

# Chemistry 202 : Fundamentals of Organic Chemistry I

Fall 2009

Dr. Carey Reed

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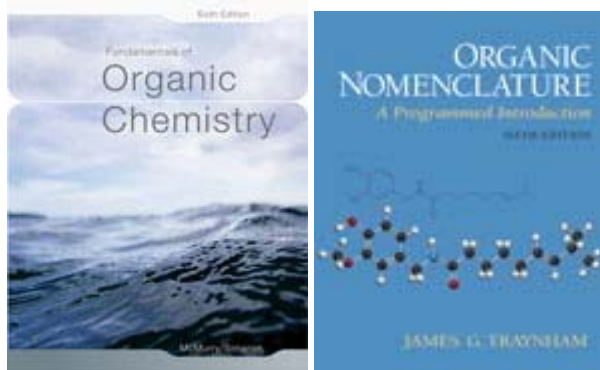
<http://www.personal.psu.edu/csr4/>

## General Information

**Lecture:** Monday at 9:00 am – 9:50 am in 202 Holt  
Wednesday and Friday at 9:00 am – 9:50 am in 210 Holt

**Course Content:** The lectures, the book, and the problems are **complementary** learning tools. You are responsible for all of them. The material in Chapter 13 of McMurry will not be covered until Chemistry 203. Some of the material in Chapters 14-17 will be covered during the treatment of earlier text chapters. The remaining text is covered in a standard biochemistry course. **The level of the lectures will be set assuming that you have done and understand the problems and the readings.** Everything on exams will at least have been touched on in lectures, but greater depth in a particular area may come from problems and readings. Some homework problems will be placed directly on exams and others will be modified slightly. This is intended to serve as a way to raise the grades of those who have kept up and understood the homework. You are encouraged to see me privately if you begin having trouble with any of the material.

- Text :**
1. McMurry, J., *Fundamentals of Organic Chemistry*, 6th ed., 2007, Brooks/Cole Publisher (REQUIRED). ISBN: 0-495-01203-3
  2. McMurry, S., *Study Guide/ Solutions Manual, Fundamental of Organic Chemistry*, 6th ed., 2007, Brooks/Cole Publisher (REQUIRED); ISBN: 0-495-01932-1
  3. Traynham, J.G., *Organic Nomenclature: A Programmed Introduction*, 6th ed, 2009, Prentice Hall Publisher (STRONGLY RECOMMENDED) ISBN: 0-130-17868-3



**Models:** A molecular model set is **required!!!!!!!**

**Attendance:** University regulations state that a student should attend **every** scheduled class (Policies and Rules for Students section 42-27). Frequent absence from class is unacceptable. If you miss a class it is **your** responsibility to determine what material, announcements, handouts, graded papers, etc., were missed due to your absence. There will be no make-ups for missed lectures. You should arrange for one of your classmates to hold returned papers in the event you are absent when papers are returned. I do not assume responsibility for holding papers if you are not there to pick them up, or have not made arrangements for someone else to pick them up. I will, of course, **try** to hold unclaimed papers for a few days.

**Office Hours** (C-127 Smith) will be announced in lecture. Additional hours may be announced, and the office hours may be changed if I do not have students utilizing the posted hours. If you cannot attend regular office hours, please leave me a message. I will check my personal campus voice mail at least once each weekday.

**Homework:** Homework assignments are given in the schedule. You are not required to turn in the assignment and consequently a homework score does not contribute directly to the course grade. You should work out the suggested problems and exercises, since they are typical of what you are expected to master and handle with ease. Also, problems from the homework assignments are regularly selected for inclusion on the exams. If you have questions about the homework, you should raise questions in class or see me outside of class.

**Grading** for the course will be based on three examinations, a final examination and a maximum of five quiz grades. There will be no extra credit assignments. The exact procedure for computing the final course grade is described later.

**Examinations:** There will be three examinations and a final examination. The dates of these examinations are given in the attached assignment schedule. The topics covered on the exams will be announced in advanced. You must **SIGN AND PRINT** your name on the first page with your ID number in order to get credit for taking the exam.

