EASTERN ARIZONA COLLEGE
Fundamental Organic Chemistry
Course Design
2013-2014

Course Information
Division Science
Course Number CHM 230 (SUN# CHM 2230)
Title Fundamental Organic Chemistry
Credits 4
Developed by Joel Shelton
Lecture/Lab Ratio 3 Lecture/3 Lab
Transfer Status

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<th>ASU</th>
<th>NAU</th>
<th>UA</th>
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Activity Course No
CIP Code 40.0500
Assessment Mode Pre/Post Test (63 Questions/100 Points)
Semester Taught Upon Request
GE Category Lab Science
Separate Lab Yes
Awareness Course No
Intensive Writing Course No

Prerequisites
CHM 130 or CHM 138 or CHM 151

Educational Value
Students will gain an understanding of the role that organic chemistry plays in our lives, and especially how it affects the agricultural and medical fields. Students will learn how to identify problems and then work as a team to solve those problems.

For students majoring in Pre-Optometry, this course will show them the composition and reactivity of several of the chemicals that they will encounter in their fields. They will also learn about hazardous waste and safety precautions when dealing with organic chemicals.

Description
An introduction to carbon-containing compounds. Included is the study of hydrocarbons, alcohols, carbonyl compounds, amines, carbohydrates, lipids, proteins, enzymes, nucleic acids, and metabolic pathways.
Supplies
None

Competencies and Performance Standards
1. Describe how carbon bonds with other elements to form compounds.
   Learning objectives
   What you will learn as you master the competency:
   a. Given a periodic table, determine the number of valence electrons of an element and write its electron dot formula.
   b. Given the formula of a compound and a periodic table, classify the compound as ionic or covalent.
   c. Classify compounds as organic or inorganic.
   d. Compare complete molecular structures with condensed structures of hydrocarbons.
   e. Identify and sketch isomers of a given molecular formula.
   f. Identify polar bonds and polar molecules.
   g. Predict molecule shapes using the VSEPR theory.
   h. Build models of molecules.
   Performance Standards
   Competence will be demonstrated:
   o by class participation
   o by written homework
   o by written examinations
   Criteria - Performance will be satisfactory when:
   o written answers are correct
   o multiple choice answers are correct
   o molecule sketches are correct

2. Describe the properties of alkanes, alkyl halides, and cycloalkanes.
   Learning objectives
   What you will learn as you master the competency:
   a. Sketch structural formulas for alkanes and alkyl halides that obey the octet rule.
   b. Sketch a correct molecule from a given name.
   c. Name a compound according to IUPAC rules.
   d. Explain low water solubility and other physical properties of hydrocarbons in terms of low molecular polarity.
   e. Sketch and name geometric formulas for cycloalkanes.
   f. Sketch boat and chair conformations of substituted cyclohexane.
   g. Write the products of halogenation of alkanes in the presence of light.
   h. Write balanced equations for the combustion of hydrocarbons.
   i. Identify cis and trans isomers for disubstituted cycloalkanes.
Performance Standards

Competence will be demonstrated:
- by written examinations
- by written homework
- by class participation

Criteria - Performance will be satisfactory when:
- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

3. Describe the chemistry of alkenes and alkynes.

Learning objectives

What you will learn as you master the competency:

a. Identify sigma and pi bonds in a double bond and the atomic orbitals that overlap to form them.

b. Sketch structures for alkenes including any cis and trans isomers.

c. Write the correct IUPAC name for an alkene or alkyne.

d. Predict products of catalytic hydrogenation of multiple bonds.

e. Predict and name products of acid-catalyzed hydration of alkenes.

f. Predict the products of addition of halogens and hydrogen halides to alkenes.

g. Use Markovnikov's rule to predict the products of regiospecific additions to double bonds.

h. Sketch a segment of an addition polymer that is formed from a given monomer.

Performance Standards

Competence will be demonstrated:
- by written examinations
- by written homework
- by class participation

Criteria – Performance will be satisfactory when:
- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

4. Describe the chemistry of aromatic compounds.

Learning objectives

What you will learn as you master the competency:

a. Identify and name compounds with benzene rings.

b. Write products of electrophilic aromatic substitution of benzene and its derivatives.

c. Identify carcinogenic aromatic compounds.

Performance Standards

Competence will be demonstrated:
- by written examinations
5. Describe the chemistry of alcohols, phenols and ethers and thiols.

**Learning objectives**

*What you will learn as you master the competency:*

a. Name alcohols, phenols, ethers, and thiols.
b. Classify alcohols as primary, secondary, or tertiary.
c. Explain increased water solubility and boiling points in terms of hydrogen bonding.
d. Write and name the products of dehydration of alcohols.
e. Write and name the products of oxidation of alcohols.
f. Explain a simple oxidation test that will distinguish between tertiary alcohol and other kinds of alcohols.
g. Sketch the products of oxidation of thiols.
h. Sketch the products of reaction of thiols with heavy metal ions.

