

**CHEMISTRY 135 A  
INORGANIC QUALITATIVE ANALYSIS  
INTERIM 2010**

**Instructor**

Duane Weisshaar      Office: GSC 248      e-mail: duane.weisshaar@augie.edu  
Phone (274)-4812      Home: 339-7269      class website: faculty.augie.edu/~dew  
Office Hours: 8:00-9:00 AM daily or by appointment  
Barrett Eichler      Office: GSC 258      e-mail: barrett.eichler@augie.edu  
Phone (274)-4814  
Office Hours: 3:00-4:00 PM daily or by appointment

**Class Schedule**

Lecture                      9:00-10:00 AM, 11:00 AM -12:00 PM daily      GSC 241  
Lab A                        12:00-3:00 PM daily                                  GSC 243 (A) & 255 (B)

**Lab work during scheduled lab time only.**

**Textbook and Supplies**

J. J. Lagowski and C. H. Sorum, *Introduction to Semimicro Qualitative Analysis*, 8<sup>th</sup> edition, Prentice-Hall: 2005.  
Any General Chemistry text to supplement the lecture  
*ACS General Chemistry Exams - The Official Guide* - recommended (several copies also on reserve in the library)  
Safety goggles (wear them faithfully in lab each day)  
Bound lab notebook (may append to notebook from another course) - does not need to be duplicate page type

**Grading Criteria**

POSSIBLE POINTS		APPROXIMATE CUTOFFS (bottom of each range)	
Exams (3)	300	A - A-	750 - 697.5 - 675
Laboratory	250	B+ - B - B-	652.5 - 622.5 - 600
Lab Final (ACS Qual)	100	C+ - C - C-	577.5 - 510 - 487.5
Lecture Final (ACS Gen Chem)	100	D+ - D - D-	465 - 435 - 412.5
	-----	<b>YOU CANNOT PASS THE COURSE UNLESS YOU PASS THE LAB (137 PTS OUT OF 250)</b>	
<b>TOTAL</b>	<b>750</b>	Borderlines will be assessed on a case by case basis.	

**Goals of the Course**

- Develop a knowledge of the descriptive chemistry of some common elements and their ions.
- Develop and enhance an understanding of some basic chemical concepts (chemical equilibria, chemical kinetics, solubility, acid-base, complex ion formation, oxidation-reduction).
- Development of an analytical thinking/problem solving **process**. This will require abstract thinking skills as we seek to relate observable phenomena to the characteristics and behavior of atoms and molecules.
- Develop and enhance basic lab skills with attention to safety issues. Particular emphasis is placed on small scale techniques (semimicro).
- Build confidence in lab skills and ability to apply concepts from lecture.
- Develop and enhance the fundamentals of keeping a lab notebook and reporting results.
- Develop and enhance the ability to follow oral and written directions.
- Provide hands-on experience with HPLC (an instrumental technique), electrochemical measurements, and determination of a reaction rate.

**Nature of the Course**

Lecture will build on your general chemistry background emphasizing the more quantitative aspects of topics supporting inorganic qualitative analysis. Lab will focus on more descriptive aspects of inorganic chemistry through separation and identification of some cations and anions.

## Expectations

This course represents your total academic load for Interim, comparable to a normal load of 15 credits during a regular semester, i.e., equivalent to a full time job. It is expected that during the four weeks of Interim, you will spend about 20-25 hours per week outside of class efficiently studying - reading the text, working the recommended problems, and preparing for exams. Interim moves quickly, so you need to start today and work diligently each day.

Working problems, not just watching someone else do it, is essential for learning chemistry, so problem solving should be a regular and significant part of your study time for this course - set a goal of working 2-3 lecture problems and 1-2 lab problems each day. You are encouraged to work in small groups on the recommended problem sets.

In the lab, practice in problem solving is represented by analyzing unknowns: a time-consuming activity, but with careful work, it can be an enjoyable experience with quite reliable results. The lab procedures in Lagowski-Sorum are quite explicit, detailed, and reliable, but there is little learning in blindly following a recipe. As you work in lab strive to connect what you do and what you observe to the chemistry involved - solubility rules, stability of complexes vs. precipitates, pH effects, redox, kinetics, LeChatelier's Principle when conditions are changed, etc.

## Attendance

If you must miss lecture or lab, call or email, preferably, before any absences. If you miss a lecture, YOU are responsible for finding out about any announcements, obtaining class notes from a classmate, etc.

