Survey of Organic Chemistry
Chemistry 325 Lecture and Lab
Spring 2017
16 week hybrid course
Dr. Badger

Contents:

The Instructor (contents)

- Name: Dr. Robert Badger (students usually call me Dr. Badger or Dr. B; colleagues or fellow basketball players call me Bob)
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Philosophy (contents)

Chemistry 325 is the first semester of a two semester organic chemistry course designed to introduce you to the properties, applications and importance of organic substances. In lecture and lab we shall discuss - demonstrate - elucidate - illuminate material from chapters 1-14 of Smith. This necessarily means we will move at a fairly rapid pace and in some cases will not be able to discuss in sufficient detail material that may be of interest or confusing to you. I urge you to ask questions in lecture, stop by my office, or stop me in the street, if necessary, to obtain satisfactory solutions to problems you may have. I can not guarantee to have all the answers, but I will try to find them, if possible.

Format:

The course consists of three hours of lecture per week, three hours of lab per week and, at least, six hours per week outside of class; some of the outside hours will be spent in on line and electronic notebook activities.

Audience:

Sophmores and Juniors majoring in chemistry, biochemistry or pre-professional preparation in pharmacy, medicine and other health professions. You must have achieved at least a C or better in Chemistry 106 or 117.

Goals:

- To understand how microscopic molecular and electronic stucture correlate with macroscopic physical properties and chemical reactivity.
- To understand how electron movement during chemical reactions cause atoms to move and change their bonding character.
- To understand how laboratory observations, measurements and experiments have led to the fundamental chemical concepts that describe the molecular structure and reactions of organic molecules.

Required and Supplementary Materials (contents)

REQUIRED:

Course Text: Smith, J. G., "Organic Chemistry," 3rd Edition, McGraw/Hill, 2011. Available at text rental. Chemistry majors ought to purchase this text or an equivalent one.

Purchase a 'Sharpie' from the bookstore or your favorite office supply store (K-Mart, Walmart, etc.). This will be used in the lab to label beakers, flasks and samples to keep track of materials you work with.

Sapling Learning - Organic Chemistry Question Sets

$40.00 per semester online purchase.

Sapling's chemistry questions are delivered in a web browser to provide real-time grading, response-specific coaching, improvement of problem-solving skills, and detailed answer explanations. Dynamic answer modules enable one to interact with 3D models and figures, utilize drag-and-drop synthetic routes, and draw chemical structures - including stereochemistry and curved arrows.

Welcome students, we will be using Sapling Learning for our homework. To get started:

1. Go to http://saplinglearning.com and click "US Higher Ed" at the top right.
2.
   a. If you already have a Sapling Learning account, log in and skip to step 3.
   b. If you have Facebook account, you can use it to quickly create a SaplingLearning account. Click the blue button with the Facebook symbol on it (just to the left of the username field). The form will auto-fill with information from your Facebook account (you may need to log into Facebook in the popup window first). Choose a password and timezone, accept the site policy agreement, and click "Create my new account". You can then skip to step 3.
   c. Otherwise, click "create account". Supply the requested information and click "Create my new account". Check your email (and spam filter) for a message from Sapling Learning and click on the link provided in that email.
3. Find your course in the list (listed by subject, term, and instructor) and click the link.
4. Select your payment options and follow the remaining instructions.
5. Work on the Sapling Learning training materials. The activities, videos, and information pages will familiarize you with the Sapling Learning user environment and serve as tutorials for efficiently drawing molecules, stereochemistry, etc. within the Sapling Learning answer modules. These training materials are already accessible in your Sapling Learning course.

* Once you have registered and enrolled, you can log in at any time to complete or review your homework assignments.

* During sign up - and throughout the term - if you have any technical problems or grading issues, send an email to support@saplinglearning explaining the issue. The Sapling support team is almost always more able (and faster) to resolve issues than your instructor.

* To optimize your Sapling Learning experience, please keep your internet browser and Flash player up to date and minimize the use of RAM-intensive programs/websites while using Sapling Learning.

