

CHEMISTRY 212 (Formerly CHEM 39) SYLLABUS

Fall Semester 2007, Section 001

Lectures: Monday, Wednesday, and Friday
105 Forum - 11:15 a.m. - 12:05 p.m.

Lecturer: Prof. Blake Peterson

Office: 433 Chemistry

Phone: 865-2969

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Prof. Peterson's Office Hours: By appointment – send an email to brpeters@chem.psu.edu to arrange an appointment

Teaching Assistant

No teaching assistant is assigned for off-sequence CHEM 212

Texts

- J. McMurry, *Organic Chemistry*, 7th ed. (You can use the 6th edition of McMurray if you follow the 6th edition problems listed at the end of this syllabus)
- S. McMurry, *Study Guide and Solutions Manual to Organic Chemistry*, 7th ed.
- J.G. Traynham, *Organic Nomenclature: A Programmed Introduction*, 5th ed.

Other Materials

- Chem 212 Course Packet (available on [the web](#))
- Home Page: <http://courses.chem.psu.edu/chem39/chem39.html>
- A molecular model kit is required
- Two other good texts have been placed on the reserve shelf in the Physical Science Library (230 Davey) for use if you want to read alternate accounts of the course materials:
 - Streitweiser and Heathcock, *Introduction to Organic Chemistry*, 3rd ed.
 - Morrison and Boyd, *Organic Chemistry*, 6th ed.

Tutorial Room

Capable undergraduate and graduate students are available to assist Chemistry 212 students in the Chemistry Department Tutorial Room (211 Whitmore Lab) after the first few days of classes. The hours are typically 6:30 - 10:30 p.m., Sundays through Thursdays.

Problems

Specific graded homework assignments will not be made. However, working the problems in the chapter and at the end of the chapter is one of the best methods to learn the material *and* prepare for the exams. It is anticipated that students will be able to solve all the problems. The problems that are particularly indicative of what to expect on the exams are listed at the end of this handout as "assigned Problems".

Course Content

For the purpose of exams, the course content is defined by (a) the lectures, (b) the relevant chapters in the text, and (c) any other specific assignments that are made. The outline and order of the topics covered is presented at the end of this handout. Please note that not all chapters will be covered in the order they are in the book. Some sections have been omitted. The sections that have been indicated as excluded will not be covered in the lectures, and the material will not be a part of the tests. It is recommended that the excluded sections be studied independently by students in pre-medicine, chemistry, or related programs.

Grades

Your course grade is based on the following criteria:

- Three comprehensive mid-term exams 75% (total)
- Comprehensive final exam 25%

Final grades will be based on a curve. After the third exam and before the **late-drop deadline of Friday, November 16, 2007**, approximate grade-line cutoffs for the major grades (A, B, C, D, F) will be provided to facilitate your planning for the rest of the semester.

Past experience indicates that the average scores on the exams typically vary from 70-50%. The average in the class (usually around 60%) typically corresponds to the C+/B- grade line. Class performance may follow a different pattern and adjustments to this grading scheme may be made.

Exam Schedule:

- 1st exam Monday, 9/17/2007, 8:15 -10:15 p.m.
- 2nd exam Monday, 10/22/2007, 8:15 -10:15 p.m.
- 3rd exam Monday, 11/12/2007, 8:15 -10:15 p.m.
- Comprehensive make-up exam Wednesday 12/5/2007, 8:15 -10:15 p.m.
- Final exam: as scheduled by the University

The exam locations will be announced in class, posted in Whitmore, and on the web. All exams will be comprehensive multiple-choice tests. They will be constructed to emphasize active understanding of the material. Old exams are provided on the web. To take the exam you will need writing implements (pencils) and your student I.D. card. You cannot use books, scratch paper other than furnished, calculators, etc. You may, however, use a molecular model kit, providing it does not contain any written materials. Answer keys for the multiple-choice exams will be posted on the web (under News and Updates) after the exams. The exam scores are e-mailed to students by the University Testing Services.

A Course Packet is available on the web. It contains copies of most transparencies shown during lectures. It will be occasionally updated with "unscheduled", "last-minute" transparencies or summary materials shown during lectures. Copies of the transparencies from the textbook are not included.

