make a few announcements before we dive in.
- You are expected to keep a laboratory notebook that includes a record of the procedure you followed as well as the observations you made.
- Feel free to ask questions about the lab procedure before, during, or after each step (Learning Goal #1). I like talking about what is happening. If you come up with a question (What would happen if…?) we may even be able to try it, but don't make modifications to the lab without checking with me first.
- Please check with me to see if I have additional instructions before you leave the lab.

After the lab meeting period:

- Most of the assessment in the lab will be in the form of papers written in the style of journal articles. Each experiment will have different reporting requirements designed to build your scientific writing skills (Learning Goal #3). Late laboratory papers are not accepted, though extensions may be granted in advance of the due date.
- Two papers will also have a *peer review* component, similar to how scientists review each other's' papers for scientific journals. After you have written your paper, it will be read by one of your peers, who will comment on how well you have presented your data and conclusions. You will then have an opportunity to improve your paper based on your peer's comment. The rubric for those two lab reports will include points for how well you responded to your peer's comments as well as how well you reviewed your peer's paper.
- See the handout on Chemistry Writing and Peer Review on Moodle.

CHE 332 Course Schedule*

Date	Topic	Reading
Aug 27	What is inorganic?	1 (all)
Aug 29	The quantum mechanical atom	2.1-2.2.3
Aug 31	Slater's Rules, periodic properties	2.2.4-2.3
Sept 3	Symmetry elements, operations, and point groups	4.1-4.2
Sept 5	Symmetry character tables	4.3
Sept 7	Vibrational spectroscopy and applications of symmetry **QUIZ**	4.4
Sept 10	Vibrational spectroscopy and applications of symmetry	4.4
Sept 12	MO theory: Linear combination of atomic orbitals, review diatomic molecules	5.1-5.3
Sept 14	MO theory : linear polyatomic molecules	5.4
Sept 17	MO theory: non-linear polyatomic molecules	5.4
Sept 19	Symmetry and MO theory: problem solving	
Sept 21	**EXAM I (Ch 1, 2, 4, 5)**	
Sept 24	Lattice structures, unit cells, density	7.1
Sept 26	Lattice structure, radius ratio rule, defects	7.2, 7.5-7.7
Sept 28	Coordination chemistry: Ligands, nomenclature, coordination numbers	9.1-9.2, 9.4
Oct 1	Isomerism, hard-soft acid-base theory	9.3, 6.1, 6.6
Oct 3	Alfred Werner and coordination theory	(Moodle)
Oct 5	Bonding: Crystal field theory, **QUIZ**	10.1-10.2
Oct 8	Bonding: Ligand field theory	10.3
Oct 10	Bonding: Angular overlap model; Jahn-Teller Theorem	10.4-10.5
Oct 15	Electronic spectroscopy, selection rules, charge-transfer transitions	11.1-11.3
Oct 17	Spectroscopy: assigning d-d transitions with Tanabe-Sugano diagrams	11.3
Oct 19	Spectroscopy: problem-solving	11.3.7
Oct 22	Kinetics of substitution mechanisms	12.1-12.4
Oct 24	The *trans* effect	12.5-12.7
Oct 26	**EXAM II (Ch 6, 7, 9, 10, 11)**	
Oct 29	Electron transfer reactions; Rudy Marcus and Henry Taube	12.8-12.9
Oct 31	Counting to 18; organometallic ligands	13.1-13.3, 13.7
Nov 2	Ligands in organometallic chemistry	13.4-13.6
Nov 5	Physical methods in organometallic chemistry	13.8
Nov 7	Organometallic reaction types	14.1-14.2
Nov 9	Organometallic catalysis, **QUIZ**	14.3-14.4
Nov 12	Olefin metathesis and Bob Grubbs	14.4
Nov 14	Semiconductors and solar energy	7.3
Nov 16	**Exam III (Ch 12, 13, 14)**	
Nov 19	Paints and pigments	(Moodle)
Nov 26	Bioinorganic: roles for metals, iron	16 (Moodle)
Nov 28	Bioinorganic: zinc	16 (Moodle)
Nov 30	Bioinorganic: copper and manganese **QUIZ**	16 (Moodle)
Dec 6	**Final Exam (Cumulative)**	

*Subject to revision. Most updated reading assignments will be on Moodle.