Honors General Chemistry 112H **Spring 2011**

COURSE SYLLABUS

Introduction

CHEM 112H is the second half of an Honors course in general chemistry designed for students majoring in chemistry, biochemistry and chemical engineering. The broad goals of this course are:

- To provide a thorough grounding in the fundamental principles of chemistry as a basis for advanced work in the molecular sciences.
- To make obvious the experimental nature of chemistry and the underlying process of scientific inquiry that led to the discovery of these principles.
- To emphasize connections between chemistry and the other sciences, the role of chemical phenomena in the "real world", and the relationship of chemistry to the concerns of the individual and society.
- To encourage independent learning by fostering the ability to recognize when/what information is needed to solve a problem and where/how to find it.
- To develop skills in: qualitative and quantitative reasoning, problem solving and critical thinking; experimental design and analysis; visualization of molecular phenomena; clear communication of ideas; and using the resources of a group effectively in tackling problems.

(More detailed course learning goals may be found on p. 9.)

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Office Hours M 2:00– 3:30* pm, R 2:30- 4:00 pm, or by appointment. Drop-in visits are also welcome, as time and duties permit. (*Ends at 3:15 on 2/14, 2/28 and 3/7)

Class Meetings Room 205, Brown Laboratory
Sec. 80: MWF 10:10 A.M. - 11:00 A.M.
Sec. 81: MWF 11:15 A.M. - 12:05 P.M.
Sec. 82: MWF 12:20 P.M. - 1:10 P.M.

Discussion Sections Room 205, Brown Laboratory
Sec. 80D: W 1:25 P.M. - 2:15 P.M.
Sec. 81D: W 2:30 P.M. - 3:20 P.M.
Sec. 82D: W 3:35 P.M - 4:25 P.M.

Examination/Demo Time Room 101, Brown Laboratory 7:00-10:00 P.M. (see below)

Exams are given outside of the 50-minute class time slots in order to provide ample time for thinking. All sections of CHEM 112H meet together for exams during the Thursday 7:00 - 10:00 P.M. time slot reserved for this course. (Specific dates appear later in the syllabus.) Since this time slot has been blocked off on your schedules, please do not expect to take exams at a different time due to conflicts with extracurricular (or irregular curricular) activities - makeups are generally not available. Students who have an emergency situation or legitimate religious conflict with the scheduled exam time should consult Dr. Groh as soon as possible. There may be a take-home and/or group component in some exams. The Thursday night discussion time may also be used for demonstrations, reviews or other special sessions – these will be announced as needed.

Texts and Materials

- *General Chemistry: Principles and Modern Applications*, 10th Edition, Petrucci, Herring, Madura and Bissonnette; Pearson-Prentice Hall, 2010 (**required**)
- Prentice-Hall Molecular Model Set for General and Organic Chemistry (**required**)
- Scientific calculator (**required**). Calculators with graphing and equation-solving capabilities (e.g., TI-83 through 89 or HP 48G) are recommended. Calculators with keyboard capabilities (e.g., TI-92), cell/smart phones, iPods, PDA's and the like may not be used during exams.
- i>clicker (available through the UD Bookstore) (**required**)

Sakai

The University of Delaware uses an online course management system ("Sakai") that allows instructors to provide an electronic workspace and resource center for a given course. Anyone registered for CHEM 112H will have access to the course site through the login link at https://sakai.udel.edu/portal . Login requires a valid UDelNet ID and password (the same used in setting up your UD email account.) Various course materials will be posted here throughout the semester, generally as Adobe PDF files, which you may then view and print. Be sure to check this site regularly! Adobe Reader is needed to open most of the files - see http://www.adobe.com/products/acrobat/readstep2_allversions.html for free downloads. If you have problems with Sakai, please consult the Help link. For difficulty with accessing any of the posted files, contact Dr. Groh for assistance.

i>clickers

I encourage students to ask and answer questions during class, but realize that speaking up is easier for some of us than for others. The i>clicker personal response system allows everyone to weigh in on questions posed during class, and provides me with a better sense of the class's understanding of various topics. You can read more about clickers http://ats.udel.edu/clickers/faq.php . To receive credit for your participation, your i>clicker must be registered; that can be done using the i>clicker link on the Sakai menu. You need do this only once on Sakai – your registration will then be available to all Sakai-based courses. (Note that all i>clickers look alike: do something to identify yours as your property, especially if your roommate/friends are also using clickers.) Plan to bring your i>clicker to every class session, since we will make frequent use of these.