**Make-up examinations** will be given only if I have prior notice with a **justifiable** and **documented** cause (illness or family emergency). A single make-up examination will be provided near the end of the semester and will cover the material of all three examinations and will **NOT** have any multiple choice questions. Individual make-up examinations following each examination will not be provided. Rules for deferred grades are determined by the Registrar.

**Quizzes:** You must **SIGN AND PRINT** your name on the first page with your ID number in order to get credit for taking the quiz. The first quiz will be given on Wed, Aug. 29 or Friday, Aug. 31.

**Computing the Course Grade:** Each quiz will count as 25 pt., each examination will count as 100 pt., and the final examination will count as 175 pt. For a total of 600 pt. At the end of the semester, the total points for each student are added up and the course then is graded on a curve (based on actual and **expected** performance).

**Dropping the Course:** Contact the Office of the Registrar. No course can be dropped after the end of the drop period. This date, and your final exam time and date, as well as other useful information is always appended to the copy of course offerings for any semester. This usually occurs just before or just after the **THIRD** scheduled examination in this course (This semester, the third exam is scheduled before the last day to drop). **Caution!** in dropping courses is advised because of a maximum (during your entire PSU tenure) allowed number of credits you may drop between the end of the "free" drop period until the end of the allowed drop period (when you have to pay to drop).

**Academic Integrity:** Instructors are asked (Senate Rule 49-20) to provide at the beginning of the course a statement to "clarify the application of academic integrity 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 tempering with the academic work of other students.*

**Consequences of Academic Dishonesty:**

You should also be aware of the extensive parts of the Rule that describe procedures for handling alleged instances of academic dishonesty. Specific instances of academic dishonesty in this course would include (but not be 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 for you, and attempting to do any of the above. *The decision concerning the severity of an infraction of academic dishonesty is made by the instructor.* The penalty for academic dishonesty in less serious cases consists of a failing grade for the work or test where this misconduct occurred. The penalties for more serious cases of dishonesty (including automatic failure for the course, probation, suspension or expulsion from the University), and formal due process procedures are available for the student and faculty involved.

**Scheduled Classes Not Met:**

In **Extraordinary** circumstances (which have occurred from time to time in the past, and which will occur from time to time in the future), when classes are missed due to reasons other than instructor illness, power failures, weather, and the like, in which the missed classes are not made up), missed classes will be rescheduled if possible, in conjunction with the Office of the Registrar. Any such rearranging and rescheduling would be announced in class so that appropriate arrangement could be made by all.

### Some Specific Objectives for Chem. 202 (these ARE NOT complete)

You must know:

- the relationship between hybridization and geometry for  $sp^3$ ,  $sp^2$ , and  $sp$  carbon orbitals and the implications for molecular shape.
- the Bronsted/Lowry acid/base definitions and be able to write B/L reactions and identify conjugate pairs.
- IUPAC rules for naming alkanes, alkenes, and alkynes.
- group names and structures for methyl, ethyl, propyl, isopropyl, vinyl, allyl, phenyl, benzyl, chloro, bromo, and iodo.
- names for the continuous-chain alkanes through decane.
- how to use numerical prefixes such as di, tri, and tetra.
- how to draw a Newman projection for a specified conformation.
- how to draw a cyclohexane ring clearly distinguishes between axial and equatorial positions.
- the definitions of *cis*- and *trans*- for 1,2-, 1,3-, and 1,4-disubstituted cyclohexane derivatives.
- how to construct models of simple hydrocarbon molecules with single, double, and triple bonds.
- how to prioritize groups for the E, Z system of naming appropriately substituted alkenes.
- how to distinguish between the following kinds of organic reactions: addition, elimination, substitution, and rearrangement.
- the difference between "polar" and "radical" reaction mechanisms. What is a mechanism?
- the following reactions of alkenes: hydrogenation, halogenation, hydrohalogenation, hydration, oxidation with basic  $KMnO_4$ , oxidation with acidic  $KMnO_4$ , and cleavage with ozone.
- the stereochemical consequences of alkene hydrogenation and halogenation.
- the mechanisms for alkene halogenation, hydrohalogenation and hydration and understand how these mechanisms are consistent with the stereospecific observed and also how they account for Markownikoff's rule.
- how to distinguish between the "initiation", "propagation", and "termination" steps in radical polymerization.
- how to recognize the monomer by looking at a segment of an alkene polymer or to draw a segment of polymer derived from a given alkene monomer.
- the elimination reactions used to prepare alkenes: dehydrohalogenation and dehydration and the role of Zaitsev's rule in determining the structure of the major product.
- the difference between a "conjugated" and an "isolated" diene.
- the rules for drawing resonance structures and what these structures really mean.