The Chem 212 Home Page (<http://courses.chem.psu.edu/chem39/chem39.html>) is under constant development. All important class announcements, assignments, and dates will be posted on the web. It is your responsibility to check it out on the regular basis. The page contains a summary of reactions, a collection of old exams and spectral problems, and daily announcements and summaries, exam schedules and general information on how to get help and how to study. I try to add new material (updates) every week. Visit it often!

Procedures

To facilitate the smooth administration of the course, even when the unexpected happens, please follow these rules:

- **Conflict exams** will be provided on the same day at different times (usually at 6:00 pm). Students with valid conflicts (for example, University scheduled activities) must sign up for the alternative time with the instructor at least three working days before the exam. The conflict final exam can be scheduled only through the Registrar.
- The **make-up exam** will be provided only to students with valid excuses (family emergency, illness, etc.). In order to be permitted to take the make-up exam you must provide me with a documented, written explanation of your absence within 2 weeks of the exam date. This explanation must include a telephone number for a person who can corroborate the reasons for the absence, but should not include any unnecessary private details. Only one **comprehensive** make-up exam will be given on December 5, 2007. All students permitted to take this exam must sign up with me one week before the exam.

- **Late-drop students** will receive WN designations on their transcripts. Students who have taken at least two exams may request a WP designation, if their class average is higher than the final grade line for a C. (The grade-lines are announced after the third exam, just before the late-drop deadline). Requests for WP designation must be submitted in writing no later than December 1.
- **Deferred grade** requests must be approved by the dean of the student's college. It is student's obligation to arrange all the necessary paperwork and to take a comprehensive final exam before the University-set deadlines. The deferred grade will be based on the average of the scores obtained on all exams taken by the student.

General Considerations: Chemistry 212 is a continuation of Chemistry 210 (38) and, as such, builds on the foundations introduced in the first semester. If you did well in Chem 210 (38), then you should be well prepared for Chem 212. If you were below average, then the second semester may be somewhat difficult for the problems are more mechanistic and a greater emphasis is placed on the synthetic aspects of organic chemistry. Owing to the hierarchical nature of the material, it is important to not fall behind or leave studying for the exams until the last few days. The material is not inherently difficult, but you must understand some concepts before you can go on to new ones. Therefore, be sure to allow yourself sufficient time for absorbing the material. Observations made over the past few years suggest some generally useful strategies that help to improve student performance. These are summarized below, and a more extensive discussion is provided on the web.

- read the chapter material *before* the lecture
- study *every day*, and do reviews weekly
- solve as many end-of-chapter problems as possible (resort to the answer book only after you have attempted the problem)
- study with a friend; if you can explain a concept to your study mate, you understand it
- just reading and understanding the material (passive understanding) is insufficient; you should be able to use new concepts in situations not previously encountered, and make logical connections with concepts learned previously (active understanding)
- constantly probe your understanding by asking (and answering) question "why?" in relation to all statements and logical constructions
- do not fall behind in your study; it is virtually impossible to prepare well for the exam in just a few days

Academic Integrity: Instructors are now asked (Senate Rule 49-20) to provide at the beginning of a course a statement to "clarify the application of academic integrity criteria to that course". The Senate Rule includes the following: Academic dishonesty includes, but is not limited to, cheating, plagiarizing, fabrication of information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students.

(You should also be aware of the extensive parts of this Rule that describe procedures for handling alleged instances of academic dishonesty.) Specific instances of academic dishonesty in this course would include (but not limited to) copying or helping someone else copy during an examination, using unauthorized materials during an examination, stealing or destroying course materials or another student's examination paper, altering answers or grades on graded examinations, having someone take an examination for you, and attempting to do any of the above. Such infractions are considered cause, at the least, for awarding a grade of "0" on the exam in question (and not allowing the student to drop the class).

