GRANDE PRAIRIE REGIONAL COLLEGE

DEPARTMENT OF SCIENCE: CHEMISTRY

FORTY-THIRD SESSION 2008 – 2009

COURSE OUTLINE: ORGANIC CHEMISTRY

CH2610 A2

CH2610A2: Organic Chemistry I; Prerequisite, CH1010 or CH1030

INSTRUCTOR: Dr. John P. Sloan
Office # J207
Phone # 539-2004
E-mail SLOAN@GPRC.AB.CA

LECTURE: CH2610 T, R 11:30 - 12:50 in J204

ALBERTA TRANSFER CREDIT
(Ref: 2008-2009 Guide to Transfer Credit at Alberta Post-Secondary Institutions)

GPRC:	CH2610	(3)
U of Alberta:	CHEM 261	(3) or AUCHE 250 (3)
U of Calgary:	CHEM 351	(3)
U of Lethbridge:	CHEM 2500	(3)
Athabasca U:	CHEM 350	(3)
Canadian UC:	CHEM 241	(4)
Concordia UC:	CHEM 261	(3)

COURSE OUTLINE:

LECTURE COMPONENT:

A study of the fundamental principles of the chemistry of carbon compounds. The study is based on a reaction mechanism approach to the functional group chemistry of alkanes, alkenes, alkynes, cycloalkanes, alkyl halides, alcohols and ethers. Topics include: structure and bonding; physical properties; acidity and basicity; conformations of molecules; stereochemistry; addition, elimination and

substitution reactions; structure-reactivity relationships; and introduction to methods for structure determination.

A representative selection of molecules found in agricultural, biological, environmental, industrial, medical, and pharmatheutical applications of organic chemistry will be discussed, e.g., molecules found in agrochemicals, fibres, food additives, perfumes, polymers, and prescription drugs.

LABORATORY COMPONENT:

Laboratory Techniques in organic chemistry; preparation of some organic compounds, and; methods of qualitative organic analysis.

TUTORIAL COMPONENT:

Problem solving and discussion sessions with short problem sets for completing and marking during the tutorial. In addition, weekly assignments consisting of 10 questions per assignment will be given. These assignments will consist of exam type questions and do not need to be submitted for marking. Detailed solutions to the assignments will be posted on Blackboard about 1 week after distribution.

NOTES:

1. Lectures, Time and Place
   CH2610 A2 T, R 11:30 - 12:50 in J204

2. Laboratory Component, Time and Place
   CH2610 L1 T 14:30 - 17:20 in J116

3. Tutorial Component, Time and Place
   CH2610 S1 F 8:30 – 9:20 in J204

4. Office Hours: Individual and group assistance will normally be available in office J207 during regular college business hours outside of formal class lecture, laboratory and tutorial hours.

TEXT BOOKS AND LABORATORY ITEMS:

<u>The following text books are required:</u>

CH2610

Either,
Solomons, T.W.G., and C.B. Fryhle, *Organic Chemistry,* 9th Edition, Wiley, 2008

Or,
Wade, L.G.(Jr), *Organic Chemistry,* 6th Edition, Pearson Prentice-Hall, 2006.

CH2610

A Three Ring Binder to Hold: Sloan, J.P., *Organic Chemistry Experiments, Chemistry 2610/2630,* Grande Prairie Regional College, 2008/2009.

The following is highly recommended:

Molecular Model Set for Organic Chemistry, Prentice Hall.

The following are supplementary items:

1. Fernandez, J.E., and Solomons, T.W.G., *Study Guide and Solutions Manual to Organic Chemistry*, 9th Edition, 2008;
2. Simek, J.W., Wade L.G.(Jr), Solutions Manual to Organic Chemistry, 6th Edition.

Note:

1. All required and supplementary books, molecular structure model sets, safety glasses, and lab coats are available at the College Bookstore. *Organic Chemistry Experiments*, by J.P. Sloan, will be given as handouts in advance of each lab period. These are to be inserted in a three ring binder.

EVALUATION:

Examination Schedule and Composition of the Final Grade:

1. Midterm Exam # 1, Friday October 10 ---------- 15%
2. Midterm Exam # 2, Friday November 14 ---------- 20%
2. Final Exam to be scheduled between December 10 - 19 ------ 35%
3. Laboratory ---------- 25%
4. Tutorial Grading Component ---------- 5%

100%

The Grades are based on the alpha grading system. The Registrar's Office will convert alpha grades to four-point equivalence for the calculation of grade point averages. Alpha grades, 4-point equivalence, and grade descriptors are as follows:

Alpha Grade	4-Point Equivalence	Descriptor
A^+	4.0	Excellent
A	4.0	
A-	3.7	Very Good First Class Standing
B+	3.3	
B	3.0	Good
B-	2.7	
C+	2.3	Satisfactory
C	2.0	
C-	1.7	
D+	1.3	Poor*
D	1.0	Minimal Pass*
F	0.0	Failure

* Other post secondary institutions may not award transfer credit for grades of D and D+.