Recommended:

- Laboratory Text: Anne B. Padias *Making the Connections: A How-To Guide for Orgniac Chemistry Lab Techniques*, 2nd ed.; Hayden/McNeil, Plymouth, MI , 2013. For purchase in the bookstore. I do not consider this text essential since I have most of the technical materials on line or will discuss them during lab.
- Molecular models (**strongly recommended**) can be purchased from the bookstore or over the internet. They range in price from about $10 to $40 or more. I particularly like the Indigo Instruments MolyMod kit. It is flexible and contains enough pieces to meet your current and future chemistry course needs. Another option would be to visit A113, our computer lab, and experiment with GausView a molecular modeling program. A somewhat less expensive possiblity would be to purchase some gumdrops and toothpicks. In any event, make sure you have access to some models before the first exam. Another possibility is to try web based tools like this one that will allow you to draw and view some molecules on many modern computers and tablets.
- I expect you to be able to solve all of the problems presented in the book paying especial attention the ones I have indicated in the study guide for each chapter. A student study guide and solutions manual for these problems is available for purchase in the bookstore and on the internet. I will be happy to discuss any of these problems in class or my office, but will not post answers since the solution manual is available.

Attendance (contents)

Lecture:

Attendance records will be maintained and extended absences will be reported to the Dean of Students. Attendance, in itself, will have no direct effect on your grade, but your performance on exams, and problem sets will undoubtedly suffer.

Lab:

Laboratory attendance is mandatory, since you will not be able to perform experimental work anywhere else.

Absences:

The student is responsible for all missed material.

Grading (contents)

Generally, final grades will be based on total points and will be assigned on the following curve:

grade	Percent points possible	Course Exercise	Course point allocations
A	93	Three Hour exams	300 pts.
A-	90-93	thirteen Problem Sets	130 pts.
B+	87-90	Laboratory	220 pts
B	83-87	Final exam	150 pts.
B-	80-83	Total	800 pts.
C+	77-80		
C	73-77	Lab points breakdown	
C-	70-73	Electronic Lab Notebook	60 pts.
D+	67-70	Reports (two)	60 pts.
D	60-67	Prelabs (5)	50 pts.
F	60	Materials pages, Postlabs and samples	50 pts.

I reserve the right to alter this curve depending on the overall performance of the class. I will under no circumstances raise this curve.

Exams (contents)

Exams are closed book and will be given during the Friday class hour indicated on the attached schedule(last page). Questions will be taken mainly from the lecture and assigned text. It has become my policy to include one or more problems from each chapter on exams. Thus, by diligently working the problems, you are assured of being able to successfully answer at least two or three questions correctly on exams. The more problems you solve the better your exam results will be. I have made sample exams available via the Chemistry 325 home page. These samples will give you an idea of the depth and type of questions I will ask.

Typically the exams will consist of five types of questions: 1) multiple choice (3-5 points each) similar to the problem sets; 2) short, fill in the blank questions, typically nomenclature questions (3-5 points each); 3) three or four short reaction or structure drawing questions (5 points each); 4) two of three longer essay questions, typically explain in some detail the mechanism of a reaction or formation of a particular product, for which partial credit will be given(10 points each); and 5) define, describe and explain questions (5 points each).

Materials you may bring: pencils, pens, erasers, calculators and one side of one 3 x 5 inch index card containing any information you feel may help you on the exam. You will not be allowed to share any of the above items during the exam.

Materials I will provide: the exam, a periodic chart, and scratch paper.

Please note the excerpt from UWSP 14 below. I am concerned about academic misconduct. It is my policy that anyone guilty of academic misconduct will receive an F for the course grade. I intend to initiate some or all of the following measures to protect your intellectual property:

- **Assigned exam seats** On exam day I may project a list of assigned seats and you will be required to sit in your assigned seat or, if and as space allows, a seat that is completely isolated from others.

- **Unique exam** I may create two or more different exams on different colored paper. You must have a different colored exam than your neighbor to the left and right.
- **Video tape** I may video tape the exam to assist in preventing academic misconduct.
- **Your assistance** During the exam please take every precaution to protect your intellectual property - the answers you have placed on your exam. Keep your eyes on your paper or the periodic chart at the front of the class.

