1. General Information

Instructor: Andy Pacheco
Office Hours: By e-mail appointment (Room 629)
E-Mail: apacheco@uwm.edu
Text: Inorganic Chemistry by Gary Wulfsberg

Course Objectives and Methods: This course is designed to provide you with an introduction to the field of inorganic chemistry. It is a vast field, and I will make no attempt to do a comprehensive survey of the entire discipline. Instead, I will use most of the lecture time to introduce what I find to be some of the most important and broadly applicable tools available to the inorganic chemist. The lectures will be supplemented by reading assignments and problem sets, chosen to give you an idea of the wide range of topics that inorganic chemists are interested in.

Tests: There will be two hour-long exams during the semester, in addition to a cumulative final. The hour-long exams will be worth 50 points each, and the final 100. All exams will be open-book. They will test on material covered in lectures, and any material covered in assigned readings.

Homework Problems: Several practice problems are listed in Section 4 below, and I may assign more. All problems are based on the material covered in my lectures and in the assigned readings. To do well in the exams you will almost certainly have to complete all of the suggested problems. Roughly once a week you will hand in a subset of the suggested problems as a graded assignment. The graded assignments for the whole semester will be worth a total of 50 points. Section 4 lists tentative due dates for the graded assignments. In my experience the pace of lectures varies substantially from year to year, so I may adjust the due dates once this year’s pace has been established. Updates of this syllabus that contain the new due dates, highlighted in red, will be provided throughout the semester.

2. Grading Summary

Exams (open-book): two in class, 50 points each; one final, 100 points; total for exams: 200 points.

Homework graded assignments: 50 Points.

Total Points: 250
3. Schedule

The following schedule is approximate. We will make adjustments to the timing of the material covered, but not to the timing of exams. Specific coverage for the exams will be set two lectures in advance of the exam.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture #</th>
<th>Topic</th>
<th>Readings and Exams</th>
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<tr>
<td>Sept. 3</td>
<td>1,2</td>
<td>Atomic structure: hydrogenic ions</td>
<td>Text, Chapter 1</td>
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<td>Sept. 10</td>
<td>3-5</td>
<td>Atomic structure: many-electron systems</td>
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<td>Sept. 17</td>
<td>6-8</td>
<td>Electronegativity and bonding</td>
<td>Text, Chapters 1-3</td>
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<td>Sept. 24</td>
<td>9-11</td>
<td>Lewis structures: review; Lewis acids and bases; bonding in</td>
<td>Text, Chapters 1-3</td>
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<td>Lewis acid-base complexes; Pauling’s electroneutrality principle</td>
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<td>Oct. 1</td>
<td>12,13*</td>
<td>Introduction to ionic solids; theoretical description of ionic</td>
<td>Text, Chapters 2 and 4</td>
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<td></td>
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<td>bonding;</td>
<td><strong>Exam #1, Oct 5th</strong></td>
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<td>Oct. 8</td>
<td>14-16</td>
<td>Born-Haber cycles: experimental calculation of lattice energies;</td>
<td>Text, Chapter 7.1</td>
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<td>Solubility: enthalpic and entropic factors; predicting a salt’s</td>
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<td>Oct. 15</td>
<td>17-19</td>
<td>Solubility (cont.); Ligand classifications: chelate and macrocyclic</td>
<td>Text, Chapter 4</td>
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<td>effects, hard-soft acids and bases.</td>
<td>Text, Chapter 5</td>
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<td>Oct. 22</td>
<td>20-22</td>
<td>Ligand classifications (cont.); Oxidation-reduction reactions:</td>
<td>Text, Chapter 5</td>
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<td>balancing half-reactions (review); pH dependence of the</td>
<td>Text, Chapter 6</td>
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<td>standard reduction potential; Pourbaix diagrams; Latimer</td>
<td>Shriver and Atkins, Ch. 5</td>
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<td>diagrams and Free energy;</td>
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<td>Week</td>
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<td>Topic</td>
<td>Readings and Exams</td>
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| Oct. 29 | 23-25      | Oxidation-reduction reactions (cont.): Frost diagrams; disproportionation and comproportionation; overpotential; Transition metal chemistry: introduction | Text, Chapters 6  
Shriver and Atkins, Ch. 5  
Text, Chapter 8 |
| Nov. 5  | 26, 27*    | Transition metal chemistry: crystal field theory                       | Text, Chapter 8  
Gerloch and Constable  
*Exam #2: Nov. 9th* |
| Nov. 12 | 28-30      | Transition metal chemistry: crystal field theory; UV/Vis spectroscopy and the spectrochemical series | Text, Chapter 8  
Gerloch and Constable |
| Nov. 19 | 31         | Transition metal chemistry: Factors affecting TM complex geometry       | Text, Chapter 8  
Gerloch and Constable  
*Thanksgiving* |
| Nov. 26 | 32-34      | Trends in transition metal reactivity; introduction to transition metal reaction mechanisms: Ligand substitution | Text, Chapters 8, 16 |
| Dec. 3  | 35-37      | Introduction to transition metal reaction mechanisms: electron transfer mechanisms | Text, Chapters 8, 16 |
| Dec. 10 | 38,39      | Review                                                                | Last class, Dec 12                                      |
| Dec. 18 |            | Final Exam                                                             | Final Exam  
3:00 – 5:00 pm |

