Mercer County Community College

COURSE OUTLINE

CHE 201  Organic Chemistry I  5
Course Number  Course Title  Credits

Hours: 3/4  Pre-requisite: CHE102 or permission of
lecture/Lab/Other instructor

Catalog description:
Theoretical principles of reaction mechanisms and the synthesis of important classes of organic
compounds. Topics include stereoisomerism; alcohols; ethers; nucleophilic substitution; elimination
reactions; and instrumental methods. Lab work introduces the synthesis, purification, separation and
identification of organic compounds. 3 lecture/4 laboratory hours

Note: Participation in Biology, Chemistry and Physics laboratory courses is permitted provided the
student has completed the required prerequisites, is a minimum of 16 years of age or by permission
of the instructor and the Dean of the division.

Is course New, Revised, or Modified? Revised

Required texts/other materials:

ORGANIC CHEMISTRY
Authors: T.W. Graham Solomons and Craig B. Fryhle

PUSHING ELECTRONS
Author: D.P. Weeks
Publisher: Thomson Learning

EXPERIMENTAL ORGANIC CHEMISTRY, a Miniscale and Microscale Approach
Authors: John C. Gilbert, and Stephen F. Martin
Publisher: Thomson Brooks/Cole Publishing
Edition: Sixth, 2016

STUDENT LAB NOTEBOOK With Spiral Binding
(100 carbon duplicate sets)
ISBN 1930882742
Publisher: Hayden-McNeil Specialty Products
**Suggested Supplementary Book:**
STUDY GUIDE AND SOLUTIONS MANUAL TO ORGANIC CHEMISTRY MENTARY BOOK: TWELFTH EDITION
Authors: Solomons, Fryle, Snyder

**Supplies:**
1. Goggles or other approved eye protection is REQUIRED in the laboratory at all times.
2. Light weight rubber or plastic gloves are required for use in certain experiments.
3. A three ring binder is recommended for organization of lecture handouts.

**Revision date:** September, 2019

**Course coordinator:** Helen V. Tanzini
Email: tanzinh@mccc.edu
Office: MS 133
Phone: 609-570-3349

**Information resources:**
The library has a collection of books that students may use for reinforcement of the content being taught in this course. The lecture and laboratory textbooks and solution manual are available in the library.

**Other learning resources:**
Tutors: The learning center is located on the second floor behind the bookstore. Students are accommodated on a walk in basis. Consult http://www.mccc.edu/student_services_learncenter_ww.shtml for tutor schedules.
www.INCHEM.org
http://web.doh.state.nj.us/rtkhsfs/indexfs.aspx?lan=english
ChemDraw®

**Accommodations**
Eligible students at Mercer County Community College are assured services under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973. Contact Arlene Stinson, Director of Academic Support Services. 570-3525.
**Course Competencies/Goals:**

*The student will be able to:*

1. Explain and interpret key concepts of organic chemistry including nomenclature, stereochemistry, organic synthesis and reaction mechanisms based on functional groups and acid-base behavior [GE Goals 1, 3, 4; Core Skills A and B]
2. Design and evaluate multi-step synthetic methods by use of retro-synthetic analysis. [GE Goal 3, 9; Core Skills A, B, C, D, E and F]
3. Create and evaluate organic reaction mechanisms using curved arrows including stereochemistry and adaptation of this skill to new situations [GE Goal 3; Core Skills B and E]
4. Demonstrate safety in the organic laboratory setting and practice environmentally sound waste disposal methods [GE Goals 3 and 9; Core Skills B, C, D, G]
5. Communicate scientific information in the form a laboratory reports and conduct literature searches then evaluate and analyze their findings [GE Goal 1, 2 and 3; Core Skills A, B C and D]
6. Perform and master the basic techniques for: (i) the separation and purification of organic compounds (recrystallization, distillation, column chromatography), (ii) the analysis of organic compounds (TLC, gas chromatography) and (iii) the characterization of organic compounds (melting and boiling points, IR spectroscopy [GE Goals 2, 3, 4; Core Skills A, B, D, E]

**Course-specific General Education Knowledge Goals and Core Skills.**

*General Education Knowledge Goals*

**Goal 1. Communication.** Students will communicate effectively in both speech and writing.

**Goal 2. Mathematics.** Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.

**Goal 3. Science.** Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.

**Goal 4. Technology.** Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

**Goal 9. Ethical Reasoning and Action.** Students will understand ethical issues and situations.

*MCCC Core Skills*

**Goal A. Written and Oral Communication in English.** Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.

**Goal B. Critical Thinking and Problem-solving.** Students will use critical thinking and problem solving skills in analyzing information.

