Organic Chemistry I

Chemistry 231, Spring 2020

COURSE DESCRIPTION

Organic chemistry is the study of the structure, properties, and reactions of molecules containing carbon. The prominence of carbon containing molecules, organic molecules, in our everyday life may explain why organic chemistry is such a rich discipline. Much of what we wear, smell, eat, build, burn, and touch during our lives is composed of organic molecules. We ourselves and all other life we know are based on compounds of carbon.

Why has carbon adopted such a central role in our lives and life itself? One reason is that carbon is a versatile and promiscuous element. It is capable of bonding to itself and other elements in a multitude of ways. One indication of carbon's versatility is the fact that tens of millions of organic compounds have been described and hundreds of new compounds are described every day.

This course is the first of a two-course sequence designed to introduce students to the theoretical underpinnings of organic chemistry. We will begin by exploring how organic molecules are held together, learn to identify the key functional groups, and develop an understanding of how spectroscopy is used in determining the structure of organic molecules. For the remainder of the year, we will take an in-depth look at the chemistry and properties of a number of functional groups. You will learn how to employ familiar concepts from thermodynamics and kinetics to predict both the products that are likely to form in an organic reaction and the detailed course of events that leads to their formation.

INSTRUCTOR AND COURSE INFORMATION

Instructor:	Dr. John Hofferberth
Email:	hofferberthj@kenyon.edu
Office:	312 Tomsich Hall
Office Hours:	Private Office Hours: MW 2:00-3:00 PM, 312 Tomsich (reserve a private office hour appointment at: https://tinyurl.com/y8ahxy9k) Group Office Hours: MW 3:00-4:00 PM, 312 Tomsich (no appointment needed) Weekly Review Session: F 2:00-3:00 PM, 201 Ascension Inclusion Hours: F 3:00-4:00 PM (Tomsich stairwell)
Classroom:	109 Hayes
Class Time:	Section 1 - 8:10-9:00, Section 2 - 9:10-10:00

MATERIALS

1. Textbook - Organic Chemistry - Structure and Function, 7th Edition (Required)
2. Model Kit - HGS Polyhedron Molecular Model #1003A (Strongly recommended)
3. Textbook Study Guide - Study Guide for Organic Chemistry - Structure and Function (Optional)

COLLECTIVE MISSION

Our collective mission is to help everyone get what they need out of this class. The science of learning suggests that a collaborative and active approach is the best way to accomplish this end. Our goal is to collectively help each individual in our community develop.

LEARNING GOALS

1. **Critical Thinking Skills** – Students will learn how to evaluate concepts, material, problems and challenges posed in the class and thoughtfully apply appropriate and efficient techniques to meet the needs of a given situation.

2. **Individual and Collaborative Efficacy** – Students will develop skills to effectively solve problems individually and as a member of a team.

Students will take responsibility for their own success and seek help and resources appropriately.

3. **Metacognitive Skills** - Students develop the ability to reflect on their own process of learning and relationship to the material to evaluate where their strengths lie and how to how to focus their energy to improve.

4. **Communication** – Students will develop oral, written, and symbolic communication skills. Communication between peers, with the instructor, and with the class as a whole all represent different and important settings to exercise professional communication skills.

5. **Engagement with Scientific Information** – Scientists continue to learn and develop skills throughout their career. Acquisition of information and skill development occurs in a variety of settings using a diversity of information sources including: the professional literature, scholarly texts, technical online resources, seminars, workshops, team members, and professional peers and superiors. Students will develop their ability to make use of all of these information sources to advance their own learning and skills.

6. **Content Mastery** - Students will master the foundational concepts in organic chemistry that will allow them to advance in their education (detailed content learning objectives provided after the course schedule).

GRADING

Your grade in the course will be determined by your engagement with class activities and your mastery of learning goals and objectives. This course will not be graded on a curve.

Graded Assignments and Weighting:

Notebook Assignments (38 × 10 pts)	380 pts	(31%)
Challenges (38 × 5 pts)	190 pts	(16%)
Quizzes (10 × 10 pts)	100 pts	(8%)
Seminar Synopses (2 × 25 pts)	50 pts	(4%)
Midterm Exams (3 × 100 pts)	300 pts	(25%)
Final Exam	200 pts	(16%)
Total Points	1220 pts	

The instructors will assign fair grades at the conclusion of the term. To estimate your grade during the semester use the following grade scheme.