Grading Final grades will be based on the following weighting scheme:

Midcourse exams	60%
Cumulative final exam	15%
Problem sets, other assignments	20%
Participation/group work	5%

Educational research suggests that learning is enhanced in situations where students can cooperate, rather than compete, with one another. To encourage this, bell-curve grading is not used in this course; for you to succeed does not mean that someone else must fail. Rather, the absolute "mastery" grading standard indicated below will be used:

	A	≥ 88
88 >	A-	≥ 84
84 >	B+	≥ 80
80 >	B	≥ 75
75 >	B-	≥ 71
71 >	C+	≥ 67
67 >	C	≥ 62
62 >	C-	≥ 58
58 >	D+	≥ 54
54 >	D	≥ 49
49 >	D-	≥ 45
45 >	F	

Point Recapture System

Everyone has bad days now and again; unfortunately, sometimes they happen to fall on exam days. The point recapture system gives you a chance to make up for less than stellar scores through an improved performance on the final exam. Each question on a midcourse exam addresses (a) particular concept(s); when the exams are graded, a spreadsheet is used to keep track of your performance on each question. The final exam is comprehensive, and so will revisit most of these same concepts. In the point recapture system, many of the final exam questions will be correlated to specific midcourse exam questions – i.e., they will address a concept in a way that is fundamentally similar to how the concept was addressed through the midcourse exam question. If you earn a higher percentage on a final exam question than you did on the corresponding midcourse exam question, the higher score is used to recalculate your midcourse exam grade. For example – suppose you earned only 5 out of 10 points on a midcourse exam question dealing with electrochemical cell potentials. If you work to understand what you did wrong and correct those misconceptions so that you answer the “cell potential” question(s) on the final correctly, you will “recapture” the lost points, and earn a new midcourse exam score (10 out of 10 points) for that question. These revised midcourse exam grades are then used in calculating the overall course grade. Thus, if you are able to learn what you didn't know before in time for the final, you not only eliminate your ignorance, but also get credit for your effort - making us both happy.

Class Format

"At times I felt the professor's notes became mine without passing through either of our minds."

The traditional lecture approach to teaching is an effective way to transfer information from one person to another, but developing a real understanding of any subject requires that the learner become actively engaged with that information. The format of this course is designed to encourage that involvement by combining a problem-based, group-centered introduction to concepts with whole class discussions and interactive lectures. Participation is encouraged and expected from everyone, as befits an Honors course, and will account for 5% of the course grade. To repeat an old but accurate adage, “ the only stupid question is the one not asked” - if you have doubts about something, there will undoubtedly be others with the same question.

In problem-based learning (PBL), real or potential problems or situations are used to introduce various topics and concepts, serving as focal points for learning new material. You may find this a bit unusual if you are accustomed to working on problems only after all the pertinent material has already been thoroughly discussed in class. The rationale here is that the problem provides a context and a reason for needing to learn the material. As a consequence, you are not expected to be able to come up with a solution instantly - such problems are designed to encourage discussion within a small group of students about what knowledge or insights each person can bring to the situation, what information you collectively still lack, and how/where to find that information. Students in this course have a wide range of backgrounds and experiences in chemistry, but each can make a valuable contribution to the efforts of the group. Some students may have more "content" knowledge than others and will be able to test just how deep that knowledge is, by trying to explain an idea to someone else. Others, by virtue of being unfamiliar with a particular area, can often help their group see a situation from different perspectives and, through their questions, make certain that all in the group end up really understanding the material.

