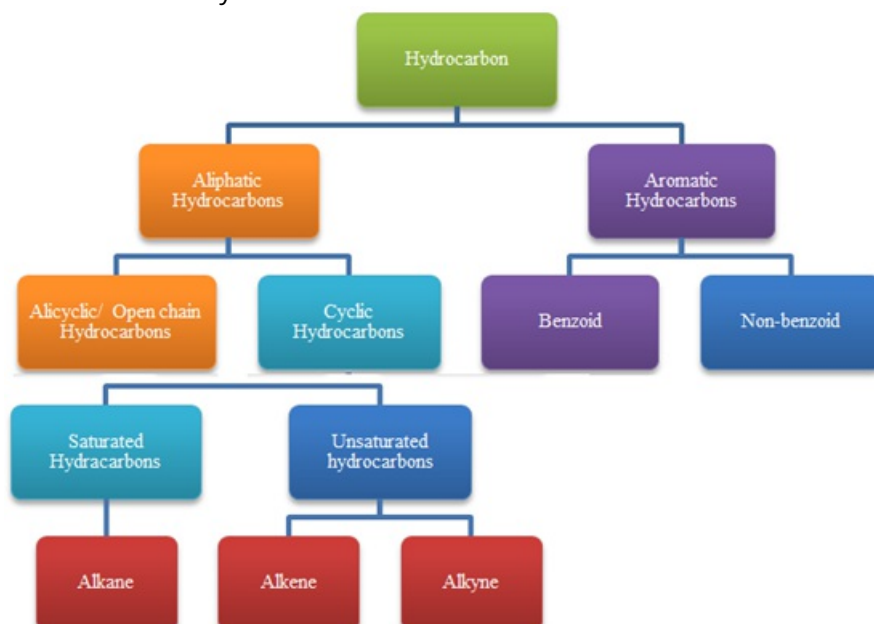


# Hydrocarbons

- Compounds of carbon and hydrogen.
- Classification of Hydrocarbons:

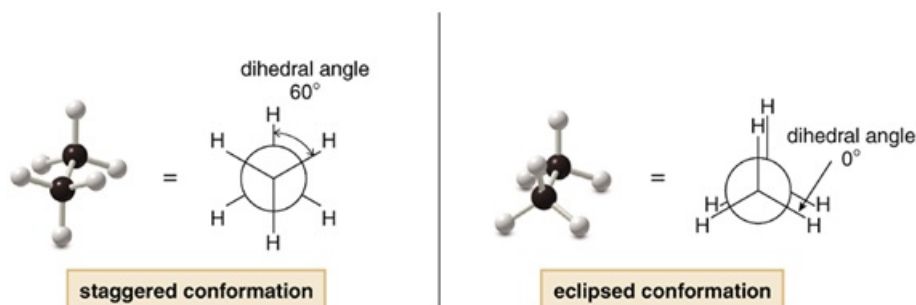


## Alkane

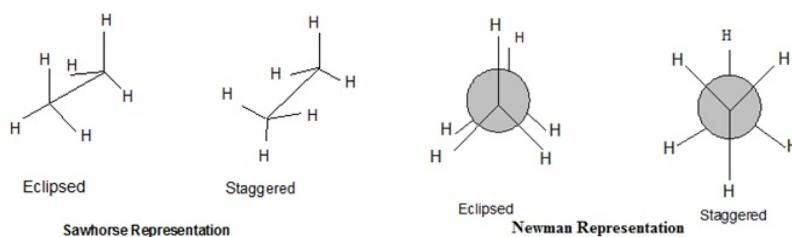
- Open chain saturated hydrocarbon with general formula  $(C_nH_{2n+2})$ .
- All the C atoms are single bonded i.e.  $sp^3$  hybridised.

## Conformations of Alkane

- Conformations are the different arrangement of atoms that can be converted into one another by rotation about single bonds.
- Eclipsed Conformation:** H atoms on two adjacent carbon atoms are closest to each other i.e. dihedral angle is 0.



- **Staggered Conformation:** H atoms on two adjacent carbon atoms are farthest to each other i.e. dihedral angle is 60°.

