

EASTERN ARIZONA COLLEGE

General Organic Chemistry II

Course Design
2009-2010

Course Information

Division Science
Course Number CHM 236
Title General Organic Chemistry II
Credits 4
Developed by Phil McBride, Ph.D.
Lecture/Lab Ratio 3 Lecture/3 Lab

Transfer Status

ASU	NAU	UA
CHM 234 (3) & CHM 238 (1)	CHM 238 (3) --and- - CHM 238L (2)	CHEM241B (3) -- and-- CHEM243B (1)

Activity Course No
CIP Code 45.0500
Assessment Mode Post Test : ACS Standardized Exam Version 2004 (70 Questions/70 Points)
Semester Taught Spring
GE Category Lab Science
Separate Lab Yes
Awareness Course No
Intensive Writing Course Yes

Prerequisites

CHM 235 and ENG 101

Educational Value

Students will gain an understanding of the role that organic chemistry plays in their lives, and the role that organic chemistry plays in the agricultural, industrial, and medical fields. Students learn how to identify problems and then work as a team to solve those problems. Students learn how to predict reactions, and devise methods to synthesize organic compounds. They learn to work as part of a cooperative team. Students communicate with others through written reports and oral presentations. They work together to present a "Chemistry Magic Show" to high school chemistry students. Students do an original research project and then report those results in the form of a written report and a poster presentation. Students visit local industries to witness how organic chemistry is used in copper mining and hydroponics.

Students learn the composition and reactivity of several chemicals that they will encounter in their various scientific fields. The students learn about hazardous waste and safety precautions that must be followed when dealing with organic chemicals.

Description

Continuation of CHM 235. General principles of organic chemistry with continued emphasis on reactivity and synthesis. Topics include the study of alcohols, ethers, epoxides, sulfides, conjugated systems, aromatic compounds, ketones, aldehydes, amines, carboxylic acids and their derivatives, enols, carbohydrates, nucleic acids, amino acids, peptides, proteins, lipids, and polymers.

Textbooks

McMurry, J. *Organic Chemistry*. Edition: 7th. Publisher: Brooks/Cole Thomson Learning. Year: 2008. ISBN-13: 9780495112587. Required.

Supplies

Comp Book 5x5

Scientific Calculator

Competencies and Performance Standards

1. Determine the structure of organic compounds with the use of IR, MS, and Nuclear Magnetic Resonance Spectroscopy (NMR).

Learning objectives

What you will learn as you master the competency:

- a. Given a structure, determine which protons are equivalent and which are nonequivalent; predict the number of signals and their approximate chemical shifts.
- b. Use the integral trace to determine the relative numbers of different types of protons.
- c. Predict which protons in a structure will be magnetically coupled, and predict the number of peaks.
- d. Use proton spin-spin splitting patterns to determine the structure of alkyl and other groups.
- e. Draw the general features of the NMR spectrum of a given compound.
- f. Predict the approximate chemical shifts of carbon atoms in a given compound.
- g. Combine information from NMR, IR, and MS spectra to determine the structures of organic compounds.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

2. Illustrate the properties, reactivity, and synthesis of ethers and epoxides.

Learning objectives

What you will learn as you master the competency:

- a. Draw and name ethers and heterocyclic ethers, including epoxides.

- b. Predict relative boiling points and solubilities of ethers.
- c. Explain the stabilizing effects of ether solvents on electrophilic reagents.
- d. Determine the structures of ethers from their spectra.
- e. Devise efficient laboratory syntheses of ethers and epoxides.
- f. Predict the products of the reactions of ethers and epoxides.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

3. Consider the unique properties of conjugated systems and methods used to detect them (UV spectroscopy)

Learning objectives

What you will learn as you master the competency:

- a. Show how to construct the molecular orbitals of ethylene, butadiene, and the allylic system.
- b. Show the electronic configurations of ethylene, butadiene, and the allyl cation, radical, anion.
- c. Recognize reactions that are enhanced by resonance stabilization of the intermediates.
- d. Develop mechanisms to explain the enhanced rates of observed products.
- e. Predict the products of Diels-Alder reactions.
- f. Predict which cycloadditions will be thermally allowed and which will be photochemically allowed.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

4. Visualize the structure and properties of aromatic compounds.

Learning objectives

What you will learn as you master the competency:

- a. Construct the molecular orbitals of a cyclic system of p orbitals similar to benzene and cyclobutadiene.