## Accommodating Disabilities

Any students with disabilities who need reasonable accommodation in this course are encouraged to speak with one of the instructors as soon as possible. Students with questions regarding disability services may contact Susan Bies at the Student Support Services Office, Career Center Suite, Room 100, in the Edith Mortinson Center, 274-5503, [susan.bies@augie.edu](mailto:susan.bies@augie.edu).

Chemistry, by its very nature, involves handling of potentially hazardous substances. The labs in this course will teach you how to properly handle these substances while minimizing the range of exposure. However, exposure effects vary from person to person. So, if you have asthma, allergies, are pregnant, or have other special circumstances, please inform one of the instructors so we can plan appropriate accommodations for your safety.

## Honor Code

As a community of scholars, the students and faculty at Augustana College commit to the highest standards of excellence by mutually embracing an Honor Code. As a College of the Evangelical Lutheran Church in America, we understand the individual and collective responsibility we have in fostering integrity. Ultimately, our purpose is to be an engaged body of academically excellent, highly articulate, and morally centered persons who learn about and examine the world together. We believe that only when we are honest with each other and ourselves can we begin to contribute to the world in a meaningful manner. To that end we pledge that we will abide by the highest standards of **academic integrity**, and that we will abide by the decisions of the joint student/faculty Honor Board. (The full description of the Honor Code is available at [www.augie.edu/admin/acadaff/](http://www.augie.edu/admin/acadaff/).)

What does "Academic Integrity" mean in this course?

- You do your own work on individual assignments (not copying others). On group assignments you contribute to the group effort and strive to understand all parts of the project, not just the part you do.
- In lab you are to be "true" to your data - your report should reflect what you measured and observed; data is not to be changed or manufactured to fit expectations. If you missed collecting some data, see the instructor; don't copy someone else's data.
- Give credit where credit is due. When you gather data from the Web, books, magazines, etc. cite the reference (author, title, etc.).

I presume we are in this class to help each other learn some chemistry (yes, instructors learn in this class too), so I trust you to turn in work that reflects your efforts and to help each other adhere to that "code of honor." As a reminder of that commitment, when submitting a group assignment, each member should **sign** it. In addition, the following statement will be appended to each exam:

***On my honor, I pledge that I have upheld the Honor Code, and that the work I have done on this assignment has been honest, and that the work of others in this class has, to the best of my knowledge, been honest as well.***

Signed \_\_\_\_\_

If you feel you can't sign this, contact the instructor (e-mail or in person)

If you cannot, in good conscience, sign this pledge or an assignment or if you have other concerns about academic integrity in this course, please come visit with me (in confidence of course) or send me an e-mail note. At a minimum, students caught violating this code will receive a zero (0) on the assignment or exam and the incident will be reported to the Vice President for Academic Services (Augustana Policy on Academic Integrity 5/01).

### **Course Materials on the Web**

The syllabus, handouts, and past exams for this course are posted on the Web at <http://faculty.augie.edu/~dew> or on Moodle. Recognize that Interim 06 the lecture section of this course was totally revamped, so prior exams may be less helpful. Looking at past exams for Chem 120H (Honors) will provide some additional insights into the kinds of questions that may be asked.

### **Communication with the Class**

The instructor will use your Augie e-mail addresses (@ole) for class announcements and general communication with the class and with individuals; check your e-mail daily. Refer to your NSS manual or see the Help Desk (Madsen Basement) for details on accessing your e-mail. If you use another e-mail account, put a forwarder in your @ole account (contact the Help Desk for help in setting up a forwarder).

### **Recommended Problems**

To help you focus on appropriate problems, a set of recommended problems supportive of the lecture and the lab are listed in the Study Guide (below). These problem assignments are for your benefit and will **NOT be collected or graded**. Pace yourself, working a few problems every day, and take good advantage of these opportunities to **think chemistry**. The worked out solutions for the problem sets will be posted on the Chem 135 Moodle site.

### **Exams**

- Three unit exams will be given, one on each Friday, during the first hour of the lecture period.
- Comprehensive, over material covered in lecture and lab to date.
- If you have to miss any of the hour exams, please notify the instructor, preferably before the absence.
  - If you have an acceptable excuse for missing an hour exam and the exam cannot be rescheduled conveniently before the exam is returned to the class, more weight will be placed on your final exam (combination of both parts) to cover the missed exam.
- No phones, graphing calculators, or alphanumeric calculators are allowed during exams.
- **Final Examination** is given in two parts:
  - ACS Qualitative Analysis Exam - in class on next to last day from **8:00 – 10:00 AM!!!**
  - ACS General Chemistry Exam - in class on last day from **8:00 – 10:00 AM!!!**
  - An ACS publication *Preparing for Your ACS Examination in General Chemistry - The Official Guide* will be helpful in preparing for this type of exam. You may purchase a personal copy on your own (check with Marlys) or use one of the copies on reserve in Mikkelsen Library. *The Study Guide is copyrighted material, so making a xerox copy of those on reserve is **not** an appropriate strategy.*
  - Attendance at these exams is mandatory.
  - If your average on the two final exams is higher than your lowest unit exam, the lowest unit exam score will be replaced by the final.
  - The table of formulas and constants provided on hour exams will also be provided for these exams.
  - Points for the ACS Exams are scaled to the national norms.