Notes:

1. The Mid-Term Exams will be of 1.5 hours duration and the Final Exam will be of 3 hours duration.

2. Between 5 and 15% of exam content will be taken from a combination of weekly assignments and questions in the organic chemistry textbooks by Solomons and Fryhle, and by Wade.

3. A pass grade is essential for the Laboratory Component.

4. The Tutorial Grading Component consists of short tests at the end of each seminar and will contribute towards 5% of the final grade. A 10 question assignment will normally be given each week. To encourage general discussion and active student participation, assignment questions may be answered within, "paired teams/study groups". The assignments do not need to be submitted for grading, however, students are encouraged to complete all assignments. Detailed solutions to the assignments will be posted on Blackboard. Assistance with assignments will be given upon request.

5. Regular attendance in Lecture, Laboratory, and Tutorial Components is a Course Requirement.

Grande Prairie Regional College Calendar 2008 - 2009: Course Description (p 178).

CH2610 3(3-1-3)UT, 105 Hours, Organic Chemistry I

The correlation of structure and bonding in carbon compounds with the physical properties and chemical reactivity of organic molecules. Discussion will be based on functional groups with emphasis on hydrocarbons and derivatives that contain halogens, oxygen, sulphur and the hydroxyl group. Introduction to stereochemistry, three dimensional structure, reaction mechanisms, especially addition to double bonds, nucleophilic substitution and elimination reactions, and methods of structure determination. The study covers the functional group chemistry of alkanes, alkenes, alkynes, alcohols, ethers and sulfides.
Prerequisites: CH1010 or CH1030
Notes: Credit will be granted for only one of CH1610 or CH2610
Transfer: UA, UC, UL, AU, AF, CU, CUC, KUC

CHEMISTRY 2610: READING, STUDYING, AND PRACTICE PROBLEMS

All references are to T.W.G. Solomons and C.B. Fryhle, *Organic Chemistry*, 9th Edition, Wiley, 2008.

FALL SEMESTER

Weeks of
Sept 4 & 8: THE BASICS: Bonding and Molecular Structure
Molecular Graphic: Glycine, an organic molecule found in space

Sect #	**Page #**	Read and Study Chapter 1 "We are Star Dust"
1.1	2	Organic Chemistry and Life
1.2	3	The Structural Theory of Organic Chemistry
1.3	4	Isomers: The Importance of Structural Formulas
1.4	5	Chemical Bonds: The Octet Rule
1.5	7	Writing Lewis Structures
1.6	9	Exceptions to the Octet Rule
1.7	10	Formal Charge
1.8	13	Resonance Theory
1.8A	15	Summary of Rules for Resonance
1.9	18	Quantum Mechanics and Atomic Structure
1.10	20	Atomic Orbitals and Electron Configuration:
1.10A	21	Aufbau Principle; the Pauli Exclusion Principle; Hund's Rule
1.11	21	Molecular Orbitals: Bonding and Antibonding
1.12	24	The Structure of Methane and Ethane: sp^3 Hybridization;
1.12A	24	The Structure of Methane
1.12B	27	The Structure of Ethane
1.13	28	The Structure of Ethene (Ethylene): sp^2 Hybridization
1.13A	31	Restricted Rotation and the Double Bond
1.13B	32	Cis-Trans Isomers
1.14	33	The Structure of Ethyne (Acetylene): sp Hybridization
1.14A	34	Bond Lengths of Ethyne, Ethene, and Ethane
1.15	35	A Summary of Important Concepts that Come from Quantum Mechanics
1.16	36	Molecular Geometry: The Valence Shell Electron-Pair Repulsion (VSEPR) Model.
1.16A-F	37	Molecular Geometry: VSEPR Models for Methane, Ammonia, Water, Boron Trifluoride, Berylium Hydride and Carbon Dioxide
1.17	39	Representation of Structural Formulas: Dash; Condensed; Bond Line; and the Three Dimensional Wedge, Dash, Line Representation
1.18	44	Applications of Basic Principles: Opposite Charges Attract; Like Charges repel; Nature Tends Towards States of Lower Potential Energy; Orbital Overlap Stabilizes Molecules
	45	Key Terms and Concepts
	46	Concept Map

Practice Problems: You are encouraged to work all of the in-chapter problems, and you are required to complete the short in-class weekly assignments. Routinely doing problems in organic chemistry leads to understanding of the theory, and good grades in organic chemistry.