- b. Use the polygon rule to draw the energy diagram for a cyclic system of p orbitals, and fill in the electrons to show whether a given compound or ion is aromatic or antiaromatic.
- c. Use Huckel's rule to predict whether a given annulene, heterocycle, or ion will be aromatic, antiaromatic, or nonaromatic.
- d. Name aromatic compounds and draw their structures from the names.
- e. Use IR, NMR, UV, and mass spectra to determine the structures of aromatic compounds.
- f. Given an aromatic compound, predict the important features of its spectra.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

5. Demonstrate the reactions of aromatic compounds.

Learning objectives

What you will learn as you master the competency:

- a. Predict products and give mechanisms for the common electrophilic aromatic substitutions: halogenation, nitration, sulfonation, and Friedel-Crafts alkylation and acylation.
- b. Draw resonance structures for the sigma complexes resulting from electrophilic attack on substituted aromatic rings.
- c. Predict the position(s) of electrophilic aromatic substitution on molecules containing substituents on one or more aromatic rings.
- d. Design syntheses that use the influence of substituents to generate the correct isomers of multisubstituted aromatic compounds.
- e. Predict the products of Birch reduction, hydrogenation, and chlorination of aromatic compounds.
- f. Predict the products of oxidation and substitution of phenols, and use these reactions in syntheses.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

6. Discuss the properties and reactions of simple carbonyl compounds.

Learning objectives

What you will learn as you master the competency:

- a. Name ketones and aldehydes, and draw the structures from their names.
- b. Interpret the IR, NMR, UV, and mass spectra of ketones and aldehydes.
- c. Write equations for syntheses of ketones and aldehydes from various functional groups.
- d. Propose effective single-step and multistep syntheses of ketones and aldehydes.
- e. Predict the products of reactions of ketones and aldehydes with various functional groups.
- f. Show how to convert ketones and aldehydes to other functional groups.
- g. Use retrosynthetic analysis to propose effective multistep syntheses using ketones and aldehydes as intermediates and protecting the carbonyl group if necessary.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

7. Study the properties and structures of amines and their use as drugs and medicines.

Learning objectives

What you will learn as you master the competency:

- a. Name amines and draw the structures from their names.
- b. Interpret the IR, NMR, and mass spectra of amines, and use the spectral information to determine the structures.
- c. Explain how the basicity of amines varies with hybridization and aromaticity.
- d. Contrast the physical properties of amines with those of their salts.
- e. Predict the products of reactions of amines with various types of functional groups.
- f. Illustrate the uses and mechanisms of the Hofmann and Cope eliminations, and predict the major products.
- g. Show how to synthesize amines from other organic compounds.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.

- o learner completes stipulated laboratory activities.

8. Discuss the properties and reactions of carboxylic acids.

Learning objectives

What you will learn as you master the competency:

- Name carboxylic acids, and draw the structures from their names.
- Show how the acidity of acids varies with their substitution.
- Contrast the physical properties of carboxylic acids and their salts.
- Interpret the IR, UV, NMR, and mass spectra of carboxylic acids.
- Show how to synthesize carboxylic acids.
- Show how acids are converted to esters and amides using acid chlorides as intermediates.
- Give the mechanism of the Fischer esterification.
- Predict the products of reactions of carboxylic acids with various functional groups.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

9. Discuss the properties and reactions of carboxylic acid derivatives.

Learning objectives

What you will learn as you master the competency:

- Name carboxylic acids derivatives and draw the structures from their names.
- Contrast the physical properties of carboxylic acids derivatives.
- Interpret the IR, UV, NMR, and mass spectra of carboxylic acid derivatives.
- Show how acid catalysis is used to synthesize acid derivatives.
- Show how acid derivatives hydrolyze to carboxylic acids.
- Show what reagents are used to reduce acid derivatives.
- Summarize the importance, uses, and special reactions of each type of acid derivative.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.

