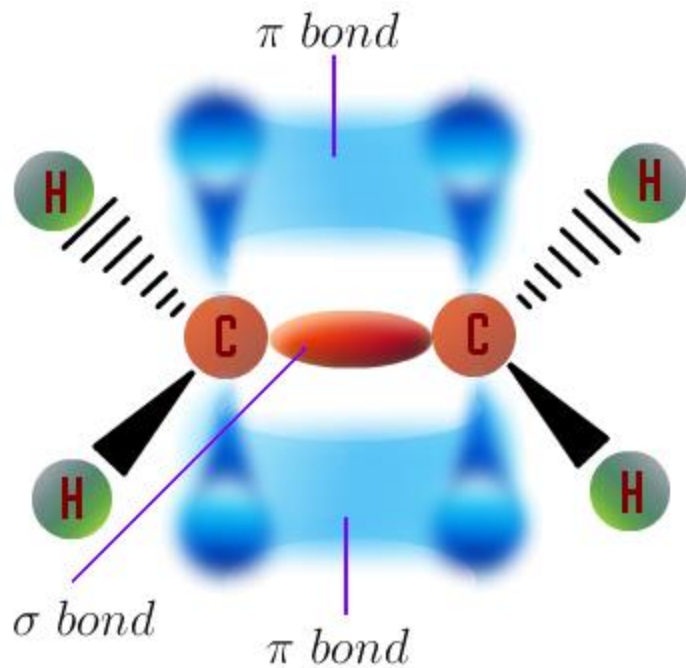


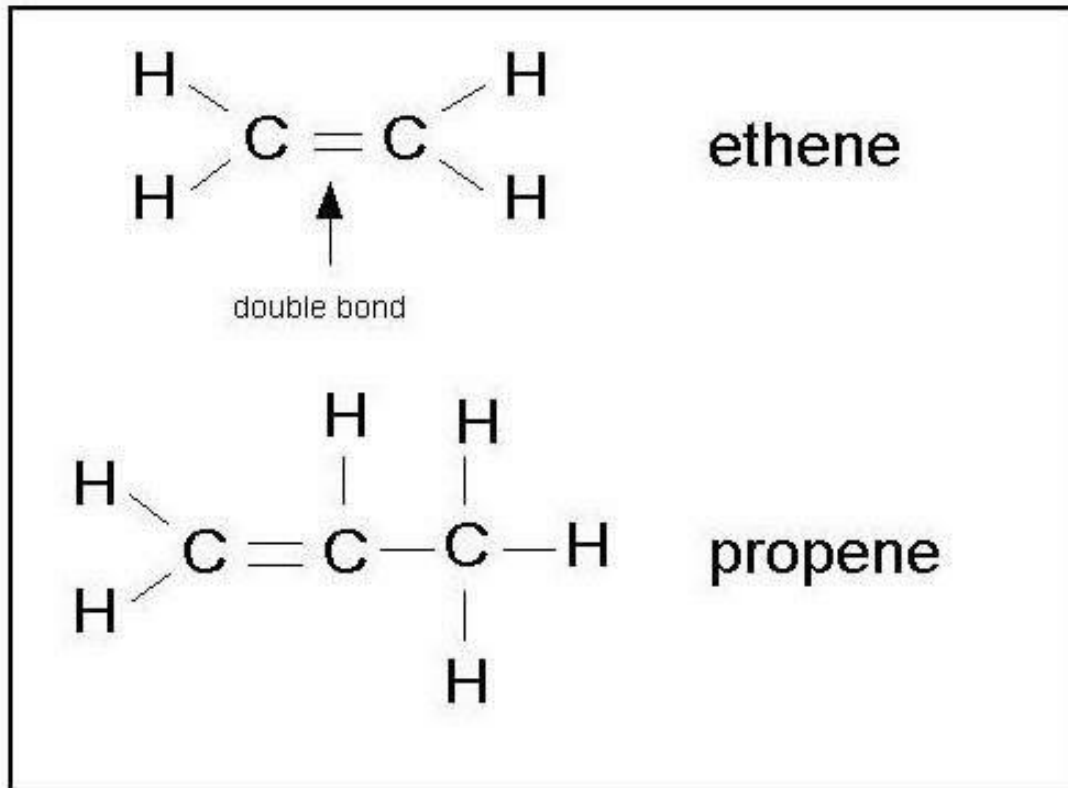
Alkenes



Dr. Munther A. M-Ali
For 1st Stage Setudents

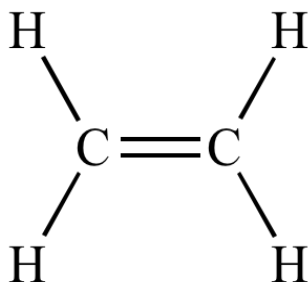
Alkenes

Family of hydrocarbons, the alkenes, which contain less hydrogen, carbon for carbon, than the alkanes