**Goal C. Ethical Decision-Making.** Students will recognize, analyze and assess ethical issues and situations.

**Goal D. Information Literacy.** Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.

**Goal E. Computer Literacy.** Students will use computers to access, analyze or present information, solve problems, and communicate with others.

**Goal F. Collaboration and Cooperation.** Students will develop the interpersonal skills required for effective performance in group situations.

**Units of study in detail.**

*The student will be able to:*

**Unit 1 Introduction to Organic Chemistry**

1. Define organic chemistry [Core Comp #1]
2. Name the element found in all organic compounds. [Core Comp #1]
3. Name at least four other elements frequently found as part of an organic compound. [Core Comp #1]
4. Given the atomic weight and number of one of the first 20 elements in the periodic table, write the electronic configuration of that element, and/or of the most common ion obtainable from the element.
5. Define what is meant by an ionic bond. [Core Comp #1]
6. Show, by suitable illustrations using electron dot (Lewis) or Bohr representations, how two elements might form an ionic (electrovalent) bond between them. [Core Comp #1]
7. Define what is meant by a covalent bond. [Core Comp #1]
8. Show by suitable illustration how two elements might form a covalent bond between them. [Core Comp #1]
9. Illustrate by a suitable labeled drawing of a simple molecule what is meant by the term dipole. [Core Comp #1]
10. Given access to a periodic table, indicate which of any two given elements is the more electronegative one. [Core Comp #1]
11. Given the Pauling electronegativities of elements which are joined by a covalent bond, indicate the direction of the dipole in the bond and indicate whether the bond is likely to be weakly, moderately or strongly polarized. [Core Comp #1]
12. Using electron dot (Lewis) formulas, show the structure of a molecule containing coordinate-covalent bonds and by means of a small arrow or polarity (+, -) signs, indicate which bond or bonds are coordinate-covalent. [Core Comp #1]
13. List at least three differences in the typical physical properties of IONIC and covalent compounds. [Core Comp #1]
14. Indicate, using appropriate illustrations, the role of solvation on the solubility of compounds. [Core Comp #1]

Unit 2  BONDS INVOLVING CARBON
1. Draw a representation of an s and p atomic orbital. [Core Comp #1]
2. Write the electronic configuration of a carbon atom. [Core Comp #1]
3. State and/or illustrate Pauli's exclusion principle. [Core Comp #1]
4. State and/or illustrate Hund's rule. [Core Comp #1]
5. Define what is meant by a sigma bond. [Core Comp #1]
6. Illustrate sigma bond formation between two atoms. [Core Comp #1]
7. By illustrative example describe and show why a tetrahedral structure rather than a planar structure is believed to result when four other atoms are bonded to a single carbon atom. [Core Comp #1]
8. Define, illustrate and differentiate between the terms empirical, molecular, and structural formula. [Core Comp #1]
9. Define the term stereoisomerism. [Core Comp #1, 2]
10. Define the term isomer. [Core Comp #1]
11. Describe and illustrate how the carbon atom as it appears in molecules differs in its apparent electronic configuration from what might be expected from the "expected" "ground" state electronic configuration of the carbon atom. [Core Comp #1]
12. Describe what is meant by a sp3 hybridized carbon atom. [Core Comp #1]
13. Illustrate an sp3 hybridized carbon atom. [Core Comp #1]
14. Illustrate sigma bond formation in methane. [Core Comp #1]
15. Illustrate an sp2 hybridized carbon atom. [Core Comp #1]
16. Illustrate an sp hybridized carbon atom. [Core Comp #1]
17. Indicate the kind of symmetry (linear, trigonal-planar, tetrahedral) associated with sp, sp2 and sp3 hybridization respectively. [Core Comp #1]
18. Draw a representation of a sigma bond and a pi bond between carbon atoms. [Core Comp #1]
19. Draw a molecular orbital representation of ethene (ethylene) labeling the bonds sigma or pi respectively. [Core Comp #1]
20. Draw a molecular orbital representation of ethyne (acetylene) labeling the bonds sigma or pi as appropriate. [Core Comp #1]
21. Know the functional groups, IUPAC and common nomenclature. [Core Comp #1, 2]
22. Review intermolecular forces. [Core Comp #1]
23. Know the alkyl groups containing 1-4 carbons. [Core Comp #1]
24. Identify functional groups found in a complicated structure [Core Comp #1]

