CHEM 215 Descriptive Inorganic Chemistry

Syllabus Fall 2008

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Class meeting times: Monday and Wednesday 1:10-2:30
Class location: Dana 119 except for Fridays when we will use Dana 300
Friday 1:10-2:30 preceptor/tutorial period
Scheduled office hours: Friday 11:00-12:00 other hours by appointment

In this course, we have the privilege of exploring the periodic table and deepening our appreciation for the chemistry of the elements. We will boldly go where we did not go in introductory chemistry while developing and applying the tools learned in CHEM 107 and 108. We will spend time studying the rich and varied chemistry of the transition metal elements and learning how the electronic structure in coordination complexes differs from that of molecules studied in organic chemistry or introductory chemistry and how these differences affect reactivity. We will refine out understanding of theoretical concepts established in introductory chemistry in order to better appreciate the structure and reactivity of specific elements and their compounds.

Topics	**Relevant Sections in the Textbook –**
Background	**Chapters 1 and 2**
Section I: properties of the elements **A. Ions and their acid-base properties**	**Chapter 4**
B. Ionic solids – structure and reactivity	**Chapter 3**
C. Reduction-Oxidation Chemistry	**Chapter 5**
Mid Term Exam I (October 13th) CH 3-5	
Section II: Transition metal chemistry **- Transition metal chemistry – the elements of choice for reactivity (for both humans and nature)**	**Chapters 8, 18, 19, 20**
Mid Term Exam (November 17th)	
Section III: Catalysis – organometallic and bioinorganic complexes and semiconductors	**Chapter 25**

Grading:	**mid-term exams (2)**	**30%**
	final	**25%**
	element papers (2)	**20%**
	problem sets	**25%**

Textbook: The textbook for the course is Shriver and Atlkins, Inorganic Chemistry, 4th edition. A number of additional inorganic chemistry textbooks are available on reserve. Of particular interest are: Bioinorganic Chemistry By Bertini *et al.* (great reference for papers), Physical Methods for Chemists by Drago (great general reader on spectroscopy), Inorganic Chemistry by Wulfsberg (the other book that I often use as a textbook for this course)

Expectations and grading: Each student shall work independently on each exam and graded problem set, relying only on texts and the instructor when permitted. A breach of the academic integrity policies of the college will result in course failure.

You are expected to do all of the assigned reading carefully. Generally you should plan on reading each assigned reading at least twice – perhaps more for scientific papers. Class periods will be devoted to applying the material you have learned from your reading and answering questions. Do not expect that class time will function in lieu of reading. It will not.

Weekly problem sets will be assigned. In general, they will be assigned on Wednesday and then discussed during our tutorial period on Friday before being turned in on Monday. Grading for these will be based both on the completeness, correctness and legibility of the problem set as well as the level of engagement demonstrated by the student in discussing the problems in-class.

This course is designed for students who have covered all the course material taught in CHEM 107 and CHEM 108. It does not require exposure to any other course material. It is designed for students who are serious about learning and who are willing to work diligently. At times material from other courses might come up in class discussion – don't let that intimidate you – ask if you want to know more about something being discussed but feel confident that you will not be held responsible for material from classes other than 107, 108 or 215.

The final exam is scheduled for Final: Thursday December 11th at 10:30 AM. It will be cumulative.

Assignments:

There will be two "element" papers due during the course of the semester. The assignment is to write a paper describing how the chemical properties of a particular element enable that element (either as an element or as part of a compound) to perform a particular function. For example, you could write about why zero-valent iron is suited to *in situ* environmental remediation or why technetium is used in medical diagnoses. The thesis of each paper must be the connection between the

chemical properties of the element and the chemistry of the use you are describing. Papers must be well written, with a clear thesis statement and with a single idea per paragraph and with a topic sentence in each paragraph. The papers are not intended to be comprehensive reviews of the chemistry of all aspects of an element, or even all aspects of the element's chemistry relevant to the thesis question. Rather the papers should be tightly focused and simply answer the question poses. It should be between 3-5 pages, typed, double-spaced, and fully referenced. At least one of the references must be from the peer reviewed scientific literature. Grades will be assigned on the basis of the clarity of the writing, the extent to which the assignment is fulfilled, and the accuracy of the science. For each paper, a rough draft is due almost a month before the final draft is due. Late rough drafts will result in a one-letter grade lowering of the final grade. Late final papers will not be accepted. Students will be given the opportunity to rewrite each paper based on comments from classmates and instructor.