In the words of Solomons and Fryhle:

"*One way to check your progress is to work each of the in-chapter problems when you come to it. These problems have been written just for this purpose and are designed to help you decide whether or not you understand the material that has just been explained.*"

And, in the words of Wade:

"*It's easy to fool yourself into thinking you understand organic chemistry when you actually do not. As you read through this book, all the facts and ideas may make sense, yet you have not learned to combine and use those facts and ideas. An examination is a painful time to learn that you do not really understand the material.*

The best way to understand organic chemistry is to use it. You will certainly need to read and reread all the material in the chapter, but this level of understanding is just the beginning. Problems are provided so you can work with the ideas, applying them to new compounds and new reactions that you have never seen before. By working problems, you force yourself to use the material and fill in the gaps in your understanding. You also increase your level of self-confidence and your ability to do well on exams".

Problems:	In-Chapter	1.1 to 1.15
47	End of Chapter	1.16 to 1.38
50	Learning Group Problem	

Week of Sept 15: REPRESENTATIVE CARBON COMPOUNDS: Functional Groups, Intermolecular Forces, and Infrared (IR) Spectroscopy

		Read and Study Chapter 2
	51	Structure and Function: Organic Chemistry, Nanotechnology, and Bioengineering
2.1	52	Carbon-Carbon Covalent Bonds
2.2	52	Hydrocarbons: Representative, Alkanes, Alkenes, Alkynes, and Aromatic Compounds
2.3	55	Polar Covalent Bonds
2.4	56	Polar and Nonpolar Molecules
2.4A	58	Dipole Moments in Alkenes
2.5	59	Functional Groups
2.5A	59	Alkyl Groups and the Symbol R
2.5B	60	Phenyl and Benzyl Groups
2.6	60	Alkyl Halides or Haloalkanes
2.7	61	Alcohols, including Classification as Primary, Secondary and Tertiary (1E, 2E, 3E)
2.8	63	Ethers
2.9	63	Amines, including Classification as Primary, Secondary and Tertiary
2.10	65	Aldehydes and Ketones
2.11	65	Carboxylic Acids, Esters, and Amides
2.12	67	Nitriles
2.13	68	Summary of Important Families of Organic Compounds
2.14	68	Physical Properties and Molecular Structure with emphasis on Intermolecular Interactions, namely:
2.14A	69	Ion-Ion Forces in ionic compounds, e.g. sodium acetate, sodium chloride
2.14B	70	Dipole-Dipole Forces resulting from permanent dipoles, e.g. acetone, chloromethane

Week of Sept 22: AN INTRODUCTION TO ORGANIC REACTIONS: ACIDS AND BASES IN ORGANIC CHEMISTRY

1. Size Effect, acidity increases upon descending a column in the Periodic Table, H-I is a stronger acid than H-F; the acidity order is: H-I > H-Br > H-Cl > H-F
2. Electronegativity Effect, acidity increases from left to right in the Periodic Table, H-F is a stronger acid than CH_4; the acidity order is: HF > H_20 > NH_3 > CH_4

3.7A 107 3. The Effect of Hybridization, more s-character means the anion has lower energy, is more stable, and is a weaker base

3.7B 108 4. Inductive Effects, from polarization by electron attracting and electron withdrawing groups

3.8 108 Energy Changes; higher potential and kinetic energy implies less stable, lower energy implies more stable

3.8A 109 Potential Energy and Covalent Bonds, exothermic reactions give out heat, endothermic reactions absorb heat

3.9 110 The Relationship Between the Equilibrium Constant and the Standard Free-Energy Change, ΔG^o; a negative value favours products at equilibrium

3.10 111 The Acidity of Carboxylic Acids, with explanations arising from Resonance Effects and Inductive Effects

3.10A 112 The Effect of Delocalization: An Explanation based on Resonance Effects, due to resonance stabilization of the carboxylate anion

3.10B 113 An Explanation based on Inductive Effects, due to inductive withdrawal of electronic charge by –O and -C=O in carboxylate anions

3.10C 114 Summary of a Comparison of Conjugate Acid-Base Strengths

3.10D 114 Inductive Effects of Other Groups

3.11 115 The Effect of Solvent on Acidity - Protic Solvents

3.12 116 Organic Compounds as Bases

3.13 117 A Mechanism for an Organic Reaction

118 The Chemistry of carbonic Anhydrase

3.14 119 Acid and Base in Nonaqueous Solutions

3.15 120 Acid-Base Reactions, and Synthesis of Deuterium- and Tritium-Labelled Compounds

3.16 121 Applications of Basic Principles: Electronegativity Differences Polarize Bonds; Polarized Bonds Underlie Inductive Effects; Opposite Charges Attract; Nature Prefers States of Lower Potential Energy; Resonance Effects Can Stabilize Molecules and Ions