Unit 3  ORGANIC REACTIONS: ACIDS AND BASES
1. Explain the terms mechanism, intermediate, heterolytic and homolytic bond cleavage, radical, carbocation and carbanion. [Core Comp #1, 5]
2. Understand Bronsted-Lowry acid base theory and the Lewis definition of acids and bases. [Core Comp #1, 2]
3. State the Arrhenius, Bronsted and Lewis definitions of acids and bases. [Core Comp #1, 2]
4. Give at least one example of an acid and of a base which do not meet the Bronsted definition, but which are in accord with the Lewis definition. [Core Comp #1, 2]
5. Illustrate carbocation and carbanion formation using equations and curved arrows. [Core Comp #1, 5]
6. Understand acid and base strength (Ka and pKa). [Core Comp #1, 2]
7. Predict the outcome of acid-base reactions using curved arrows and the principle “Acid-base reactions always favor the formation of the weaker acid and the weaker base.” [Core Comp #1, 2]
8. Describe the effect of structure, hybridization and solvent (aqueous and nonaqueous) on acidity. [Core Comp #1]
9. Explain the terms inductive effect and resonance effect. [Core Comp #1]
10. Understand thermodynamics in a qualitative sense. [Core Comp #1]
11. Explain and write a mechanism showing how an organic compound can act as a base. [Core Comp #1, 5]
12. Know how to synthesize deuterium and tritium-labeled compounds using acid-base principles. [Core Comp #1, 3, 4]
13. Begin writing mechanisms in a separate one subject notebook (one mechanism per page). [Core Comp #1, 5]

Unit 4 ALKANES
1. Write the general molecular formula for any alkane. [Core Comp #1]
2. Draw a molecular orbital representation of a simple alkane such as ethane or propane and label the kinds of bonds found between the atoms. [Core Comp #1]
3. Name the C1 through C20 straight chain alkanes. [Core Comp #1]
4. Write and correctly label the structures of the following alkyl groups: methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, and tert-butyl. [Core Comp #1]
5. Given a structure, name any given alkane using the IUPAC system of nomenclature or given an IUPAC name draw the corresponding structure. [Core Comp #1]
6. Define the terms 1°, 2°, 3° carbon atoms and hydrogen atoms. [Core Comp #1]
7. For any given alkane, label each of the carbon and hydrogen atoms as to whether they are 1°, 2°, 3°. [Core Comp #1]
8. Know the names of the functional groups, generalized formulas and IUPAC nomenclature of compounds. [Core Comp #1]
9. Predict the effect of increasing carbon number on the boiling point, density, and melting point of alkanes. [Core Comp #1]
10. Predict the effect of carbon branching on the boiling point and melting point of alkane isomers of given carbon number. [Core Comp #1]
11. State the major natural source of alkanes and discuss how and to what extent individual alkanes can be obtained from such a source or sources. [Core Comp #1]
12. Write balanced equations for alkane synthesis, eg hydrogenation of an alkane and alkyne. [Core Comp #1, 3]
13. Draw structural formulas for the constitutional isomers of given a molecular formula. [Core Comp #1]
14. Define and illustrate the concept of homologs and homologous series as used in organic chemistry. [Core Comp #1]
15. Calculate the Index of Hydrogen Deficiency for hydrocarbons. [Core Comp #1]
16. Apply heat of combustion to compound stability. [Core Comp #1]