In this course, the course text and posted readings will generally be adequate resources for the information or ideas that you will need to deal with problems. You will have access to a collection of general chem texts for use in class, but you may prefer to have one person in your group bring along a copy of the course text as well. You should be accustomed to viewing the <u>whole</u> text, not just the most pertinent chapter, as a source of information; in addition, the University library has a wealth of useful reference materials. The Internet is a good source as well, particularly for more topical information - provided that you take care to evaluate the reliability of any sites you consult. See http://owl.english.purdue.edu/owl/resource/553/01/ for helpful guidelines.

You are encouraged to work together in this course - not just on formal group assignments, but on problem sets and most other activities as well. If you have collaborated with others in any way in preparing an individual assignment, you are responsible for constructing your own answers in your own words, and acknowledging your discussions with others by citing your collaborators' names in your assignment. Please note: work that appears simply to have been copied from another's paper will not be accepted from **either** student involved. Work that has been copied from someone else (even if carefully modified by changes in adjectives, voice, etc.) sticks out like a sore thumb – it is very easy to spot without trying, and it **will** be noticed. Even when you have worked together with others, an answer constructed from your own understanding of the problem will sound different from anyone else's. Copying is a violation of the academic code of conduct (as discussed below) and has very serious consequences: don't do it.

Assignments

In addition to exams, problem sets will be used for assessing your understanding of the course material. There may be other assignments as well – for example, group or individual reports from your group's work on a problem, a short reflection paper on some material, etc. **While no formal daily homework is assigned, it is expected that your study routine for this course will include reading the text and working problems at the end of the chapters and from the old course material in a continual and timely fashion.** The problems labeled by their section in the text are good for drills in learning the basics; move on to the "comprehensive" problems for more practice. What you will see on problem sets and exams are generally harder problems that incorporate multiple concepts and require a reasonable amount of thought, application and analysis to solve, rather than simple regurgitation of fundamentals. The best way to prepare for these is to **practice**, thoughtfully working through as many textbook and old practice problems as you can.

Group Work

In this class you will often be asked to work together in a group of about four students on problems or exercises. Working in a group offers an excellent opportunity for you to brainstorm, discuss ideas, try out solutions, etc., in a nonthreatening atmosphere. A number of studies confirm that students who work and study in groups come to a greater understanding of the material than those who work solely on their own. Even students who initially feel that they will do better on their own find that trying to explain something to someone else is an excellent way to test and reinforce that understanding. In addition, group work can be a lot more fun, and in the process you develop the interpersonal skills and practice in teamwork that future employers find very valuable. *(Please see the "Working in Groups" FAQ at http://www.udel.edu/pbl/working-in-groups/ for more discussion.)*

During a group assignment each person in the group is expected to participate fully; to ensure that, it is common that each member will be assigned a role to fulfill. These roles rotate with each assignment or activity. The descriptions of responsibility for each of these roles follow:

- Discussion leader - Moves the group forward in accomplishing the assignment; refocuses the group if discussion goes astray. Makes sure that each person has the chance to participate. Consults with instructor or other groups for advice or clarification if needed. Keeps track of role assignments. Aids the group in summarizing conclusions.
- Recorder - Takes "official" notes as discussions proceed, keeping a record of assignments, discussions, strategies, data and results of calculations. Calls for discussion to stop momentarily for a chance to summarize comments for recording, as needed. Has the group check over the notes/report, to clarify and add missing items.
- Presenter - Reports out to the class on the results of the group's discussion. Also takes notes, to back up the recorder; with the recorder's help, writes up a report summarizing the group's work. Responsible for having the other group members review the report, and turning it in by the designated time. Reports out orally for the group.
- Resource Person - Checks resource cabinet for appropriate materials to use; locates and provides other resources needed. Performs calculations, graph construction, etc. Organizes out-of-class meetings. Reads the problem aloud if required.
- Advocate – Checks group members on their understanding of concepts involved in problems. Checks for alternative approaches and ideas. Takes the lead in summarizing the group's conclusions.