- o learner completes stipulated laboratory activities.

10. Discuss alpha substitution and carbonyl condensations

Learning objectives

What you will learn as you master the competency:

- Show how enols and enolate ions act as nucleophiles.
- Give mechanisms for acid-catalyzed and base-promoted alpha halogenation of ketones and acid-catalyzed halogenation of acids (the HVZ reaction).
- Show how alkylation and acylation of enamines and lithium enolates are used synthetically
- Predict the products of aldol and crossed aldol reactions.
- Predict the products of Wittig reactions.
- Predict the products of Claisen and crossed Claisen condensations, and give mechanisms.
- Show how the malonic ester synthesis and the acetoacetic ester synthesis are used to make substituted acetic acids and substituted acetones.
- Predict the products of Michael additions.

Performance Standards

Competence will be demonstrated:

- o through short oral class presentations.
- o through completion of a weekly laboratory report.
- o through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- o learner completes assigned homework.
- o learner participates in class activities.
- o learner completes stipulated laboratory activities.

11. Demonstrate the use of carbohydrates and nucleic acids in the use of consumer products.

Learning objectives

What you will learn as you master the competency:

- Recognize the structures of other anomers and epimers of glucose, drawn as either Fischer projections or chair structures, by noticing the differences from the glucose structure.
- Correctly name monosaccharides and disaccharides, and draw their structures from their names.
- Predict which carbohydrates mutarotate, which reduce Tollens reagent, and which undergo epimerization and isomerization under basic conditions.
- Draw the common types of glycosidic linkages, and recognize these linkages in disaccharides and polysaccharides.
- Recognize the structures of DNA and RNA, and draw the structures of a ribonucleotide and a deoxyribonucleotide.

Performance Standards

Competence will be demonstrated:

- through short oral class presentations.
- through completion of a weekly laboratory report.
- through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- learner completes assigned homework.
- learner participates in class activities.
- learner completes stipulated laboratory activities.

12. Obtain a basic understanding of amino acids, peptides, and proteins along with their functions.

Learning objectives

What you will learn as you master the competency:

- Name amino acids and peptides, and draw the structures from their names.
- Explain which amino acids are acidic, which are basic, and which are neutral.
- Show how amino acids might be synthesized.
- Predict products of the following reactions of amino acids: esterification, acylation, reaction with ninhydrin.
- Use information from terminal residue analysis and partial hydrolysis to determine the structure of an unknown peptide.
- Show how solution-phase peptide synthesis or solid-phase peptide synthesis would be used to make a given peptide.
- Discuss and identify the four levels of protein structure (primary, secondary, tertiary, quaternary).

Performance Standards

Competence will be demonstrated:

- through short oral class presentations.
- through completion of a weekly laboratory report.
- through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- learner completes assigned homework.
- learner participates in class activities.
- learner completes stipulated laboratory activities.

13. Discuss the properties and uses of lipids.

Learning objectives

What you will learn as you master the competency:

- Classify lipids both into the large classifications and into the more specific classifications.
- Predict the physical properties of fats and oils from their structures.
- Identify the isoprene units in terpenes, and classify terpenes according to the number of carbon atoms.
- Predict the products of reactions of lipids with standard organic reagents. In particular, consider the reactions of the ester and olefinic groups of glycerides and the carboxyl groups of fatty acids.
- Explain how soaps and detergents work, with particular attention to their similarities and

differences.

Performance Standards

Competence will be demonstrated:

- through short oral class presentations.
- through completion of a weekly laboratory report.
- through successful completion of periodic written examinations.