*Why use a standardized exam?*

The rationale for using a standardized exam includes several aspects:

- Assessment tool for the Chemistry Department as it evaluates its curriculum.
- Comparison tool for you and the Chemistry Department to see how you and the class as a whole “stack up”

against your counterparts across the nation.

- National norms provide a yardstick for determining a consistent grading scale.
- True mastery of a concept implies an ability to apply it in new situations. Exams prepared by someone other than the instructor provide new contexts and formats to test this ability. Or as John W. Moore wrote in an editorial in *The Journal of Chemical Education* **1998**, 75(2), 135:  
In a world in which change is the norm, only an educated student has been properly equipped to prosper. This means that students need to be able to identify and define problems, to solve them imaginatively, and to apply the chemistry they learn in a variety of contexts in other disciplines.
- Students gain experience/practice in taking standardized, multiple-choice exams often used as a “hurdle” for many post-college endeavors (e.g. MCAT for medical school, OAT for optometry school, DAT for dental school, GRE for graduate schools, Nursing Boards, Bar Exam, CPA certification, etc.)

*Strategies for Preparation:* A common myth propagated among students is that studying for standardized exams is a fruitless endeavor. **THIS IS ABSOLUTELY NOT TRUE.** If you have a firm understanding of the *material covered in class*, you can score quite well on these exams. So, **PREPARE** by focusing on the material we have covered in class. Also make use of the guidebook *Preparing for Your ACS Examination in General Chemistry - The Official Guide* (ACS publication).

#### **Lab work is permitted only during the scheduled lab period.**

- Lab work should **not** begin until the instructor arrives and must be terminated each day at the designated time.
- It is your responsibility to make sure you complete all lab projects by the end of the last lab period.
- With organized, careful work and diligence, it is possible to complete the qualitative analysis lab work early; providing yourself some less hectic days toward the end of Interim.

#### **Qualitative Analysis Portion of the Lab**

- Work individually and proceed at your own rate.
- You are strongly encouraged to set up **collaborative groups** of 3-4 to compare and consult as you go.
  - Think together about reactions and results.
  - Rely on each other to help interpret results. Your group will provide a sounding board for questions like: Is there a precipitate here or not? What color is this? Is this the right color for a positive test? Ooh, that's a weird test result, what does it mean? Does this unknown conclusion make sense? What kind of alternate or blanket test could I run to verify a conclusion?
  - Provides more opportunity to experience the chemistry, more experience in how chemistry (science) is done, and a way to build your confidence in your lab skills and your understanding.
- Review the “Helpful Hints” and “Safety and Locations” handouts each day to ensure you don't miss essential details.
- General instructions for the lab are given on pages 154-158 of Lagowski & Sorum, with specific directions for each project presented in the subsequent pages.

#### **Lab Notebook for the Qualitative Analysis Portion of the Lab**

- Keep track of your progress in lab in a bound **lab notebook**. (You can use blank pages in a notebook from another course if you wish). There is no specified format for the lab notebook, but it must contain the following information:
  - initials and date on each page.
  - flow charts and all reactions in the flow scheme for that group known.
  - observations and notes on the analysis of the known (may be incorporated into the flow chart).
  - **unknown number** - If forgotten, either guess and take your chances or do a new unknown. A new unknown costs you 10% (same as requesting more unknown).
  - flow chart, observations, and notes for the first attempt on the unknown, including ID of ions present and absent.
  - documentation of subsequent attempts on unknown, including discussion of the evidence for changes in your ID report.

#### **Qual Lab Projects**

- Seven Lab Projects (see list in lab schedule below with their respective allotted points). Lab Projects must be completed sequentially in the order given.
  - **Four Cation Groups**
    - Analyze a known solution containing all the ions of that group.
    - Analyze an unknown solution for that group.
  - **Anion Analysis**
    - Complete the preliminary (blanket) test for anions summarized on pp. 245-254 of Lagowski & Sorum. Record observations in your notebook, not in the text.
    - Run the **blanket tests** on an unknown for anions to deduce the possible anions present.
  - **Single Salt Unknown**
    - Analyze a solid containing a single cation and a single anion as summarized on pages 285-287 of Lagowski & Sorum.
  - **Alloy Analysis**
    - Analyze an alloy for elemental composition using the cation scheme.