Ground rules

While it is to be understood that students will treat one another with the concern and respect that they would wish for themselves, it is also important to establish ground rules and consequences for behavior when working in groups. Each group should decide on the ground rules they will adopt; the following is a recommended minimal list:

1. Attendance is required - if you are absent, you are hurting your group. Problems are designed to draw on the strengths of all members, with a role assigned to each. If you do not attend, there is a gap in responsibility.
2. Come to class prepared. It is your responsibility to be ready to contribute to the group effort through discussion, questions, prior reading, research, etc. as required.
3. Fulfill your role. Your group mates will count on you to take care of your obligations, just as you will count on them to meet theirs.
4. If there is disagreement about problem-solving strategies, solutions, conclusions, etc., the

group should come to consensus before writing up the assignment. However, if the group agrees, a "minority" report can be submitted with the group assignment.

5. The group agrees not to ignore infractions of the ground rules or the attendant consequences.

Your group can establish other ground rules as long as everyone in the group is in consensus. Your group should also discuss consequences: i.e., how you want to deal with group members who do not carry their share of the responsibility. For formal projects you will be given the opportunity to evaluate the contributions of each member of the group (including yourself) to the group's progress; these comments, together with the instructor's observations, will be used in evaluating the group work component of the participation grade. If a problem should arise in your group, turning to the group's ground rules and consequences is the first step in resolving the conflict. The course instructor can serve as a mediator if the conflict persists. If these steps fail, the instructor has the final decision on grades, and reserves the right to apply penalties for nonparticipation, poor group performance, etc. as appropriate. Make sure all members of the group have a copy of the ground rules and provide a set for the instructor as well. Be sure to share information for contacting one another outside of class; while most group work will be done in class, there will be occasions where you need to meet at other times.

Other Policies

Attendance. Attendance in this class is mandatory and counts towards the participation grade. If you find that you need to be absent for any reason, notify the course instructor and members of your group. It will also be necessary for you to contact your group after the missed class to find out your assignments for any project that might have been initiated during that class. You are responsible for any material or activities missed due to absence.

Classroom Behavior. Stated bluntly: this is not high school – no one is required to pursue studies at a university, especially at the Honors level, so I will assume that your presence here indicates a serious interest in learning. **If that is not the case, please reconsider your enrollment in this course**. Behavior that shows respect for your classmates and instructor is expected. Activities such as coming to class late, excessive or off-task conversations during class, etc. will have a negative impact on the class participation grade. Cell phones (smart or dumb), iPods, pagers, PDA's, etc. may not be used during class or exam times – please turn them off or set them to vibrate. Laptop use during class time is restricted to note taking and sanctioned class-relevant research only; abusers will forfeit this privilege.

Late Penalties. Problem sets and other assignments that are turned in after their due dates will not be accepted without prior permission, and may be subject to grade penalties, depending on circumstances.

Integrity. Academic dishonesty has no place in this or any other course. The observation of cheating in any form (plagiarism, copying, sharing data or text files without permission, altering data and/or other information, using information stored in calculators and/or other cribs during exams, etc.) will result in judicial proceedings in accordance with the University's policy on academic dishonesty. For a discussion of what constitutes academic dishonesty, please see the Code of Conduct (http://www.udel.edu/stuguide/10-11/code.html) . You should also adhere to the Policy for Responsible Computing (http://www.udel.edu/codeoftheweb/code2code.html).

How To Do Well in CHEM 111-2H

A standard rule of thumb for most college courses is that **you should expect to spend 2-3 hours in preparation and study for every hour spent in class.** This course is no exception – developing more than a superficial understanding of chemistry takes effort, and effort requires time. Students in their first college-level courses are often blind-sided by the faster pace – there will be little, if any, time spent reviewing material from the previous class, so recognizing when you're confused and doing something about it quickly is important! If you need help with time management skills, contact the Academic Enrichment Center - they offer sessions on time management, note taking and reading strategies that you might find useful. Their web site may be found at http://www.aec.udel.edu/ .