Grade	Percent of Total Points Earned
A (+/-)	100% - 90%
B (+/-)	89% - 80%
C (+/-)	79% - 70%
D (+/-)	69% - 60%
F	< 60%

COURSE CHARACTERISTICS

Preparation:

The material in this course builds on itself. For that reason it is imperative that you keep up with the course material. Organic chemistry is a subject that requires the memorization of facts, the understanding and application of concepts, and the integration and synthesis of knowledge from all parts of the course. To be successful, students will need to employ a variety of study tactics and learning strategies. The instructor will highlight good strategies for the different kinds of materials we study. An understanding of how we learn best is a valuable asset in this course (and others). An excellent guide to understanding how best to learn is the following text and it is highly recommended reading prior to and throughout the course: "Make it stick: the science of successful learning", Brown, Roediger, and McDaniel, ©2014 Harvard University Press. In brief, ***ACTIVE*** learning strategies are far more valuable than passive ones. The course is structured to encourage the use of effective learning strategies that can be transferred to other courses as you learn how to use them.

Course Structure and Rationale:

Active preparation is essential for your success in chemistry courses. Prior to each class session (except the first day and prior to exam days), your job will be to expose yourself to the material and concepts that will be the focus of the next session; process, consolidate and organize that information into your course notebook; and complete a Course Preparation Assignment (CPA) in your notebook. Each day when you arrive at class, you will find a pre-session assignment (Meta Monday, Wildcard Wednesday, Formative Friday (low-stakes quiz)) displayed on the screen that you will begin as soon as you are seated. Class will begin with a discussion of the pre-session activity and then there will be a discussion of the CPA to allow you to get feedback and calibrate your understanding of the material. After the CPA discussion, using only your notebook as a resource (not your textbook), you will work with your peers on a challenge activity that will apply and extend your knowledge of the topic. Teams will submit their collective work on the challenge activity at the end of the class session. After class, you will

complete the challenge in your course notebook and complete additional practice activities, as you see fit, to build your confidence and reinforce your skills.

The structure used in this course is based on the science of how humans learn best: (1) exposure to new information or concepts (establish short-term memory traces while reading or watching videos), (2) consolidation and organization of information (place new information in your existing scaffold of knowledge while writing the key information into your notebook and completing the CPA), (3) recall and application on CPAs, challenges, practice exercises, pre-session assignments (shift knowledge into long-term memory and practice cueing it when needed to solve a problem) and (4) timely feedback on your work (establish knowledge in long-term memory and solidify it in the scaffold of knowledge available for complex cognitive processes). For more information read “Make it Stick” (referenced above).

Aspects of learning that are less cognitively demanding such as exposure to new terms and concepts, memorization, initial comprehension, and basic applications are focused outside of class sessions. Of primary importance during class sessions, when support and immediate feedback is available, are activities that require higher cognitive functions such as applications to more complex problems, analysis of data, and synthesis of concepts to create new models or ways of understanding. Like most things in life, you will get out of the class what you put in. Doing your part prior to class will allow you to benefit more from what we do in class. Your goal during each class session is to learn what you need to know to be able to complete the challenge and practice on novel practice problems outside of class.

The structured nature of the course is known to improve learning outcomes for ***all students*** and is especially valuable in maximizing the benefits of having a diversity of backgrounds and life-experiences in our class community. (An excellent literature article with leading references on this topic: CBE—Life Sciences Education Vol. 13, 453–468, Fall 2014)

Notebook and Notebook Assignments:

You will be provided with a course notebook (a bound composition notebook) on the first day of class. You may use the provided notebook or any bound notebook you prefer. Your notebook will be the record of your work for the class and will have the following structure for each cycle of class sessions (label the sections clearly in your notebook):

1. **Date Stamp** - on arrival to class each day
2. **Pre-Session Activity** - Metacognitive Monday, Wildcard Wednesday, Formative Friday
3. **In-Class Notes** - CPA discussion, mini-lectures, class discussions

4. **Refined Practice** - Challenge (required) and Additional Practice Activities (optional)
5. **Processing** - Key information distilled from exposure to readings and videos
6. **Course Preparation Assignment** - Brief application activity to prepare you for high-level cognitive work during the next class session.

Bring your notebook to every class session (including exams) and any office hours you attend.

Your notebook will be a temporal record of your activities for the class. Many students find it helpful to number the pages and make an index on the first few pages. After the index, **there will be no blank pages**. Each day upon entering class, students will date stamp where they completed their out-of-class work. Course notebooks will be spot checked during the midterm exams and final exam and returned the same day.