### Procedure for obtaining and reporting qualitative unknowns

- To *obtain* an unknown for a Lab Project you must complete the known and present your notebook with completed flow chart and reactions for the known to the instructor.
- For the Lab Projects without a known, the instructor will issue you an unknown when you have completed the prior projects.
- Be sure to specify which unknown (group) you want from the instructor.
- You will be issued sufficient unknown to complete all the tests at least three times. Additional unknown may be requested, but it will cost you 10% of the total points for that Project. Take good care of what you receive and use it wisely.
- Remember to record your unknown number in your notebook.
- To *report* your results on an unknown, fill out the yellow Report Card (on front desk) and present it along with your notebook to the instructor.
  - Be prepared to defend your decision using the evidence recorded in your notebook - random guessing will not be permitted.
  - If your report is not completely correct, the instructor will also tell you if you are missing some, have extras, or both. **Score = Pts Poss • (#ions correct/#ions in group). For the single salt - Score = 15 pts for each ion identified correctly (2 possible ions).**
- After you have completed all the projects, you may make second attempts on any of the previous projects to “redeem” up to half of the points you missed on the first attempt. Preserve and label original unknown and prior tests for use in any second attempts (additional unknown still costs you 10%).
  - **Score = Score from 1<sup>st</sup> attempt + Pts Poss/2 • (Δ#ions correct/#ions in group)** - note it is possible to *lose* points on the second attempt.
  - Making a second attempt is your option; you can accept the score from the first trial.
- If time permits, after you have *completed all* the projects (correct identification or completed two attempts), you can repeat a project to improve your score. For repeating any of the cation groups, a general cation unknown (ions from all 4 groups) will be issued.

### Electrochemistry and Kinetics Labs

- To be done on the assigned days.
- Work in pairs turn in one report - details in the lab procedures will be provided.
- Record all data on the data sheets provided.

### Study Guide

Note: You will **NOT** be given **ANY** equations or constants for exams, so they must be memorized. The list on p. 11 of this document should be helpful.

### Acid-Base and Solid Equilibria

#### Terms

Arrhenius definitions

Bronsted-Lowry definitions

Lewis definitions

conjugate pairs

anhydride	pH	ionization constant	$K_a$ , $K_b$ , $K_w$
hydrolysis	buffer	amphoteric/amphiprotic	indicator
end point	equivalence point	saturated solution	supersaturated
solvation	solubility product - $K_{sp}$		

### Concepts and Skills

Recognize the 6 strong acids (HCl, HBr, HI, HNO<sub>3</sub>, HClO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub> (both protons))

Recognize the strong bases - soluble oxides and hydroxides except NH<sub>4</sub>OH

For aqueous solutions, identify acids and bases, strong and weak from the formula

Write stepwise, net ionic reactions for acids and bases in water (Bronsted-Lowry definition)

pH, pOH calculations for aqueous solutions of strong acids and strong bases

pH, pOH, pK calculations with weak acids, bases, and buffers

Calculations for titration reactions

Recognize and design buffer systems

Describe the chemistry giving rise to acid rain

Solubility Rules

Calculations with  $K_{sp}$

Write stepwise, net ionic reactions showing the effect of acids and bases on solubility (LeChatelier's Principle)

### Recommended Problems

Lagowski & Sorum *Chapter 2*: 3; *Chapter 3*: 1acegj, 3, 15; *Chapter 4*: 8, 10c, 11, 15, 17

- What is the pH of  $7.35 \times 10^{-5}$  M Sr(OH)<sub>2</sub>?
- What is the pH of a solution formed when 25.0 mL of 0.385 M HNO<sub>2</sub> is mixed with 10.0 mL of 0.500 M NaOH?