Structure of ethylene, The carbon-carbon double bond

The simplest member of the alkene family is ethylene, C_2H_4



carbon makes use of three equivalent hybrid orbitals: sp^2 orbitals, lie in one plane

trigonal arrangement

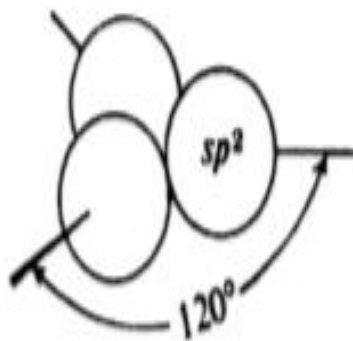
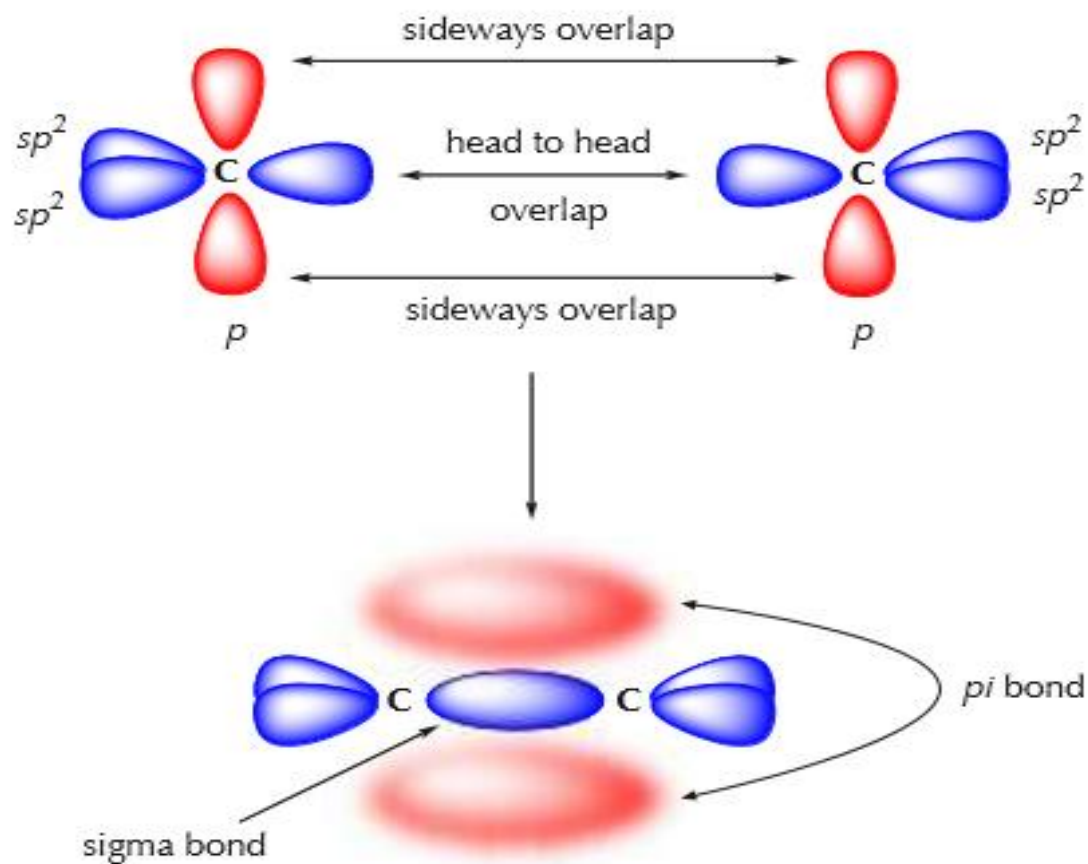


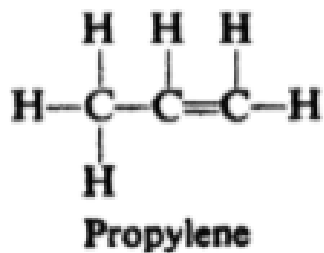
Figure 5.1. Atomic orbitals: hybrid sp^2 orbitals. Axes directed toward corners of equilateral triangle.

Because it is formed by the overlap of p orbitals, this bond is called a pi bond (π bond).

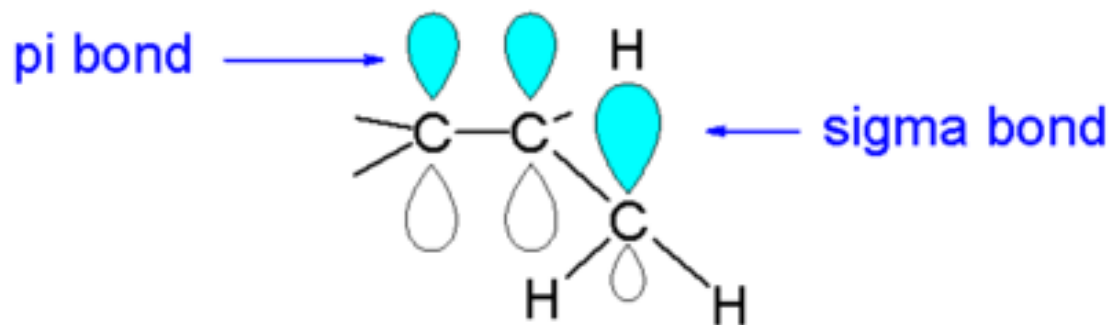


Propylene

The next member of the alkene family is propylene, C_3H_6

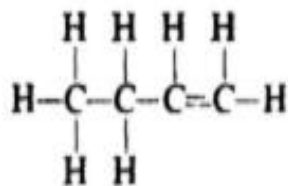


There are two types of hybridized carbon atoms, sp^2 in $C=C$ (unsaturated carbons) and sp^3 in saturated carbon atom