Chem 212 Notes

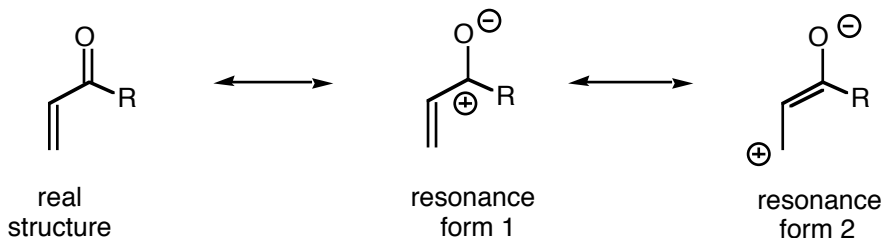
1) Commonly used abbreviations:

Me =	-CH ₃	Nu (Nu [⊖]) =	generic nucleophile
Et =	-CH ₂ CH ₃	E [⊕] =	generic electrophile
t-Bu =	-C(CH ₃) ₃	X =	halogen, tosylate
Ph =	C ₆ H ₅	R =	alkyl residue
hν =	light (irradiation)	Ar =	aryl residue
		P =	protecting group (e.g., -OP, -NHP)

2) If you can master the following concepts, you should do well in this course:

A) Nucleophile/Electrophile pairing. Products of most reactions that you will see in this course can be predicted by identifying the **nucleophilic** (excess electron density - negative charge, lone pair, π -orbital) and **electrophilic** (electron deficiency - positive charge, leaving group, C=X, X = O, N, S) sites on the reaction partners, and connecting them to form a bond. Kinetic vs. thermodynamic control of bond formation is a consideration when more than one reactive site exists.

B) Resonance Forms. The distribution of either electron surplus or electron deficiency (see above) through a π molecular framework. Resonance forms are not real chemical entities - they are simply models used to predict sites of nucleophilic or electrophilic reactivity in a molecule. For example:



C) pK_a. The pK_a of a proton in a compound R-H is a measure of the acidity of that proton. The lower the pK_a, the more acidic the proton, and the more stable the resultant anion. In most chemical reactions that involve proton (H[⊕]) transfer, the system ends up with the most acidic compound deprotonated.

D) Electron counting/Charge balance. The formal charge on an atom can be deduced by counting the valence electrons that surround it (one electron per bond to a neighbor), and subtracting that number from the column number of the atom in the periodic table (carbon, silicon = 4, nitrogen, phosphorus = 5, oxygen, sulfur = 6, halogens = 7).

Frequently Asked Questions in Chem 212

- **Do your exams cover material not mentioned in lecture but discussed in the text?** Generally speaking, no. I lecture on what I think is important, and I test on what I think is important. However, there may be cases where more extensive knowledge will help you. For example, I may present a synthesis problem on an exam that can be solved only with knowledge from the lectures; nevertheless, other solutions may be possible using chemistry from the text not discussed in the lectures and so you will increase your chances of devising an acceptable answer if you know more material. I will not design questions that specifically require a working knowledge of chemistry not discussed in lecture. For example, I do not lecture on the Cannizzaro reaction while discussing Chapter 19, and so I will not quiz you on this topic. Ultimately, however, you might wish to learn material that may be of use to you outside of class (i.e., for the MEDCAT exam).
- **How your exams designed?** My exams consist of 25 multiple-choice questions. I try to design questions that probe three aspects of your scholarship: 1) Reproduction of knowledge/arguments that I presented to you. 2) Using knowledge learned in one section to solve problems in a different area that you have seen. 3) Exporting your knowledge and *understanding* of the material to solve problems that you have never seen before. Clearly, this last aspect can be quite challenging. In specific terms, I ask several questions which probe fundamentals of structure/reactivity trends (fastest, slowest, most, least, biggest, smallest, etc.). I ask questions about mechanism, kinetics/thermodynamics, synthesis and spectroscopy. I provide all data (bond strengths, pKa's, spectroscopic values) necessary to solve these questions. In general, the mechanism and synthesis questions are perceived to be the most problematic. Memorization is rarely an effective strategy to approach this material. Learning the fundamentals, and how to apply them to various situations, is more productive.
- **How can I best study for your exams?** First, some generalities: The best way that you can identify the limits of your knowledge and hence where you need to improve is by trying to explain the material (or practice questions) to someone else. Various formats are possible -- study with friends, use the students in the tutorial room, set up a visit with me in my office, or hire a private tutor. If you choose this last option, a list of chemistry tutors is available through the Chem Undergrad office, 210 Whitmore, 865-9391. Tutors go fast, so don't wait until the last minute. More specifically, you should try as many text problems as you can tolerate. When you solve a problem, you should ask "what was this question really trying to probe -- my knowledge of thermodynamics, reactivity, use of resonance forms, etc.?" Obviously, cramming at the last minute has its drawbacks. Rewriting your class notes, with additional annotations about what the key points of each discourse are, will allow you to keep focused on the major issues (which is where my test questions aim). You should read the text like an instruction manual and not a novel--active rather than passive learning will help build your problem solving skills that in turn will help you on the exams. Finally, anecdotal feedback from former students suggests that you should not vary your eating/sleeping habits prior to the exam.
- **I'd like a recommendation for medical (graduate, etc.) school, but the class is so large that I really haven't had much contact with you. What should I do?** If you received an A or A-, I would be happy to write you a recommendation. These recommendation letters are fairly standard and describe your rank in the class, the grade you received, etc. It is to your advantage to visit me in my office during the semester so I can get to know you better and embellish your letter with more personal assessments of your intellect, motivation, maturity, curiosity, etc.