### Electrochemistry

#### Terms

half-reaction	disproportionation	anode	cathode
galvanic cell	electrolytic cell	current	reduction potential
Gibbs Free Energy ( $\Delta G$ )	voltage	spontaneous reaction	electrolysis

### Concepts and Skills

Balance redox reactions and half-reactions (review)

Write and balance overall cell reaction from half reactions

Predict what reactions may occur and the direction of reaction based the standard cell voltage

Describe a cell using standard line notation

Calculations with  $\Delta G$ ,  $K_{eq}$ , and E

Calculate standard cell voltages

Calculations using the Nernst Equation

Calculations relating mass, moles, charge (coulombs), current, time

### Recommended Problems

Lagowski & Sorum *Chapter 6*: 1, 2af, 5, 6ab, 7; *Chapter 13*: 7 (consider redox with acids)

- What is the  $E^\circ$  and balanced reaction for the cell: Fe(s)|Fe<sup>+2</sup>(aq)||H<sup>+</sup>(aq), H<sub>2</sub>O(l)|O<sub>2</sub>(g)|Pt(s)?
- Which is the strongest reducing agent: Fe<sup>+2</sup>, Fe<sup>+3</sup>, Sn<sup>+2</sup>, I<sup>-1</sup>? Explain your reasoning.
- Nitrate reduction to NO(g) occurs at 0.96 V under standard conditions. Will nitrate's strength as an oxidizing agent increase, decrease, or stay the same if the [H<sup>+</sup>] is increased to 16M?
- Copper is purified electrolytically by setting up a cell with the impure copper as the anode (oxidation) and a pure copper rod as the cathode (reduction) with aqueous CuSO<sub>4</sub> as the electrolyte. If a constant current of 100.0

amp is passed through the solution for 24.0 hr, how many kilograms of copper are refined (deposited on the cathode)?

- What is the reduction potential for the half cell:  $\text{Pt}|\text{H}_2 (0.835 \text{ atm})|\text{H}^+ (\text{pH } 4.00)|?$

### Complex Ions

#### terms

ligand	Lewis acid/base	mono/polydentate	isomer
diastereomer	enantiomer	<i>cis, trans</i> isomers	low spin complex
high spin complex	hybrid orbital	crystal field	para/diamagnetic

#### Concepts and Skills

Know formulas and colors of  $\text{NH}_3$  and  $\text{OH}^-$  complexes (Lagowski & Sorum)

Write electron configurations for transition metal ions

Draw Lewis structures for complex ions, including those with polydentate ligands

Identify the hybrid orbital and shape of a complex from its Lewis structure, draw a 3D rendition of the shape

Distinguish when a 4-ligand system is square planar and when it's tetrahedral

Use systematic nomenclature to name and write formulas for complex ions

Draw Lewis structures for isomers of complex ions

Recognize diastereomers, enantiomers, and linkage isomers

Draw orbital diagrams for high and low spin complexes

Predict magnetic behavior (para or diamagnetic) for complexes

Using d orbital and hybrid shapes, explain the d orbital energy splitting in tetrahedral and octahedral crystal fields

### Recommended Problems

Lagowski & Sorum *Chapter 5*: 3 (draw Lewis structure too)

- Name the following complex ions encountered in lab:  
 $\text{Cr}(\text{OH})_4^{-1}$        $\text{Co}(\text{NH}_3)_6^{+3}$        $\text{Fe}(\text{SCN})_6^{-3}$        $\text{Cu}(\text{CN})_2^{-1}$
- Write formulas for the following complex ions:  
 pentacarbonyliron(0)      dichloroargentate(I)      hexafluoroferrate(III)      monoaquatetrahydrozinc(II)
- Draw 3D representations of all the diastereomers of  $\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3$ .
- Draw 3D representations of the enantiomers of the following. In each case, would the enantiomers be expected to rotate light in opposite directions?  
 $\text{CFCIBrI}$        $\text{Cu}(\text{en})\text{Cl}_2$
- Draw the orbital diagrams (box notation electron configuration) for the high spin and the low spin complexes of  $\text{Fe}(\text{CN})_6^{-4}$ . Identify each as paramagnetic or diamagnetic.
- Draw the energy diagram showing the expected crystal field splitting for the following complexes:  
 $\text{Ni}(\text{NH}_3)_6^{+2}$        $\text{Co}(\text{Br})_4^{-2}$

### Chemical Kinetics

#### Terms

reaction rate	rate law	reaction order	half life
rate constant	mechanism	chain reaction	elementary reaction
energy of activation	catalyst		

#### Concepts and Skills

Express the rate of a reaction in terms of the concentration change of a reactant or product

Write a rate law expression given the orders with respect to each reactant and visa versa

Determine rate laws from initial rates data

Calculations with integrated rate laws, half-life, and rate constant

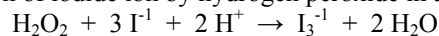
Calculations with the Arrhenius Equation

Correlate micro factors affecting rate with the macro factors (lab conditions that control each factor)

### Recommended Problems

Lagowski & Sorum *Chapter 2*: 2, 4, 11

- The reaction for the oxidation of iodide ion by hydrogen peroxide in acid is:



The table shows initial rate data for the appearance of the red colored triiodide ion.