122 Key Terms and Concepts

123 Concept Map

Problems: In-Chapter 3.1 to 3.14

124 End of Chapter 3.15 to 3.42

127 Learning Group Problem

Week of Sept 29: NOMENCLATURE AND CONFORMATIONS OF ALKANES AND CYCLOALKANES

Read and Study Chapter 4

129 To be Flexible or Inflexible - Molecular Structure Makes the Difference

4.1 130 Introduction to Alkanes and Cycloalkanes

4.1A 130 Sources of Alkanes: Petroleum

130 The Chemistry of Petroleum Refining

131 Typical Fractions Obtained by Distillation of Petroleum

Problems: In-Chapter 4.1 to 4.21
178 End of Chapter 4.22 to 4.54
180 Learning Group Problems

Week of Oct 6: STEREOCHEMISTRY: CHIRAL MOLECULES

Read and Study Chapter 5

	181	The Handedness of Life
5.1	182	The Biological Significance of Chirality
5.2	183	Isomerism, Constitutional Isomers and Stereoisomers
5.3	184	Enantiomers and Chiral Molecules
5.4	187	More about the Biological Importance of Chirality
5.5	188	The Historical Origin of Stereochemistry
5.6	189	Tests for Chirality, Planes of Symmetry and Points of Symmetry
5.7	190	Nomenclature of Enantiomers: The R-S System
5.8	194	Properties of Enantiomers, Optical Activity
5.8A	195	Plane-Polarized Light
5.8B	195	The Polarimeter
5.8C	195	Specific Rotation
5.9	198	The Origin of Optical Activity
5.9A	199	Racemic Forms
5.9B	199	Racemic Forms and Enantiomeric Excess
5.10	200	The Synthesis of Chiral Molecules
5.10A	200	Racemic Forms
5.10B	201	Stereoselective Synthesis
5.11	202	Chiral Drugs
	203	The Chemistry of: Selective Binding of Drug Enantiomers to Left- and Right-Hand Coiled DNA
5.12	203	Molecules with More Than One Chirality Centree
5.12A	205	Meso Compounds
5.12B	206	Naming Compounds with More than One Chirality Centre
5.13	207	Fischer Projection Formulas
5.14	209	Stereoisomerism of Cyclic Compounds
5.14A	209	Cyclohexane Derivatives
5.15	211	Relating Configurations Through Reactions in Which No Bonds to the Chirality Centre are Broken
5.15A	212	Relative and Absolute Configurations
5.16	213	Separation of Enantiomers: Resolution
5.16A	214	Pasteur's Method for Separating Enantiomers
5.16B	214	Current Methods for Resolution of Enantiomers
5.17	214	Compounds with Chirality Centres Other than Carbon
5.18	215	Chiral Molecules that do not Possess a Chirality Centre (a Tetrahedral Atom with Four Different Groups Attached)
	216	Key Terms and Concepts
	217	Concept Map

Problems: In-Chapter 5.1 to 5.29

	218	End of Chapter 5.30 to 5.44
	220	Learning Group Problems
		Additional Problems - The CD accompanying the text book includes a set of computer molecular model stereochemistry exercises that are keyed to the text

Weeks of Oct 13 & 20: IONIC REACTIONS: Nucleophilic Substitution and Elimination Reactions of Alkyl Halides

Read and Study Chapter 6

	221	Breaking Bacteria Cell Walls With Organic Chemistry
6.1	222	Organic Halides
	222	Table 6.1: Carbon-Halogen Bond lengths and Bond Strengths
6.1A	223	Physical Properties of Organic Halides
	223	Table 6.2: Organic Halides
6.2	224	Nucleophilic Substitution Reactions
6.3	224	Nucleophiles
6.4	225	Leaving Groups
6.5	226	Kinetics of a Nucleophilic Substitution Reaction - a Substitution Nucleophilic Bimolecular (S_N2) Reaction
6.6	227	A Mechanism for the S_N2 Reaction
6.7	228	Transition State Theory: Free-Energy Diagrams
6.8	229	The Stereochemistry of S_N2 Reactions
6.9	235	The Reaction of Tert-Butyl Chloride with Hydroxide Ion: An S_N1 Reaction
6.9A	235	Multistep Reactions and the Rate-Determining Step
6.10	236	A Mechanism for the S_N1 Reaction
6.11	237	Carbocations
6.11A	237	The Structure of Carbocations
6.11B	238	The Relative Stabilities of Carbocations
6.12	239	The Stereochemistry of S_N1 Reactions
6.12A	239	Reactions That Involve Racemization
6.12B	240	Solvolysis – Cleavage of the Solvent by the Nucleophile
6.13	241	Factor's Affecting the Rates of S_N1 and S_N2 Reactions
6.13A	241	The Effect of the Structure of the Substrate
	241	Table 6.4: Relative Rates of Reactions of Alkyl Halides in S_N2 Reactions
	243	S_N1 Reactions and the Hammond-Leffler Postulate
6.13B	244	The Effect of the Concentration and the Strength of the Nucleophile
	244	Nucleophilicity versus Basicity
6.13C	245	Solvent Effects on S_N2 Reactions: Polar Protic and Aprotic Solvents
6.13D	247	Solvent Effects on S_N1 Reactions: The Ionizing Ability of the Solvent
	247	Table 6.5: Dielectric Constants of Common Solvents
6.13E	247	The Nature of the Leaving Group
	249	Summary of S_N1 versus S_N2
	249	Table 6.6: Factors Favouring S_N1 versus S_N2 Reactions
6.14	250	Organic Synthesis - Functional Group Transformations Using S_N 2 Reactions
	251	The Chemistry of ... Biological Methylation: A Biological Nucleophilic Substitution Reaction
6.14A	252	The Unreactivity of Vinylic and Phenyl Halides
6.15	253	Elimination Reactions of Alkyl Halides