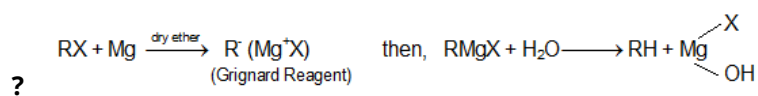
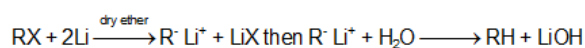


## Preparation of Alkanes:

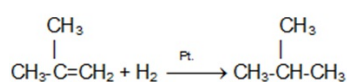
- **Reduction of Alkyl Halides:**



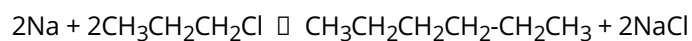
- **Grignard Reagent:**



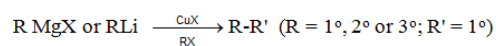
- **Hydrogenation of Alkenes:**



- **Wurtz Reaction:**



- **Corey House Reaction:**



- **Decarboxylation of a mixture of the sodium salt of a carboxylic acid:**

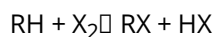


- **Kolbe's electrolytic method:**



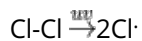
## Chemical Properties of Alkane

- Direct Halogenation

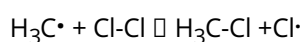
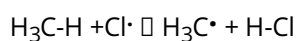


Order of Reactivity of  $X_2$ :  $F_2 > Cl_2 > Br_2$ ;  $I_2$  does not react

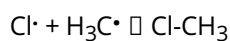
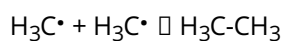
a. Initiation Step



b. Propagation Step



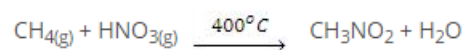
c. Termination Step



- Nitration

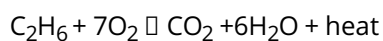
Nitration of alkane is made by heating vapours of alkanes and  $HNO_3$  at about  $400^\circ C$  to give nitroalkanes.

“This is also known as vapour phase nitration.



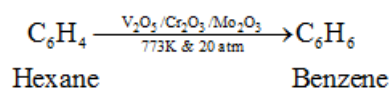
- Combustion:

“Alkanes burn readily with non luminous flame in presence of air or oxygen to give  $CO_2$  & water along with evolution of heat.



- Aromatization

“Alkanes having six to 10 carbon atoms are converted into benzene and its homologues at high pressure and temperature in presence of catalyst.



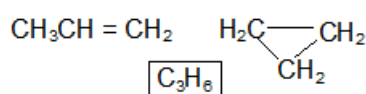
- Oxidization of  $3^\circ$  alkane:?

Tertiary alkanes are oxidized to tertiary alcohols by  $KMnO_4$

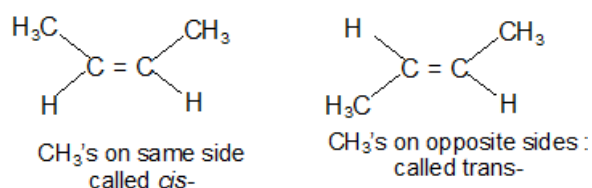


## Alkene (olefins)

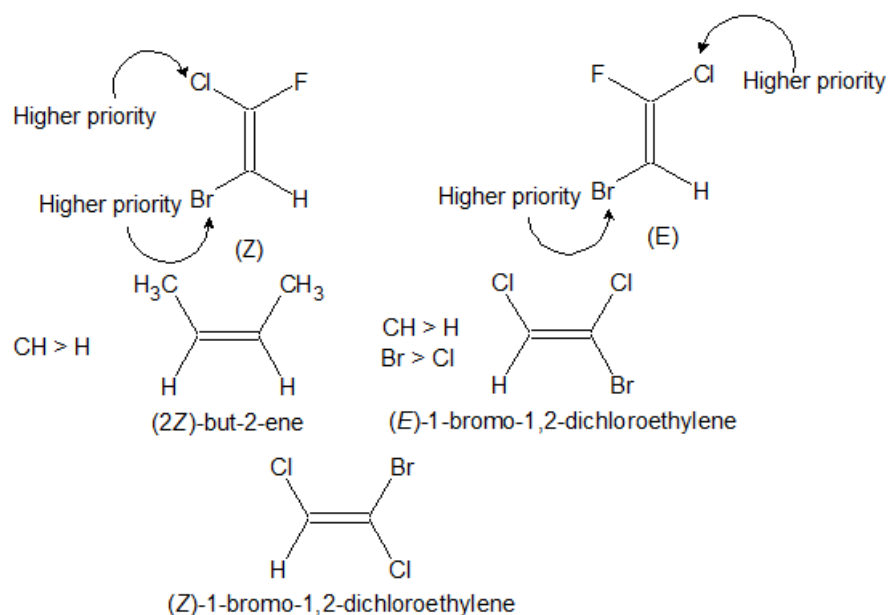
- Open chain, Unsaturated hydrocarbons with general formula ( $C_nH_{2n}$ ).
- At least one  $>C=C<$  (double bond) group i.e.  $sp^2$  hybridisation, is present throughout the chain.
- Allene: alkene molecule in which at least one C has double bonds with each of the adjacent carbon i.e.  $-C=C=C-$  group.
- Isomeric with saturated cycloalkanes.