Expt #	Init $[\text{H}^+]$ (M)	Init $[\text{H}_2\text{O}_2]$ (M)	init $[\text{I}^-]$ (M)	$\Delta[\text{I}_3^-]/\Delta t$ (M/s)
1	0.100	0.100	0.100	$1.15 \times 10^{-4}$
2	0.100	0.100	0.300	$3.45 \times 10^{-4}$
3	0.100	0.400	0.100	$4.60 \times 10^{-4}$
4	0.500	0.100	0.100	$1.15 \times 10^{-4}$

- What is the rate law for the reaction?
  - What is the value of the rate constant?
  - What is the rate of formation of  $\text{I}_3^-$  when  $[\text{H}_2\text{O}_2]=0.300$  M,  $[\text{I}^-]=0.400$  M, and  $[\text{H}^+]=0.300$  M?
- Hydrogen iodide gas decomposes at  $410^\circ\text{C}$ 
$$2 \text{HI} \rightarrow \text{H}_2 + \text{I}_2$$
The table presents data for a decomposition experiment.

Time (min)	0	20	40	60	80
$[\text{HI}]$ (M)	0.500	0.382	0.310	0.260	0.224

  - In a spreadsheet graphically determine if this reaction is first order or second order.
  - From linear regression on the appropriate graph, determine the rate constant for the reaction.
- The thermal decomposition of nitryl chloride ( $\text{NO}_2\text{Cl}$ ) is believed to occur by the following mechanism:
$$\text{NO}_2\text{Cl} \rightarrow \text{NO}_2 + \text{Cl} \quad (1)$$
$$\text{NO}_2\text{Cl} + \text{Cl} \rightarrow \text{NO}_2 + \text{Cl}_2 \quad (2)$$
  - What is the overall reaction?
  - What is the molecularity of each elementary reaction?
  - If the rate law for the reaction is determined to be  $\text{Rate} = k[\text{NO}_2\text{Cl}]$ , which step is the rate determining step?
- The rate constant for the decomposition of gaseous dinitrogen pentoxide is  $3.7 \times 10^{-5} \text{ s}^{-1}$  at  $25^\circ\text{C}$  and  $1.7 \times 10^{-3} \text{ s}^{-1}$  at  $55^\circ\text{C}$ .
  - What is the energy of activation for this reaction in kJ/mole?
  - What is the rate constant for this reaction at  $35^\circ\text{C}$ ?

### Nuclear Chemistry

#### Terms

alpha, beta, gamma radiation  
moderator  
transmutation

positron  
control rod  
Roentgen, Curie, rad, rem

electron capture  
fission

Geiger counter  
fusion

#### Concepts and Skills

Balance nuclear reactions

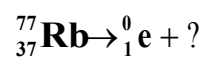
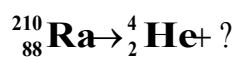
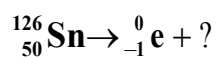
Calculations involving radioactive decay rates

Identify biological risks

Identify uses of nuclear chemistry

### Recommended Problems

- The decay constant for mercury-197, a radioisotope used medically in kidney scans, is  $1.08 \times 10^{-2} \text{ hr}^{-1}$ . What is the half-life of mercury-197.
- What is the half-life of iron-59, a radioisotope used medically in the diagnosis of anemia, if a sample has an initial decay rate of 16,800 disintegrations/min and a decay rate of 10,860 disintegrations/min after 28.0 days.
- What is the difference between an  $\alpha$  particle and a He atom?
- Why is an  $\alpha$ -emitter more hazardous to an organism internally than externally, whereas a  $\gamma$ -emitter is equally hazardous internally and externally?
- Complete and balance the following nuclear reactions:



### Structure and Bonding in Solids

#### Terms

simple cubic lattice	body centered cubic	face centered cubic	molecular solid
ionic solid	unit cell	coordination number	amorphous solid
network solid	allotrope		

#### Concepts and Skills

Calculations relating the unit cell with bulk properties like density and formula  
Identify substances as molecular, ionic, metallic or covalent solids

### Recommended Problems

- Three different metals form crystals with a unit cell length  $d = 291 \text{ pm}$ . One unit cell is a simple cubic arrangement, one is a body-centered cubic array, and the third is a face-centered cubic lattice. What is the radius of an atom in the
  - simple cubic unit cell?
  - body-centered cubic cell?
  - face-centered cubic cell?
- If the bcc unit cell above is for Fe, calculate the density of Fe in g/mL.