* Review sessions will precede each exam. Length of review will depend on the number of questions that students have. The course schedule will be adjusted accordingly.
4. Problem Sets

Problem Set 1 Text Chapter 1, Exercises 1-5.

**Hand in assignment 1:** Q.3; **Friday, Sept 14th**.

Problem Set 2 Text Chapter 1, Exercises 7-9,13,16,17,41,43,45.

**Hand in assignment 2:** Q16def, 17ef; **Wednesday, Sept 19th**  
**Hand in assignment 3:** Q13; Q43ch; **Wednesday, Sept 26th**

Problem Set 3

(a) Draw Lewis structures for the following molecules. If a molecule has more than one plausible resonance form, draw them all (but don’t bother drawing out equivalent resonance forms). (b) Assign the formal charge and oxidation state of each atom in the molecules of part (a). For compounds with more than one resonance structure, determine the most stable form on the basis of the formal charges and satisfaction of the octet rule. (c) Use the VSEPR model to determine the geometry of each molecule (remember: the geometry is the same for all resonance structures of the same molecule. Also, if a molecule has an odd number of electrons, the extra electron is treated the same as a lone pair).

SO$_4^{2-}$; PCl$_5$; NO$_3^-$; SF$_6$; BF$_3$; XeF$_4$; BrF$_3$; TeCl$_4$; ICl$_2^-$; SO$_3$; SO$_3^{2-}$; NO$_2$.

**Hand in assignment 4:** TeCl$_4$, SO$_3$, SO$_3^{2-}$ **Friday, Sept 28th**  
*(note additional problem below!)*

Problem Set 4

Identify the Lewis acids and bases in the following reactions:

SiO$_2$+Na$_2$O $\rightarrow$ Na$_2$SiO$_3$  
NOF+ClF$_3$ $\rightarrow$ NO$^+$+ClF$_4^-$  
Li$_3$N+2NH$_3$ $\rightarrow$ 3Li$^+$+3NH$_2^-$

**Hand in assignment 4:** middle problem **Friday, Sept 28th**
Problem Set 5

(a) For the following transition metal compounds first draw the Lewis structure in 100% ionic form and assign the metal oxidation state, then draw the 100% covalent form with all single bonds. If appropriate, draw additional resonance structures with multiple metal-Lewis base covalent bonds. **Be sure to include all formal charges in the covalent forms.** (b) For compounds that you identify as having partially ionic single bonds, use Pauling’s electroneutrality principle to estimate the % covalency of the Metal-Lewis base bonds. For compounds that you identify as having resonance structures with multiple covalent bonds, use Pauling’s electroneutrality principle to identify the resonance form(s) likely to be most stable. You are encouraged to make educated guesses, provided that they are accompanied with reasoned arguments!

a) [Co(NH3)6]3+ b) [Ni(CN)5]3− c) MnO4−

*Hand in assignment 5:* [Ni(CN)5]3−, MnO4−; **Wednesday, Oct. 3rd**

Problem Set 6 Text Chapter 4, problems 20, 25-27, 28, 43, 45, 48, 50, 58. Text Chapter 7, problems 2, 3.

*Hand in assignment 6:* Ch. 4: Q27d **Friday, Oct. 12th**

*Hand in assignment 7:* Ch. 7: Q2 **Wednesday, Oct. 17th**

*Hand in assignment 8:* Ch. 4: Q25, 43 **Monday, Oct. 22nd** (suggestion: in Q43 try eliminating false statements before settling on the true one.)