Criteria - Performance will be satisfactory when:

- learner completes assigned homework.
- learner participates in class activities.
- learner completes stipulated laboratory activities.

14. Discuss the fundamental principles of polymer chemistry.

Learning objectives

What you will learn as you master the competency:

- a. Differentiate between addition and condensation polymers.
- b. Predict whether a given structure will polymerize to give an addition or a condensation polymer.
- c. Explain how a specific monomer will polymerize under acidic, basic, or free-radical conditions.
- d. Predict the general characteristics of a polymer based on its structure.
- e. Explain how chain branching, cross-linking, and plasticizers affect the properties of polymers.
- f. Compare the stereochemistry of isotactic, syndiotactic, and atactic polymers.

Performance Standards

Competence will be demonstrated:

- through short oral class presentations.
- through completion of a weekly laboratory report.
- through successful completion of periodic written examinations.

Performance will be satisfactory when:

- learner completes assigned homework.
- learner participates in class activities.
- learner completes stipulated laboratory activities.

15. Evaluate a laboratory report for correct science and readability.

Learning objectives

What you will learn as you master the competency:

- a. Review the laboratory report for readability.
- b. Examine the laboratory report for correct chemistry.

Performance Standards

Competence will be demonstrated:

- upon completion of a reviewers guide.

Criteria - Performance will be satisfactory when:

- o learner reviews a peer's laboratory report for correct science and readability.

16. Communicate the results of a laboratory experiment through written and oral means.

Learning objectives

What you will learn as you master the competency:

- Communicate the results of a laboratory experiment via an oral presentation
- Write a 1000 word written report to communicate the results of a laboratory experiment.

Performance Standards

Competence will be demonstrated:

- o by a 1000 word report.
- o by a poster presentation at the Student Chemistry Adventure.

Criteria - Performance will be satisfactory when:

- o learner writes a 1000 word report to communicate the results of an experiment.
- o prepares an oral presentation.

17. Develop a laboratory experiment.

Learning objectives

What you will learn as you master the competency:

- Develop a laboratory activity that could be used in a middle school, high school, or college chemistry class.
- Communicate the results of a laboratory experiment via an oral presentation
- Communicate the results of a laboratory experiment via a 1000 word written report.

Performance Standards

Competence will be demonstrated:

- o by a 1500 word report detailing the laboratory experiment, which will be graded based on ACS style, grammar, sentence and organizational structure, and chemistry content.

Criteria - Performance will be satisfactory when:

- o develops a laboratory experiment that can be used in a chemistry course.
- o learner has a peer microtest their lab.
- o learner has their laboratory experiment peer reviewed.
- o learner uses the microtest, peer review, and instructor review to write the final report.
- o learner follows the ACS Style Guide in writing the report.

Types of Instruction

Lecture/Classroom Presentation

Laboratory

Field Trips

Grading Information

Grading Rationale

Exams will be given after every 2 or 3 chapters in the textbook. Laboratory activities will be held each week. Laboratory notebooks will be turned in and graded each week. At least one formal laboratory report will be assigned during the semester. Students will be expected to present several short oral presentations on given topics. Students will peer review each others laboratory reports. A post test will be administered at the end of the semester.

Pre-Test counts 0% of the final grade.

Homework counts 15% of the final grade.

Laboratory activities count 25% of the final grade and are composed of the following:

- Informal Lab Reports (8-12)
- Formal Lab Reports (At least 2) Each lab report will be at least 500 words.
- 500 word Critical Review of a Scientific Journal Article
- Peer Review of a Laboratory Report
- 1500 word Formal Paper

Exams count 50% of the final grade.

Post Test counts 10% of the final grade. The Post Test is the 2004 Version of the American Chemical Society Organic Chemistry Exam.

Grading Scale

A	90-100%
B	80-89%
C	65-79%
D	50-64%
F	0-49%