

Unit 3: More Alkene and Alkyne Addition Reactions

Learning Outcomes

Reaction Mechanisms

- Draw curved arrows to depict the mechanism of an organic reaction. Explain how the arrows are used to show bonds breaking and/or forming.
- Specifically be able to show mechanisms for Brønsted-Lowry acid-base reactions (proton transfer), addition of HX to alkenes or alkynes, acid-catalyzed hydration of alkenes, and addition of X₂ (in the presence or absence of water) to alkenes. Predict the major organic product for these types of reactions.
- For oxymercuration-reduction or hydroboration-oxidation of alkenes, be able to predict products and also be able to draw partial mechanisms of these reactions; you should be able to draw the mechanisms for the oxymercuration and hydroboration parts.
- Analyze carbocation intermediate structures to determine if a rearrangement is likely to occur. Clearly use mechanism arrows to indicate rearrangements of secondary carbocations, when appropriate, including hydride shifts, methyl shifts, and expansions of 3 or 4-membered rings.
- Classify reaction mechanisms as either step-wise or concerted.
- Demonstrate heterolytic bond cleavage (both electrons stay with a single atom) using curved arrows to show the electron movement.
- Draw intermediates that form in oxymercuration and hydroboration and predict partial mechanisms of these reactions.

General Trends in Stability and Reactions

- Arrange a set of alkenes by their relative stabilities and explain the reasons for this ordering.
- Arrange a set of alkynes by their relative stabilities and explain the reasons for this ordering.
- Arrange carbocation intermediate structures in order of relative stability, and explain the trend using known mechanisms of electron donation. Identify primary, secondary and tertiary carbocations.
- Define the following terms: hyperconjugation and induction. Apply those terms to specific structures.
- Explain Markovnikov's rule for additions to unsaturated compounds.
- Construct an energy versus extent of reaction diagram (also called a reaction coordinate diagram) for a general organic reaction based on energy predictions for reactive intermediates.
- Distinguish between a *syn*-addition and *anti*-addition and give an example of each type of reaction.

Alkenes

- Predict the products of hydration reactions (acid-catalyzed, oxymercuration-reduction, or hydroboration-oxidation) and determine the correct regiochemistry
- Determine starting materials required to form desired products via acid-catalyzed hydration, oxymercuration-reduction, hydroboration-oxidation.
- Draw the mechanism for acid catalyzed hydration of an alkene.
- Predict the products with correct regiochemistry and stereochemistry of halogenation (addition of X₂) and halohydrin formation reactions, and draw mechanisms for these reactions which clearly show that they are *anti*-additions.
- Predict the products of metal-catalyzed hydrogenation reactions, and determine the correct stereochemistry, when applicable, for this *syn*-addition.

Alkynes

- Demonstrate reaction conditions that can be used to make *cis*- or *trans*-alkenes by hydrogenation of alkynes.
- Predict the product for the addition of X₂ to alkynes.

Readings

Loudon: 4.8-4.9, 14.4, 14.6, 5.1-5.4

Assignments and Additional Resources (Assignments in red are **required**)

Lab Work

The Scientific Method, Separations, and Solvents (Sapling)

Extraction – Isolation Caffeine from Tea

Introduction to Chromatography (Sapling)

Recitation Worksheets (complete in recitation)

Topic IV A: More Alkene Additions

Topic IV B: Alkyne Additions

Sapling Assignments

Chapters 4 and 5

Getting Started with Addition Reactions

(some of these were from Unit 2; Unit 3 finishes this set.)

Chapter 4: Additional Optional Problems

Chapter 5: Additional Optional Problems

Loudon Practice Problems

Chapter 4: 54, 57, 63, 66

Chapter 5: 27afghjklmn, 29bcef, 32abcefij, 34, 48abc

Chapter 14: 26abcf, 27abd

Animated Online Lectures

To Navigate in Sakai: Within the Resources Folder, click on “Tutorials, Animations, and Places for Extra Help”, then on “Animated Online Lectures”

Topics in Chapter 3

20. Bronsted Acid-Base pKa Review

21. Bronsted Acid-Base Strength Review

Topics in Chapter 4

22. Alkene IUPAC 1: Basics

23. Alkene IUPAC 2: Stereoisomers, CIP rules

24. Alkene Structure and Bonding

25. Alkene Relative Stabilities

26. Catalytic Hydrogenation of Alkenes

27. HX Addition to Alkenes

28. Acid Cat Hydration of Alkenes

Topics in Chapter 5

30. Alkene Addition Halogenation and Halohydrin Formation

31. Hydroboration Oxidation of Alkenes

Topics in Chapter 14

95. Alkyne Hydrogenation

96. Alkyne HX Addn

97. Alkyne X₂ Addn

Powerpoints to Review

Loudon Chapter 4

Loudon Chapter 5

Loudon Chapter 14 Part 1

Review Concepts from General Chemistry

- Acid and base chemistry, standard free energy, catalysis, formal charge

Review Concepts from Previous Chapters in Loudon

- Alkane IUPAC nomenclature, Alkene IUPAC nomenclature, including E and Z, Alkyne IUPAC nomenclature, and drawing organic compounds