UWSP 14.03 ACADEMIC MISCONDUCT SUBJECT TO DISCIPLINARY ACTION. (contents)

Academic misconduct is an act in which a student:

1. Seeks to claim credit for the work or efforts of another without authorization or citation;
2. Uses unauthorized materials or fabricated data in any academlc exercise;
3. Forges or falsifies academic documents or records;
4. Intentionally impedes or damages the academic work of others;
5. Engages in conduct aimed at making false representation of a student's academic performance; or
6. Assists other students in any of these acts.
7. Examples of academic misconduct include, but are not limited to:

- cheating on an examination
- collaborating with others in work to be presented, contrary to the stated rules of the course
- submitting a paper or assignment as one's own work when a part or all of the paper or assignment is the work of another
- submitting a paper or assignment that contains ideas or research of others without appropriately identifying the sources of those ideas
- stealing examinations or course materials
- submitting, if contrary to the rules of a course, work previously presented in another course
- tampering with the laboratory experiment or computer program of another student
- knowingly and intentionally assisting another student in any of the above, including assistance in an arrangement whereby any work, classroom performance, examination or other activity is submitted or performed by a person other than the student under whose name the work is submitted or performed.

Lab (contents)

The lab grade is broken down into four parts:

Electronic Lab Notebook(60 pts.)

Grading:

The guiding principle in writing up an experiment is to record all the details which would enable another person to understand what was done and to repeat the entire experiment exactly without prior knowledge. An important first step to this process is a table of physical data, such as chemical names, chemical formulas, reported melting point where boiling point, expected mass/moles that will be used or produced. This page should also include balanced chemical reactions produced using ChemDraw or other structure drawing program. Thus, in addition to a written account of the work done, including notes on any special apparatus used, details of all volumes, weights, temperatures, times, chromatographic procedures (for instance TLC were GLC) and conditions and results, etc., must all be recorded. The writing up of all laboratory work must be done at the time of the work, in your electronic lab notebook; a loosely notebook is not suitable. It is important that numerical results such as yields, melting points and boiling points, etc., are entered directly into the notebook and not on scratch paper. The latter are liable to be lost and your use encourages untidy practical habits. Spectral data, such as proton and carbon NMR spectra and infrared spectra should be annotated and pasted directly into a graphics pane of a notebook page. Digital data files can be attached directly to that page to make it easier to retrieve and examine the spectra. Pictures of experimental apparatus and other analyses can also be placed in the notebook. (paraphrased from Kanare, H. M. **Writing the Laboratory Notebook;**, American Chemical Society: 1985 and Furniss et al, **Vogel's Textbook of Practical Organic Chemistry,** 5th ed., Wiley, 1989, p. 32.)

Five points for each lab period, are allocated for keeping the notebook up to date which means you must make at least one notebook entry each day describing what you have done. I will periodically scan through your notebook and comment on what you have posted. The 'guiding principle' stated above will be the rubric used to evaluate your records. Basically you will start each lab period with five points. If you do a good job recording your work, you will receive the five points.

Laboratory Maintenance(15 pts.)

I will inspect(unannounced) all workstations once during the semester to see that your benchtop, sink, lab drawer and common equipment drawers are in good working order. White solids and unidentifiable liquids on your benchtop will result in loss of points. Paper towels, broken glass and other water insoluble solids found in the sink will result in loss of points. Missing common equipment or improperly stored (in the wrong drawer - common equipment drawers are labeled) equipment will result in loss of points(the only exception will be a hot plate that is too hot to put away). I will evaluate on a day when you have been present in lab. Everyone will lose one maintenance point every time I am required to clean up the balances or chemical hoods. Please speak with me if you are unsure how to clean up a particular spill.

Prelabs (five)(50 pts.)

The multiple choice prelabs will consist of 10 or more questions that you will be able to answer by reading the lab procedure (also links and videos therein on the web site), and material in your lecture text that pertain to reactions being performed. There will undoubtably be some questions you can not answer without help from me. Please do not hesitate to ask and I will point you in the correct direction to answer the questions.

Homework (contents)

The most efficient way to learn new material is to practice applying it. To this end, I will have 13 problem sets available on the Sapling web site worth 10 points each. Just to keep you coming back, there will also be two extra credit problem sets. While you are encouraged to discuss these problems with the instructor and classmates you must ultimately provide your own answers. Due dates are listed in the schedule.