Problem Set 7

I. Try the following problems from Chapter 5 of your text book: Q. 11, 13, 21, 24, 27, 30, 37

II. Read pages 215-228 of Wulfson, then try question 60 from the text book.

III. (a) Find one example each of a bidentate, tridentate and tetradeinate ligand. You may search online or in reference books, but you may not use any of the examples that already I gave in my class notes. (b) Sketch the ligands and clearly label the donor atoms. (c) Are the donor atoms hard or soft? (d) Bonus: what are the names of these ligands? (trivial names are fine; keep in mind that I rarely know these myself, but if you can find them they might be useful in future!)

*Hand in assignment 9:* Chapter 5, Q. 21, 37; Question III above **Friday, October 26th**
Problem Set 8

1. In class we derived $E_{\text{pH}}^o$ as the apparent standard reduction potential measured in a solution buffered at a given pH. Use this equation to calculate $E_{\text{pH}}^o$ at pH = 14. Does this value agree with the literature value for the standard reduction potential under “basic conditions” (meaning at pH = 14)?

2. Derive an expression for $E_{\text{pH}}^o$ starting from the chemical equation balanced for basic conditions:

$$\text{MnO}_4^- (aq) + 2\text{H}_2\text{O (l)} + 3e^- \rightarrow \text{MnO}_2 (s) + 4\text{OH}^- (aq)$$

3. Here’s a tricky example from antimony chemistry: the standard reduction potential for Sb$_2$O$_5$ going to Sb$_4$O$_6$ is +0.699 V in acidic (pH=0) solution. What will the apparent standard reduction be at pH = 6?

4. Wulfsberg Chapter 6, problems 64 – 67, 69, 72

   Hand in assignment 10: Question 3 above, Wulfsberg problem 6.64.

   Friday, November 2nd

Problem Set 9

Given the following Latimer Diagram (for pH = 0):

\[ \begin{align*} 
\text{BrO}_4^- & \rightarrow^{+1.82 \text{ V}} \text{BrO}_3^- & \rightarrow^{+1.49 \text{ V}} \text{HBrO} & \rightarrow^{+1.59 \text{ V}} \text{Br}_2 & \rightarrow^{+1.07 \text{ V}} \text{Br}^- 
\end{align*} \]

(i) Write balanced half reactions for each step in the diagram

(ii) Identify species that are unstable with respect to disproportionation at pH = 0

(iii) Determine $E^o$ for BrO$_3^-$ reduction to Br$_2$ at pH = 0, and then at pH = 7.

   Hand in assignment 11: (all of Problem set 9)  Wednesday, Nov. 7th

Problem Set 10

1. Provide the metal oxidation state and d$^n$ electron configuration for the complexes illustrated on the following page.

   Hand in assignment 12:  Monday, Nov. 19th
2. [PtCl₄]²⁻ is a square-planar compound. Sketch a diagram that shows how the 6p orbital set splits in a square-planar crystal field (yes, I do mean the 6p set!). In your diagram clearly label the barycenter, the difference in energy $\Delta_{sp}$ between different 6p orbitals, and the fraction of $\Delta_{sp}$ that each orbital lies above or below the barycenter.

3. Try the following problems from Ch. 8 of the textbook: Q. 3, 7, 10, 16, 26, 29, 31, 38, 46, 51, 55, 57.

   Hand in assignment 13: Q.2 above, and Q. 10 from Chapter 8.  
   Hand in assignment 14: Ch.8 Q. 7, 31, 46.

   Monday Nov. 26th 
   Wednesday Dec 5th

Note that for some of these problems you will need material from Chapter 8 that I won’t cover in class. In particular you should read pp 363-364 and section 8.5, and know what “corrected molar magnetic susceptibility” is, and how to use the f and g factors listed in Table 8.5. You should also be able to convert spectral information provided in nanometers (nm) into wavenumbers (cm⁻¹). I expect you to be able to answer problems like these in the final exam!

For PS10, question 1:

(a) 

(b) 

(c) 

(d) [Cr(NCS)₆]³⁻ 

(e) [Cr(C₂O₄)₃]³⁻
5. University and Departmental Policies

For information regarding university policies on such subjects as students with disabilities, accommodations of religious observances, students called to military active duty, and other important topics, please visit the following web site maintained by the Secretary of the University: http://www.uwm.edu/Dept/SecU/SyllabusLinks.pdf.

Chemistry Department policies are posted on bulletin boards across from Chemistry 195 and Chemistry 164.

6. Some Useful References


