BROOKDALE COMMUNITY COLLEGE

CHEM 203 – ORGANIC CHEMISTRY I

5 Credits

COURSE SYLLABUS

0903

BROOKDALE COMMUNITY COLLEGE
CHEM 203 - Organic Chemistry I
5.0 Credits

Prerequisites: CHEM 102

Course Objectives: The student will be able to name, draw, give properties, predict reaction products and provide mechanisms for selected reactions for the major classes of organic compounds The laboratory will include preparation, isolation, reaction and identification of organic compounds using modern instrumental techniques

Course Materials:

1. **Textbook:** Organic Chemistry, 4th edition
   by G Marc Loudon, Oxford University Press, Inc , 2002

2. **Lab Manual:** Theory and Practice in the Organic Laboratory, 5th edition
   by John A Landgrebe, Brooks/Cole Publishing Company, 2004

3. **Safety Goggles:** New Jersey State law requires that all impact proof safety goggles while performing laboratory experiments or during demonstration of experiments They Store

Disability Services: If you have a documented disability and would like to and/or academic adjustments, contact the Disability Adaptive Services) at (732) 224-2730 or TYY (732)

Units Of The Course:

Unit 1 Inorganic Review, Alkanes and Acid-Base Chemistry
Unit 2 Alkenes and Stereochemistry
Unit 3 Spectroscopy, Introduction to Alkyl Halides, Alcohols, Thiols, & Sulfides
Unit 4 Alkyl Halides, Alcohols, Thiols, Ethers, Epoxides & Sulfide Reactions

Core Competencies
CHEM-203 Organic Chemistry I

The following objectives of the **Scientific Perspective** and the **Critical Thinking, Problem Solving Competency** are taught in this course

Students will

2 1 identify a problem and analyze it
2 2 recognize and construct logical forms of argumentation

5 1 develop appropriate skills in observation and experimentation to solve problems
5 2 be able to analyze and interpret scientific data
5 3 be able to evaluate and apply appropriate technology

The course tests, labs, and other assignments are used to assess student attainment of these competency objectives within the context of the course curriculum

In addition, this course reinforces objective 1 1 of the **Communication Skills Competency** that states the student will "communicate information and ideas clearly and effectively in written form" Students are required to write, using correct English and Chemical symbols, responses to lab and test questions requiring explanations, comparisons, and/or interpretation of results

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Name of Unit: Introduction to Organic Chemistry Lecture and Laboratory

Unit Objective: Students will be able to use electronic structures of ions and molecules and their component atoms to determine formal charges, geometries, polarities and hybrid states Students will be able to draw Lewis and resonance structures and determine bond orders Draw and name alkanes their conformational and configurational isomers For alkanes give and explain physical properties and write combustion reactions Define Bronsted-Lowry and Lewis acids and bases and use them in predicting reaction products Relate acidity to Free Energy and the Element and Polar (inductive) effects

Text: Loudon, G Marc, Organic Chemistry, 4th edition Chapters 1, 2 & 3

Lab Manual: Landgrebe,, John A, Theory and Practice in the Organic Laboratory, 4th edition, Brooks/Cole Publishing Company, 1993
Experiments 3 (Determination of Melting points), 2 (Thin-Layer Chromatography), Handout (Gas Chromatography), 6 (Fractional Distillation), 10 (Extraction & Recrystallization)

Objectives	Recommended Learning Experiences
You will be able to	
1 state in your own words what each is with an example a polar- and non-covalent bonds b coordinate-covalent bond c ionic bond d bonded and non-bonded (lone) electron pairs e formal charges	1 Review these concepts in your General Chemistry text Chapter 1 Problems 1 3, 1 6, 1 7, 1 18-1 21, 1 31 & 1 33
2 draw atomic orbitals, ground-state and hybrid states (sp, sp^2, sp^3) for Carbon and its ligands State geometries and bonding associated with each Give and recognize examples of each	2 Chapter 1 Problems 1 8, 1 9, 1 17 & 1 24