Here are some other recommendations, from former students:

- **Read the textbook.** It is impossible to discuss everything you need to know in three 50-minute classes each week – this is where that expensive textbook comes in. At the very least skim through the chapter as each new area is begun, to familiarize yourself with the vocabulary and general ideas – you will get more out of the lectures and class discussions if you have a general sense of the topic. Reading the chapter summary first is also a good idea. Scientific text is different from other types of writing – it is typically information-rich, not word-rich, with much of that information embedded in figures, graphs and tables. It needs to be read slowly and thoughtfully, with a pencil in hand. There is a nice discussion of how to read in science at http://www3.wittenberg.edu/dfinster/reading.html ***Your reading should always be supplemented by working a reasonable number of problems from the ends of each section and chapter to test your ability to understand and apply the material.***
- **Review class notes and slides within 24 hours of the class.** Taking good notes in class is much easier if you have followed the advice given above about reading first: you will have a better idea of what's important and what isn't, and will not need to spend your time frantically writing down every word that's uttered. Please remember that **slides shown in class are always available on Sakai after class for printing** – it is a waste of time to copy what's being projected during class time. Instead, **take notes on the ideas and discussion** associated with that slide, and review those notes as you review the slides after class. Remember, too, that notes that make sense as you write them today may not be as meaningful three weeks later. Many students find it helpful to take notes in class, marking comments or sections that are unclear, and then to rewrite the notes (on a facing page or in a second binder that includes the slide printouts) before the next class. Generating this second set of notes is really a way of studying the material: you can look up things that were not clear, or make a list of questions to pose to the instructor. It gives you a chance to decipher sloppy handwriting or notes while things are still fresh in your mind, helps move material from short term to long-term memory, and generates a summary of material that will be much easier to use in reviewing for exams.
- **Work problems**. The best way to test your understanding of the material is to work through as many problems as you can. If your time is limited, it is better to try problems and then consult the text as needed to fill in the gaps, rather than reading every page in the chapter without working any problems. There are two main sources for practice problems: the textbook, and old course problems and test questions posted on Sakai. The former will provide a wealth of problems at a variety of difficulty levels; try enough of the easier problems to make sure you understand the basics, then move on to the more advanced exercises. The tests and problem

sets from earlier years are also valuable - this material will give you a sense of the general style and level of difficulty you may expect to see in this year's problem sets and tests. Please note that this course continues to evolve, and **there will not necessarily be a 1:1 correspondence between this year and last with respect to what particular topics are covered when and to what extent–** be sure to look through all the old documents for pertinent examples.

- **Form an informal study group outside of class.** Compare your notes from class, work together on problems, and discuss things that seem unclear. You will find that you are not the only one who gets confused, and talking things over can help improve everyone's understanding. Make sure that you first attempt the work on your own, though, and can explain the answer yourself readily at the end. While copying others' answers without really understanding them may seem expedient at the time, remember that the truth comes out in the exams…
- **Seek help if you start to feel lost, ASAP**. Take advantage of the discussion sessions, help sessions and office hours, ask me questions by e-mail, and/or make an appointment to see me. Not everyone comes into this course with the same background, and some may need a bit more guidance than others. I am happy to meet with you to go over material or otherwise help you get the most from this course. If you think you need extensive outside help, the Academic Enrichment Center often offers tutoring sessions in general chemistry. Similarly, the CHEM-BIOC department maintains a list of people offering tutoring services for a fee – contact Mrs. Staib in 102 Brown Lab for that information.
- **Speak up in class**. Participation is 5% of the grade - that's the difference, e.g., between an A$^-$ (84) and a B (79). You don't have to have the "right" answer to get credit – asking questions about what you do not understand counts just as much. (Participation is especially important if you plan to be asking for letters of recommendation later on.)

