Instructor: Prof. Rory Waterman
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Lecture: MWF 12:00–12:50, Waterman 413

Office hours: M 1:00–2:00 and T 1:00–2:00 or feel free to make an appointment.

Course description: A general overview of inorganic chemistry. Topics include bonding, molecular structure, periodic properties, symmetry, main-group and transition-metal (including organometallic) chemistry, and bioinorganic systems.

Course objective: My goal is that students who complete this course should be able to use some basic inorganic concepts, broadly defined, to enable problem solving in other fields. To address that goal, one should have a basic idea about the bonding across inorganic systems, the interplay of symmetry and physical properties, transition metals, and main group elements. To meet that goal, we should investigate the inorganic chemistry in biological systems and applied fields like catalysis and energy conversion.

Learning outcomes: The course is broken into several parts (up to five, if all goes well—see outline below). Each section will have a set of specific objectives associated with it. Those documents form a roadmap for the course. If you *understand* what the content of the objectives and can *perform* the skills, then you are learning the course material. We will get to that point by using class time to review concepts and for you to do exercises and activities that reinforce those ideas and practice skills. That plan will work if you engage in course materials (the book, homework, or other provided materials) before or after a given class, as prescribed.

Basic outline

I. The basics of inorganic chemistry
II. Metals in biology
III. Catalysis
IV. Energy
V. Grand challenges

Important dates:

Friday, February 5, paper topic due
Wednesday, February 24, exam 1
Monday, March 14, paper draft 1 due
Wednesday, March 23, exam 2
Wednesday, April 6, peer review due
Wednesday, April 27, option to "drop" exam 1 deadline
Friday, April 29, final papers due
Final exam date: May 13, 10:30–1:15 PM

No class: Monday February 15 (Presidents' Day) and Monday 3/7 – Friday 3/11 (spring break)

Text: *Inorganic Chemistry* by Miessler, Fischer, and Tarr (ISBN-13: 978-0-321-81105-9). Some supplementary readings and resources will be distributed in class, available in the library, and/or posted on the course Web page. An i>clicker is also required.

The i>clicker is how I will administer most quizzes and award any in-class credit. You should obtain this and register it asap. We will test them on January 22, and they will be used on the following week. Bring your clicker daily; I have no mechanism to account for clickers left home.

Grading: Grades will be based on two exams (10% and 20%), a final exam (25%), a paper in several parts (25%), quizzes (10%), and homework/in- or pre-class work (10%).

Quizzes: Short (5–10 min) quizzes will be given at the beginning of a class on all Fridays except January 22. The quizzes are based on fundamental material covered in lectures over the previous week and thus intended to help you see what topics are important.

Problem Sets: Problem sets will be given approximately weekly. Solutions will be provided, and these will not be graded completely. Only one question per problem set will be graded. Completing the problem sets is the best way to review course material and practice key skills in the course.

Pre-class questions: On most class days, I will deploy a set of no more than three question on Blackboard after 5:00 am to be completed by 11:40 am. The purpose of these questions is for me to see how people are handling the material and helping me gauge where we need to go in a given class. These are a brief (~5 minutes of effort) and not graded for correctness. You receive full credit by attempting all of the questions because I want to know what is going on in the class not measure performance. These will be summed over the semester as one or two problem set grades.

Web content: Course materials are available through Blackboard (bb.uvm.edu).

Academic Honesty: As students of the University of Vermont, you are expected to conduct yourself in accordance with the Code of Academic Integrity (www.uvm.edu/~uvmppg/ppg/student/acadintegrity.pdf).

Grading details:

- Any graded in-class work will be evaluated as an additional homework grade.
- The best 11 of 13 quiz scores will be used to calculate your quiz grade (10% of the course grade). Therefore, there will be no rescheduling for quizzes except in the case of a University-approved absence.
- The first exam is of a low percent to give you the opportunity to better understand my style of exam. If your grade is particularly low on the first exam, you may elect to weigh the final exam at 35% and “drop” the first exam from your course grade. To take advantage of this, you must inform me via e-mail by April 29 at 5:00 PM.
- All grading policies of the Department of Chemistry and University hold.

Late policy: Materials submitted in print are due at the *beginning* of class on the date specified, and electronic material is to be sent by 11:30 AM on the date specified with your last name as the file name. Items submitted within 24 hours of the due date will be given 50% credit and after 48 hours, no credit.

Miscellaneous: For those issues not explicitly noted in these documents, the instructor may set policies during the semester. However, no part of this course does or is meant to supersede the policies of the University of Vermont and the College of Arts and Sciences.

Learning Goals: The Department of Chemistry has a set of learning goals for all chemistry majors. The specific learning objectives of this class are meant to directly address some of these goals as part of the broader program for students taking chemistry courses.

1. Students will demonstrate general knowledge in chemistry and will be able to apply chemical and physical principles in the solution of qualitative and quantitative chemical problems.
2. Students will understand the interplay of observational data, hypotheses, and hypothesis-driven experimentation through application of the scientific method.
3. Students will become proficient in chemical laboratory techniques and be able to apply these to practical and current problems in research.
4. Students will be able to read and critically evaluate the chemical and scientific literature.
5. The students will learn to present scientific data clearly and effectively through both written and verbal communication.

Parts of CHEM 131 specifically addresses goals 1, 2, 4, and 5.

The instructor reserves the right to make changes, with notice.

Outline

I. The basics of inorganic chemistry
- A. Recap of Lewis structure & VSEPR
- B. Point symmetry
- C. Molecular orbital theory
- D. Periodic trends
- E. Lewis acids, hard-soft concept, and frustration

II. Metals in biology
- A. Metals: More than a point charge
- B. Moving oxygen
- C. Probing the metal center
- D. Moving electrons/metals doing work

III. Catalysis
- A. Catalysis, chemistry that affects all of us
- B. Taming the organometallic beast
- C. Solid-state: oil processing and catalytic converters
- D. Homogeneous catalysis: reactions to make drugs and useful things

IV. Energy
- A. Solar cell technology
- B. Solid-state refrigerant
- C. Making hydrogen

V. Grand challenges
- A. Nitrogen fixation
- B. C–H functionalization
- C. Water oxidation

Key skills

- Identify point symmetry of molecules
- Interpret MO diagrams for simple molecules
- Identify d-orbital splitting in various metal coordination geometries
- Assign formal oxidation state and d-electron count to metal complexes
- Predict or identify ligand exchange reactions
- Assign electronic spectra of metal complexes
- Determine Δ_o from spectral data
- Apply appropriate dopant to change semiconductor electronic properties
- Determine valence electron count for a metal complex and relate to possible organometallic reactions
- Sequence fundamental organometallic reaction mechanisms into a catalytic cycle to produce a product
- Use kinetic data to determine mechanism
- Predict rates of electron transfer from barrier and driving force data