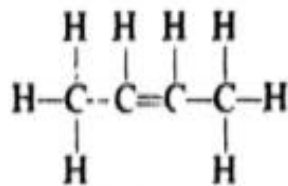


The butylenes

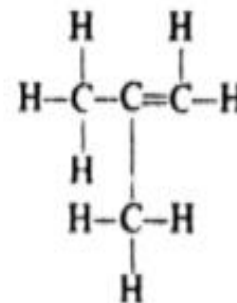
butylenes, C_4H_8 , there are a number of possible arrangements



1-Butene

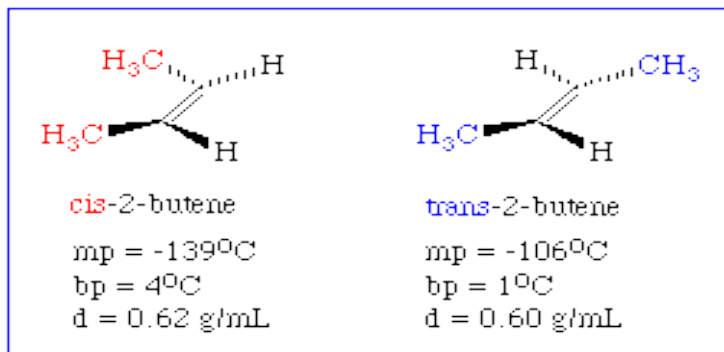


2-Butene



Isobutylene

Experiment has shown that not three but **four** alkenes of the formula C_4H_8 exist, ; they have the physical properties

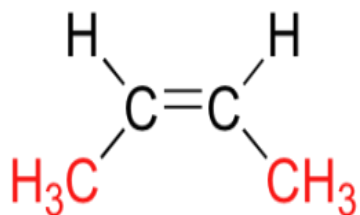


Geometric isomerism

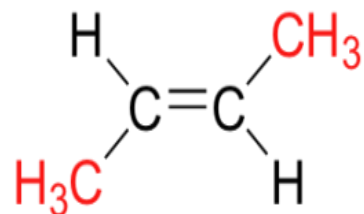
Isomeric 2-butenes differ from one another only in the way the atoms are oriented in space,

stereoisomers

The arrangement of atoms that characterizes a particular stereoisomer is called its **configuration**



cis-2-butene



trans-2-butene

Higher alkenes

The general formula for this family is C_nH_{2n}

Common names are seldom used except for three simple alkenes: ethylene, propylene, and isobutylene

Most alkenes are named by the IUPAC system

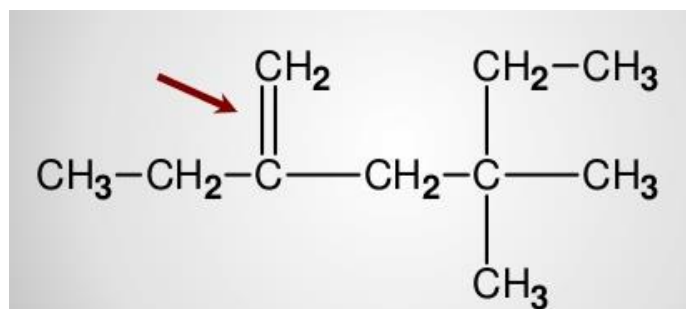
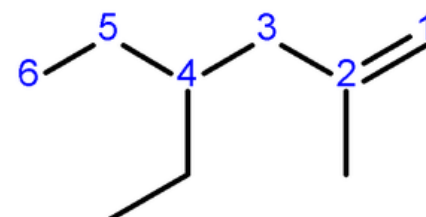
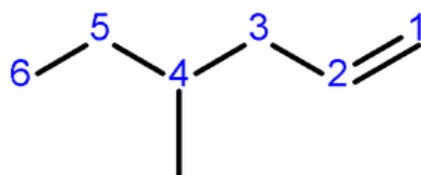
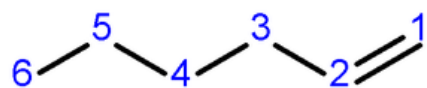
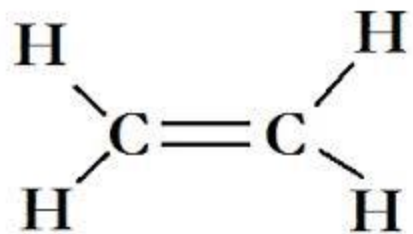
1- Select as the parent structure the longest continuous chain that contains the carbon-carbon double bond

name is derived by changing the ending **-ane** of the corresponding alkane name to **-ene**