The **Notebook Assignment** for each class session will appear on Moodle following class. The assignment will have 3 parts: **Refined Practice** for the material in the previous session (typically the challenge from the previous session and optional practice problems), a description of new material (readings or videos) that you need to **Process** before the next class, and a **Course Preparation Assignment** (CPA) that you will complete in your notebook. You will complete the Notebook Assignment, photograph it, and submit the images using the Notebook Assignment Submission Form before 11:59 PM day before the next class session. You must be logged into your Kenyon Google account when you submit your assignment.

Your work preparing for class is essential and genuine engagement on each Notebook Assignment will be rewarded with 10 points . Because of the importance of your out-of-class work, your Notebook Assignment grade makes up the largest single contribution to your final grade (~380 points total for the semester, 31% of your grade). Notebook Assignment grades are *all or nothing* (0 or 10 points). Each student will be permitted one missed Notebook Assignment for the semester without a grade penalty. Notebook Assignments that are submitted on time, are complete, and show genuine engagement with **every question/prompt/part** will receive credit. You need your rest - assignments submitted after 11:59 PM will not be graded.

It is your job to correct the CPA portion of each Notebook Assignment (in your notebook) during the discussion at the beginning of each class. If you have questions about one of your CPA responses it is your responsibility to ask about it during the discussion - if you have a question, it is very likely that others do as well, so don't hesitate to ask it.

Challenges and Teams:

Following the discussion during the first part of each class session, pairs of students will work on a challenge activity. Challenge activities are designed to build from the CPA and concepts learned earlier in the course. Typically challenges will focus on developing higher-level cognitive abilities. In order to get the most out of challenge activities, teams must work efficiently and make sure that they have the opportunity to work on the difficult parts of the material as a collaborative team. During challenges the instructor and the Lead Tutor will be available as a resource and groups that get stuck should get help quickly.

Active engagement with the challenges will be evidenced by what is written on partner white boards during the class session. Teams will photograph (with a phone, tablet, or computer) their work and challenges and submit the images of what they accomplished using the Challenge Submission Form in the last minute of each class session. Teams that substantiate their engagement with a rich written record (text, calculations, drawings, structures, mechanisms, plots, etc.) of their work will receive full credit (5 points) for the challenge. To be clear, challenge grades will be determined by the level of engagement evidenced by the written work submitted and not the correctness or amount of the challenge that was completed.

Student teams will be randomly selected at the beginning of each class session by drawing a popsicle stick. The number and letter on the stick will assign each student a partner (1A with 1A, 1B with 1B, etc) and a group of four students (all students with 1, two pairs of partners). Partners will sit next to one another and groups will sit in the same area of the room so they can work together when needed. To be maximally effective, these collaborations must be inclusive endeavors. Group members who quickly understand a particular question or part of a challenge should transition to the role of mentor/teacher for other group members. Two individuals who both think they understand but have different answers should carefully listen to each other and try to discover the correct interpretation. It is a good practice to alternate who writes on the whiteboard for every question part and, at the end of each part, for the partners to touch base to confirm that both are ready to move on. Working in teams is an essential skill in the workforce today and people with ability to function well in a team, make the most of all the human resources in a team, and team leadership skills are tremendously valuable.

Quizzes:

Quizzes are an important learning tool that will enable you to calibrate your own understanding of course material. Quizzes have also been shown to help students consolidate their memory of a topic and allow them to build durable knowledge (read “Make it Stick” for details). Quizzes will be given at the beginning of class on Fridays

(Formative Friday) and will be 5-10 minutes in length depending on the topic. Students will write their responses to the quiz on the next available blank page of their course notebook.

Seminar Synopses:

You will attend two seminars during the semester that relate to the course and prepare a half-page synopsis of each seminar that clearly describes the motivation for the work and the significance of the results presented in the seminar. It should be clear from your synopsis how the seminar relates to this class. You should indicate your name, the title and date of the seminar clearly at the top of the page. Synopses will be typed and submitted electronically on the course Moodle page. If you don't know if a particular seminar relates to the class, just ask during class (so all might benefit). **You must submit your synopsis within 24 hours of each seminar you attend.**

POLICIES

Attendance:

Your attendance at every class session is expected. There will be no grade penalty for excused absences. Notify the instructor in advance of any excused absence so a plan to minimize its impact can be devised. The penalties for an unexcused absence are the points for any class activity that takes place during the absence (challenge, quiz, exam, etc.) and missing the powerful learning experience that took place in class on the day that was missed. Students are responsible for learning material missed as a result of any absence. It is very difficult to catch up once you fall behind so Notebook Assignments are due for every class session even when you have an excused absence.

