Chemistry 035 : Organic Chemistry
Spring 2005
Dr. Carey Reed
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General Information

Course Content: The lectures, the book, and the problems are **complementary** learning tools. You are responsible for all of them. **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. The best way to arrange this is to see me after class so we can talk or set up a conference. I can be reached at my voice mail at my Altoona Campus office (814) 949-5752. Sending e-mail to csr4@psu.edu is also possible but my email may not be checked everyday.

Text :
1. McMurry, J., ***Fundamentals of Organic Chemistry***, 5th ed., 2003, Brooks/Cole Publisher (REQUIRED).
2. **Lab Guide for Chemistry 35 & Chemistry 36 Introductory Oganic Chemistry Laboratory**, 2004-2005 ed., Hayden McNeil Pulishers (REQUIRED)
3. Laboratory Notebook with permanently numbered pages and duplicate carbon pages. (REQUIRED)
4. Traynham, J.G., ***Organic Nomenclature: A Programmed Introduction***, 5th ed, 1997, Prentice Hall Publisher (STRONGLY RECOMMENDED)

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

Safety: Goggles will be worn at all times. Gloves will be worn when advised to.

Prerequisite: Chem 34.

Attendance: University regulations state that a student should attend **every** scheduled class (Policies and Rules for Students section 42-27). Frequent absence from class in 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 form 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, a maximum of 5 quizzes, and lab reports. There will be **NO** extra credit assignments. The exact procedure for computing the final course grade is described later.

Lab Report due dates: Usually one week from the completion of the experimental work.

Make-ups: At my convenience before the end of the semester. If you cannot makeup the lab before the semester ends you will be given a 0 for the lab.

Lab Data: All original data measurements must be promptly and properly recorded directly into the lab notebook. Data recorded elsewhere is subject to confiscation and discarded.

Lab Reports: All laboratory reports are to include the following:

- **Cover page** – Download from webpage
- **PreLab** – this is to be **COMPLETED BEFORE** you come into the lab. If it is not completed, you will not be permitted to do the experiment till it is completed which may result in insufficient time for the experiment.
    - **Summary of Experiment** – This is a thorough but BRIEF summary of what you plan to do. This is NOT a summary of the procedure, which should simply be referenced. State what you plan to do making sure to include named reactions, special procedures, and special apparatus utilized. Do NOT give experimental details. Think of this as what could be a verbal summary you would give if someone asked what you were doing.
    - **Learning/Experimental Goals** – Provide atleast 3 that would be specific to the experiment.
    - **Reaction Equations and/or Diagrams of Special Apparatus**
    - **Chemical Data Table** – Blank data tables are downloadable from the class webpage.
    - **Chromatographic Behavior Comparison of Starting Material and Product**
    - **Spectral-Feature Comparison of Starting Material and Product**
    - **Explanation of Product Isolation and Purification or "Work-Up"**
    - **PreLab Exercises** – Only for those experiments that provide them.
- **InLab** – This consists of the your **observations and data** that you collected during the experiment in your lab notebook. The first thing that you should do is reference the source of the procedure. Since you have referenced the procedure you do not write down every detail of the experiment, but what you do write must be clear and concise and in complete sentences. You must include all measurements and observations for everything that you do as you do it, even if it does not work. The idea is that based upon what you have written in your lab notebook, it should be possible for someone to read it and understand exactly what you did during the experiment and be able to repeat it.
- **PostLab**
    - **Results and Discussion** – See the Cover Page for requested material.
    - **PostLab Exercises** – Answer all questions at the end of the experiment.

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.

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.

Computing the Course Grade: Exams will 30%, Final will be 20%, Quizzes will be 10%, and Lab Reports will be 40% of your grade. Remember, there is no extra credit in this course. The tentative grade scale is as follows;

Percentage		**Grade**
95	or more	A
92	or more	A-
88	or more	B+
85	or more	B
82	or more	B-
75	or more	C+
70	or more	C
60	or more	D
Less than 60		F

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 instanced 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 you should have accomplished in Chem. 34 (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 Bonsted/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 contract 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 form a drawing or model.

-how to recognize a place 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 2n 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 shich 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 form 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), $SOCl_2$ and PBr_3; 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 $KMnO_4$, reduction of aldehydes and ketones with $NaBH_4$ and reduction of esters with $LiAlH_4$.