- the following reactions of alkynes: hydrogenation including its stereochemical result; halogenation; hydrohalogenation including its obedience to Markownikoff rule; hydration including its contrast to hydration of alkenes due to tautomerism.
- that terminal alkynes can be B/L acids.
- the structures of the following aromatic compounds: benzene, toluene, phenol, nitrobenzene, aniline, benzaldehyde, and benzoic acid and the rules for naming alkyl- or halo- derivatives of these compounds.
- how to use the prefixes *ortho*, *meta*, and *para* (*o-*, *m-*, *p-*) when naming appropriate aromatic compounds.
- the molecular orbital basis for the stability of the aromatic system. You should be able to draw different "Kekule" structures for any aromatic compound.
- how to recognize chiral structures from drawings of models.
- how to make models of single enantiomers and how to recognize absolute configuration from a drawing or model.
- how to recognize a plane of symmetry in a structural formula or model.
- how to apply the priority rules for absolute configuration designation (even for chiral carbons in rings).
- the meaning of the terms "optical activity", "enantiomers", "racemic mixture" ("racemate"); "diastereoisomer"; meso form"; and "resolution" well enough to recognize examples or provide them.
- how to determine the number of stereoisomers by applying the  $2^n$  rule.
- the stereochemical rule illustrated by the addition of HBr to alkenes, namely, "optically inactive reactants give optically inactive products".
- IUPAC rules for naming alkyl halides, alcohols, phenols, and thiols.
- common nomenclature for ethers, sulfides, and disulfides.
- how to construct models (or name models) of simple alkyl halides, alcohols, phenols, ethers, thiols, sulfides, and disulfides.
- which alkyl halides are practical to prepare by direct halogenation of alkanes. You should also know the free-radical mechanism for this reaction.
- how to convert a given alkyl halide into a Grignard reagent and use this reaction to introduce deuterium.
- the reactions (including their limitations) in which alkyl halides are used as substrates in nucleophilic displacements (substitutions): Williamson ether synthesis, nitrile synthesis, conversions to alcohols by hydroxide ion, and internal alkyne formation from terminal alkynes (sec. 4.16).
- how to apply the Zaitsev rule to elimination reactions of alkyl halides.
- how to illustrate hydrogen-bonding between alcohol molecules or between alcohols and water.