2. Indicate by a number the position of the double bond in the parent chain.

designate its position by the number of the first doubly-bonded carbon

3. Indicate by numbers the positions of the alkyl groups attached to the parent chain.



Physical properties

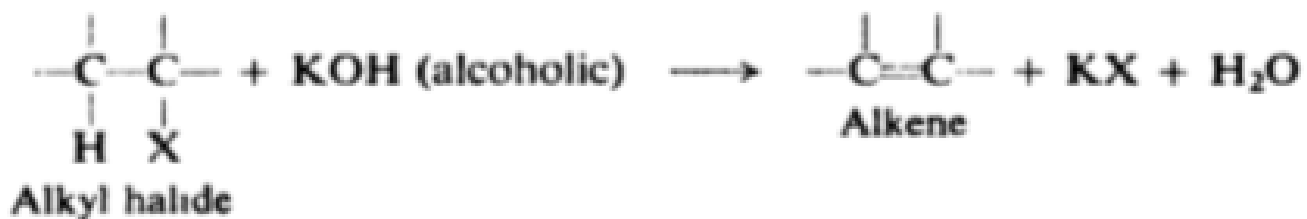
- They are insoluble in water, but quite soluble in nonpolar solvents like benzene, ether, chloroform, or ligroin.
- They are less dense than water.
- The boiling point rises with increasing carbon number; as with the alkanes, the boiling point rise is 20-30° for each added carbon.
- Branching lowers the boiling point.

Preparation

1- Dehydrohalogenation of alkyl halides.

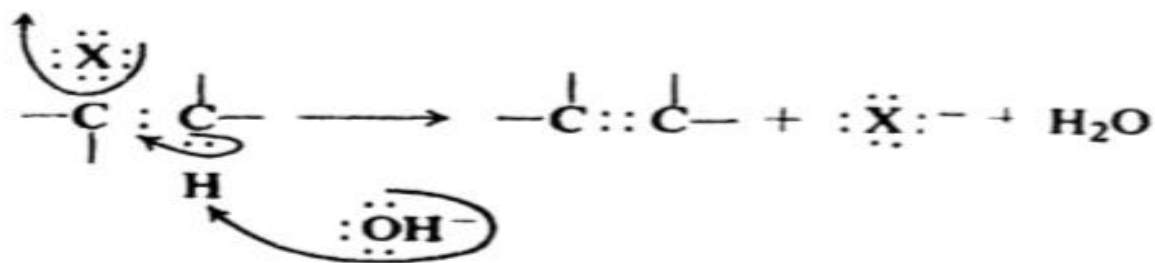
Alkyl halides are converted into alkenes by **dehydrohalogenation**: *elimination of the elements of hydrogen halide*.

Dehydrohalogenation: elimination of HX

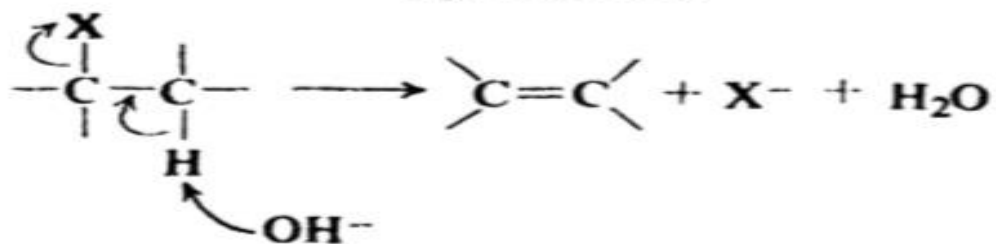


Mechanism of dehydrohalogenation

The function of hydroxide ion is to pull a hydrogen ion away from carbon; simultaneously a halide ion separates and the double bond forms.

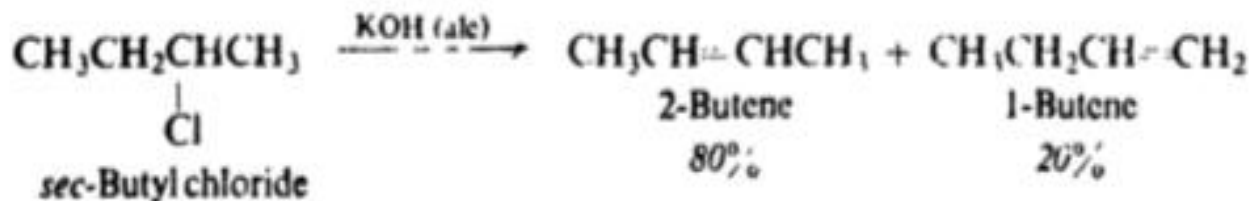
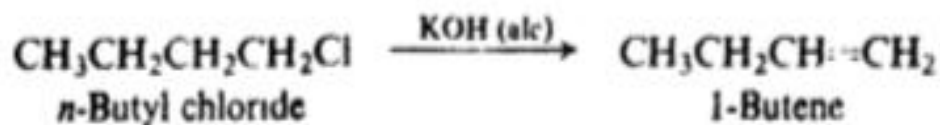
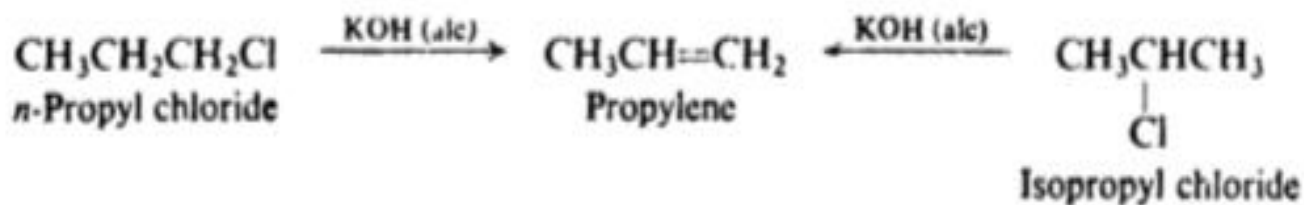


represented as



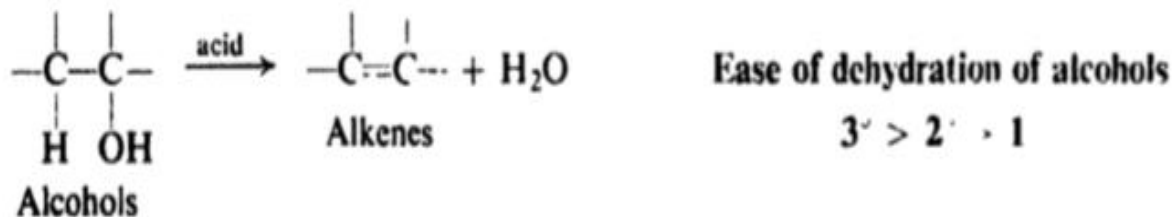
where arrows show the direction of electron shift

The preferred product is the alkene that has the **greater number of alkyl groups** attached to the doubly-bonded carbon atoms.

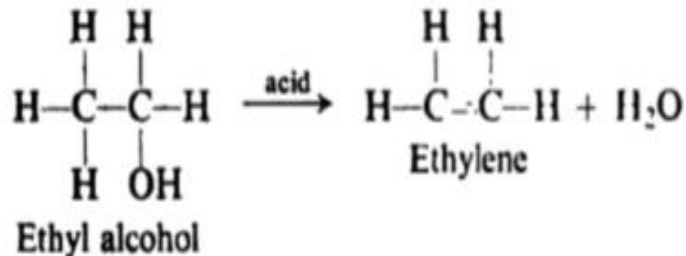


2- Dehydration of alcohols

An alcohol is converted into an alkene by dehydration: **elimination of a molecule of water**. Dehydration requires the presence of an acid and the application of heat.



Examples:

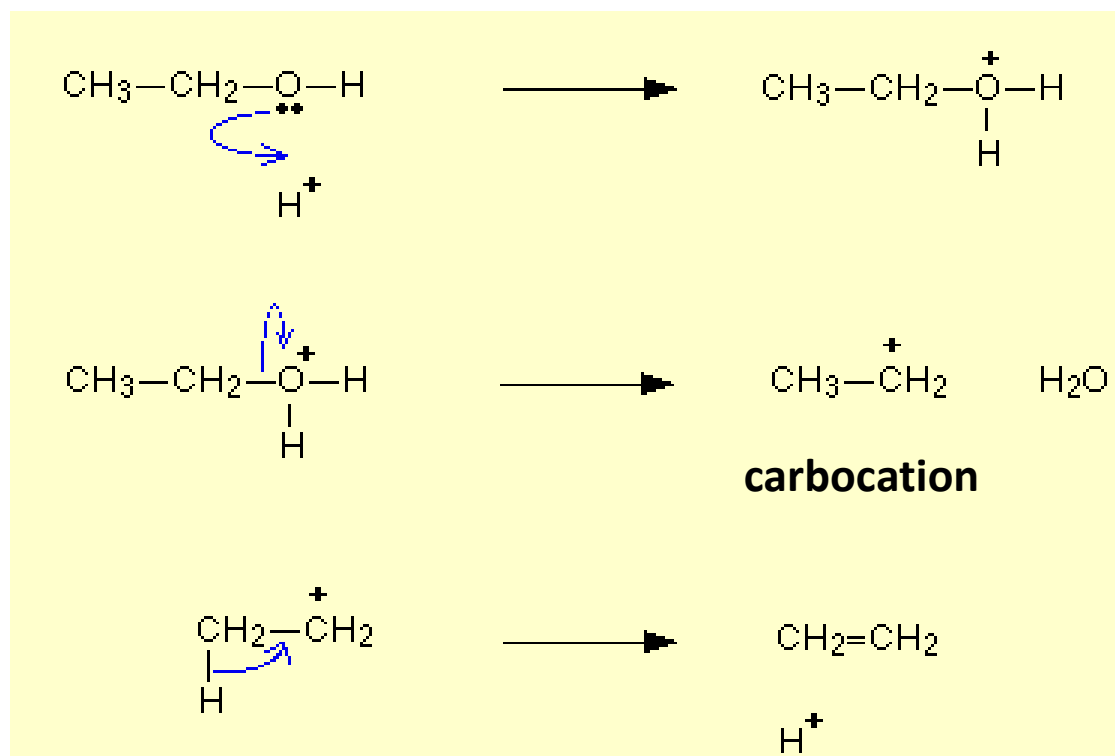


Mechanism of dehydration of alcohols

(step 1), The alcohol reacts with a hydrogen ion to form the protonated alcohol,

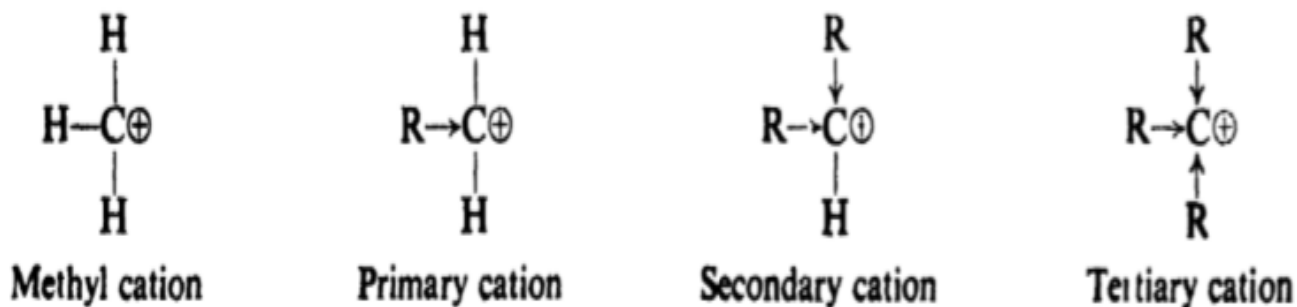
(step 2), which dissociates into water and a **carbocation**;

(step 3), the carbocation then loses a hydrogen ion to form the alkene.



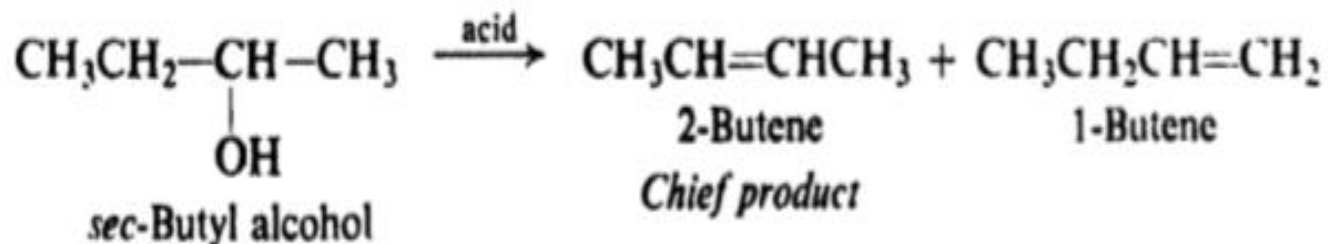
Ease of formation of carbocation $3 > 2 > 1 > \text{CH}_3^+$

the greater the number of alkyl groups, the more stable the carbocation

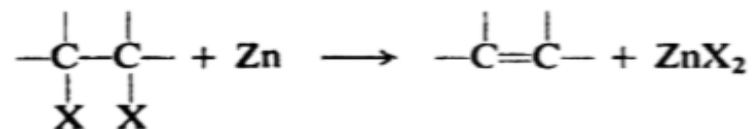


Electron release: *Disperses charge, stabilizes ion*

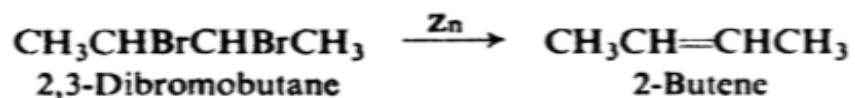
Q/ Explain formation of two product in the following reaction



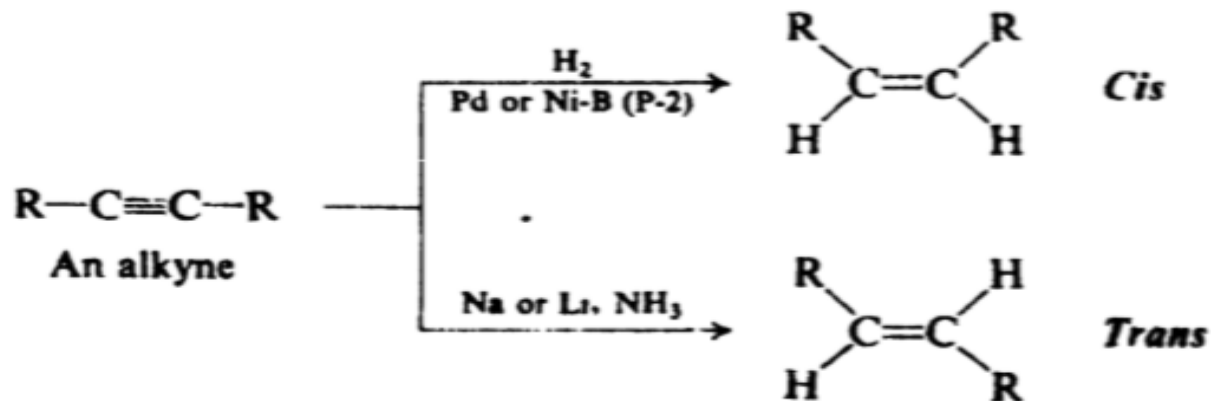
3- Dehalogenation of vicinal dihalides.