Schedules (contents)

Chemistry 325 - Tentative Lecture Schedule - Spring 2017

Modified on Monday, January 2, 2017 at 9:21 AM.					
Exams will be held on the Exam days during the lecture hour.					
Problems sets will be due on problem days by 23:55.					
Reading assignments in Smith.					
January					
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Reading Assign.**
23	24	25	26	27	Chap 1
30	31				Chap 2
February					
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Reading Assign.**
		1	***2 Prob 1***	3	Chap 2
6	7	8	***9 Prob 2***	10	Chap 3
13	14	***15 Prob 3***	16	17 Exam 1	Chap 4
20	21	23	24	25	Chap 5
27	28				Chap 5
March					
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Reading Assign.**
		1	***2 Prob 4***	3	Chap 5
6	7	8	***9 Prob 5***	10	Chap 6
13	14	15	***16 Prob 6***	17	Chap 7
20	21	22	23	24	
27	28	***29 Prob 7***	30	31 Exam 2	Chap 8
April					
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Reading Assign.**
3	4	5	***6 Prob 8***	7	Chap 9
10	11	12	***13 Prob 9***	14	Chap 10
17	18	19	***20 Prob 10***	21	Chap 11
24	25	***26 Prob 11***	27	28 Exam 3	Chap 12 (partial)
May					
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Reading Assign.**
1	2	3	***4 Prob 12***	5	Chap 13
8	9	10	***11 Prob 13***	12	Chap 14
15	16 Chem 325 10:15 A121	17 Chem 387 14:45 A111	18	19	

Chemistry 325 - Tentative Lab Schedule - Spring 2017

	A materials table must be posted in your electronic notebook on the Friday specified below for the specified projects. The prelab quizzes for all projects are due by midnight on the specified Sundays.	
	Postlab Questions or Reports will be due by midnight on the days specified.	
	January	
Mon	Experiment	Wed
23	Check-in, electronic notebooks and safety	25
	Prelab Quiz and Materials Page due Jan. 29 DISTILLATION	
	February	
Mon	Experiment	Wed
Jan. 30	DISTILLATION	1
6	DISTILLATION (cont')	8
13	DISTILLATION (cont')	16
20	Organic Models	22
	Prelab Quiz and Materials Page due Feb. 26 EXTRACTION AND CRYSTALLIZATION	
	Distillation Postlab questions due in notebook Mar. 3	
	March	
Mon	Experiment	Wed
Feb. 27	EXTRACTION AND CRYSTALLIZATION	1
6	EXTRACTION AND CRYSTALLIZATION (cont')	8
	Extraction Postlab questions due in notebook Mar. 17	
	Prelab Quiz and Materials Page due Mar. 12 TLC of Analgesics	
13	TLC of Analgesics	15
27	LAB PRACTICAL	29
	April	
Mon	Experiment	Wed
	Prelab Quiz and Separation flow sheet due first day of lab. LAB PRACTICAL	
	TLC Postlab questions due April 15	
4	LAB PRACTICAL (cont')	5
11	LAB PRACTICAL (cont')	13
18	LAB PRACTICAL (cont')	20
25	SPECTROSCOPY UNKNOWN	27
	May	
Mon	Experiment	Wed
	Lab Practical Report due May 12	
	Prelab Quiz only due Apr. 29 SPECTROSCOPY UNKNOWN	
2	SPECTROSCOPY UNKNOWN (cont)	4
9	Check-out	11
	Spectroscopy Report due May 16	

Learning Goals (contents)

Chapter 1 Structure and Bonding

1. Be able to discuss atomic structure and bonding.
2. Be able to generate Lewis structures of organic molecules.
3. Be able to predict the shape of molecules from the Lewis structure.
4. Be able to predict the hybridization of atoms from the Lewis structure.
5. Identify and predict the polarity of polar covalent bonds and molecules.
6. Be able to calculate formal charge.
7. Be able to predict major and minor resonance contributors.
8. Utilize curved arrow notation to denote electron motion in resonance structures.
9. Be able to use and recognize the characteristics of condensed structural formulas.
10. Be able to identify and draw π and σ bonded systems of alkanes, alkenes and alkynes.
11. Be aware of the trends in bond lengths as we move about the periodic table and change the hybridization of the atoms involved.

Suggested problems: Pages 47-53

39, 40, 42, 44, 48, 50, 51, 52, 59, 62, 64, 66, 69, 74, 81, 85, 87, 88

Chapter 2 Acids and Bases

1. Be able to define and identify Bronsted-Lowry and Lewis acids and bases.
2. Be able to identify electrophiles and nucleophiles.
3. Be able to convert pH and pK_a to $[H^+]$ and K_a respectively.
4. Be able to identify conjugate acids and bases.
5. Be able to predict acid/base reactions based on relatively acidity.
6. Be able to use curved arrow notation to show electron motion in acid/base reactions.