**Performance Standards**

*Competence will be demonstrated:*

- by written examinations
- by written homework
- by class participation

*Criteria - Performance will be satisfactory when:*

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

6. Describe the chemistry of aldehydes and ketones

**Learning objectives**

*What you will learn as you master the competency:*

a. Identify the functional groups that define aldehydes and ketones.
b. Explain the physical properties of aldehydes and ketones in terms of the polarity of the carbonyl group.
c. Name aldehydes and ketones.
d. Write the products of oxidation of aldehydes.
e. Write the products of reduction of aldehydes and ketones.
f. Explain how to identify the aldehyde functional group by the Tollen's test.
g. Write equations for the reaction of alcohols with aldehydes and ketones to form hemiacetals, acetals, hemiketals, and ketals.
h. Write equations for the hydrolysis of hemiacetals, acetals, hemiketals, and ketals.
Performance Standards

Competence will be demonstrated:

- by written examinations
- by written homework
- by class participation

Criteria - Performance will be satisfactory when:

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

7. Describe the chemistry of carboxylic acids and their derivatives.

Learning objectives

What you will learn as you master the competency:

- Sketch and name carboxylic acids and esters using the IUPAC and common names.
- Relate water solubility and boiling points to molecular polarity and presence or absence of hydrogen bonds.
- Write equations for the dissociation of carboxylic acids in water.
- Write equations for the reaction of carboxylic acids with bases.
- Name salts of carboxylic acids.
- Write equations for the preparation of esters by reaction of alcohols with carboxylic acids, acyl chlorides, and acid anhydrides.
- Write equations for the acid catalyzed hydrolysis of esters.
- Write equations for the base promoted hydrolysis (saponification) of esters.
- Sketch esters prepared from alcohols reacting with nitric or phosphoric acids.
- Write the products of reaction of acid anhydrides with water.

Performance Standards

Competence will be demonstrated:

- by written examinations
- by written homework
- by class participation

Criteria - Performance will be satisfactory when:

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

8. Describe the chemistry of amines.

Learning objectives

What you will learn as you master the competency:

- Provide correct common and IUPAC names for amines and amides.
- Classify amines as primary, secondary, or tertiary.
- Relate physical properties of amines and amides to the availability of hydrogen bonding.
- Write reactions for the dissociation of amines in water.
e. Explain how pH paper can help identify amines in the laboratory.
f. Write equations for reactions of amines with acids.
g. Write equations for reactions of amine salts with bases.
h. Write equations for reactions of amines (or ammonia) with acyl chlorides and acid
anhydrides to form amides.
i. Write equations for hydrolysis of amides.
j. Identify amines and amides of physiological importance.

Performance Standards
Competence will be demonstrated:
- by written examinations
- by written homework
- by class participation
Criteria - Performance will be satisfactory when:
- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

9. Describe and name stereoisomers.
Learning objectives
What you will learn as you master the competency:
a. Identify chiral carbons in molecules.
b. Relate optical activity to the presence of chiral carbons in molecules.
c. Identify pairs of molecules as enantiomers, diastereomers, or neither.
d. Compare the physical and chemical properties of enantiomers and diastereomers.
e. Write Fischer projections to represent D and L compounds.

Performance Standards
Competence will be demonstrated:
- by written examinations
- by written homework
- by class participation
Criteria - Performance will be satisfactory when:
- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

10. Describe the chemistry of carbohydrates.
Learning objectives
What you will learn as you master the competency:
a. Describe the functions of carbohydrates in living organisms.
b. Classify carbohydrates as monosaccharides, disaccharides, polysaccharides, aldoses,
or ketoses.
c. Sketch Haworth projections for closed-ring sugars showing both the alpha and beta
11. Describe the chemistry of lipids.

Learning objectives

What you will learn as you master the competency:

a. Identify the kinds and functions of lipids in biochemistry.
b. Classify lipids as saponifiable or nonsaponifiable.
c. Sketch fatty acids.
d. Classify fatty acids and triacylglycerols as saturated or unsaturated.
e. Sketch triacylglycerol and waxes.
f. Relate the melting points of fats and oils to structural features.
g. Use structural features to differentiate among triacylglycerols, waxes, phospholipids, sphingolipids, and steroids.
h. Write reactions for hydrogenation of fats and oils.
i. Write reactions for the hydrolysis of triacylglycerols.
j. Diagram micelles and lipid bilayers.