### Colligative Properties

#### Terms

solution	solvent	solute	mole fraction
mass percent	molarity	molality	colligative property
Raolt's Law	van't Hoff factor	osmosis	osmotic pressure
freezing point	boiling point	vapor pressure	semipermeable

#### Concepts and Skills

Calculations and conversions with concentrations  
Calculations with Raolt's Law  
Calculations involving boiling point elevation and freezing point depression  
Calculations involving osmotic pressure

### Recommended Problems

- What is the vapor pressure in torr of a solution prepared by dissolving 25.0 g of ethyl alcohol ( $C_2H_5OH$ ) in 100.0 g of water at  $25.0^\circ C$ ? At  $25.0^\circ C$  the vapor pressure of pure water is 23.8 torr and that of ethyl alcohol is 61.2 torr.
- What is the expected freezing point of a solution prepared by dissolving 7.40 g  $MgCl_2$  in 110 g water?  $K_f$  for water is  $1.86^\circ C \cdot kg/mole$ .
- If the cost per gram were the same for glucose ( $C_6H_{12}O_6$ ),  $LiCl$ ,  $CaCl_2$ , and  $AlCl_3$ , which would be the most efficient per unit mass for melting snow from sidewalks and roads? Explain your reasoning.
- Cellobiose is a sugar obtained by degradation of cellulose. If 200.0 mL of aqueous solution containing 1.5000 g of cellobiose at  $25.0^\circ C$  gives rise to an osmotic pressure of 407.2 torr, what is the molecular mass of cellobiose?
- Elemental analysis of  $\beta$ -carotene, a dietary source of vitamin A, shows that it contains 10.51% H and 89.49% C. Dissolving 0.0250 g of  $\beta$ -carotene in 1.5 g camphor gives a freezing point depression of  $1.17^\circ C$ . What are the molecular mass and molecular formula of  $\beta$ -carotene?  $K_f$  for camphor is  $37.7^\circ C \cdot kg/mole$ .

### Silver Group Recommended Problems

Lagowski & Sorum *Chapter 9*: 9, 11, 15

### Copper-Arsenic Group Recommended Problems

Lagowski & Sorum *Chapter 10*: 10, 18, 22

### Aluminum-Nickel Group Recommended Problems

Lagowski & Sorum *Chapter 11*: 9, 13, 15

### Barium-Magnesium Group Recommended Problems

Lagowski & Sorum *Chapter 12*: 5, 9, 12

### Anion Group and Single Salt Recommended Problems

Lagowski & Sorum *Chapter 14*: 21, 31, 32, 39a-f, 40

## EQUATIONS AND CONSTANTS YOU SHOULD KNOW

$$N_A = 6.022 \times 10^{23} \frac{\text{particles}}{\text{mole}} \quad 1 \text{ mL} = 1 \text{ cm}^3 \quad D = \frac{M}{V} \quad c = \lambda\nu \quad E = h\nu$$

$$c = 2.998 \times 10^8 \frac{\text{m}}{\text{s}} \quad h = 6.626 \times 10^{-34} \frac{\text{J} \cdot \text{s}}{\text{photon}} \quad \frac{1}{\lambda} = R_H \left( \frac{1}{m^2} - \frac{1}{n^2} \right)$$

$$R_H = 1.097 \times 10^{-2} \text{ nm}^{-1} \quad \lambda = \frac{h}{mv} \quad (\Delta x)(\Delta mv) \geq \frac{h}{4\pi} \quad K = C + 273.15$$

$$C_p(\text{H}_2\text{O}) = 4.184 \frac{\text{J}}{\text{g} \cdot \text{deg}} \quad -q_{\text{lost}} = -q_{\text{gained}} \quad q = m C_p \Delta T \quad \Delta G = \Delta H - T\Delta S$$

$$\Delta H = \frac{q_{\text{rxn}}}{\text{mole lim reagent}} \quad PV = nRT \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad P_T = P_1 + P_2 + P_3 + \dots$$

$$1 \text{ atm} = 760 \text{ torr} = 101.325 \text{ kPa} = 14.7 \frac{\text{lb}}{\text{in}^2} \quad 1 \text{ torr} = 1 \text{ mm Hg}$$

$$R = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mole}} = 62.36 \frac{\text{L} \cdot \text{torr}}{\text{K} \cdot \text{mole}} = 62360 \frac{\text{mL} \cdot \text{torr}}{\text{K} \cdot \text{mole}} = 8.314 \frac{\text{J}}{\text{K} \cdot \text{mole}}$$

$$\text{Rate} = k[A]^x[B]^y \dots \quad \text{zero order : } [A] = [A]_0 - kt \quad \text{1st order : } \ln \frac{[A]}{[A]_0} = -kt$$