Suggested problems: Pages 75-80

34, 35, 36, 38, 40, 44, 45, 49, 50, 52, 54, 62, 66, 67, 70, 71

Chapter 3 Introduction to Organic Molecules and Functional Groups

1. Be able to identify the types of intermolecular forces based upon structure and functional group analysis.
2. You should be able to identify van der Waals, dipole-dipole, hydrogen bonding and ion-ion interactions.
3. From intermolecular force analysis you should be able to explain differences and trends in boiling point, melting point and solubility.
4. Be able to identify nucleophiles and electrophiles.
5. Be able to identify electrophilic carbon atoms based upon bond polarity.
6. Be aware that lone pairs and π bonds are nucleophilic sites that tend to react with electrophiles.
7. Be able to identify and draw, including non-bonding electrons, the following functional groups: aliphatic hydrocarbons (alkanes, alkenes and alkynes), aromatic hydrocarbons, alkyl halides, alcohols, ethers, amines, thiols, sulfides,

aldehydes, ketones, carboxylic acids, esters, amides, and acid chlorides.

Suggested problems: Pages 106-112

19, 21, 23, 24, 26, 27, 31, 32, 33, 36, 39, 40, 42, 45, 46, 47, 49, 50

Chapter 4 Alkanes

1. Be able to describe the intermolecular forces in alkanes and explain how they affect physical properties.
2. Be able to name linear, branched and cyclic alkanes with a stem chain containing up to twenty carbons. More than you wanted to know about IUPAC nomenclature can be found here.
3. Be able to identify primary, secondary, tertiary and quaternary carbons.
4. Identify and name eclipsed and staggered conformations of ethane. An animation of ethane rotation.
5. Identify and name anti and gauche conformations of more complex alkanes. An animation of butane rotation.
6. Draw wedge projections or Newman projections of molecules to show conformations.
7. Be able to differentiate between constiutional isomers.
8. Be able to define/describe angle strain and torsional strain.
9. Be able to draw chair cyclohexane showing all axial and equatorial hydrogens.
10. Be able to explain the relative stability of chair and boat cyclohexane.
11. Be able to identify cis and trans isomers of substituted cyclohexanes.
12. Be able to predict/explain relative stability of disubstituted cyclohexanes.
13. Be able to balance combustion reactions of alkanes.
14. Be able to define/describe the term isomer.
15. Be able to determine the difference between constitutional (structural) and stereo isomers.

Suggested problems: Pages 153-158

36, 39, 40, 42, 43, 47, 48, 49, 56, 57, 60, 63, 65, 69, 71

Chapter 5 Stereochemistry

1. Be able to differentiate between constitutional isomers and stereoisomers.
2. Be able to differentiate between enantiomers and diastereomers.
3. Be able to differentiate between chiral and achiral molecules.
4. Be able to assign absolute configuration (R or S) of stereogenic centers and identify stereogenic centers.
5. Be able to draw wedge and Fischer projections of molecules containing one or two stereogenic centers.
6. Be able to discuss the difference between enantiomers and diastereomers with respect to physical and chemical properties.
7. Be able to assign configurations in acyclic and cyclic molecules with two or more stereocenters.
8. Be able to identify meso compounds.
9. Describe plane polarized light and its use in a polarimeter.
10. Define the terms dextrorotatory, levorotatory, racemic mixture and resolution.

Be able to define specific rotation. Be able to calculate ee(enantiomeric excess).

