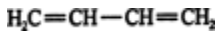
Conjugated Dienes Defined

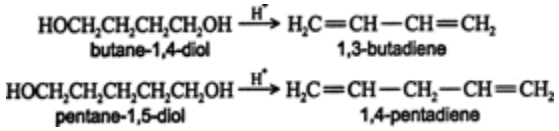
A **diene** is a molecule that has two double bonds. If the molecule is also a hydrocarbon, it is called an **alkadiene.** When the double bonds are separated from each other by two or more single bonds, they are called **isolated double bonds.** Isolated double bonds undergo normal alkene reactions, revealing that no interaction occurs between them. If, however, the double bonds are separated by only one single bond, atypical reactions occur. Such an arrangement is called a **conjugated double-bond system.** The interaction between the two double bonds in conjugated dienes delocalizes the electron density and increases the stability of the molecule. The simplest conjugated diene is 1,3-butadiene.



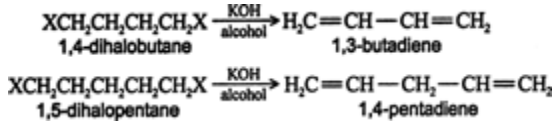
Preparations: Conjugated Dienes

Dienes are prepared from the same reactions that form ordinary alkenes. The two most common methods are the dehydration of diols (dihydroxy alkanes) and the dehydrohalogenation of dihalides (dihaloalkanes). The generation of either an isolated or conjugated system depends on the structure of the original reactants. Vicinal diols, which have two hydroxyl groups on adjacent carbon atoms, and vicinal dihalides, which have halogen substituents on adjacent carbons, always become conjugated systems in elimination reactions. Other reactant configurations can lead to products that include both conjugated and isolated systems.

Dehydration of diols:

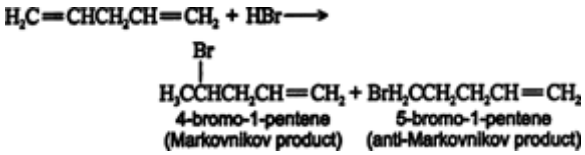


Dehydrohalogenation of dihalides:

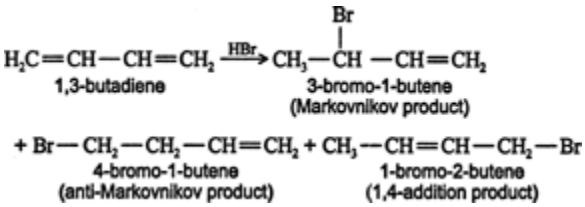


1,2 and 1,4 Additions

Both isolated and conjugated dienes undergo electrophilic addition reactions. In the case of isolated dienes, the reaction proceeds in a manner identical to alkene electrophilic addition. The addition of hydrogen bromide to 1,4-pentadiene leads to two products.



This reaction follows the standard carbocation mechanism for addition across a double bond. The addition of more hydrogen bromide results in addition across the second double bond in the molecule. In the case of conjugated dienes, a 1,4-addition product forms in addition to the Markovnikov and anti-Markovnikov products. Thus, in the addition of hydrogen bromide to 1,3-butadiene, the following occurs.



Diels–Alder Reaction

The **Diels-Alder reaction** is a cycloaddition reaction between a conjugated diene and an alkene. This reaction produces a 1,4-addition product. A typical example is the reaction of 1,3-butadiene with maleic anhydride.