3 draw a Lewis structures, b conformational isomers, c resonance contributing forms and d resonance hybrids for any given ion or molecule	3 Chapter1 Problems a 1 3, 1 5 b 1 10 c 1 11, 125 & 1 26 d see 'c'
4 for molecular orbitals, draw and describe a bonding orbitals b anti-bonding orbitals c orbital symmetry (σ and π)	4 Chapter1 Problems 1 15, 1 36 & 1 37
5 recognize and give functional groups and an example of each of these classes of hydrocarbons a Alkanes (Paraffins) b Alkenes (Olefins) c Alkynes (Acetylenes) and d Aromatics (Benzenoids)	5 Chapter2 Problems 2 1, 2 2, 2 40 & 2 41
6 name (IUPAC and Common names) and draw alkanes (cyclic and acyclic) in/from molecular, condensed and structural formulae	6 Chapter2 Problems 2 5-2 7, 2 10, 2 11, 2 24-2 26 Appendix A-1
7 identify carbons and hydrogens as 1°, 2°, 3° or 4°	7 Chapter2 Problems 2 9, 2 22 & 2 23
8 perform conformational analyses for alkanes using saw-horse and Newman projections	8 Chapter2 Problems 2 3, 2 27 & 2 30
9 draw and name all constitutional (configurational) isomers for any alkane	9 Chapter2 Problems 2 21
10 describe the physical properties of alkanes and explain variations in physical properties especially with respect to boiling, melting, solubility and density	10 Chapter2 Problems 2 12-2 14 & 2 20
11 write reaction equations for alkane combustion	11 Chapter2 Problems 2 36 & 2 39
12 define Lewis acid and base, electrophile and nucleophile and identify each in a reaction	12 Chapter3 Problems 3 1 - 3 4 & 3 18
13 explain with illustrations Lewis acid-base theory and be able to apply the curved-arrow formalism to Lewis acid-base reactions	13 Chapter3 Problems 3 1 - 3 4 3 19, 3 21 & 3 23

14 Define Bronsted-Lowry acid and base, conjugate acid, conjugate base and be able to determine relative acidities and basicities for conjugate acids and bases	14 Chapter 3 Problems 3 5 - 3 12, 3 20 & 3 21
15 Explain with illustrations Bronsted-Lowry acid-base theory	15 Chapter 3 Problems 3 5 - 3 7
16 Relate the standard Free Energy (ΔG^{o}) of a reaction to its equilibrium constant	16 Chapter 3 Problems 3 13, 3 14, 3 16, 3 17 & 3 28 - 3 32
17 Explain variations in acidity based upon a the Element Effect and b the Polar (Inductive) Effect	17 Chapter 3 Problems 3 15, 3 17, 3 34, 3 36, 3 39 & 3 40
18 Demonstrate laboratory techniques in a Melting Points b Thin-Layer Chromatography c Gas Chromatography d Distillation e Extraction	18 Experiments a 3 Determination of Melting points b 2 Thin-Layer Chromatography c Handout (Gas Chromatography) d 6 Fractional Distillation e 10 Extraction & Recrystallization

Course Objectives: The student will be able to name, draw, give properties, predict reaction products and provide mechanisms for selected reactions for the major classes of organic compounds The laboratory will include preparation, isolation reaction and identification of organic compounds using modern instrumental techniques

Name of Unit: Alkenes and Stereochemistry

Unit Objective: Students will be able to name, draw, explain variations in physical properties, explain variations in stabilities of synthesize and write addition reaction products for alkenes and provide mechanisms for the reactions Draw, name and give properties for constitutional (geometric) and stereoisomers Show how stereoisomers can be used to help elucidate reaction mechanisms

Text: Chapters 4, 5, 6, 7 (§'s 7-9)

Lab Manual: Experiment Handout on Hydrocarbon Chemistry

Objectives	Recommended Learning Experiences
You will be able to	
1 Draw and name alkenes including the cis-trans and E-Z-systems for constitutional (geometric) and stereoisomers	1 Chapter 4 Problems 4 1 - 4 6, 4 35, 4 38-4 41 & 4 42
2 Determine unsaturation numbers (Ω or U) given a structural or molecular formula and given unsaturation numbers give structural features that might account for them	2 Chapter 4 Problems 4 7-4 10 Chapter 5 Problems 5 38
3 Draw orbital diagrams for alkenes and use them to explain their stability and reactivity	3 Chapter 4 Problems 4 15, 4 16 & 4 37
4 Explain the physical properties of alkenes based upon molecular geometry and the hybridization (sp^2) of the vinyl carbons especially with respect to boiling, melting, solubility and density and E-Z isomerism	4 Chapter 4 Problems 4 11, 4 41, 4 43 & 4 44
5 Synthesize alkenes and predict products for alkene reactions and use these reactions in syntheses	5 Chapter 4 Problems 4 17,4 18,4 21,4 28-4 34,4 36 & 4 45-4 48 Chapter 5 Problems 5 1-5 7,5 9,5 15,5 18,5 19-5 21,5 25,5 26,5 28 & 5 31