UNIT 5 CYCLOALKANES
1. Given a structure, name any given cycloalkane or given a name draw the corresponding structure. [Core Comp #1]
2. Explain what is meant by the conformation of a molecule. [Core Comp #1]
3. Describe and illustrate by means of Newman projections or "sawhorse" formulas what is meant by eclipsed, skew, and staggered conformations. [Core Comp #1]
4. Analyze Newman representations of the anti, eclipsed, and gauche conformers of a given molecule with respect to stability. [Core Comp #1]
5. Evaluate what factors cause a molecule to exist as one conformer as opposed to another. [Core Comp #1]
6. Analyze which conformations are the most stable and which are the least stable. [Core Comp #1]
7. Compare and contrast the ease of formation and the reactivity of the three categories of cycloalkanes; (a) cyclopropane and cyclobutane; (b) cyclopentane and cyclohexane; and (c) cycloheptane and larger rings. [Core Comp #1, 2]
8. In terms of conformational stability, analyze the stabilities of the boat, chair, and twist conformations of cyclohexane. [Core Comp #1]
9. Identify substituents on a cyclohexane ring as being axial or equatorial and indicate the preferred conformation. [Core Comp #1]
10. Explain what is meant by the term 1,3-diaxial interaction and indicate what role it plays in the preferred conformation of substituted cyclohexanes. [Core Comp #1]
11. Draw structures and write IUPAC names of bicyclic compounds. [Core Comp #1]

UNIT 6   STEREOCHEMISTRY
1. State what is meant by the term stereoisomerism. [Core Comp #1]
2. State what is meant by the configuration of a molecule. [Core Comp #1]
3. Describe what is meant by plane polarized light. [Core Comp #1, 11]
4. Sketch the parts of a polarimeter, labeling each part, and describe how the polarimeter works. [Core Comp #1, 11]
5. Given the appropriate experimental data, calculate the specific rotation of a compound. [Core Comp #1, 11]
6. Define the terms dextrorotatory and levorotatory and indicate what symbols are used for their designation. [Core Comp #1, 11]
7. Discuss factors involved in why some compounds show optical activity while others do not. [Core Comp #1, 5]
8. Define and illustrate the term enantiomers and give appropriate examples. [Core Comp #1]
9. Define the term chirality (dissymmetry). [Core Comp #1]
10. Discuss the relationship between chirality (dissymmetry) and enantiomerism. [Core Comp #1]
11. Discuss the relationship between enantiomers and optical activity. [Core Comp #1, 11]
12. Define and illustrate the term chiral (asymmetric) carbon atom. [Core Comp #1]
13. Analyze the relationship between chiral (asymmetric) carbon atom, chirality (dissymmetry), enantiomerism and optical activity. [Core Comp #1]
14. Define the term racemic mixture of racemic modification. [Core Comp #1]
15. Describe how a racemic mixture might be separated into its components. [Core Comp #1, 12]
16. Given the structure of a compound, classify its configuration as R or S. [Core Comp #1]
17. State the principal sequence rules used for R and S designation of configuration. [Core Comp #1]
18. Define the term diastereomer. [Core Comp #1]
19. Define the terms meso structure or meso compound and draw the structure of an appropriate example. [Core Comp #1]
20. Differentiate between enantiomers and diastereomers. [Core Comp #1]
21. Show, by suitable structures and equations, how a chiral (asymmetric) center can be introduced into a molecule. [Core Comp #1]
22. Explain and illustrate what is meant by the term optical purity.
23. Show, by means of suitable equations, how a second chiral (asymmetric) center can be formed in a molecule. [Core Comp #1, 2]
24. Show, by means of a suitable equation, how the reaction of a particular enantiomer can result in a product which is a racemic mixture. [Core Comp #1, 2, 5]
25. Describe the role of diastereomerism in the resolution of racemic mixtures. [Core Comp #1]
26. State whether a given disubstituted cycloalkane can exist in diastereomeric, enantiomeric or meso form. [Core Comp #1, 2]
Unit 7  ALKYL HALIDES AND NUCLEOPHILIC ALIPHATIC SUBSTITUTION