11. Describe some biological consequenses of chiral molecules and chiral drugs.

Suggested problems: Pages 190-195

35, 36, 37, 38, 39, 41, 44, 45, 46, 50, 52, 56, 61, 62, 66, 69

Chapter 6 Understanding Organic Reactions

1. Be able to used curved arrows to show movement of electrons.
2. Be aware that full-headed arrows are used for electron pairs and half-headed arrows are used for single electrons.
3. Be aware that reagents (reactants) can be draw to the left or over the reaction arrow. Catalysts are usually drawn above or below the arrow.
4. Be able to recognize substitution, elimination and addition reactions.
5. Be aware that bond dissociation energy parallels bond strength.
6. Be aware that a higher energy species is less stable.
7. Be aware that higher activation energy (E_a) means a reaction will occur more slowly.
8. Be aware that higher activation energy (E_a) means the rate constant for the reaction is smaller.
9. Be aware of other factors that may affect the rate of a chemical reaction.
10. Be able to identify radical, carbocation and carbanion reactive intermediates.
11. Be able to identify whether a particular reactive intermediate is electrophilic or nucleophilic.
12. Be aware of what kind of reactive intermediate is made when homolysis or heterolysis occurs.
13. Be able to identify the various components of a reaction coordinate diagram.
14. Be aware of the relationship between the equilibrium constant (K_{eq}) and the free energy (ΔG) of a reaction.
15. Be aware of the relationship between free energy

Suggested problems: pages 222-227

26, 27, 28, 29, 32, 33, 34, 36, 38, 39, 40, 42, 44, 46, 48, 49, 52, 54, 55

Chapter 7 Alkyl Halides and Nucleophilic Substitution

1. Be able to explain why tertiay haloalkanes react much faster than primary haloalkanes in polar protic solvents.
2. Be able to draw the electron arrow pushing mechanism for S_N2 and $S_N1$reactions.
3. Be able to explain the rate laws for S_N1 and S_N2 reactions.
4. Be able to draw transition states for S_N1 and S_N2 reactions that show bond breaking, bond forming and charge distribution.
5. Be able explain how internal nucleaphiles frequently cause the formation of heterocyclic rings.
6. Be able to examine reaction conditions (substrate, solvent and nucleophile) and determine which mechanism is most likely.
7. Be able draw the structure of the products.
8. Be aware that vinyl and aryl halides to not undergo S_N1 and S_N2 reactions.
9. Be able to use S_N1 and S_N2 reactions in synthetic processes.

Suggested problems: pages 271-277

44, 45, 46, 48, 49, 50, 51, 52, 53, 56, 58, 59, 62, 63, 65, 67, 68, 70, 72, 74, 77, 79, 80, 84

Chapter 8 Alkyl Halides and Elimination Reactions

1. Be able to describe what the terms S_N1, S_N2, E1 and E2 mean.
2. Be able to compare nucleophilic substitution (specifically S_N2) and elimination reactions (specifically E2).
3. Be able to compare E1 and E2 elimination.
4. Be able to determine whether E1 or E2 occurs based on base strength.
5. Be able to determine whether E1 or E2 occurs based on substrate.
6. Be able to describe the conditions that favor substitution over elimination.
7. Be able to describe the conditions required to prepare alkynes.

Suggested problems: pages 305-311

26, 27, 28, 31, 32, 33, 34, 36, 38, 40, 41, 42, 46, 47, 50, 53, 54, 60, 62, 66

Chapter 9 Alcohols, Ethers and Epoxides

1. Be able to name alcohols and draw structures from their names.
2. Be able to predict/explain relative boiling points and acidities of alcohols.
3. Be able to predict the product(s) of the reaction of alcohols with alkalai metals.
4. Be able to predict the product(s) of the reaction of alcohols with HCl, HBr, HI, PBr_3, $SOCl_2$ and other inorganic acids and acid chlorides.
5. Be able to predict the product(s) of the reaction of alcohols with H_3PO_4 or H_2SO_4.
6. Be able to name ethers.
7. Be able to explain/predict water solubility and boiling point of ethers.
8. Be able to prepare ethers using the Williamson ether synthesis, acid dehydrations and acid catalyzed condensation of alkenes and alcohols.
9. Be able to predict the reaction of ethers with hydrohalic acids and draw reaction mechanisms for these reactions.
10. Be able to predict the stereochemistry and regiochemistry of acid catalyzed ring opening of epoxides.
11. Be able to predict the stereochemistry and regiochemistry of nucleophilic ring opening of epoxides.