Chemistry 212: Outlines of Lectures

1. Structure Determination (~6 lectures)

- Mass Spectrometry
- UV spectroscopy (review)
- Infrared Spectroscopy
- Nuclear Magnetic Resonance (^1H , ^{13}C)

Sections covered: 12.1 - 12.9, 13.1 - 13.13, 14.8 - 14.11, 15.10

Sections specifically excluded: none

Problems assigned 7th ed. of McMurray: 12.16, 12.24, 12.27, 12.28, 12.29, 12.31, 12.32, 12.34, 12.35, 12.41, 12.42, 13.29, 13.33, 13.38, 13.44, 13.48, 13.50, 13.52, 13.54 (part b only), 13.55, 13.57, 13.58, 13.59, 13.60, 15.41, 15.44, 15.45, 15.46

Problems assigned 6th ed. of McMurray: 12.20, 12.29, 12.34, 12.35, 12.36, 12.38, 12.39, 12.41, 12.42, 12.48, 12.49, 13.28, 13.32, 13.37, 13.43, 13.47, 13.49, 13.51, 13.53 (part b only), 13.54, 13.56, 13.57, 13.58, 13.59, 15.40, 15.43, 15.44, 15.45

2. Aldehydes and Ketones: Nucleophilic Addition Reactions (~4 lectures)

- Overview of chemistry of carbonyl compounds (molecular orbital description of the carbonyl group, nucleophilic addition/substitution reactions, α -substitution, enolates, condensations)
- preparation (oxidation of alcohols, ozonolysis, functional-group interconversions)
- nucleophilic addition (irreversible: hydride, organometallic reagents, Wittig; reversible: HCN, alcohols, amines)
- conjugate addition (HCN, cuprates)

Sections covered: pp. 686-694; 19.1 - 19.12, 19.14 - 19.16

Sections specifically excluded: 19.13

Problems assigned 7th ed.: 19.34, 19.35, 19.36, 19.38, 19.42, 19.45, 19.48, 19.51

Problems assigned 6th ed.: 19.32, 19.33, 19.34, 19.37, 19.41, 19.45, 19.46, 19.49

3. Carboxylic Acids and Derivatives: Nucleophilic Acyl Substitution Reactions (~3 lectures)

- structure and acidity (pK_a) of carboxylic acids
- preparation of carboxylic acids (oxidation, haloform reaction, Grignard carboxylation, nitrile hydrolysis)
- preparation of carboxylic acid derivatives (acyl chlorides, anhydrides, esters, amides, nitriles)
- mechanism and relative reactivity of carboxylic acid derivatives in nucleophilic acyl substitution reactions

Sections covered: 20.1 - 20.10, 21.1 - 21.8, 21.10

Sections specifically excluded: 21.9 (covered under polymers);

Problems assigned 7th ed.: 20.27, 20.28, 20.36, 20.37, 20.38, 20.48, 21.37, 21.42, 21.43, 21.47

Problems assigned 6th ed.: 20.25, 20.26, 20.33, 20.34, 20.35, 20.45, 21.45, 21.41, 21.42, 21.37

4. Carbonyl α -Substitution Reactions (~2 lectures)

- enols/enolates, (pK_a of carbonyl compounds)
- reactions with electrophiles (halogens, alkylations)