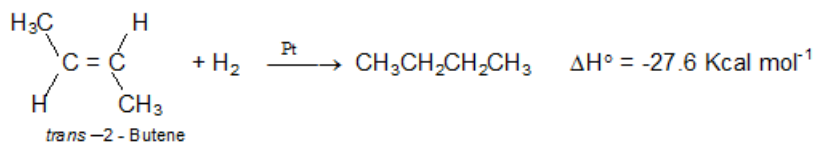
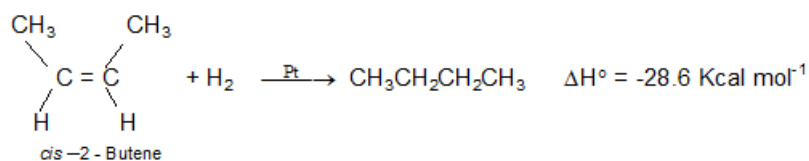
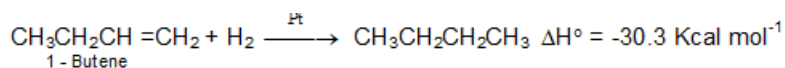
### Geometric Isomers:



Z is used if the higher - priority substituents on each C are on the same side of the double bond. letter E is used if they are on opposite sides



Heats of Hydrogenation: Heat of hydrogenation increases with increase in stability of alkene.



**Order of heat of hydrogenation:** 1-Butene > *cis*-2-Butene > *trans*-2-Butene

**Order of stability:** 1-Butene > *cis*-2-Butene > *trans*-2-Butene

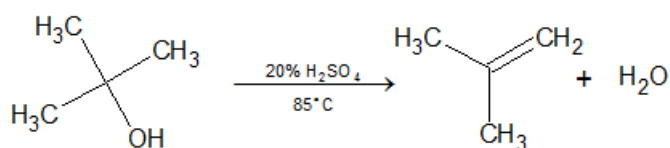
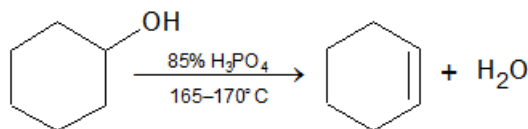
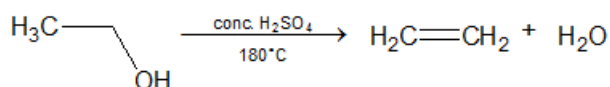
### Preparation of Alkenes:

1. Cracking of petroleum:  $\text{R}-\text{CH}_2-\text{CH}_3 \xrightarrow{\text{Pt or Pd}} \text{R}-\text{CH}=\text{CH}_2 + \text{H}_2$

2. Dehydrohalogenation of alkyl halides:  $\text{RCH}_2\text{CH}_2\text{X} + \text{alc.KOH} \rightarrow \text{RCH}=\text{CH}_2$

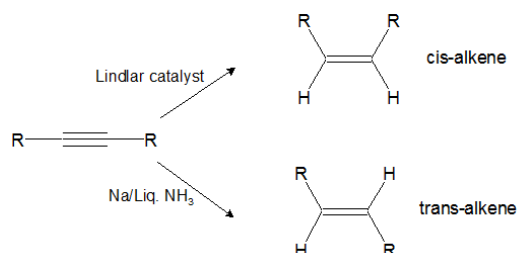
3. Dehydration of Alcohols :