Week of Oct 27: ALKENES AND ALKYNES I: Properties and Synthesis. Elimination Reactions of Alkyl Halides

Read and Study Chapter 7

Week of Nov 3: ALKENES AND ALKYNES II: Addition Reactions.

Read and Study Chapter 8.

Week of Nov 10: RADICAL REACTIONS

Read and Study Chapter 10

Problems: In-Chapter 10.1 to 10.22
461 End of Chapter 10.23 to 10.34
463 Learning Group Problems.

Week of Nov 17: ALCOHOLS AND ETHERS.

Read and Study Chapter 11.

	469	Molecular Hosts
11.1	470	Structure and Nomenclature
11.1A	471	Nomenclature of Alcohols
11.1B	472	Nomenclature of Ethers
11.2	472	Physical Properties of Alcohols and Ethers
	473	Tables 11.1 and 11.2: Physical Properties of Ethers and Alcohols
11.3	474	Important Alcohols and Ethers
11.3A-D	474	Methanol, Ethanol, Ethylene Glycol, Diethyl Ether
11.4	476	Synthesis of Alcohols from Alkenes
	476	1. Acid-Catalyzed Hydration of Alkenes
	477	2. Oxymercuration-Demercuration
	477	3. Hydroboration-Oxidation
11.5	478	Reactions of Alcohols
11.6	479	Alcohols as Acids
11.7	480	Conversion of Alcohols into Alkyl Halides
11.8	480	Alkyl Halides from the Reactions of Alcohols with Hydrogen Halides
11.8A	481	Mechanisms of the Reactions of Alcohols with HX
11.9	483	Alkyl Halides from the Reactions of Alcohols with PBr_3 or $SOCl_2$
11.10	484	Tosylates, Mesylates and Triflates: Leaving Group Derivatives of Alcohols
	487	The Chemistry of Alkyl Phosphates
11.11	487	Synthesis of Ethers
11.11A	487	Ethers by Intermolecular Dehydration of Alcohols
11.11B	489	The Williamson Synthesis of Ethers
11.11C	490	Synthesis of Ethers by Alkoxymercuration-Demercuration
11.11D	490	tert-Butyl Ethers by Alkylation of Alcohols: Protecting Groups
11.11E	491	Silyl Ether Protecting Groups
11.12	482	Reactions of Ethers: Ether Cleavage by Strong Acids
11.13	493	Epoxides
11.13A	493	Synthesis of Epoxides: Epoxidation of Alkenes
11.13B	495	Stereochemistry of Epoxidation
	494	The Chemistry of The Sharpless Asymmetric Epoxidation
11.14	496	Reactions of Epoxides: 1. Acid Catalyzed Ring Opening 2. Base Catalyzed Ring Opening
	498	The Chemistry of Epoxides, Carcinogens, and Biological Oxidation
11.14A	499	Polyethers from Epoxides
11.15	500	Anti 1,2-Dihydroxylation of Alkenes via Epoxides
	502	The Chemistry of Environmentally Friendly Alkene Oxidation Methods
11.16	503	Crown Ethers: Nucleophilic Substitution Reactions in Relatively Nonpolar Aprotic Solvents by Phase-Transfer Catalysis
11.16A	504	Crown Ethers
11.16B	506	Transport Antibiotics and Crown Ethers
11.17	506	Summary of Reactions of Alkenes, Alcohols and Ethers
11.17A	506	Alkenes in Synthesis
	507	Key Terms and Concepts.