1. Given the structure of an alkyl halide write an appropriate name or given a name draw the corresponding structure. [Core Comp #1]
2. Write equations for at least three methods of preparing alkyl halides including at least one from alcohols; one from alkanes, or arenes; and one from alkenes or alkynes. [Core Comp #1, 2, 3]
3. Write equations for at least three general reactions of alkyl halides. [Core Comp #1, 2, 3]
4. Differentiate between first and second order kinetics of a reaction. [Core Comp #1]
5. Define what is meant by an SN1 and SN2 reaction and give an example of each. [Core Comp #1, 2]
6. Define the terms enthalpy change and energy of activation. [Core Comp #1]
7. State and illustrate in terms of enthalpy changes ENDOTHERMIC and EXOTHERMIC reactions. [Core Comp #1]
8. By means of a potential energy diagram, interpret the energy profile for an endothermic or an exothermic reaction indicating on the diagram the “role” of activation energy. [Core Comp #1]
9. Describe why an increase in reaction temperature might generally be expected to increase the rate of a chemical reaction. [Core Comp #1]
10. Describe what is meant by the term TRANSITION STATE. [Core Comp #1]
11. Analyze examples of what might be found in the transition state of various chemical reactions. [Core Comp #1]
12. By means of suitable equations write the mechanism for an SN1 reaction, including the concepts of nucleophiles and leaving groups. [Core Comp #1, 2, 5]
13. Explain why optical purity is lost in an SN1 reaction. [Core Comp #1, 5]
14. Given a list of alkyl halides, list them in decreasing order of reactivity toward SN1 reactions, explain. [Core Comp #1]
15. Explain why and under what circumstances rearrangements may be observed in conjunction with SN1 reactions. [Core Comp #1, 2, 5]
16. By means of a suitable equation write an illustrative mechanism of an SN2 reaction. [Core Comp #1, 2, 5]
17. State what is meant by inversion of configuration is an SN2 reaction and by suitable structural formulas show how it comes about. [Core Comp #1, 2, 5]
18. Explain how and why optical purity is maintained in an SN2 reaction. [Core Comp #1, 2, 5, 11]
19. State the relative importance of electronic and steric factors in SN2 reactions. [Core Comp #1, 5]
20. Given a list of alkyl halides, list them in decreasing order of reactivity toward SN2 reactions. [Core Comp #1]
21. List and explain what experimental variables can be manipulated to influence SN1 vs SN2 reactions eg. solvent. [Core Comp #1]
22. Differentiate between the terms, STEREOSELECTIVE REACTIONS and STEREOSPECIFIC REACTIONS. [Core Comp #1]
23. Define the terms carbocation and give an example. [Core Comp #1]
24. List the carbocations (1°, 2°, 3°) in order of decreasing stability and account for these differences in stability. [Core Comp #1, 5]
25. Define the term inductive effect and give an example. [Core Comp #1]
26. Illustrate the rearrangement of carbocations via alkanide or hydride 1,2-shifts. [Core Comp #1, 2, 5]

UNIT 8  E1 AND E2 REACTIONS

1. Write the mechanism for the dehydrohalogenation of an alkyl halide to form an alkene. [Core Comp #1, 5]
2. Write a mechanism for an E1 reaction and list the experimental evidence for it. [Core Comp #1, 5]
3. Write the mechanism for an E2 reaction and list the experimental evidence supporting it. [Core Comp #1, 5]
4. By means of suitable “sawhorse” formulas or Newman projections, show how trans elimination is involved in E2 elimination reactions. [Core Comp #1, 5]
5. State and illustrate how the structure of the substrate can affect the nature of the products when elimination and substitution can be competing reactions. [Core Comp #1, 5]
6. Understand the factors that influence the competition between substitution and elimination reactions. [Core Comp #1, 2]
7. By means of generalized structural formulas, prepare a list of alkenes in increasing order of stability or decreasing ease of formation. [Core Comp #1, 2]