Exam Schedule (all in Brown Lab 101, 7:00 - 10:00 P.M.)

Exam 1	Exam 2	Exam 3
Mar. 10	Apr. 14	May 12

Problem Set Schedule

	Distribution Date	Due Date
PS1	Feb. 25	Mar. 4
PS2	Mar. 25	Apr. 8
PS3	Apr. 29	May 6

Other important dates

M	2/21	End of free drop/add period
F	3/25	First year students' midterm marking period ends
M-F	3/28-4/1	Spring Break week – no classes
M	4/18	Last day to change registration or withdraw from courses without academic penalty
T	5/17	Last day of classes
R-W	5/19-25	Final exam period

CHEM 112H Course Learning Goals

After successful completion of this course, a student should be able to:

1. Describe key intermolecular forces and apply this knowledge in connecting molecular structures and physical properties of condensed states, including liquid crystals. (1*)
2. Interpret/construct simple phase diagrams. (1)
3. Discuss the enthalpic, entropic, and external factors involved in solution formation and apply this knowledge in explaining/predicting the behavior of solutions; explain the effects that solutes have on solvent properties, and interpret experimental data/calculate predicted properties based on these effects. (1, 5)
4. Identify species as acids or bases according to various classification systems, and predict/interpret their chemical behavior according to these models (including gas phase, aqueous and nonaqueous solvent conditions); predict/rationalize pK_a, pK_b values for compounds based on molecular structure and inductive, resonant and steric effects. (1)
5. Recognize common organic functional groups, and name/interpret names for simple organic molecules; rationalize/predict products for simple nucleophilic and electrophilic reactions involving alkyl halides, carbonyl derivatives and alkenes, write mechanisms for same, and propose simple synthetic schemes using such reactions. (1)
6. Interpret/propose experiments and analyze kinetic data to determine reaction orders, rate laws, activation energies and mechanisms; explain/interpret/predict reaction mechanisms based on kinetic data, molecular structure and collision theory. (1, 5)
7. Identify coordination complexes and their characteristic features (ligands, geometries, spin states), assign/interpret names and structures, and apply the principles of crystal and ligand field theory in explaining/interpreting/predicting their properties and behavior. (1)
8. Describe and apply fundamental relationships (both qualitative and quantitative) in thermodynamics to simple systems under well-defined conditions, with particular emphasis on energy transfer through heat and work, and changes in enthalpy, entropy and free energy. (1, 5)
9. Explain the distinguishing features of voltaic and electrolytic cells, calculate cell potentials, and use/interpret reduction potential data to explain/predict chemical behavior; discuss key features of different types of batteries and electrolytic processes. (1)
10. Describe different types of nuclear decay processes and calculate associated changes in energy, predict nuclear stability based on nuclear shell model and N/Z ratios, recognize/explain processes of nuclear fusion and fission and their applications, and describe the effects of radiation on matter and common uses of radioactive materials. (1)
11. Work together with other students in discussing ideas, evaluating information and formulating solutions to problems. (8)
12. Communicate ideas clearly and effectively in written and oral formats. (10)
13. Find and evaluate sources and information needed in solving problems. (3)

(Numbers in parentheses indicate the departmental learning goals (http://www.udel.edu/chem/goals.html) with which each course goal is aligned.)*

Proposed Course Outline and Readings

The following outline provides a chronology for CHEM 112H together with appropriate readings for various topics. Unless otherwise indicated, chapter citations are for *General Chemistry: Principles and Modern Applications* (10th ed.) by Petrucci, Herring, Madura and Bissonnette. Other materials may be found posted on the CHEM 112H Sakai page; additional readings may be posted throughout the semester as well. Please note: reading should be active, accompanied by working problems; practice material may be found in the exercises embedded within chapters, the end of chapter problems, and among the old CHEM 112H problem sets, quizzes and exams posted on Sakai. The approximate class periods in which different topics are most likely to appear have been given as a guide for completing readings.