508 Summary and Review Tool: Some Synthetic Connections of Alkynes, Alcohols, Alkyl Halides and Ethers

Problems: In-Chapter 11.1 to 11.24

509 End of Chapter 11.25 to 11.51

512 Learning Group Problems.

Week of Nov 24: ALCOHOLS FROM CARBONYL COMPOUNDS: OXIDATION-REDUCTION AND ORGANOMETALLIC COMPOUNDS.

Read and Study Chapter 12

513 The Two Aspects of the Coenzyme NADH

12.1 514 Introduction

12.1A 514 Structure of the Carbonyl Group

12.1B 515 Reactions of Carbonyl Compounds with Nucleophiles

12.2 515 Oxidation-Reduction Reactions in Organic Chemistry

12.2A 516 Oxidation States of Organic Chemistry

12.3 517 Alcohols by Reduction of Carbonyl Compounds

12.3A 517 Lithium Aluminum Hydride Reductions of Carbonyl Compounds

12.3B 518 Sodium Borohydride Reductions of Carbonyl Compounds

12.3C 519 Overall Summary of $LiAlH_4$ and $NaBH_4$ Reactivity

519 The Chemistry of Alcohol Dehydrogenase

520 The Chemistry of Stereoselective Reductions of Carbonyl Groups

12.4 521 Oxidation of Alcohols

12.4A 521 Oxidation of Primary Alcohols to Aldehydes: RCH_2OH to RCHO

12.4B 522 Oxidation of Primary Alcohols to Carboxylic Acids: RCH_2OH to RCO_2H

12.4C 522 Oxidation of Secondary Alcohols to Ketones: RCH(OH)R' to RCOR'

12.4D 523 Mechanism of Chromate Oxidations

12.4E 525 A Chemical Test for Primary and Secondary Alcohols

12.4F 525 Spectroscopic Evidence for Alcohols

12.5 526 Organometallic Compounds

12.6 526 Preparation of Organo Lithium and Organo Magnesium Compounds

12.6A 526 Organolithium Compounds

12.6B 527 Grignard Reagents

12.7 528 Reactions of Organolithium and Organomagnesium Compounds

12.7A 528 Reactions with Compounds Containing Acidic Hydrogen Atoms

12.7B 529 Reactions of Grignard Reagents with Oxiranes (Epoxides)

12.7C 530 Reactions of Grignard Reagents with Carbonyl Compounds

12.8 531 Alcohols from Grignard Reagents: Reaction of Grignard Reagents with:

1. Formaldehyde to Give Primary Alcohols
2. Other Aldehydes to Give Secondary Alcohols
3. Ketones to Give Tertiary Alcohols
4. Esters with 2 x RMgX to Give Tertiary Alcohols

12.8A 532 Planning a Grignard Synthesis

12.8B 536 Restrictions on the Use of Grignard Reagents

12.8C 537 The Use of Lithium Reagents

12.8D 537 The Use of Sodium Alkynides

12.9 539 Protecting Groups

540 Summary of Reactions

541 Synthetic Connections of Alcohols and Carbonyl Compounds
541 Key Terms and Concepts

Problems: In-Chapter 12.1 to 12.10
542 End of Chapter 12.11 to 12.29
545 Learning Group Problems.
546 First Review Problem Set 1 to 25.

Week of Dec 1: CONJUGATED UNSATURATED SYSTEMS.

Read and Study Chapter 13.

550 Molecules With the Nobel Prize in Their Synthetic Lineage
13.1 551 Introduction
13.2 551 Allylic Substitution and the Allyl Radical
13.2A 552 Allylic Chlorination (High Temperature)
13.2B 554 Allylic Bromination with N-Bromosuccinimide (Low Conc. of Br_2)
13.3 555 The Stability of the Allyl Radical
13.3A 555 Molecular Orbital Description of the Allyl Radical
13.3B 557 Resonance Description of the Allyl radical
13.4 558 The Allyl Carbocation
13.5 559 Summary of Rules for Resonance
13.5A 560 Rules for Writing Resonance Structures
13.5B 561 Estimating the Relative Stability of Resonance Structures
13.6 563 Alkadienes and Polyunsaturated Hydrocarbons
13.7 564 1,3-Butadiene: Electron Delocalization
13.7A 564 Bond Lengths of 1,3-Bitadiene
13.7B 565 Conformations of 1,3-Butadiene, s-cis and s-trans
13.7C 565 Molecular Orbitals of 1,3-Butadiene
13.8 566 The Stability of Conjugated Dienes
13.9 568 Ultraviolet-Visible Spectroscopy
13.9A 568 The Electromagnetic Spectrum
13.9B 569 UV-Vis Spectrophotometers
13.9C 571 Absorption Maxima for Nonconjugated and Conjugated Dienes
573 The Chemistry of The Photochemistry of Vision
13.9D 576 Analytical Uses of UV-Vis Spectroscopy
13.10 576 Electrophilic Attack on Conjugated Dienes: 1,4-Electrophilic Addition
13.10A 578 Kinetic Control versus Thermodynamic Control of a Chemical Reaction
13.11 580 The Diels-Alder Reaction: 1,4-Cycloaddition of Dienes
13.11A 581 Factors Favoring the Diels-Alder Reaction
13.11B 582 Stereochemistry of the Diels-Alder Reaction
13.11C 584 Molecular Orbital Considerations That Favor an Endo Transition State
586 The Chemistry of Asymmetric and Intramolecular Diels-Alder Reactions
588 Concept Map
589 Key Terms and Concepts.

