GRANDE PRAIRIE REGIONAL COLLEGE

DEPARTMENT OF SCIENCE: CHEMISTRY

FORTY-FOURTH SESSION 2009 – 2010

COURSE OUTLINE: ORGANIC CHEMISTRY

CH2610 A3 & B3

CH2610 A3 & B3: 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 1:00 – 2:20 in D308

ALBERTA TRANSFER CREDIT
(Ref: 2009-2010 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. Weekly assignments will be given in two formats, namely:

1. WileyPlus Interactive-On-Line, including on-line grading, and;
2. WileyPlus Posted Ten-Question-Assignments for completion On-Line or through Hand-Writing.

Detailed solutions to the, "Ten-Question-Assignments", will be posted on WileyPlus after the due dates for the assignments

NOTES:

1. Lectures, Time and Place
   CH2610 A2 T, R 1:00 - 2:20 in D308

2. Laboratory Component, Time and Place
   CH2610 L1 M 14:30 - 17:20 in J116
   CH2610 L2 T 14:30 - 17:20 in J116

3. Tutorial Component, Time and Place
   CH2610 S1 F 8:30 - 9:20 in J201
   CH2610 S2 F 10:00 - 10:50 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 book is required:</u>

CH2610

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

And
A Three Ring Binder to Hold: Sloan, J.P., *Organic Chemistry Experiments, Chemistry 2610/2630,* Grande Prairie Regional College, 2009/2010.

Molecular Models are highly recommended, namely:

Molecular Model Set for Organic Chemistry, Prentice Hall.

Study Guides, Solutions Manuals, and Wiley Plus are supplementary items, namely:

1. Fernandez, J.E., and Solomons, T.W.G., *Study Guide and Solutions Manual to Organic Chemistry*, 9th Edition, 2008;
2. Wiley Plus.

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 February 12 ---------- 15%
2. Midterm Exam # 2, Friday March 19 ---------- 20%
2. Final Exam to be scheduled between April 17 – 29 ---------- 30%
3. Laboratory ---------- 25%
4. Tutorial Grading Component ---------- 10%

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, Wiley Plus, and questions in the organic chemistry textbook by Solomons and Fryhle.

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

4. The Tutorial Grading Component will contribute to 10% of the final grade and will consist of two components as determined by the Instructor with input from the class. The two components are;
   4.1 Printed assignments consisting of ten questions per assignment, and;
   4.2 On-line Wiley Plus tests prepared by the Instructor and marked electronically, with feedback to the students.

5. 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 2009 - 2010: Course Description (p 185).

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
Jan 5 & 11: 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 assignments given in-seminar-class and from Wiley Plus. 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 Jan 18: 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

Week of Jan 25: AN INTRODUCTION TO ORGANIC REACTIONS: ACIDS AND BASES IN ORGANIC CHEMISTRY

3.7	105	The Relationship between Structure and Acidity, i.e. Structural Effects on Acidity and Basicity, namely:
		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 Feb 1: 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

176 Key Terms and Concepts
177 Concept Maps

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

Week of Feb 8: 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 Feb 15: 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

Problems: In-Chapter 6.1 to 6.12
252 End of Chapter 6.13 to 6.48
268 Learning Group Problems

Week of Feb 22: ALKENES AND ALKYNES I: Properties and Synthesis. Elimination Reactions of Alkyl Halides

Read and Study Chapter 7

7.12 292 Alkylation of Alkynide Anions: Some General Principles of Structure and Reactivity Illustrated
7.13 292 Hydrogenation of Alkenes
293 The Chemistry of Hydrogenation in the Food Industry
7.14 294 Hydrogenation: The Function of the Catalyst
7.14A 295 Syn and Anti Additions
295 The Chemistry of Homogeneous Asymmetric Catalytic Hydrogenation: Examples Involving L-DOPA, (S)-Naproxen, and Aspartame
7.15 297 Hydrogenation of Alkynes
7.15A 297 Syn Addition of Hydrogen: Synthesis of cis-Alkenes
7.15B 297 Anti Addition of Hydrogen: Synthesis of trans-Alkenes
7.16 298 An Introduction to organic Synthesis
7.16A 298 Why do Organic Synthesis?
7.16B 299 Retrosynthetic Analysis – Planning an Organic Synthesis
7.16C 300 Identifying Precursors
302 The Chemistry of – From the Inorganic to the Organic
7.16D 302 Raison d'Etre
303 Summary and Review Tools
304 Summary of Methods for the Preparation of Alkenes and Alkynes ;
1. Dehydrohalogenation of Alkyl Halides (Section 7.6, p 275)
2. Dehydration of Alcohols (Sections 7.7 & 7.8, p 280)
3. Hydrogenation of Alkynes (Section 7.15, p 297)
(4. Dehydrohalogenation of vic-Dihalides x 2 (Section 7.9, p 288))
305 Summary and Review Tools
306 Key Terms and Concepts