Topic	Readings	Class # (approx.)
I. **Condensed Phases**		1-6
A. Intermolecular forces		
a. Types, characteristics and connection to molecular structure	12.1	
b. Condensed state properties and IMFs	12.2-12.3	
B. Phase diagrams	12.4	
C. Liquid crystals	posted readings	
II. **Solutions**		7-10
A. Solution formation	(terminology 13.1-13.2)	
a. Intrinsic (enthalpic and entropic) factors	13.3	
b. External factors (temperature, pressure) and solubility	13.4-13.5	
B. Colligative properties		
a. Vapor pressure lowering	13.6	
b. FP depression and BP elevation	13.8	
c. Behavior of electrolytic solutes; van't Hoff factor	13.9	
d. Osmotic pressure	13.7	
III. **Acid-Base and Solvent Systems**		11-14
A. Acid-base systems and their characteristics	16.1-16.2, 16.9	
B. Acid-base strength		
a. Proton affinity and gas-phase acidity	posted readings	
b. Solution acid-base strength	16.3-16.8	
C. Nonaqueous solvents	posted readings	
D. Superacids	posted readings	
E. Lewis Acids and Bases	posted readings	
a. Nucleophiles and electrophiles		
b. Hard-soft acid-base concept		
c. Reactions: patterns, examples		
IV. **Organic Chemistry**		15-17
A. Overview and nomenclature*	26.1, posted readings. **scattered throughout chapter*	
B. Common functional groups and characteristics	26.7	

C. Organic reactions: overview	27.1, posted readings	
D. Selected organic reactions and mechanisms: nucleophilic substitution in halides and carbonyls; electrophilic addition in alkenes	27.2, 27.4. 27.5, 27.9, posted readings	
V. **Kinetics**		18-21
A. Terminology, methods of rate measurement and expression	14.1-14.2	
B. Concentration dependence and rate laws	14.3-14.7, 25.5	
C. Temperature effects and collision theory	14.8-14.9	
D. Reaction mechanisms	14.10	
E. Catalysis	14.11	
VI. **Coordination Chemistry**		22-27
A. Types of ligands and complexes	24.1-24.2	
B. Nomenclature	24.3	
C. Isomerism	24.4	
D. Bonding		
a. Crystal field theory	24.5, 24.7	
b. Ligand field theory	posted readings	
E. Magnetic behavior	24.6	
F. Bioinorganic chemistry: selected principles, examples	posted readings	
VII. **Thermodynamics**	posted readings	27-32
A. Fundamental definitions	7.1	
B. First law		
a. Work, heat and internal energy b. Heat flow and capacity; calorimetry	7.2-7.5	
c. Enthalpy	7.6-7.8	
C. Second law		
a. Entropy and probability b. Molecular interpretations	19.2-19.4	
D. Gibbs free energy, spontaneity and equilibrium		
a. Temperature effects b. Concentration and pressure effects	19.5-19.8	
E. Metallurgy and thermodynamics	23.2-23.3	
VIII. **Electrochemistry**		33-37
A. Voltaic cells		
a. Cell features and potentials	20.1-20.2	
b. Free energy and the Nernst equation	20.3-20.4	
c. Predicting redox reactions		
d. Battery design principles and applications	20.5	
e. Corrosion	20.6	
B. Electrolytic cells		
a. Cell features	20.7	
b. Predicting electrolysis behavior: common reactions		

c. Electrosynthesis and electroplating	20.8	
IX. **Nuclear Chemistry**		37-40
A. Types of radiation and particles	25.1	
B. Energetics of nuclear decay	25.6-25.7	
C. Nuclear reactions, decay processes and stability	25.2-25.4	
D. Nuclear fission and fusion	25.8-25.9	
E. Effects of radiation on matter; applications	25.10-25.11	
F. Stellar nucleosynthesis	posted readings	