Suggested problems: pages 351-357

39, 40, 41, 42, 44, 47, 48, 49, 51, 52, 54, 57, 58, 61, 63, 65, 67, 70, 71, 72, 73

Chapter 10 Alkenes

1. Be able to calculate the ***elements of unsaturation.*** given a chemical formula or structure.
2. Be able to name alkenes, dienenes, trienes and cycloalkenes using common and IUPAC nomenclature.
3. Be able to name *cis/trans* isomers using the ***E-Z system***.
4. Be able to predict the addition reaction products resulting from reaction of alkenes with:
   elemental halogens, water, and acids, such as HCl,HBr, HI, aqueous H_2SO_4.
5. Be able to describe various general aspects of reaction mechanisms such as

reaction coordinate, transition state, reaction intermediate, rate limiting step, activation energy and heat of reaction.
6. State and apply Markovnikov's rule to the prediction of reaction products from the addition reactions.
7. Be able to describe the relative stability of primary, secondary and tertiary carbocations.
8. Be able to describe the how carbocation stability provides a foundation for Markovnikov's rule.
9. Be able to explain the stereoselectivity of halogen addition reactions.
10. Be able to predict the products of hydroboration/oxidation of alkenes (anti-Markovnikov or non-Markovnikov addition).
11. Be able to describe the addition products of alkenes resulting from treatment with: hydrogen and catalyst.
12. Be able to explain and predict the relative stability of substituted alkenes using ***heats*** of hydrogenation.

Suggested problems: Pages394-398

36, 38, 39, 40, 45, 50, 52, 55, 56, 59, 61, 65, 67, 73, 74

Chapter 11 Alkynes

1. Be able to name alkynes and draw structures from their names.
2. Be able to explain why terminal alkynes are more acidic than alkanes or terminal alkenes.
3. Be able to generate acetylides from terminal alkynes.
4. Be able to synthesize alkynes from reaction of acetylides with alkyl halides.
5. Be able to synthesize alkynes via elimination reactions.
6. Be able to predict the products of reaction between alkynes and hydrogen, HCl, HBr, HI, Cl_2, Br_2, Cl_2/H_2O, or Br_2/H_2O .
7. Be able to predict and explain the products formed via '***hydration*** ' of alkynes with 1) BH_3/ 2) basic H_2O_2.

Suggested problems: pages 421-425

25, 27, 28, 29, 30, 37, 41, 45, 46, 48, 49, 53, 57, 58, 61, 67

Chapter 12 Oxidation and Reduction

1. Be able to identify whether the organic reactant in a reaction has undergone oxidation or reduction.
2. Be able to identify the common reduction reactions of carbon-carbon multiple bonds.
3. Be able to determine the stereoselectivity of the common reduction reactions of carbon-carbon multiple bonds.
4. Be able to use the common reduction reactions of carbon-carbon multiple bonds in synthetic processes.
5. Be able to identify the common reduction reactions of alkyl halides and expoxides with lithium aluminum hydride.
6. Be to identify the common oxidation reactions of alkenes, alkynes and alcohols.

Suggested problems: Pages 457-462

32, 33, 34, 35, 39, 40, 43, 44, 45, 46, 49, 50, 53, 63, 64, 65, 66

Chapter 13 Mass Spectrometry and Infrared Spectroscopy

1. Be able to integrate IR and NMR to determine structure.
2. Given the structure of a molecule, be able to predict important features of its IR and NMR spectra.
3. Be able to identify functional groups (alkane, alkene, alkyne, aromatic, alcohols, amines, aldehydes, ketones, carboxylic acids, carboxylic esters, and amides) present in a molecule from characteristic band frequency, intensity and shape.
4. Be able to predict stretching frequencies and band shapes for a given structure.
5. Be able to identify conjugated systems from their IR frequencies.

Spectroscopy Tutorials

Suggested problems: Pages 490-493

37, 38, 39, 40, 42

Chapter 14 Nuclear Magnetic Resonance Spectroscopy

1. Be able to determine the number of different hydrogens and carbons given the molecular structure.
2. Be able to predict the number of signals and approximate chemical shifts from the molecular structure in both ^{1}H and ^{13}C spectra.
3. Be able to predict which nuclei will be magnetically coupled.
4. Be able to predict the number of peaks and coupling constants expected from magnetically coupled systems.
5. Be able to use the integral trace of an ^{1}H spectrum to determine the relative number of hydrogens.
6. Be able to integrate data from NMR (proton and carbon-13) and IR to determine the structure of organic compounds.

Suggested problems: Pages 528-537

34, 35, 39, 40, 41, 42, 44, 46, 49, 50, 51, 54, 58, 59, 63, 65, 68

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