**UNIT 9  PREPARATION OF ALKENES**
1. Write the general molecular formula for any alkene. [Core Comp #1]
2. Draw a molecular orbital representation of a simple alkene such as ethene or propene and label the kinds of bonds found between the atoms. [Core Comp #1]
3. Given a structure, name any given alkene using the IUPAC system of nomenclature, or given a IUPAC name draw the correct structure. [Core Comp #1]
4. Define and give examples of geometric isomers. [Core Comp #1]
5. Given a structure, label it correctly as the cis or trans isomer, or given the isomer name draw the correct structure. [Core Comp #1]
6. Given a structure, label it correctly as the Z (zusammen) or E (entgegen) configuration, or given the isomer name, draw the correct structure. [Core Comp #1]
7. State the applicable Cahn-Ingold-Prelog rules for designation of Z or E configuration [Core Comp #1]
8. Write balanced equations for at least three methods of alkene synthesis.
9. Write the mechanisms for the dehydration of alcohols to alkenes (E1 /E2). [Core Comp #1, 5]
10. State carbocation stability and explain carbocation rearrangements.
11. Explain how Zaitsev’s rule is used to predict the product of an elimination reaction. [Core Comp #1, 2]
12. Compare Zaitsev’s rule and Hofmann’s rule. [Core Comp #1]

**UNIT 10  REACTIONS OF ALKENES**
1. Write balanced equations for at least five addition reactions of alkenes. [Core Comp #1, 2, 4]
2. Define the terms electrophilic addition and electrophilic reagent. [Core Comp #1, 2]
3. State Markovnikov’s rule and give examples showing its effect. [Core Comp #1]
4. State what is meant by anti-Markovnikov addition and note the conditions under which it takes place. [Core Comp #1, 2]
5. Write a mechanism for the electrophilic addition of electrophilic reagents to alkenes, including stereochemistry. [Core Comp #1, 2, 5]
6. Write a mechanism which accounts for carbon skeleton rearrangement and isomer formation during the electrophilic addition of electrophilic reagents to alkenes. [Core Comp #1, 5]
7. Write a mechanism which accounts for the addition of symmetrical reagents such as bromine or chlorine to alkenes. [Core Comp #1, 5]
8. Write a mechanism which accounts for the formation of halohydrins with the observed arrangement of substituents. [Core Comp #1, 5]
9. Explain the role played by the catalyst in the hydrogenation of alkenes. [Core Comp #1, 2]
10. Define the terms dimer and dimerization and write an equation for the dimerization reaction. [Core Comp #1, 2]
11. Write the mechanism for the acid-catalyzed dimerization of 2-methylbutene. [Core Comp #1, 5]
12. Use the principle of Retrosynthetic analysis to plan an organic synthesis. [Core Comp #1, 2, 3]
13. Write the mechanism for an acid catalyzed addition reaction involving an alkene and alkyne. [Core Comp #1, 5]
14. State what is meant by the term CIS (SYN) and TRANS (ANTI) addition to alkenes. [Core Comp #1, 5]
15. State and give examples of how geometric isomerism of an alkene can affect the nature of the stereoisomers resulting from cis (syn) or trans (anti) addition to the alkene. [Core Comp #1, 5]
16. Give examples of reagents which add to alkenes mainly by cis (syn) addition and examples of those which add mainly by trans (anti) addition. [Core Comp #1, 5]
17. Use regioselective reactions in the synthesis of alcohols from alkenes [Core Comp #1, 2, 3]
(hydroboration, oxymercuration/demercuration).
18. Write a balanced equation for the cleavage reaction of an alkene with ozone and name, by general class, all the key intermediate compounds. [Core Comp #1, 2, 3]
19. Write oxidation reactions using KMNO₄ and OsO₄. [Core Comp #1, 2, 3]
20. Describe simple chemical tests which can be used for the qualitative identification of an alkene and write equations for the reactions involved. [Core Comp #1, 12]
21. Describe tests for alkanes, alkynes, alkyl halides and alcohols. [Core Comp #1, 12]
22. Define the term carbene and give an example [Core Comp #1]
23. Use carbene and Simmons-Smith reactions for cyclopropane synthesis. [Core Comp #1, 2, 3]