Office Hours:

Office hours are a valuable resource for you to interact directly with the instructor. To make the most of office hours, come prepared and be organized. For questions about course material, it is good practice to write a list of your questions in your notebook and include the pages in the notebook/textbook where you can find the source of the question. *Always bring your course notebook to office hours.* Arriving at your office hour with a small group of students (2-5) is **preferred** if your questions relate to course material. For personal questions (those not related to course material), please reserve a private appointment. If you have a personal question that you think needs more than 10 minutes to discuss, email the instructor to set up a time to meet. If you need help but your schedule does not allow you to come to an office hour when you need it, email the instructor to make an appointment.

Integrity and Collaboration Expectations:

Academic integrity is expected in all aspects of this course. A detailed description of academic integrity and the College policy regarding academic dishonesty can be found here. Many aspects of this class encourage or require collaboration. Daily team challenges will give you the opportunity to develop your ability to collaborate with your peers and the instructor. Learning material at lower cognitive levels (exposure, memorization, basic applications) is a solitary activity and is best done independently. However, work at higher cognitive levels often benefits from a collaborative approach as long as each member of the collaboration develops their own understanding as a result. The cognitive demand of the CPA assignments will vary and collaboration is encouraged when it is helpful for every individual involved. Work submitted for quizzes, seminar synopses, midterm exams, and the final exam is to be completed independently.

Devices:

Full engagement with the in-class portion of this course will be a key component of success. All electronic devices should be silenced and put away before the beginning of every class session unless otherwise directed by the instructor. Wireless devices (computers, tablets, or phones) will be used in class and you are encouraged to bring such devices to class but keep them put away until they are needed for a particular activity.

Accessibility Accommodations:

A student with a disability who thinks they may need an accommodation to access a campus program, activity, or service should contact Erin Salva in Student Accessibility and Support Services (SASS) at salvae@kenyon.edu to discuss specific needs. Advance notice is required to review documentation, evaluate accommodation requests and provide notice or make arrangements for any accommodation.

Title IX:

As a faculty member, your instructor is deeply invested in the well-being of each student they teach. Your instructor is here to assist you with your work in this course. If you come to an instructor with non-course-related concerns, they will do their best to help. It is important for you to know that all faculty members are mandated reporters of any incidents of harassment, discrimination, and intimate partner violence and stalking. Meaning, faculty must report any such discussion to the Civil Rights/Title IX coordinator. Faculty cannot keep information involving sexual harassment, sexual misconduct, interpersonal violence, or any other form of harassment or discrimination based on a protected characteristic, confidential. The Health and Counseling Center, the College chaplains, and the staff at New Directions Domestic Abuse Shelter & Rape Crisis Center are confidential resources.

TENTATIVE SCHEDULE

Date - Day - (session)	**Content Learning Goals**	**New Book Sections**
1/13 - M - (1)	Introduction, Course Structure, Community Rules	Review: Ch1 - 1-9, Ch2 - 1
1/15 - W - (2)	I: A - E	Ch1 - 3, 4, 7, 9; Ch11 - 11
1/17 - F - (3)	I: F - I	Ch1 -5, 8; Ch2 - 2
1/20 - M - (4)	II: A - E	Ch2 - 1, 3
1/22 - W - (5)	II: D - F	No New Sections
1/24 - F - (6)	II: A - H	Ch2 - 4, 5, 6
1/27 - M - (7)	II: A, H, I	Ch 2 - 7, 8, 9
1/29 - W - (8)	III: A, B	Ch 10 - 1-7
1/31 - F - (9)	III: A, B	Ch 10 - 8, 9
2/3 - M - (10)	**Exam 1**	
2/5 - W - (11)	III: A, B, C, D	Ch 11 - 4, 8
2/7 - F - (12)	III: A, B, C, D	No New Sections
2/10 - M - (13)	IV: A, B	Ch 3 - 1, 2
2/12 - W - (14)	IV: C	Ch 3 - 4, 5, 6
2/14 - F - (15)	IV: D, E, F	Ch 3 - 7, 8, 9
2/17 - M - (16)	IV: G and V: A, B	Ch 3 - 11; Ch 4 - 1, 2, 3
2/19 - W - (17)	V: C, D	Ch 4 - 4, 5, 6, 7
2/21 - F - (18)	VI: A, B	Ch 5 - 1, 3
2/24 - M - (19)	VI: A - D	Ch 5 - 5, 6
2/26 - W - (20)	**Exam 2**	
2/28 - F - (21)	VI: E	Ch 5 - 4
3/16 - M - (22)	VI: F - H	Ch 5 - 7, 8

3/18 - W - (23)	VII: A, B (S_N2)	Ch 6 - 2-9
3/20 - F - (24)	VII: A, B (S_N2, S_N1)	Ch 7 - 1-4
3/23 - M - (25)	VII: A, B, C (S_N1)	Ch 7 - 5
3/25 - W - (26)	VII: A, B (E1, E2)	Ch 7 - 6, 7
3/27 - F - (27)	VII: A-D (SN1, SN2, E1, E2)	Ch 7 - 7, 8
3/30 - M - (28)	VIII: A, B, D	Ch 8 - 1, 2, 3, 5, 6
4/1 - W - (29)	VIII: E, F	Ch 8 - 7, 8
4/3 - F - (30)	VIII: G	Ch 8 - 9, Ch 9 - 6
4/6 - M - (31)	VIII: C, H	Ch 9 - 1-4
4/8 - W - (32)	VIII: I, J	Ch 9 - 7, 8, 9, 10
4/10 - F - (33)	**Exam 3**	
4/13 - M - (34)	IX: A-D	Ch 11 - 1-6
4/15 - W - (35)	IX: E	Ch 11 - 7
4/17 - F - (36)	IX: F	Ch 12 - 1, 2
4/20 - M - (37)	IX: G	Ch 12 - 3-6
4/22 - W - (38)	IX: H	Ch 12 - 7
4/24 - F - (39)	IX: I	Ch 12 - 8
4/27 - M - (40)	IX: J	Ch 12 - 9-11
4/29 - W - (41)	IX: J, K	Ch 12 - 12,13
5/1 - F - (42)	Wrap Up	No New Sections
5/7 (8:30 a.m.)	**Final Exam for 231.02**	
5/7 (6:30 p.m.)	**Final Exam for 231.01**	

CONTENT LEARNING OBJECTIVES BY UNIT (I-IX)

I. **Chapter 1:** Structure and Bonding

A. Represent (draw) organic molecules using bond-line notation and draw a pool of structurally distinct isomers of organic molecules given a molecular formula
B. Interconvert Kekulé (Lewis), Condensed, and Bond-Line structures (with wedge-dash notation) representations for organic molecules
C. Interconvert any 2-dimensional representation into a 3-dimensional plastic model
D. Identify the hybridization of all atoms in organic molecules
E. Predict the formal charge of atoms in the first two periods in the context of organic molecules
F. Illustrate the movement of electrons using the curved-arrow notation
G. Identify organic molecules and ions in which resonance is important
H. Draw all important resonance contributors, and evaluate the relative stability of resonance forms
I. Use the valence-bond model of covalent bonding to identify the atomic or hybridized orbitals that make up the bonds in organic molecules

II. **Chapter 2:** Structure and Reactivity

A. Draw and interpret the qualitative meaning of reaction coordinate diagrams and total energy diagrams for a reaction
B. Write and interpret the rate law for an elementary reaction step
C. Describe the meaning of the Arrhenius equation and its variables
D. Know, quickly recall, and make structural analogies using the benchmark pK_a values (estimate the acidity and basicity of novel organic structures by analogy to benchmark values)
E. Represent (draw) acid-base reactions using the curved-arrow notation
F. Predict if products or reactants will be favored (qualitative) for acid-base reactions using knowledge of benchmark pK_a values
G. Know, quickly recall, and identify common organic functional groups in polyfunctional molecules
H. Determine the IUPAC name for acyclic alkanes
I. Use conformational analysis to draw Newman Projections, predict conformational potential energy diagrams or interpret the meaning diagrams

III. **Chapters 10 & 11 (Selected Sections):** Deducing Organic Structures from Spectra

A. Predict the ^{1}H and ^{13}C NMR spectrum of small organic molecules
B. Apply equivalence tests to any two protons in a small organic molecule
C. Predict important IR absorption frequencies of small organic molecules
D. Given spectral data (NMR and IR) and a molecular formula, determine the structure of a small organic molecule