Saytzeff Rule: In dehydration and dehydrohalogenation the preferential order for removal of an H is  $3^\circ > 2^\circ > 1^\circ$



Order of reactivity of alcohols:  $1^\circ > 2^\circ > 3^\circ$

4. Reduction of alkynes:

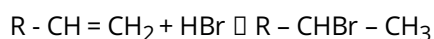


### Chemical Properties:

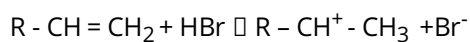
## 1. Electrophilic Polar Addition Reactions

Reagent		Product	
Name	Structure	Name	Structure
Halogens (Cl <sub>2</sub> , Br <sub>2</sub> only)	X:X	Ethylene dihalide	CH <sub>2</sub> XCH <sub>2</sub> X
Hydrohalic acids	H:X	Ethyl halide	CH <sub>3</sub> CH <sub>2</sub> X
Hypohalous acids	X:OH	Ethylene halohydrin	CH <sub>2</sub> XCH <sub>2</sub> OH
Sulfuric acid (cold)	H:OSO <sub>2</sub> OH	Ethyl bisulfate	CH <sub>3</sub> CH <sub>2</sub> OSO <sub>3</sub> H
Water (dil. H <sub>3</sub> O <sup>+</sup> )	H:OH	Ethyl alcohol	CH <sub>3</sub> CH <sub>2</sub> OH
Borane	H <sub>2</sub> B:H	Ethyl borane	(CH <sub>3</sub> CH <sub>2</sub> BH <sub>2</sub> ) → (CH <sub>3</sub> CH <sub>2</sub> ) <sub>3</sub> B
Peroxyformic acid	H:O-OCH=O (HCO <sub>3</sub> H)	Ethylene glycol	CH <sub>2</sub> OHCH <sub>2</sub> OH

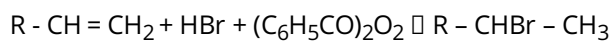
## 2. Addition of Hydrogen Halides to Alkenes: Markovnikov's Addition:



### Mechanism:

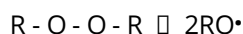


### Anti-Markovnikov's Addition (Peroxide Effect):

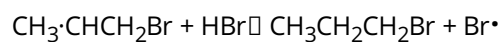
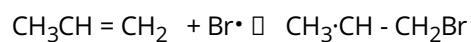


### Mechanism

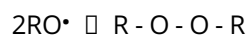
Initiation:



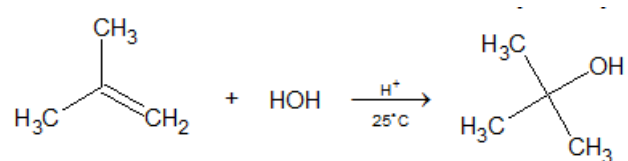
Propagation



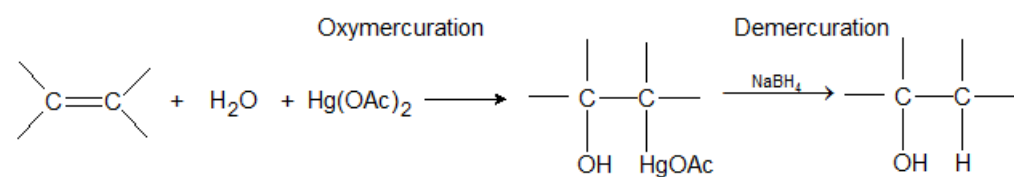
Termination:



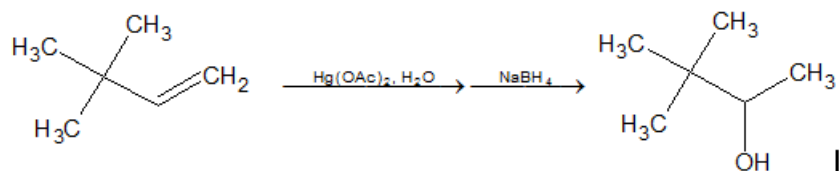
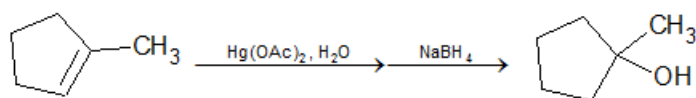
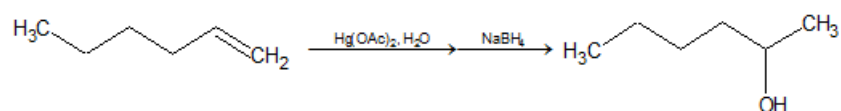
### 3. Addition of Water to Alkenes: Acid Catalyzed Hydration:



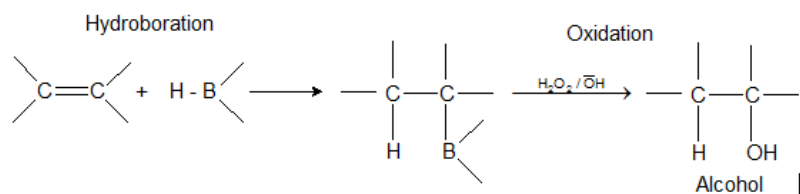
### 4. Oxymercuration-Demercuration:



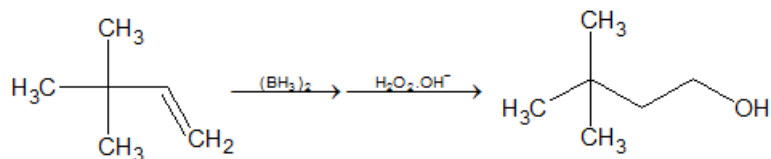
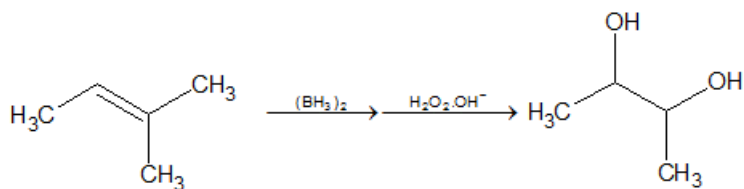
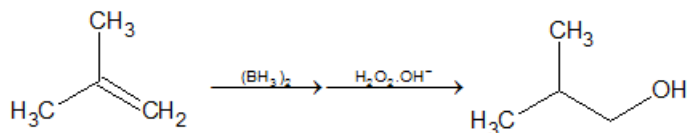
#### Examples:



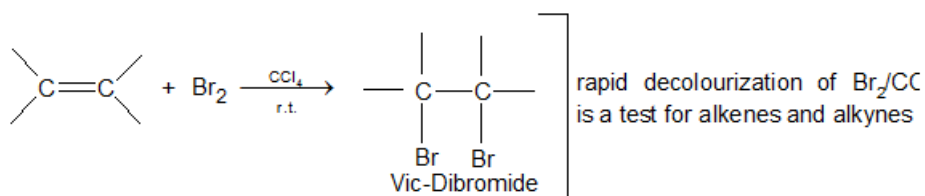
## 5. Hydroboration-Oxidation:



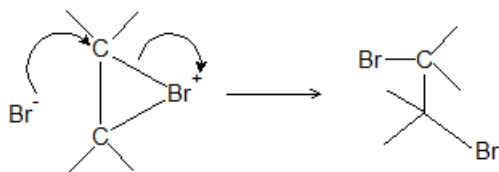
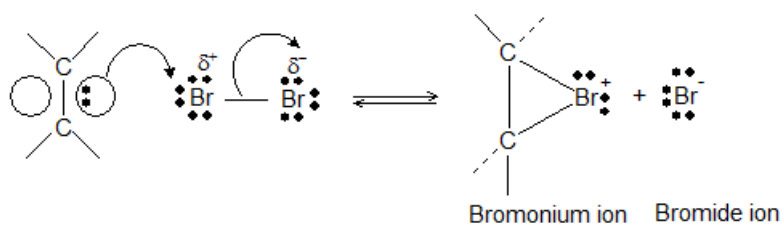
### Examples:



## 6. Halogen Addition in Non-polar Solvent:

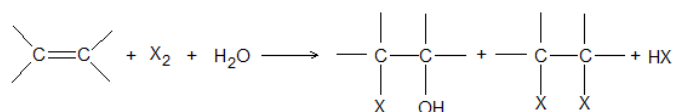


### Mechanism:



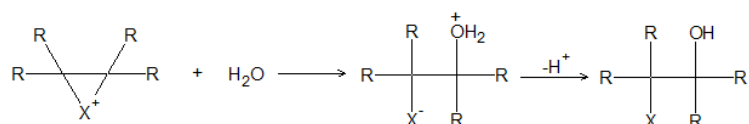
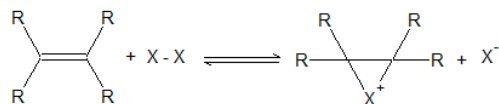


## 7. Halogen Addition in Aqueous Medium:

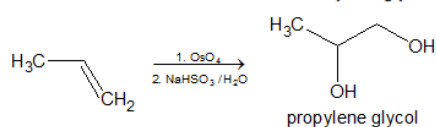
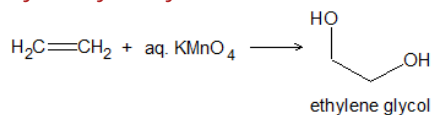


X = Cl<sub>2</sub> or Br<sub>2</sub>

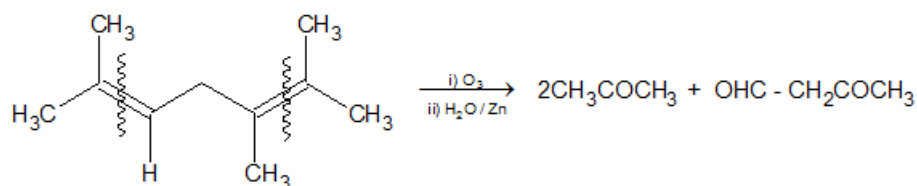
**Mechanism:**



## 8. Syn - Hydroxylation: Formation of di-ols.



## 9. Ozonolysis of Alkenes:

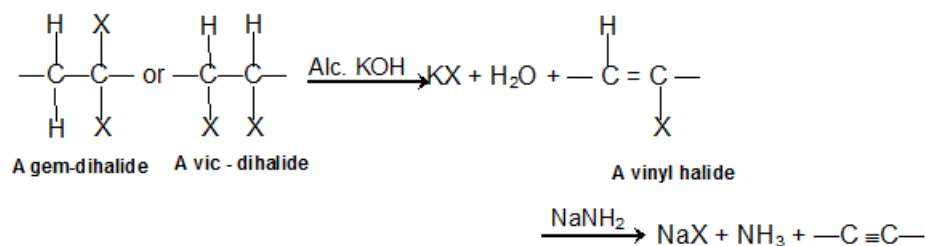


## Alkyne

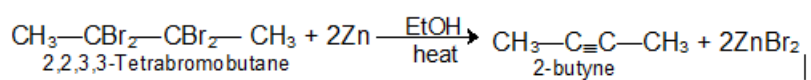
- Saturated open chain hydrocarbon with general formula (C<sub>n</sub>H<sub>2n-2</sub>).
- At least one -C≡C- (triple bond) group i.e. sp hybridisation, is present throughout the chain.
- Physical properties of alkynes are similar to those of the corresponding alkenes

### Preparation

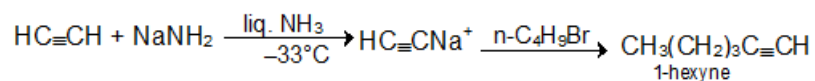
### 1. Dehydrohalogenation of vic-Dihalides or gem-Dihalides



### 2. Dehalogenation of vic-Tetrahalogen Compounds



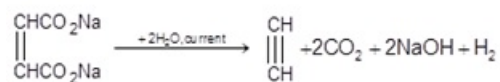
### 3. Alkyl Substitution in Acetylene; Acidity of ° C-H



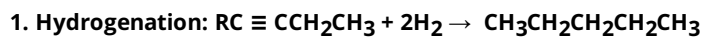
### 4. From Calcium Carbide:



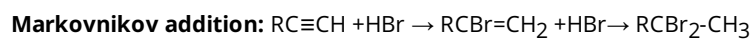
### 5. Kolbe's Electrolysis:



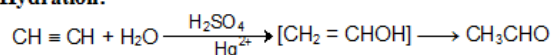
## Chemical Properties



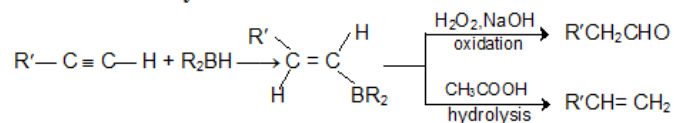
2. Hydro-halogenation:



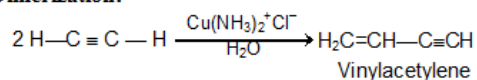
### 3. Hydration:



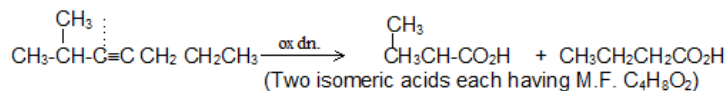
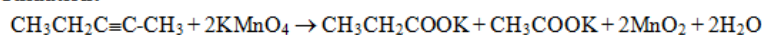
### 4. Addition of boron hydride:



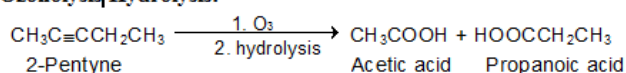
### 5. Dimerization:



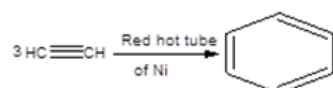
### 6. Oxidation:



### 7. Ozonolysis|Hydrolysis:



### 8. Cyclic polymerization:



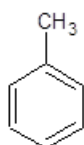
## Aromatic Hydrocarbons:

For being aromatic a hydrocarbon should

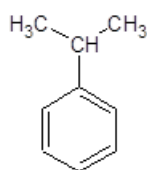
- be a cyclic compounds.
- have planarity in geometry.
- have complete delocalization of electrons over ring.
- follow Huckel Rule i.e. number of ?? electrons in ring =  $(4n+2)$ . :



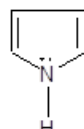
Benzene



Toluene



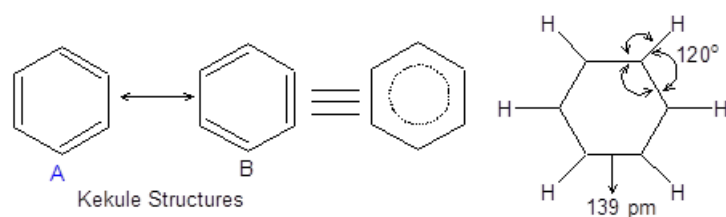
Isopropyl benzene  
(Cumene)



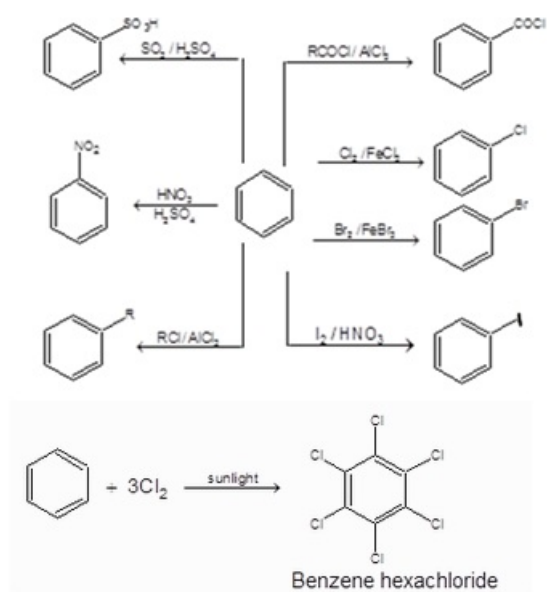
Pyrrole

## Benzene ( $\text{C}_6\text{H}_6$ )

### 1. Structure:



## 2. Chemical Reactions of Benzene:



## Anti-aromatic Hydrocarbons:

Highly unstable compounds.

Number of  $\pi$  electrons in ring =  $4n$ .

Example:

