

8.1: PREPARATION OF ALKENES - A PREVIEW OF ELIMINATION REACTIONS

OBJECTIVES

After completing this section, you should be able to

- explain the relationship between an addition reaction and an elimination reaction.
- write an equation to describe the dehydrohalogenation of an alkyl halide.
- identify the reagents required to bring about dehydrohalogenation of an alkyl halide.
- write an equation to represent the dehydration of an alcohol.
- identify the reagents required to dehydrate a given alcohol.

KEY TERMS

Make certain that you can define, and use in context, the key terms below.

- dehydration
- dehydrohalogenation
- elimination reaction

STUDY NOTES

An *elimination reaction* is a reaction in which two or more atoms, one of which is usually hydrogen, are removed from adjacent atoms in the reactant, resulting in the formation of a multiple bond.

The relationship between addition reactions and elimination reactions is shown in Figure 8.1, below.

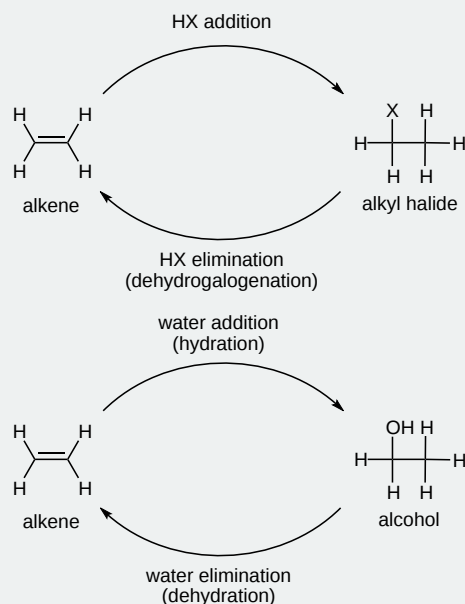
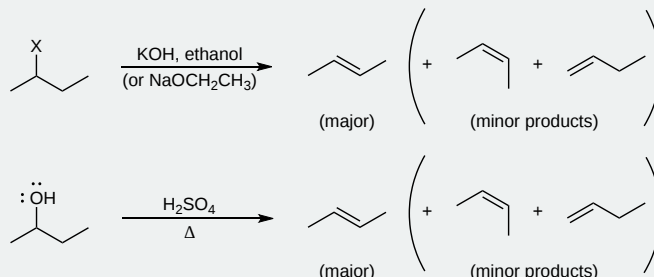


Figure 8.1: Relationship of addition and elimination reactions

Alkenes can be readily prepared from the alkylhalide ($X = \text{Cl}, \text{Br}, \text{I}$) or the alcohol.

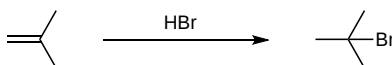


ELECTROPHILIC ADDITION

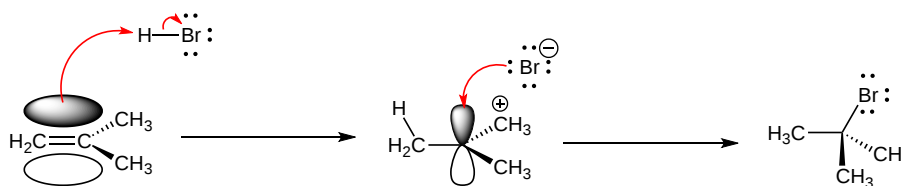
Alkenes are found throughout nature. They form the basis of many natural products, such as terpenes, which play a variety of roles in the lives of plants and insects. The C=C bonds of alkenes are very different from the C=O bonds that are also common in nature. The C=C bonds of alkenes are electron-rich and nucleophilic, in contrast to the electron-poor C=O bonds of carbohydrates, fatty acids and proteins. That difference plays a role in how terpenes form in nature.

Alkenes, or olefins, are also a major product of the petroleum industry. Reactions of alkenes form the basis for a significant portion of our manufacturing economy. Commonly used plastics such as polyethylene, polypropylene and polystyrene are all formed through the reactions of alkenes. These materials continue to find use in our society because of their valuable properties, such as high strength, flexibility and low weight.

Alkenes undergo addition reactions as you will see carbonyls do as well. Most commonly they add a proton to one end of the double bond and another group to the other end. These reactions happen in slightly different ways, however.



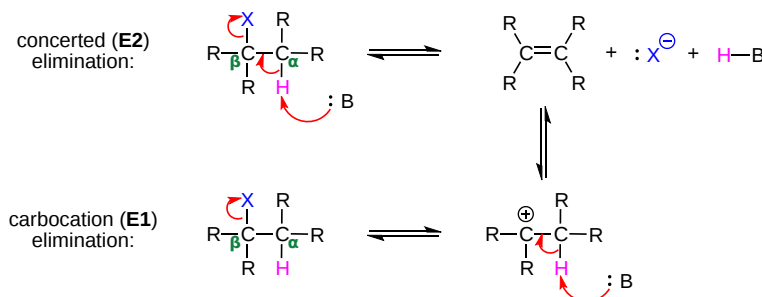
Alkenes are reactive because they have a high-lying pair of π -bonding electrons. These electrons are loosely held, being high in energy compared to σ -bonds. The fact that they are not located between the carbon nuclei, but are found above and below the plane of the double bond, also makes these electrons more accessible.



Alkenes can donate their electrons to strong electrophiles other than protons, too. Sometimes their reactivity pattern is a little different than the simple addition across the double bond, but that straightforward pattern is what we will focus on in this chapter.

ELIMINATION REACTIONS

Elimination reactions are possible by abstraction of a proton at positions that are next to a potential leaving group. This type of elimination can be described by two model mechanisms: it can occur in a single concerted step (proton abstraction at C_α occurring at the same time as C_β -X bond cleavage), or in two steps (C_β -X bond cleavage occurring first to form a carbocation intermediate, which is then 'quenched' by proton abstraction at the alpha-carbon).

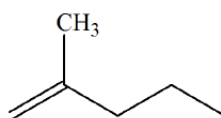
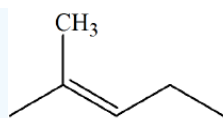


The most common elimination reactions are dehydrohalogenation and dehydration. In the mechanism above, X could be Cl, Br, or I for the dehydrohalogenation where there is a loss of HX from an alkyl halide. For dehydration, X would be an OH group in the above mechanism where the overall loss is water from an alcohol. These mechanisms, termed E2 and E1, respectively, are important in laboratory organic chemistry, but are less common in biological chemistry. As explained below, which mechanism actually occurs in a laboratory reaction will depend on the identity of the R groups (ie., whether the alkyl halide is primary, secondary, tertiary, etc.) as well as on the characteristics of the base.

? EXERCISE 8.1.1

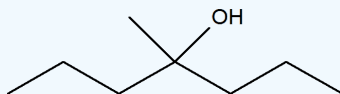
In elimination reactions there tends to have a mixture of products. What are the two possible alkene products for the reaction of 2-bromo-2-methylpentane with NaOH?

Answer

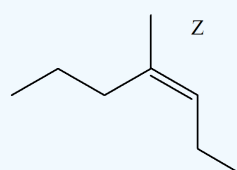
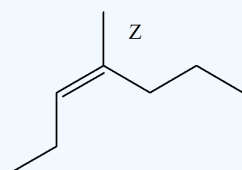
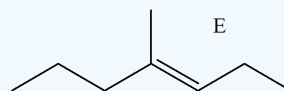
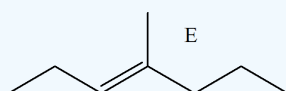


? EXERCISE 8.1.2

Predict the *E/Z* isomers for the following molecule when reacted with H_2SO_4 .



Answer



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