- how to recognize (or provide examples of) reactions in which alcohols and phenols behave as B/L acids or bases. How do phenols compare with alcohols in acid strength?
- the following reactions of alcohols: conversion to halides via HCl, HBr (including mechanism), SOCl<sub>2</sub> and PBr<sub>3</sub>; acid catalyzed dehydration to alkenes (including mechanism).
- the following reactions used to synthesize alcohols: acid-catalyzed hydration of alkenes (mechanism and M's rule too), 1,2-diol formation from alkenes using basic KMnO<sub>4</sub>, reduction of aldehydes and ketones with NaBH<sub>4</sub> and reduction of esters with LiAlH<sub>4</sub>.
- the following oxidation reactions of alcohols: conversion of primary alcohols to aldehydes using PCC; conversion of primary alcohols to carboxylic acids using CrO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub>; conversion of secondary alcohols to ketones using CrO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub>.
- the details of the S<sub>N</sub>1 and S<sub>N</sub>2 mechanisms (including the stereochemical consequences). What conditions of requirements control which mechanism applies in a given nucleophilic displacement? Learn to recognize substrates as varied as alkyl halides, protonated alcohols, oxiranes (protonated or not), tosylates, phosphates, and sulfonium ions. Be able to label other participants in nucleophilic displacements as "nucleophile", "product", and "leaving group".
- the limitations of the Williamson ether synthesis as an S<sub>N</sub>2 reaction.
- the cleavage of ethers using HI as an S<sub>N</sub>2 (sometimes S<sub>N</sub>1) reaction.
- the reactions in which oxirane rings are opened (including their mechanisms).
- IUPAC rules for naming aldehydes and ketones and common nomenclature for ketones.
- how to construct models (or name molecules represented by models) of aldehydes and ketones.
- the details of the nucleophilic addition mechanism in which aldehydes and ketones react with oxygen- and nitrogen- nucleophiles.
- how to write equations and complete mechanisms for the following reactions (sometimes acid-catalyzed, sometimes not) of aldehydes or ketones: the addition of water to form hydrates; the addition of alcohols to form hemiacetals, hemiketals, acetals, or ketals; the addition of ammonia or amines to form imines; and the addition of Grignard reagents to form alcohols.
- how to draw enol forms of aldehydes and ketones.
- what a positive Tollen's test consists of and how to interpret it.
- IUPAC rules for naming carboxylic acids and carboxylate ions and the common names for the first four carboxylic acids.
- how to construct models (or name molecules represented by models) of carboxylic acids and carboxylate ions.
- how to complete and balance Bronsted/Lowry acid-base reactions of carboxylic acids.
- how to relate electron-donating ability (such as that of alkyl groups) and electron-withdrawing ability (such as that of halide substituents) to acid strength of carboxylic acids.
- the relationship between numerical value of pK<sub>a</sub> and acid strength.

- the connection between the boiling points of carboxylic acids and their ability to hydrogen-bond.
- how to synthesize carboxylic acids via nitriles, via the Grignard method, via oxidation of primary alcohols or aldehydes.
- how to convert carboxylic acids to acid chlorides.
- the order of reactivity among the members of the carboxylic acid family.
- how to convert acid chlorides to esters, thioesters, substituted and unsubstituted amides, and carboxylic anhydrides. What is produced when acid chlorides react with water?
- how to convert esters into different esters, thioesters, substituted and unsubstituted amides.
- the details of the two-step nucleophilic displacement mechanism - ACYL TRANSFER - by which members of the carboxylic acid family react. You must be able to add Bronsted/Lowry steps before (i.e., acid catalysis) and after these two steps when appropriate. You must be able to write a mechanism as a series of balanced equations.
- some of the historical evidence for the acyl transfer mechanism.

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Tentative Weekly Assignment Schedule For Fall 2009

DATE	TOPICS	CHAPTER	EXERCISES
M. Aug. 24	Intro., Structure and Bonding	<u>1</u> .1-11	<u>1</u> . ??????????????
W. Aug. 26	Bonding Cont.		
F. Aug. 28	Acids and Bases	<u>1</u> .12-13	<u>1</u> . ??????????????
M. Aug. 31	Alkanes	<u>2</u> .1-8	<u>2</u> . ?????????????? Traynham: <u>1</u> .1-32,41-45 <u>2</u> .1-4,6-11,13,17-25,28,29,32-37
W. Sept. 2	Alkanes Cont.	<u>2</u> .9-11	<u>2</u> . ??????????????
F. Sept. 4	Alkenes	<u>3</u> .1-4	<u>3</u> . ?????????????? Traynham: <u>3</u> .1-33,37-44,46-65 <b>QUIZ #1 – Due Sept. 9</b>
M. Sept. 7	<b>NO CLASS – Labor Day</b>		
W. Sept. 9	Reactions of Alkenes	<u>3</u> .5-11	<u>3</u> . ??????????????
F. Sept. 11	Rxn. of Alkenes Cont.	<u>4</u> .1-12	<u>4</u> . ?????????????? Traynham: <u>4</u> .1-12 <b>QUIZ #2 – Due Sept. 16</b>
M. Sept. 14	Rxn. of Alkenes Cont.		
W. Sept. 16	Alkynes	<u>4</u> .13-16	
F. Sept. 18	<b>FIRST EXAMINATION</b>		
M. Sept. 21	Alkynes Cont.		
R. Sept. 23	Aromatic	<u>5</u> .1-7	<u>5</u> . ?????????????? Traynham: <u>5</u> .1-34
F. Sept. 25	Aromatic Cont.	<u>5</u> .8-13	<u>5</u> . ?????????????? Traynham: <u>8</u> .1-22
M. Sept. 28	Aromatic Cont.		

W. Sept. 30	Aromatic Cont.		
F. Oct. 2	Stereochemistry	<u>6</u> .1-9	<u>6</u> . ??????????????
M. Oct. 6	Stereochemistry Cont.	<u>6</u> .10-13	<u>6</u> . ??????????????
W. Oct. 8	Stereochemistry Cont		
F. Oct. 9	Alkyl Halides	<u>7</u> .1-5	<u>7</u> . ?????????????? <b>QUIZ #3 – Due Oct. 14</b>
M. Oct. 12	Alkyl Halides Reactions	<u>7</u> .8-12	<u>7</u> . ??????????????
W. Oct. 14	Alcohols, Ethers, and Phenols	<u>8</u> .1-12	<u>8</u> . ?????????????? Traynham: <u>6</u> .1-46 <u>7</u> .1-18
F. Oct. 16	Alcohols, Ethers, and Phenols Cont.		
M. Oct. 19	Aldehydes and Ketones	<u>9</u> .1-6	<u>9</u> . ?????????????? Traynham: <u>11</u> .1-14,24-27
W. Oct. 21	Aldehydes and Ketones Cont.	<u>9</u> .7-12	<u>9</u> . ??????????????
F. Oct. 23	<b>SECOND EXAMINATION</b>		
M. Oct. 26	Aldehydes and Ketones Cont.		
W. Oct. 28	Aldehydes and Ketones Cont.		
F. Oct. 30	Carboxylic Acids	<u>10</u> .1-4	<u>10</u> . ?????????????? Traynham: <u>9</u> .1-35 <u>10</u> .1-30,38-42
M. Nov. 2	Carboxylic Acid Reactions	<u>10</u> .5-12	<u>10</u> . ??????????????
W. Nov. 4	Carboxylic Acid Rxns Cont.	<u>10</u> .5-12	
F. Nov. 6	Carbonyl Reactions	<u>11</u> .1-6	<u>11</u> . ?????????????? <b>QUIZ #4 – Due Nov. 11</b>
M. Nov. 9	Condensation Reactions	<u>11</u> .7-10	<u>11</u> . ??????????????
W. Nov. 11	Condensation Reactions Cont.		
F. Nov. 13	Amines	<u>12</u> .1-8	<u>12</u> . ?????????????? Traynham: <u>12</u> .1-19,22-38
M. Nov. 16	Amines Cont.	<u>14</u> .1-7	<u>14</u> . ??????????????

T. Nov. 18      Carbohydrates  
 F. Nov. 20      **THIRD EXAMINATION**

**Thanksgiving Break, Nov. 23-27**

M. Nov. 30	Carbohydrates Cont.	<u>14</u> .8-12	<u>14</u> .??????????????
W. Dec. 2	Carbohydrates Cont.		
F. Dec. 4	Amino Acids and Proteins	<u>15</u> .1-5	<u>15</u> .?????????????? <b>QUIZ #5 – Due Dec. 10</b>

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M. Dec. 7	AA and Proteins Cont.	<u>15</u> .6-12	<u>15</u> .??????????????
W. Dec. 9	Lipids	<u>16</u> .1-5	<u>16</u> .??????????????
F. Dec. 11	Nucleic Acids	<u>16</u> .6-13	<u>16</u> .??????????????

**THURSDAY, DECEMBER 17<sup>TH</sup> 1:00-2:50PM COMPREHENSIVE FINAL EXAMINATION**  
**210 Holt**  
**DURING FINAL EXAM PERIOD.**

Special emphasis will be placed on the last topics not covered on the midterms.

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**?????? UNDER EXERCISES INDICATE ASSIGNMENTS THAT WILL BE GIVEN AS WE GO.**

**No multiple choice questions will be asked on examinations (Final is multiple choice).**

**It is recommended that you work more than the assigned problems.**  
**Work as many as possible of the combined skills problems is also advised.**

**I recommend that you form small study groups of three or four to work/discuss the problem assignments.**