IV. **Chapter 3:** Halogenation of Alkanes

A. Draw homolytic and heterolytic bond cleavage using the curved-arrow notation
B. Predict relative bond-dissociation energies (bond strength) using the concept of hyperconjugation
C. Draw a detailed mechanism for the halogenation of alkanes
D. Predict the product distribution for a given alkane halogenation reaction using the Hammond Postulate
E. Predict transition state structures using the Hammond Postulate
F. Design synthetically useful alkane halogenation reactions
G. Understand how heats of combustion can be used to assess the relative energy of acyclic isomeric alkanes

V. **Chapter 4:** Cycloalkanes

A. Determine IUPAC names monocyclic alkanes and their derivatives
B. Predict the relative conformational energy of cycloalkanes and their derivatives and articulate the type(s) of strain that contribute to the conformational potential energy
C. Draw a qualitative conformational potential energy diagram for a given cycloalkane or cycloalkane derivative
D. Given the structure of a polycyclic alkane, identify and name the type of ring junction(s) (spiro, fused, bridged)

VI. **Chapter 5:** Stereochemistry

A. Identify and name chiral organic molecules
B. Identify the isomeric relationship given the structure of two isomeric molecules using the isomer hierarchy
C. Identify the absolute configuration of an asymmetric carbon in a given structure
D. Draw a stereochemically accurate representation of an organic molecule given an IUPAC name

E. Use the specific rotation and optical purity to determine the enantiomeric composition of a mixture of enantiomers
F. Predict the specific rotation or optical purity given the enantiomeric composition of a mixture of enantiomers
G. Given a reaction mechanism and thermodynamic information, predict the isomeric composition (qualitative) for the reaction
H. Describe how different types of isomers can be separated and suggest a separation protocol given a pair of isomeric organic molecules

VII. **Chapters 6 & 7:** Haloalkanes, Substitution and Elimination Reactions

A. Draw the mechanism, predict the transition state structures, draw qualitative energy diagrams, and predict the products of S_N1, S_N2, E1, E2 reactions
B. Determine the relative rate of substitution and elimination reactions based on the factors that govern rate (electrophile structure, leaving group, nucleophile, solvent)
C. Draw the structure of sulfonate leaving groups and predict their reactivity
D. Design the synthesis of an organic molecule using substitution and elimination reactions (and identify products that cannot be easily/cleanly prepared).

VIII. **Chapters 8 & 9:** Hydroxy Functional Groups and their Derivatives

A. Interconvert the IUPAC name and structure of alcohols, ethers, thiols, and sulfides
B. Make predictions of the physical properties of alcohols and ethers based using intermolecular force arguments.
C. Identify when direct or indirect synthesis of alcohols is preferred
D. Identify when oxidation and reduction reactions are occuring on carbons bonded to oxygen
E. Know the reagents and conditions needed to oxidize or reduce carbon atoms bound to oxygen and draw the mechanism of those reactions
F. Know the reagents and conditions of organometallic reactions and draw the mechanism of those reactions
G. Use retrosynthetic analysis to plan the synthesis of simple organic molecules using organometallic chemistry, Williamson Ether synthesis and previously studied reactions
H. Predict molecules that are likely to rearrange during unimolecular substitution and elimination reactions and predict the products of such rearrangements

I. Understand the relative lack of chemical reactivity of ethers and draw the mechanism for and predict the products for reactions of ethers.
J. Predict the reactivity of cyclic ethers and predict the products that are likely to form in such reactions.

IX. **Chapters 11 & 12:** Alkene Chemistry

A. Interconvert the IUPAC name and structure of alkenes
B. Describe the bonding of alkenes using Valence Bond Theory
C. Predict the relative stability of alkenes based on heats of hydrogenation or based on structural arguments.
D. Predict the products of dehydrohalogenation reactions and determine when synthetically useful dehydrogenation reactions
E. Predict the products of alcohol dehydration reactions and determine when synthetically useful dehydrogenation reactions
F. Know the reagents for hydrogenation of alkenes and predict the products produced in such processes
G. Predict the products of electrophilic addition to alkenes and draw the mechanism for their formation
H. Know the reagents and draw the mechanism of oxy-mercuration/demercuration and understand its synthetic utility
I. Know the reagents and draw the mechanism of hydroboration oxidation and understand it synthetic utility
J. Know the reagents and draw the mechanism of alkene oxidative addition (dihydroxylation, epoxidation) and cleavage (ozone)
K. Know the conditions that lead to anti-markovnikov addition to alkenes and draw the mechanism for such reactions