6 Explain the Electrophilic Addition mechanism for alkenes Include the addition, regioselectivity, carbocation formation rearrangements, carbocation stability and stereochemistry	6 Chapter 4 Problems 4 21, 4 22, 4 23, 4 25-4 27, 4 30, 4 31, 4 36, 4 49, 4 50, 4 51, 4 55, 4 56, 4 59 & 4 61 Chapter 5 Problems 5 23, 5 38 & 5 39
7 Explain the Free Radical mechanism for addition to alkenes Include the addition, the peroxide effect, free radical formation, free radical stability and regioselectivity	7 Ch 5 Problems 5 19-5 21, 5 30, 5 36 & 5 40
8 For stereoisomerism explain with examples a plane-polarized light b (+), (-), (±), (d), (l), (dl) c enantiomers d diastereomers e racemate f meso compounds g R and S h chiral center, asymmetric center i Fischer Projections	8 Ch 6 Problems 6 13, 6 16, 6 19, 6 26, 6 27, 6 34, 6 35, 6 37, 6 39, 6 41, 6 42
9 Determine whether a substance is optically active	9 Ch 6 Problems 6 1-6 4, 6 19-6 22, & 6 45
10 Draw and name R/S configurations for substances	10 Ch 6 Problems 6 5, 6 6, 6 8, 6 11, 6 25 & 6 28-6 31
11 Describe how enantiomers can be resolved	11 Ch 6 Problems 6 15
12 Describe how stereochemistry a affects reactivity b products formed c can be used to determine reaction mechanisms, eg for alkene additions and alkyl halide substitutions	12 Ch 6 Problems 6 40 Ch 7 read sections 7 through 9 Ch 7 Problems 7 22-7 29, 7 41, 7 42, 7 44 & 7 49
13 Demonstrate some of the properties of hydrocarbons in the laboratory	13 Handout Chemistry of Hydrocarbons

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Name of Unit: Spectroscopy & An Introduction to Alkyl Halides, Alcohols, Ethers, Thiols, Sulfides and Organometallics

Unit Objective: Students will be able to name, draw, explain variations in physical properties, syntheses and some of the chemical properties of alkyl halides, alcohols, ethers, thiols and sulfides Be able to describe properties of solvents They will also be able to identify substances from IR and NMR Spectra

Text: Chapters 12 (omit § 6), 13, 8 Also, Appendices A-2 through A-7

Lab Manual: Experiment 30 Revised (Infrared), 31 Revised (NMR + NMR/IR)

Objectives	Recommended Learning Experiences
You will be able to	
1 Perform calculations involving wavelength, wavenumber, frequency and energy	1 Ch 12 Problems 12 1-12 6
2 Correlate IR position of absorption with bond strength	2 Ch 12 Problems 12 5-12 7, 12 11, 12 26 & 12 27
3 Use Infrared and/or NMR spectra to identify compounds	3 Ch 12 Problems 12 10, 12 23(a,b), 12 24, 12 25 & 12 28 Ch 13 Problems 13 9-13 15, 13 20, 13 21, 13 34, 13 39, 13 43 & 13 44
4 For NMR spectra use or predict a degree of unsaturation (Ω) b number of peaks c chemical shifts (δ) d peak areas and e splitting to interpret NMR spectra	4 Ch 13 Problems 13 1-13 8, 13 10, 13 12-13 17, 13 30, 13 31, 13 35, 13 36 & 13 38
5 Correlate electronegativity, proximity to electronegative groups, contributions of multiple groups, class (1°, 2°, 3°), hybridization, hyperconjugation and unsaturation with chemical shifts in NMR	5 Ch 13 Problems 13 4-13 6, 13 22 & 13 23