Example:



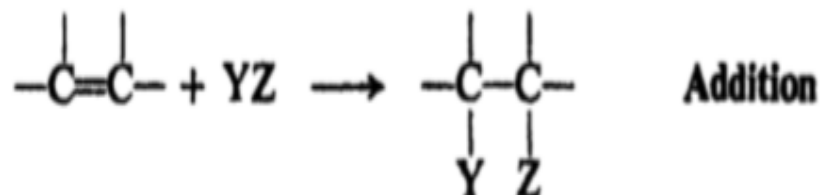
4- Reduction of alkynes.



Reactions of alkenes

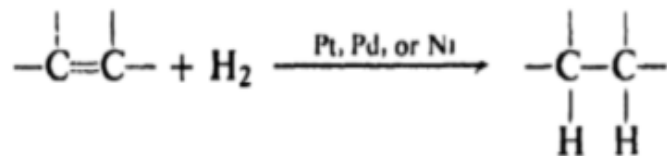
Reactions of the carbon-carbon double bond: addition

The double bond consists of a strong σ bond and a weak π bond; we might expect, therefore, that reaction would involve the breaking of this weaker bond

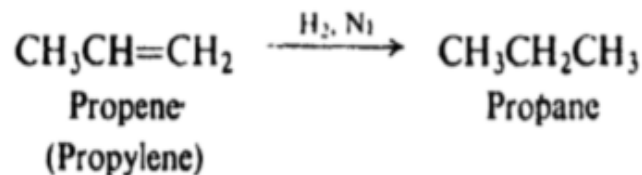


1- Addition of hydrogen. Catalytic hydrogenation.

We can convert an alkene into an alkane

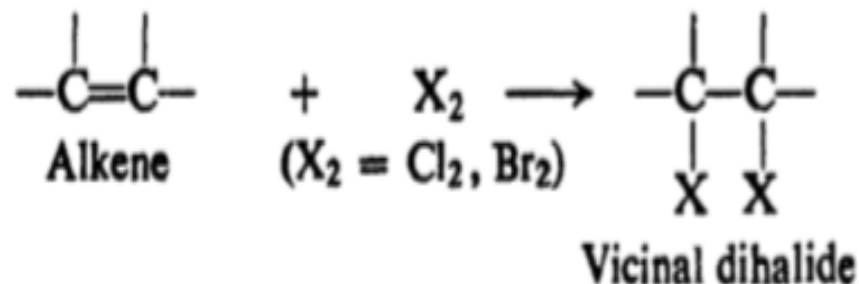


Example:



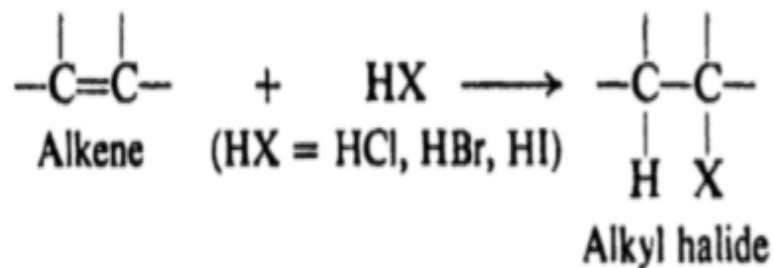
2- Addition of halogens.

Alkenes are readily converted by chlorine or bromine into saturated compounds

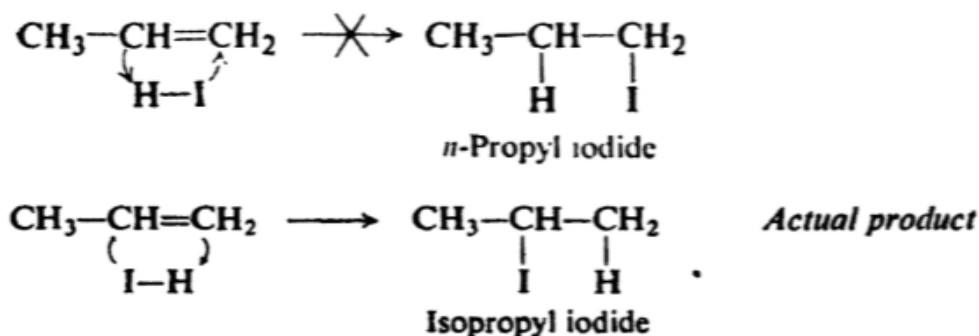


3- Addition of hydrogen halides.