Problems: In-Chapter 7.1 to 7.17
306 End of Chapter 7.18 to 7.46
310 Learning Group Problems

Week of Mar 1: ALKENES AND ALKYNES II: Addition Reactions.

Read and Study Chapter 8.

311 The Sea: A Treasure of Biologically Active Natural Products
8.1 312 Introduction: Addition to Alkenes
8.1A 313 Understanding Additions to Alkenes
8.2 314 Electrophilic Addition of Hydrogen Halides to Alkenes: Mechanism and Markovnikov's Rule
8.2A 316 Theoretical Explanation of Markovnikov's Rule
8.2B 318 Modern Statement of Markovnokov's Rule
8.2C 319 Regioselective Reactions
8.2D 319 An Exception to Markovnikov's Rule
8.3 319 Stereochemistry of the Ionic Addition to an Alkene
8.4 320 Addition of Sulfuric Acid to Alkenes
8.4A 320 Alcohols from Alkyl Hydrogen Sulfates
8.5 321 Addition of Water to Alkenes: Acid Catalyzed Hydration
8.5A 321 Mechanism for Acid-Catalyzed Hydration
8.5B 322 Rearrangements

Week of March 15: RADICAL REACTIONS

Read and Study Chapter 10

	427	Radicals in Biology, Medicine, and Industry
10.1	428	Introduction
10.1A	428	Production of Radicals
10.1B	428	Reactions of Radicals
10.2	429	Homolytic Bond Dissociation Energies
10.2A	430	Homolytic Bond Dissociation Energies and Heats of Reaction
	430	Table 10.1 Single-Bond Homolytic Dissociation Energies DH^o at 25^o C
10.2B	431	Homolytic Bond Dissociation Energies and the Relative Stabilities of Radicals
10.3	433	The Reactions of Alkanes with Halogens
10.3A	433	Multiple Substitution Reactions versus Selectivity
10.4	435	Chlorination of Methane: Mechanism of Reaction
		1. Chain Initiation
		2. Chain Propagation
		3. Chain Termination
10.5	437	Chlorination of Methane: Energy Changes
10.5A	438	The Overall Free-Energy Change
10.5B	439	Activation Energies
10.5C	441	Reaction of Methane with other Halogens
10.6	443	Halogenation of Higher Alkanes
10.6A	445	Selectivity of Bromine, and Selectivity versus Reactivity
10.7	446	The Geometry of Alkyl Radicals
10.8	446	Reactions that Generate Tetrahedral Chirality Centres
10.8A	447	Generation of a Second Chirality Centre in a Radical Halogenation
10.9	449	Radical Addition to Alkenes:
		The Anti-Markovnikov Addition of Hydrogen Bromide
10.9A	450	Summary of Markovnikov versus Anti-Markovnikov Addition of HBr to Alkenes
10.10	451	Radical Polymerization of Alkenes: Chain Growth Polymers
	451	Radical Polymerization of Ethene
	453	Other Common Chain-Growth Polymers
10.11	455	Other Important Radical Reactions
10.11A	455	Molecular Oxygen and Super Oxide
10.11B	455	Nitric Oxide
10.11C	456	Combustion of Alkanes
10.11D	457	Autoxidation
	458	The Chemistry of Antioxidants
	459	The Chemistry of Ozone Depletion and Chlorofluorocarbons (CFCs)
	460	Concept Map: Mechanism Review of Radical Reactions
	461	Key Terms and Concepts
	464	Special Topic A: Chain-Growth Polymers

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

Week of March 22: 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 March 29: 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 April 5: 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.

April 12: Review Class, e.g. review of a Practice Final Exam.

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