$$t_{1/2} = \frac{\ln 2}{k} \quad \text{2nd order : } \frac{1}{[A]} = kt + \frac{1}{[A]_0} \quad k = Ae^{E_a/RT} \text{ or } \ln k = \ln A - \frac{E_a}{R} \left( \frac{1}{T} \right)$$

$$\text{pH} = \log [H^+] \quad K_w = 1.00 \times 10^{-14} \quad K_w = K_a K_b = [H^+][OH^-] \quad \text{p}K_w = 14.00 = \text{pH} + \text{pOH}$$

$$\Delta G = -nFE \quad \Delta G^\circ = -RT \ln K_{\text{eq}} \quad F = 96485.31 \frac{\text{coul}}{\text{mole } e^-} \quad A = \frac{\text{cou}}{\text{s}} \quad J = \text{coul} \cdot V$$

$$E_{\text{cell}} = E_{\text{red}} - E_{\text{ox}} \quad E = E^\circ - \frac{RT}{nF} \ln Q \quad E_{25^\circ} = E^\circ - \frac{0.05916}{n} \log Q$$

AX <sub>2</sub>	linear	AX <sub>5</sub>	trigonal bipyramid	AX <sub>6</sub>	octahedral
AX <sub>3</sub>	trigonal planar	AX <sub>4</sub> E	see saw	AX <sub>5</sub> E	square pyramid
AX <sub>2</sub> E	bent	AX <sub>3</sub> E <sub>2</sub>	T	AX <sub>4</sub> E <sub>2</sub>	square planar
AX <sub>4</sub>	tetrahedral	AX <sub>2</sub> E <sub>3</sub>	linear	AX <sub>3</sub> E <sub>3</sub>	T
AX <sub>3</sub> E	trigonal pyramid			AX <sub>2</sub> E <sub>4</sub>	linear
AX <sub>2</sub> E <sub>2</sub>	bent	square planar family not included			

CHEM 135 TENTATIVE LECTURE AND EXAM SCHEDULE	
Date	Topic
4-6	Equilibria - acid/base, solubility, complexation
7	Electrochemistry - redox reactions and cells
<b>F 8</b>	□□□□ <b>Exam 1</b> □□□□
8, 11-12	Electrochemistry - redox reactions and cells
13-15	Complex Ion Chemistry - nomenclature, bonding, isomers, crystal field theory
<b>F 15</b>	□□□□ <b>Exam 2</b> □□□□
18-19	Kinetics - rate laws, mechanisms, energy of activation
20	Nuclear Chemistry
21	Structure and Bonding in Solids
<b>F 22</b>	□□□□ <b>Exam 3</b> □□□□
22, 25	(Colligative Properties)
<b>T26</b>	□□□□ <b>Lab Final Exam 8-10 am</b> □□□□
<b>W27</b>	□□□□ <b>Lecture Final Exam 8-10 am</b> □□□□
Topics in parentheses will be covered only if there is time. There will be 1 hour for non-ACS exams and the second hour of class will be lecture.	

TENTATIVE LABORATORY SCHEDULE*			
*This is a schedule that allows you to finish in a timely manner. To allow for unforeseen snags, I strongly suggest that you make full use of all lab periods. It is far better to finish the lab early by working efficiently each period than to not get finished because you didn't use lab time early in the Interim.			
# Days	Topic	Pts	Ch: pp.
1	Lab check in and silver group	25	9: 159-169
2	Copper-arsenic group	30	10: 171-199
3	Aluminum-nickel group	30	11: 201-225
1	Barium-magnesium group	25	12: 227-237
3	Anions (blanket tests)	30	14: 245-283
1	Single salt	30	9-15: 159-287
2	Alloy	30	13: 239-243
TW* Week 2	Electrochemistry Experiment	25	Electrochemistry lectures
TW* Week 3	Kinetics Experiment	25	Kinetics lectures
W Week 4	checkout		
<b>Make sure you regularly consult Qual Scheme Helpful Hints handout as you proceed.</b>			
*Tuesday - 135A, work in pairs, report due Wednesday at 5 pm, one report per group			
*Wednesday - 135B, work in pairs, report due Thursday at 5 pm, one report per group			

List of handouts available on Moodle or the class website (<http://faculty.augie.edu/~dew>):

- Text errors list
- Symbols & Charges
- Solubility Rules
- Helpful Hints
- Stock Acids (concentrations, etc.)
- Redox Table
- Ka/indicators Table
- Electrochem Expt
- Kinetics Expt
- Answers to Recommended Problems