Sections covered: 22.1 - 22.8

Sections specifically excluded: none

Problems assigned 7th ed.: 22.20, 22.29, 22.23, 22.27, 22.38, 22.39, 22.44, 22.49

Problems assigned 6th ed.: 22.21, 22.31, 22.24, 22.29, 22.40, 22.41, 22.44, 22.48

5. Carbonyl Condensation Reactions (~3 lectures)

- aldol reaction
- Claisen condensation
- Michael reaction (and Stork enamine reaction)
- Robinson annulation

Sections covered: 23.1 - 23.14

Sections specifically excluded: none

Problems assigned 7th ed.: 23.28, 23.35, 23.36, 23.37, 23.39, 23.40, 23.43, 23.44, 23.50, 23.51, 23.59

Problems assigned 6th ed.: 23.28, 23.35, 23.36, 23.37, 23.39, 23.40, 23.43, 23.44, 23.47, 23.48, 23.57

6. Synthetic Polymers (~3 lectures)

- chain growth
- step growth
- Ziegler-Natta catalysts
- polymer morphology

Sections covered: 31.1 - 31.5

Sections specifically excluded: none

Problems assigned 7th ed.: 31.14, 31.15, 31.18, 31.25, 31.28, 31.29, 31.32

Problems assigned 6th ed.: 31.14, 31.15, 31.18, 31.25, 31.28, 31.29, 31.32

7. Aliphatic Amines and Arylamines (~3 lectures)

- amine basicity
- synthesis of amines
- reactions of amines

Sections covered: 24.1 - 24.8

Sections specifically excluded: 24.9

Problems assigned 7th ed.: 24.30, 24.35, 24.37, 24.38, 24.40, 24.41, 24.42, 24.43, 24.57, 24.63, 24.64, 24.67

Problems assigned 6th ed.: 24.25, 24.31, 24.33, 24.34, 24.36, 24.37, 24.38, 24.39, 24.50, 24.57, 24.59, 24.63

8. Carbohydrates (~3 lectures)

- structure of carbohydrates
- reactions of monosaccharides

Sections covered: 25.1 - 25.7

Sections specifically excluded: 25.8-25.12

Problems assigned 7th ed.: 25.30, 25.31, 25.32, 25.37, 25.42

Problems assigned 6th ed.: 25.32, 25.33, 25.34, 25.39, 25.44

9. Amino Acids, Peptides and Proteins (~3 lectures)

- structures, properties and synthesis of amino acids
- peptide synthesis and sequencing
- protein structure

Sections covered: 26.1 - 26.16

Sections specifically excluded: none

Problems assigned 7th ed.: 26.27, 26.30, 26.31, 26.32, 26.37, 26.43, 26.55, 26.56, 26.57

Problems assigned 6th ed.: 26.30, 26.34, 26.35, 26.36, 26.41, 26.48, 26.59, 26.60, 26.61

10. Lipids (1 lecture)

- structure of waxes, fats, oils

Sections covered: 27.1 - 27.4

Sections specifically excluded: 27.5-27.9

Problems assigned 7th ed.: 27.21, 27.22, 27.25

Problems assigned 6th ed.: 27.22, 27.23, 27.25

11. Heterocycles and DNA (~3 lectures)

- Structure of heterocycles
- DNA structure (nucleotide, double helix forms)
- central dogma of molecular biology
- DNA sequencing
- DNA synthesis, oligonucleotides

Sections covered: 28.1, 28.2, 28.4, 28.7, 28.8 - 28.17

Sections specifically excluded: 28.3, 28.5, 28.6

Problems assigned 7th ed.: 28.19, 28.21, 28.42, 28.47

Problems assigned 6th ed.: 28.37, 28.39, 28.42, 28.47

12. Pericyclic Reactions (~3 lectures)

- molecular orbitals of conjugated π -systems (review)
- electrocyclic reactions
- cycloaddition reactions

Sections covered: 30.1 - 30.7; 14.5 - 14.6

Sections specifically excluded: 30.8-30.10

Problems assigned 7th ed.: 14.32, 14.37, 14.40, 14.44, 30.13, 30.18, 30.20, 30.22, 30.30

Problems assigned 6th ed.: 14.33, 14.38, 14.40, 14.44, 30.13, 30.18, 30.20, 30.22, 30.30