Performance Standards

Competence will be demonstrated:

- by written examinations
- by written homework
- by class participation

Criteria - Performance will be satisfactory when:

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct
12. **Describe the chemistry of amino acids and proteins.**

*Learning objectives*

*What you will learn as you master the competency:*

a. Identify the characteristic parts of amino acids and their various ionic forms.
b. Sketch an oligopeptide when given the structure of the side-chains.
c. Identify the peptide bonds, the N-terminal and the C-terminal on sketches of peptides.
d. Differentiate among the primary, secondary, tertiary, and quaternary structural levels of a protein.
e. List specific, naturally occurring examples of secondary, tertiary, and quaternary structures of proteins.
f. Relate the three-dimensional structure of proteins to hydrogen bonds and side-chain interactions.
g. Describe the conditions and consequences of protein denaturation.

*Performance Standards*

*Competence will be demonstrated:*

- by written examinations
- by written homework
- by class participation

*Criteria - Performance will be satisfactory when:*

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct

13. **Describe the function of enzymes.**

*Learning objectives*

*What you will learn as you master the competency:*

a. Describe the essential role of enzymes in biochemistry.
b. Identify the nutritional source and function of cofactors.
c. Compare the lock-and-key and the induced-fit models in explaining enzyme specificity and selectivity.
d. Identify the physical and chemical conditions that influence enzyme activity.
e. Compare reversible and irreversible enzyme inhibition.

*Performance Standards*

*Competence will be demonstrated:*

- by written examinations
- by written homework
- by class participation

*Criteria - Performance will be satisfactory when:*

- written answers are correct
- multiple choice answers are correct
- molecule sketches are correct
14. **Describe the chemistry of nucleic acids.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Identify the parts of a nucleotide.

b. List three structural differences between DNA and RNA.

c. Describe how base pairing works.

d. Identify the 5' and 3' ends of DNA and RNA.

e. Identify three kinds of RNA and their functions.

f. Outline the processes of replication, transcription, and, translations.

g. Identify codons and their purpose.

h. Describe the uses of restriction enzymes.

**Performance Standards**

*Competence will be demonstrated:*

 o by written examinations
 o by written homework
 o by class participation

*Criteria - Performance will be satisfactory when:*

 o written answers are correct
 o multiple choice answers are correct
 o molecule sketches are correct

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15. **Describe the metabolism of carbohydrates.**

**Learning objectives**

*What you will learn as you master the competency:*

a. Differentiate among metabolism, anabolism, and catabolism.

b. Identify the parts and function of the ATP molecule.

c. Describe the reactions in which the coenzymes NAD+, FAD, and coenzyme A participate.

d. Identify oxidation and reduction reactions in metabolism.

e. State the overall purpose, the reactants, and final products of the glycolysis, TCA cycle, and oxidative phosphorylation pathways.

f. List the three pathways possible for pyruvate and the conditions for each.

g. Correlate the metabolism of glucose to the production of a specific number of ATP molecules.

**Performance Standards**

*Competence will be demonstrated:*

 o by written examinations
 o by written homework
 o by class participation

*Criteria - Performance will be satisfactory when:*

 o written answers are correct
 o multiple choice answers are correct
16. **Perform basic laboratory operations pertaining to organic chemistry.**

**Learning objectives**

*What you will learn as you master the competency:*

- a. Describe the safe handling of chemicals which may be toxic, flammable, corrosive, or irritating.
- b. Locate physical properties and hazards of chemicals in available literature.
- c. Write complete and clear laboratory reports.
- d. Measure and interpret melting point ranges, boiling points, and refractive indices.
- e. Perform the operations of distillation, filtration, recrystallization, sublimation, and chromatography.
- f. Perform simple classification tests.
- g. Create a derivative to help identify an unknown.
- h. Synthesize compounds.
- i. Isolate natural products.

**Performance Standards**

*Competence will be demonstrated:*

- o by class participation
- o by written homework
- o by written examinations
- o by laboratory reports

*Criteria - Performance will be satisfactory when:*

- o written answers are correct
- o molecule sketches are correct
- o laboratory reports are complete and legible
- o laboratory is left clean
- o laboratory work follows all safety standards

**Types of Instruction**

Classroom Presentation

Laboratory Activities

**Grading Information**

**Grading Rationale**

A. Quizzes are optional, but will count the same as homework if administered.
B. There will be 6 exams of which the lowest score will be dropped.
C. The lowest lab score will be dropped.

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<th>Percentage</th>
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<tr>
<td>Homework</td>
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<tr>
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<td>Post-test</td>
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Grading Scale

A  90 - 100%
B  80 - 89%
C  70 - 79%
D  60 - 69%
F  0 - 59%