-the following oxidation reactions of alcohols: conversion of primary alcohols to aldehydes using PCC; conversion of primary alcohols to carboxylic acids using CrO_3 and H_2SO_4; conversion of secondary alcohols to ketones using CrO_3 and H_2SO_4.

-the details of the Sn1 and Sn2 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 Sn2 reaction.

-the cleavage of ethers using HI as an Sn2 (sometimes Sn1) 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 not0 of aldehydes of 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 pKa 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 of aldehydes.

-how to convert caboxylic 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.

Chemistry 35 : Organic Chemistry
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Tentative Weekly Assignment Schedule For Spring 2005

DATE	TOPICS	CHAPTER	EXERCISES
M. Jan. 10	Carbonyl Reactions	**11**.1-6	**11**.18-25,29,30
T. Jan. 11	Administrative details and desk assignments.		
F. Jan. 14	Condensation Reactions	**11**.1-6	**11**.18-25,29,30
M. Jan. 17	Condensation Reactions	**11**.7-10	**11**.35,36,46-48
T. Jan. 18	Lab Safety, Lab Notebook	**2** and **3**	
F. Jan. 21	Condensation Reactions Cont.		
M. Jan. 24	Amines	**12**.1-7	**12**.20-31,433,44,47,52 Traynham: **12**.1-19,22-38
T. Jan. 25	Recrystallization & Melting Point Determination	**4**	
F. Jan. 28	Amines Cont.		**12**.?????????????
M. Jan. 31	Amines Cont.		**12**.?????????????
T. Feb. 1	Recrystallization & Melting Point Determination Cont.		
F. Feb. 4	Structure Determination Infrared Spectroscopy	**13**.1-2 **11**.3,5 of Lab Manual	**13**.?????????????
	Exam #1		
M. Feb. 7	Structure Determination Ultraviolet Spectroscopy	**13**.3-4 **11**.4 of Lab Manual	**13**.?????????????
T. Feb. 8	Distillation	**5**	
F. Feb. 11	Structure Determination Nuclear Magnetic Resonance	**13**.5-12 **11**.6 of Lab Manual	**13**.?????????????
M. Feb. 14	Structure Determination NMR Cont.		**13**.?????????????

T. Feb. 15	Distillation Cont.		
F. Feb. 18	Structure Determination Mass Spectroscopy	**11**.2 of Lab Manual	
M. Feb. 21	Structure Determination Mass Spectroscopy Cont		
T. Feb. 22	Liquid/Liquid Extractions	**6**	
F. Feb. 25	Structure Determination Mass Spectroscopy Cont.		**13**.?????????????
M. Feb. 28	Carbohydrates	**14**.1-7	**14**.?????????????
T. March 1	Liquid/Liquid Extractions Cont.		
F. March 4	Carbohydrates Cont.		

Exam #2

March 7-11		**SPRING BREAK**	
M. March 14	Carbohydrates	**14**.8-11	**14**.?????????????
T. March 15	Thin-Layer Chromatography	**7**	
F. March 18	Carbohydrates Cont.		
M. March 21	Amino Acids and Proteins	**15**.1-5	**15**.?????????????
T. March 22	Column Chromatography	**8**	
F. March 25	AA and Proteins Cont.	**15**.6-12	**15**.?????????????
M. March 28	AA and Proteins Cont.		
T. March 29	**ORGANIC FIELD TRIP**		
F. April 1	Lipids	**16**.1-5	**16**.?????????????

Exam #3

M.April 4	Lipids Cont.		
T. April 5	Synthetic Experiments Nitration of Methyl Bensoate	**9** Expt. #50	

F. April 8	Nucleic Acids	**16**.6-13	**16**.?????????????
M.April 11	Nucleic Acids Cont.		
T. April 12	Synthetic Experiments		
F. April 15	Metabolic Pathways	**17**.1-6	**17**.?????????????
M.April 18	Metabolic Pathways Cont.		
T. April 19	Synthetic Experiments		
F. April 22	Polymers		
M. April 25	Polymers Cont.		
T. April 26	Clean-up and Check-out		
F. April 29	**REVIEW**		

May 5TH 8:00-9:50PM COMPREHENSIVE FINAL EXAMINATION 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 ASSINGMENTS 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.