UNIT 11 ALKynes
1. Write the general molecular formula for any alkyne. [Core Comp #1]
2. Draw a molecular orbital representation of a simple alkyne and label the kinds of bonds found between the atoms. [Core Comp #1]
3. Given a structure, name any given alkyne using the IUPAC system of nomenclature, or given an IUPAC name draw the correct structure. [Core Comp #1]
4. Write balanced equations for at least two methods of alkyne synthesis. [Core Comp #1, 2, 3]
5. Explain why the hydrogen atom on the first carbon atom of a terminal alkyne is more acidic than the hydrogen atom of an alkane. [Core Comp #1]
6. Describe, illustrate with suitable equations, and name any relevant catalyst used to reduce alkynes to cis or trans alkenes. [Core Comp #1, 2, 3]
7. Compare and contrast substitution vs. elimination reactions of sodium acetylide with alkyl halides, indicating which halides are most easily substituted, and which are more likely to undergo elimination reactions. [Core Comp #1, 2, 3, 5]
8. Write bromine and chlorine addition reactions with alkynes. [Core Comp #1, 2, 3]
9. Write hydrogen halide addition reactions with alkynes (regioselectivity). [Core Comp #1, 2, 3]

UNIT 12 – RADICAL REACTIONS
1. Define bond dissociation energy and indicate how it differs from bond energy. [Core Comp #1]
2. Write a balanced equation for the stepwise chlorination of methane showing the successive replacement of one, two, three, and four hydrogen atoms. [Core Comp #1, 2, 3, 5]
3. Define the term free radical and give an example. [Core Comp #1]
4. State what is meant by a chain reaction. [Core Comp #1, 2]
5. State what is meant by CHAIN-INITIATING, CHAIN PROPAGATING, and CHAIN TERMINATING steps in a reaction. [Core Comp #1, 2, 5]
6. Show, by suitable balanced equations, an example of a chain reaction indicating the chain-initiation, chain propagation, and chain termination steps. [Core Comp #1, 2, 5]
7. State what is meant by a reaction inhibitor. [Core Comp #1]
8. Write a balanced equation for the halogenation of an alkane noting the conditions under which it would typically be performed. [Core Comp #1, 2, 5]
9. Write equations outlining the mechanism by which the halogenation of alkanes will normally proceed. [Core Comp #1, 2, 5]
10. Given the relative rates of reaction of 1°, 2°, and 3° hydrogen atoms, predict the isomer distribution resulting from the chlorination of an alkane. [Core Comp #1]
11. Explain why bromination of alkanes, which is much slower, is much more selective than chlorination with respect to isomer formation. [Core Comp #1, 5]
12. Show, by means of an appropriate equation, how cyclopropane derivatives can be made by means of methylene insertion reactions. [Core Comp #1, 2, 3]
13. Write a mechanism for the free radical addition reaction to alkenes using hydrogen bromide; bromine or chlorine; or compounds such as CHCl₃ and CBrCl₃ serving as the reagent being added. [Core Comp #1, 2, 3]
14. Define the terms monomer, polymer. [Core Comp #1]

LABORATORY

All procedures and reading assignments are in the lab text and / or handouts. Refer to course outline for details.