An alkene is converted by hydrogen chloride, hydrogen bromide, or hydrogen iodide into the corresponding alkyl halide.

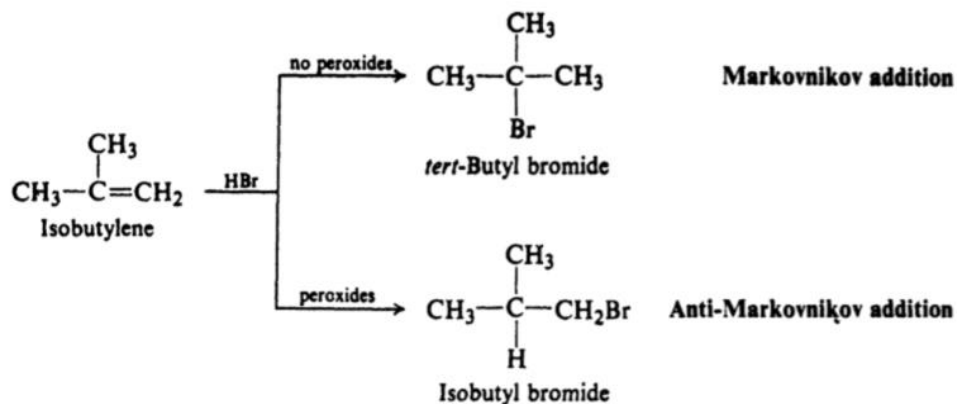


Propylene could yield either of two products, the n-propyl halide or the isopropyl halide



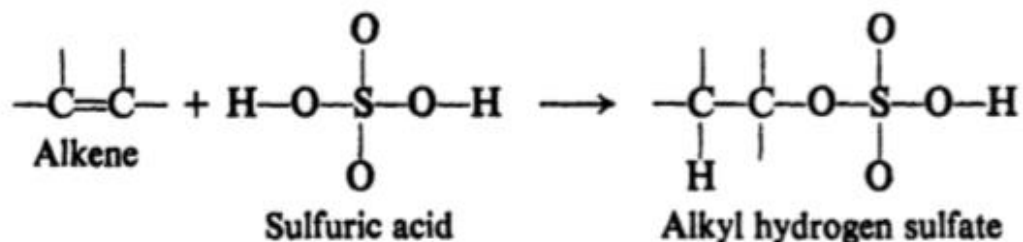
In the **ionic addition** of an acid, hydrogen of the acid attaches itself to the carbon atom that already holds the **greater number of hydrogens**. This statement is generally known as **Markovnikov's rule**.

But in the **radical addition** of an acid to the double bond of alkene, using peroxide as catalyst, **anti-Markovnikov's rule**.

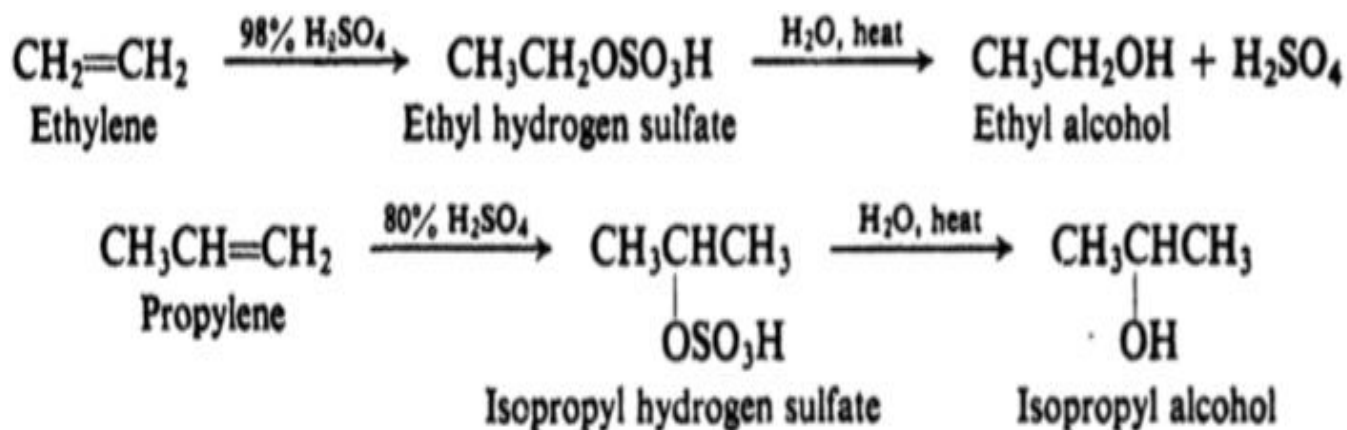


4- Addition of sulfuric acid.

Alkenes react with cold, concentrated sulfuric acid to form compounds of the general formula **ROSO₃H**, known as **alkyl hydrogen sulfates**.



The alkyl hydrogen sulfate has been cleaved by water to form the **alcohol** and sulfuric acid, and is said to have been **hydrolyzed**



5- Addition of water, Hydration

Water adds to the more reactive alkenes in the presence of acids to yield **alcohols**. Since this addition, too, follows **Markovnikov's rule**