Paper due dates: First paper topic, September 17. First paper thesis statement September 26. First draft, first paper October 8th, Second paper topic, September 26. Second paper thesis statement October 8. First draft second paper October 31; Final draft first paper November 7; Final draft second paper December 5.

Some potential areas for topics include:

- Why is Pt effective as an anticancer agent in cis-platin (and other Pt-based drugs)?
- Why is Au effective as anarthritic drug?
- Why is Li effective as a drug for treating manic depression? (warning, this is very interesting, but hard)
- Why is chromium carcinogenic?
- Why is arsenic carcinogenic?
- Why is beryllium toxic?
- Why is Fe(0) used to remediate groundwater?
- Why is chromium used in magnetic storage devices?
- Why is sulfur used in chemical weapons?
- Why is platinum used in catalytic converters?
- Why is chlorine used to disinfect water?
- Why is boron used in neutron capture therapy?
- Why are certain lanthanides used as magnetic contrast agents?
- Why are certain lanthanides used to treat cancer?
- Why is manganese added to gasoline?
- Why are certain oxygen species toxic?
- Why is titanium used in artificial body parts?
- Why is mercury toxic?
- Why is tin used on boats?
- Why is titanium used on windows?
- Why is tungsten used on windows?
- Why was lead added to gasoline?
- Why is sodium considered for use as a coolant in nuclear power plants?

- Why does carbon make silicon carbide an industrially useful semiconductor?
- Why is carbon the building block of life and not, for example, silicon?
- Why is silicon used in ceramics?
- Why is palladium used as a catalyst in carbon-carbon bond formation?
- Why is titanium so effective in enantioselective synthesis (Chem Rev 2006, 106, 2126)?
- Why is fluorine added to drinking water systems?

You can also get ideas for topics from reading inorganic journals. We get *Inorganic Chemistry*, *Organometallic chemistry*, and the *Journal of Bioinorganic Chemistry*. *Chemical and Engineering News*, which we also get, can be a good source of ideas too.

There will be occasional quizzes both to help reinforce the learning of simple facts such as the order of elements on the periodic table or rules for nomenclature and also to challenge you to reason through a new type of problem.

Academic Honesty:

As a student at Bates College, you are obliged to follow the College's policies on academic honest and fair use of materials. Establishing good practices for correct use of sources is an important step in the development of the intellect. Complete guidelines for academic honesty are found in the student handbook. I expect you to read those guidelines.

The key points from those guidelines are outlined here.

1. Any idea or words that you obtain from any other source must be acknowledged in your work unless they clearly fall into the domain of "common knowledge". For example, I do not need to reference the idea that the earth is round since that is considered common knowledge, even though I myself have never done any experiments that taught me this fact directly. Sources include web sites (references to which should be dated to note the date access), books, magazines, etc. If you obtain multiple ideas from a single source, you must cite the source each time you introduce a new idea. If you use four or more words consecutively you must use quotations. Do not try to get around this rule by sticking in a word or two to interrupt the "four word" rule. The basic idea here is that if you are getting specific words and phrase structures from a source, the words and phrases must be represented with quotations.

2. Avoid, at all costs, deliberate plagiarism! Faculty members have access to many sophisticated search tools that allow us to easily track down plagiarized papers. The penalty for plagiarism is severe -- generally a year's suspension for the first infraction, expulsion for the second infraction, and a permanent blight on your academic record. If you feel yourself utterly stressed and seemingly hopelessly behind in all your classes either approach your faculty members and ask for extensions (note my late policy above, which does allow for late papers) or contact someone in the Dean of Students' Office who can help you both establish better time management skills and often help you through a crisis.

3. When in doubt about what is acceptable in any assignment (e.g. what degree of collaboration is allowed, how much work from a prior course can you include?), it is your responsible to ask the professor for clarification.

General Schedule

Week of September 1: Introduction, overview, expectations, quick review of electronic structure
Week of September 8: Acid/base properties of ions, searching the chemical literature
Week of September 15: Acids and base properties of multiatom ions, reading a research article
Week of September 22: Structure and properties of solids
Week of September 29: Solids and Redox chemistry
Week of October 6 : Redox chemistry continued
Week of October 13: **first midterm exam**, Fall break
Week of October 20: Transition metal complexes – geometry and ligands
Week of October 27: Electronic structure of transition metal complexes
Week of November 3: Reactivity of coordination complexes
Week of November 10: Reactivity of coordination complexes,
Week of November 17: **second midterm exam**, Catalysts
Week of December 1: Catalysts