The student will be able to:

- Prepare and organize laboratory notebook prior to coming to class. [Core Comp #1, 6, 8, 9]
- Maintain a laboratory notebook that is accurate and up to date [Core Comp #1, 6, 7, 8]
- Demonstrate safety in the laboratory [Core Comp #1, 6, 7]
- Prepare organic compounds using safe and proper lab techniques [Core Comp #1, 2, 3, 9, 10, 11, 12]
- Complete syntheses using separation, purification and assessment methods [Core Comp #1, 8, 11, 12]
- Use IR spectrophotometer, chromatography and Meltemp for data acquisition then analyze the data compound identification and purity [Core Comp #1, 10, 11, 12]

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<td>Experimental Procedure-handout</td>
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<td>7</td>
<td>Extraction continued</td>
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<tr>
<td></td>
<td>Prepare Diasteromeric salts for week 8</td>
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<tr>
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<td>(see course outline for procedure)</td>
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<td>8</td>
<td>Resolution of Racemic 1-phenylethamnine</td>
<td>209 - 211</td>
</tr>
<tr>
<td></td>
<td>Experimental Procedure p226 - 228 and</td>
<td>223 - 228</td>
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<td></td>
<td>course outline</td>
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<td>9</td>
<td>Chromatography I</td>
<td>175 - 190</td>
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<td>Experimental Procedures-handout, course outline</td>
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<tr>
<td></td>
<td>column p188 - 190, TLC-pigment p180 - 182</td>
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<td>Chromatography II-Gas Chromatography</td>
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<td><strong>ChemDraw Assignment I</strong></td>
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<td>Experimental Procedure p457 - 459</td>
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<td><strong>ChemDraw Assignment II</strong></td>
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<td>12</td>
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<td>GC</td>
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<td>13</td>
<td>Dehydration of Cyclohexanol</td>
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<td>Experimental Procedure B, p349</td>
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<tr>
<td>14</td>
<td>Infrared Spectroscopy, Checkout</td>
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</tbody>
</table>
**Evaluation of student learning**

Grading: Letter grades will be assigned based on the total number of points earned in the course as compared to the total number of possible points. The percentage breakdown for letter grades is shown on the next page.

Three Hour examinations, highest 10 of 11 quizzes, and laboratory work will contribute to the total points as shown in the point composition column.

<table>
<thead>
<tr>
<th>% of maximum points</th>
<th>Grade</th>
<th>Point Composition</th>
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<tbody>
<tr>
<td>93 - 100%</td>
<td>A</td>
<td>Hour Examinations 37.5%</td>
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<tr>
<td>90 - 92%</td>
<td>A-</td>
<td>Quizzes 12.5%</td>
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<tr>
<td>87 - 89%</td>
<td>B+</td>
<td>Final Examination 20%</td>
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<tr>
<td>83 - 86%</td>
<td>B</td>
<td>Laboratory Work* 30%</td>
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<tr>
<td>80 - 82%</td>
<td>B-</td>
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</tr>
<tr>
<td>77 - 79%</td>
<td>C+</td>
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<tr>
<td>70 - 76%</td>
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<tr>
<td>60 - 69%</td>
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</tr>
<tr>
<td>0 - 59%</td>
<td>F</td>
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</tbody>
</table>

*Acceptable laboratory participation and performance is required to pass the course.

**Academic Integrity Statement:** See [http://mlink.mccc.edu/omb/OMB210.pdf](http://mlink.mccc.edu/omb/OMB210.pdf)

The following statement of ACADEMIC INTEGRITY applies to the taking of quizzes, examinations and lab reports.

Your examinations should reflect your work and knowledge alone. You may not use any outside help, written, oral or electronic. You may not use notes of any sort; nor exchange papers, comments or gestures with classmates. Such an exchange of information constitutes cheating. Any observed instance of cheating is punishable by confiscation of the examination papers and being assigned a grade of zero for the examination and a grade of “F” in the course. Any additional penalties are at the discretion of the instructor. This applies equally to the giver and receiver of information. You are just as guilty of cheating giving information to a person as is the person receiving it. All academic integrity violations will be reported to the Academic Integrity Committee as a record of academic misconduct.

Be careful not to give the appearance of cheating. Keep your eyes on your paper. Keep your papers right in front of you so they cannot be seen by the people to either side of you or the person behind you. If you have a question, raise your hand and consult with the instructor.

Your lab reports should reflect your work and knowledge alone. Plagiarism will result in a zero grade on the lab report and will be reported to the Academic Integrity Committee as an integrity violation.