Problems: In-Chapter 13.1 to 13.15
589 End of Chapter 13.16 to 13.46
594 Learning Group Problems.

CHEMISTRY 2610: READING, STUDYING, AND PRACTICE PROBLEMS

All references are to Wade, L.G.(Jr), *Organic Chemistry,* 6th Edition, Pearson Prentice-Hall, 2006.

FALL SEMESTER

Weeks of
Sept 4, 8, 15, & 22: INTRODUCTION AND REVIEW, Chapter 1;
STRUCTURE AND PROPERTIES OF ORGANIC MOLECULES, Chap. 2;
INFRARED SPECTROSCOPY, Chap. 12, Sect 12-1 to 12-12;

Chapter 1, INTRODUCTION AND REVIEW

Sect #	**Page #**	Read and Study Chapter 1
1-1	1	The origin of Organic Chemistry
1-2	3	Principles of Atomic Structure
1-3	6	Bond Formation: The Octet
1-4	7	Lewis Structures
1-5	8	Multiple Bonding
1-6	9	Electronegativity and Bond Polarity
	9	Summary: Common Bonding Patterns (uncharged)
1-7	12	Formal Charge
1-8	12	Ionic Structures
	13	Summary: Common Bonding Patterns in Organic Compounds and Ions
1-9	13	Resonance
1-10	17	Structural Formulas
1-11	20	Molecular Formulas and Empirical Formulas
1-12	21	Arrhenius Acids and Bases
1-13	22	Bronsted-Lowry Acids and Bases
1-14	29	Lewis Acids and Bases
	32	Chapter 1 Glossary
	34	Essential Problem Solving Skills in Chapter 1
	34	Study Problems:
		In-Chapter, 1-1 to 1-19
	34	End of Chapter 1-20 to 1-48

Practice Problems: You are encouraged to work all of the in-chapter problems, and you are required to complete the short in-class weekly assignments. Routinely doing problems in organic chemistry leads to understanding of the theory, and good grades in organic chemistry.

In the words of Solomons and Fryhle:

"*One way to check your progress is to work each of the in-chapter problems when you come to it. These problems have been written just for this purpose and are designed to help you decide whether or not you understand the material that has just been explained.*"

And, in the words of Wade:

"It's easy to fool yourself into thinking you understand organic chemistry when you actually do not. As you read through this book, all the facts and ideas may make sense, yet you have not learned to combine and use those facts and ideas. An examination is a painful time to learn that you do not really understand the material.

The best way to understand organic chemistry is to use it. You will certainly need to read and reread all the material in the chapter, but this level of understanding is just the beginning. Problems are provided so you can work with the ideas, applying them to new compounds and new reactions that you have never seen before. By working problems, you force yourself to use the material and fill in the gaps in your understanding. You also increase your level of self-confidence and your ability to do well on exams".

Chapter 2, STRUCTURE AND PROPERTIES OF ORGANIC MOLECULES;

Read and Study Chapter 2

Chapter 12, Sections 12-1 to 12-12; INFRARED SPECTROSCOPY

Read and Study Chapter 12, Sections 12-1 to 12-12

12-9	523	Characteristic Absorptions of Carbonyl Compounds
12-10	529	Characteristic Absorptions of C-N Bonds
12-11	530	Simplified Summary of IR Stretching Frequencies
12-12	532	Reading and Interpreting IR Spectra (Solved Problems)
	552	Study Problems
		In-Chapter 12-1 to 12-6
	552	End of Chapter 12-12 to 12-28

