

7.S: ALKENES- STRUCTURE AND REACTIVITY (SUMMARY)

CONCEPTS & VOCABULARY

7.1 Industrial Preparation and Use of Alkenes

- Breaking up of large hydrocarbon molecules into smaller, useful molecules is called cracking.

7.2 Calculating Degree of Unsaturation

- Saturated molecules contain only single bonds and no rings.
- Saturated hydrocarbons have the formula C_nH_{2n+2} , where n can be any integer.
- Degrees of unsaturation account for the total number of rings and pi bonds in a molecule.
- Each degree of unsaturation reduces the number of hydrogens in the molecule by 2.

7.3 Naming Alkenes

- When the two largest groups are on the same side of the double bond (top or bottom) they are called cis or Z.
- When the two largest groups are on opposite sides of the double bond (top or bottom) they are called trans or E.
- Endocyclic double bonds occur when there is a pi bond within a ring.

7.4 Cis-Trans Isomerism in Alkenes

7.5 Alkene Stereochemistry and the E, Z Designation

- E and Z are less limited than cis and trans in naming.
- E and Z configurations use the same priority rules as R and S (CIP rules).

7.6 Stability of Alkenes

- Relative stability of alkenes can be measured by using heats of hydrogenation upon reduction to the related alkane.
- More substituted alkenes are more stable than less substituted.
- Alkenes with the largest groups trans are more stable than cis.

7.7 Electrophilic Addition Reactions of Alkenes

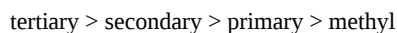
- In electrophilic addition reactions, the pi bond of the alkene acts as the nucleophile.
- Electrophilic addition reactions occur faster with larger hydrogen halides as well as more substituted alkenes.

7.8 Orientation of Electrophilic Additions: Markovnikov's Rule

- The more substituted carbocation intermediate forms during electrophilic addition reactions, since more substituted carbocations are more stable. This is known as Markovnikov's rule.

7.9 Carbocation Structure and Stability

- Molecules or ions that can disperse (delocalize) charge are more stable than structures with charge localized on a single atom.
- Due to inductive stabilization, carbocation stability follows the order:



- Electron donating groups stabilize carbocations.
- Electron withdrawing groups destabilize carbocations.
- Resonance effects can stabilize a carbocation (some examples include benzylic and allylic carbocations).
- Vinylic carbocations are unstable and are unlikely to form.

7.10 The Hammond Postulate

- The Hammond Postulate states that transition state structure most resembles the nearest stable species.
- Based on the Hammond Postulate, transition states for exothermic reaction steps resemble reactants, while endergonic step transition states resemble products.

7.11 Evidence for the Mechanism of Electrophilic Additions: Carbocation Rearrangements

- Carbocations will rearrange from less stable to more stable isomers through hydride shifts or alkyl shifts.

SKILLS TO MASTER

- Skill 7.1 Calculate degree of unsaturation for organic molecular formulae.
- Skill 7.2 Draw isomers from a molecular formula.
- Skill 7.3 Name alkenes following IUPAC rules, including configuration (E, Z).

- Skill 7.4 Draw structures from IUPAC name.
- Skill 7.5 Describe bonding in alkenes including bond length, strength, angle and restricted rotation.
- Skill 7.6 Explain stability of alkenes.
- Skill 7.7 Rank alkenes in order of stability.
- Skill 7.8 Draw mechanism for electrophilic addition of HX to alkenes, including regiochemistry.
- Skill 7.9 Explain stability of carbocations.
- Skill 7.10 Explain transition states related to the Hammond Postulate.
- Skill 7.11 Explain products formed by carbocation rearrangements.

MEMORIZATION TASKS

MT 7.1 Memorize formula for saturated hydrocarbons C_nH_{2n+2} .

MT 7.2 Memorize basic IUPAC naming rules.

MT 7.3 Memorize relative stability of alkenes.

MT 7.4 Memorize relative stability of carbocations.

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