6 Draw and name alkyl halides, alcohols, ethers, thiols and sulfides	6 Chapter 8 Problems 8 1-8 7, 8 27 & 8 32
7 Explain the physical properties of alkyl halides, alcohols, ethers, thiols and sulfides	7 Ch 8 Problems 8 9-8 12, 8 17-8 18, 8 30-8 31 & 8 35
8 Explain the properties of solvents	8 Ch 8 Problems 8 13-8 16, 8 40 & 8 41
9 Explain the acidity of alcohols and thiols and basicity of alcohols and ethers	9 Ch 8 Problems 8 20, 8 33, 8 34 & 8 37
10 Write equations for the synthesis and protonolysis of Grignard and organolithium compounds	10 Ch 8 Problems 8 21-8 24, 8 44 & 8 46
11 Write equations for the synthesis by free-radical chain reaction of alkyl halides	11 Ch 8 Problems 8 25, 8 26, 8 45 & 8 48
12 Study IR and NMR spectroscopy in the laboratory a Infrared Spectroscopy (IR) b Nuclear Magnetic Resonance (NMR)	12 Experiment a 30 Revised (Infrared) b 31 Revised (NMR + NMR/IR

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Name of Unit: Alkyl Halides, Alcohols, Ethers, Epoxides, Thiols and Sulfides

Unit Objective: Students will be able to synthesize and predict reaction products for alkyl halides, alcohols, ethers, epoxides, thiols and sulfides and provide mechanisms for the reactions Be able to give a detailed look at the Nucleophilic Substitution (S_N1 & S_N2) and Elimination (E1 & E2) reactions

Text: Chapters 9, 10, 11

Lab Manual: Experiment 34 (Carbocation Rearrangements), 18 (Hydroboration)

Objectives	Recommended Learning Experiences
You will be able to	
1 Predict and name reaction products for alkyl halides, alcohols, ethers, epoxides, thiols and sulfides	1 Ch 9 Problems 9 1-9 3 Ch 10 Problems 10 1-10 3, 10 5, 10 8, 10 10-10 13, 10 22, 10 23, 10 29, 10 31, 10 36, 10 40, 10 41, 10 47 & 10 48 Ch 11 Problems 11 1-11 11, 11 15-11 17, 11 20-11 23, 11 32, 11 34, 11 39 & 11 49
2 Give mechanisms for S_N1, S_N2, E1, E2, Alcohol Dehydration (for alkenes and ethers) & Oxidation (including NAD^+ the bio-catalyst), alcohols with thionyl chloride, Williamson synthesis, alkoxymercuration of alkenes, epoxide formation (from peroxyacids and halohydrins), ether & epoxide cleavage, Grignard reaction with epoxides, oxonium and sulfonium salt and intramolecular (neighboring group participation) reactions	2 Ch 9 Problems 9 4-9 13, 9 14, 9 16, 9 17, 9 18-9 20, 9 21-9 23, 9 24, 9 29-9 33, 9 35-9 37, 9 39, 9 42, 9 43, 9 52 & 9 55 Ch 10 Problems 10 4, 10 6, 10 26, 10 37,10 50-10 52, 10 54 & 10 55 Ch 11 Problems 11 3, 11 12-11 14, 11 18, 11 19, 11 24, 11 31, 11 35, 11 36, 11 41,11 43, 11 51 & 11 63
3 Predict and name products for carbene (carbenoid) reactions and use the reaction in syntheses	3 Ch 9 Problems 9 25-9 26
4 Determine oxidation numbers for elements from Lewis structures and be able to use these to determine whether a reaction is a redox reaction	4 Ch 10 Problems 10 18, 10 38

5 Balance alcohol redox equations using the half-reaction (half-cell) method	5 Read §10 5B pp 463-466 Ch 10 Problems 10 19, 10 21 & 10 42
6 For the S_N1, S_N2 reactions give the a rate equation b mechanism c stereochemistry d effect of alkyl halide structure e effect of nucleophile/base strength f solvent effect g basicity of leaving group	6 Ch 9 Problems 9 4-9 7, 9 9-9 12, 9 22, 9 32-9 33, 9 35-9 36, 9 38-9 39, 9 41-9 42,
7 For the E1, E2 (β-elimination) reactions give the a rate equation b mechanism c primary isotope effect d stereochemistry e regioselectivity f effect of alkyl halide structure g effect of nucleophile/base strength h solvent effect i basicity of leaving group	7 Ch 9 Problems 9 13, 9 15-16, 9 22, 9 44, 9 51-9 52, 9 59
8 Discuss conditions which affect the competition between substitution and elimination reactions for alkyl halides	8 Ch 9 Problems 9 17-9 21
9 Determine equivalent atoms	9 Ch 10 Problems 10 25 & 10 36
10 Study carbocation rearrangements and properties of alkenes in the laboratory	10 Experiment a 34 (Carbocation rerrangements) b 18 (Hydroboration)