Week of Sept 29: STRUCTURE AND STEREOCHEMISTRY OF ALKANES

Read and Study Chapter 3

3-1	81	Classification of Hydrocarbons (Review)
3-2	82	Molecular Formulas of Alkanes
3-3	83	Nomenclature of Alkanes
	83	Summary: Rules of Naming Alkanes
3-4	89	Physical Properties of Alkanes
3-5	91	Uses and Sources of Alkanes
3-6	93	Reactions of Alkanes
3-7	94	Structure and Conformations of Alkanes
3-8	98	Conformations of Butane
3-9	100	Conformations of Higher Alkanes
3-10	100	Cycloalkanes
3-11	103	cis-trans Isomerism in Cycloalkanes
3-12	103	Stabilities of Cycloalkanes: Ring Strain
3-13	107	Cyclohexane Conformations
	110	Problem-Solving Strategy: Drawing Chair Conformations
3-14	111	Conformations of Monosubstituted Cyclohexanes
3-15	114	Conformations of Disubstituted Cyclohexanes
	116	problem-Solving Strategy: Recognizing cis and trans isomers
3-16	117	Bicyclic Molecules
	119	Chapter 3 Glossary
	122	Essential Problem Solving Skills in Chapter 3
	122	Study Problems
		In-Chapter, 3-1 to 3-31
	34	End of Chapter 3-32 to 3-46

Week of Oct 6: STEREOCHEMISTRY: CHIRAL MOLECULES

Read and Study Chapter 5

5-1	167	Introduction
5-2	168	Chirality
5-3	174	(R) and (S) Nomenclature of Asymmetric Carbon Atoms
5-4	179	Optical Activity
5-5	184	Biological Discrimination of Enantiomers
5-6	185	Racemic Mixtures
5-7	186	Enantiomeric Excess and Optical Purity

Weeks of Oct 13 & 20: ALKYL HALIDES: NUCLEOPHILIC SUBSTITUTION AND ELIMINATION REACTIONS

Read and Study Chapter 6

Week of Oct 27 and Nov 3: ALKENES, AND ALKYNES: STRUCTURE, SYNTHESES AND REACTIONS (Chapters 7, 8 and 9)

Chapter 7: STRUCTURE AND SYNTHESIS OF ALKENES

Read and Study Chapter 7

Chapter 8: REACTIONS OF ALKENES

Read and Study Chapter 8

Chapter 9: ALKYNES

Read and Study Chapter 9

Week of Nov 10: THE STUDY OF CHEMICAL REACTIONS: RADICAL REACTIONS

Read and Study Chapter 4

Week of Nov 17 and 24: ALCOHOLS, ETHERS, EPOXIDES AND SULFIDES (Chapters 10, 11 and 14)

Chapter 10: STRUCTURE AND SYNTHESIS OF ALCOHOLS

Read and Study Chapter 10

Chapter 11: REACTIONS OF ALCOHOLS

Read and Study Chapter 11

Chapter 14: ETHERS, EPOXIDES AND SULFIDES

Read and Study Chapter 14

14-7	636	Industrial Synthesis: Bimolecular Dehydration of Alcohols
	636	Summary: Synthesis of Ethers
14-8	636	Cleavage of Ethers by HBr and HI
14-9	639	Autoxidation of Ethers
	639	Summary: Reactions of Ethers
14-10	640	Sulfides (Thioethers)
14-11	642	Synthesis of Epoxides
	645	Summary: Epoxide Syntheses
14-12	645	Acid-Catalyzed Ring Opening of Epoxides
14-13	649	Base-Catalyzed Ring Opening of Epoxides
14-14	650	Orientation of Epoxide ring opening
14-15	652	Reactions of Epoxides with Grignard and Organolithium Reagents
14-46	653	Epoxy Resins: The Advent of Modern Glues
	655	Summary: Reactions of Epoxides
	656	Chapter 14 Glossary
	658	Essential Problem Solving Skills in Chapter 14
	658	Study Problems
		In-Chapter Problems 14-1 to 14-28
		End of Chapter Problems 14-29 to 14-48

Week of Dec 1: CONJUGATED SYSTEMS, ORBITAL SYMMETRY, AND ULTRAVIOLET SPECTROSCOPY

Read and Study Chapter 15.

15-1	663	Introduction
15-2	663	Stabilities of Dienes
15-3	665	Molecular orbital Picture of a Conjugated System
15-4	669	Allylic Cations
15-5	670	1,2- and 1,4- addition to Conjugated Dienes
15-6	672	Kinetic Versus Thermodynamic Control in addition of HBR to 1,3-Butadiene
15-7	674	Allylic Radicals
15-8	676	Molecular Orbitals of the Allylic System
15-9	678	Electronic Configurations of the Allylic Radical, Cation, and Anion
15-10	679	S_N2 Displacement Reactions of Allylic Halides and Tosylates
15-11	680	The Diels-Alder Reaction
	680	Key Mechanism: The Diels-Alder Reaction
15-12	689	The Diels-Alder as an Example of a Pericyclic Reaction
15-13	692	Ultraviolet Absorption Spectroscopy
	699	Chapter 15 Glossary
	701	Essential Problem Solving Skills in Chapter 15
	701	Study Problems
		In-Chapter Problems 15-1 to 15-22
	701	End of Chapter Problems 15-23 to 15-38

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