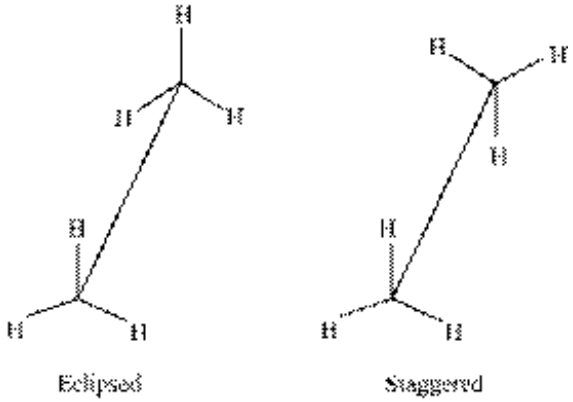
Hydrocarbons

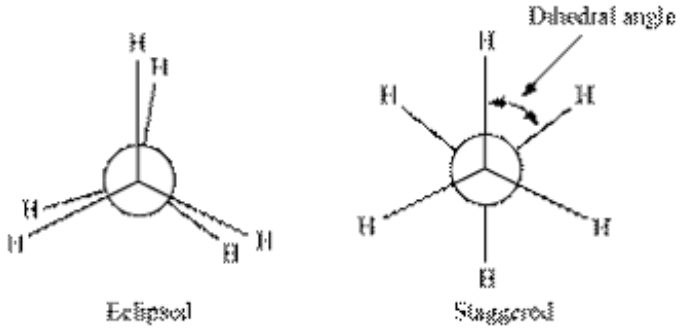
Alkanes:

- General formula is C_nH_{2n+2}.
- Isomerism: Structural isomer → Difference in structure
  Chain isomer → Difference in chain
- Conformations: The spatial arrangements of atoms which can be converted into one another by rotation around a C–C single bond

1. Sawhorse projections



2. Newman projections



Preparation

1. From unsaturated hydrocarbons (hydrogenation)

$$CH_3-CH=CH_2 + H_2 \xrightarrow{Pt/Pd/Ni} CH_3-CH_2-CH_3$$

1. Wurtz reaction (Preparation of higher alkanes containing even number of carbon atoms)

$$CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} CH_3-CH_3 + 2NaBr$$

1. De-carboxylation (Elimination of carbon dioxide from carboxylic acid)

$$CH_3COONa + NaOH \xrightarrow[\Delta]{CaO} CH_4 + Na_2CO_3$$

Physical properties

Boiling point increases with increase in molecular mass. Further, it decreases with increase in number of branched chains.

Chemical properties

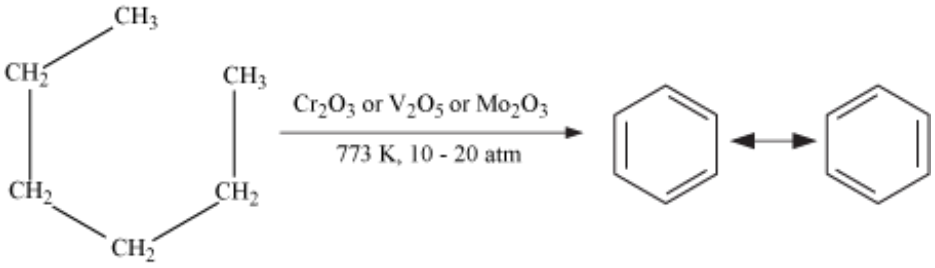
1. Undergo substitution reactions in which one or more hydrogen atoms of alkanes are substituted by halogens
2. Rate of reaction of alkanes with halogens is $F_2 > Cl_2 > Br_2 > I_2$
3. Combustion

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

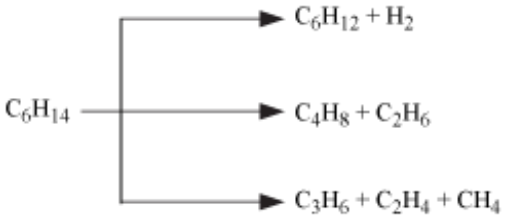
4. $KMnO_4$ can oxidise alkanes having tertiary H atoms to corresponding alcohols.

$$(CH_3)_3CH \xrightarrow[\text{Oxidation}]{KMnO_4} (CH_3)_3COH$$

5. Aromatization



6. Pyrolysis or cracking



Alkenes:

- General formula is C_nH_{2n}.
- Isomerism

1.Position isomer

$$\overset{1}{CH_2}=\overset{2}{CH}-\overset{3}{CH_2}-\overset{4}{CH_2}-\overset{5}{CH_3}$$

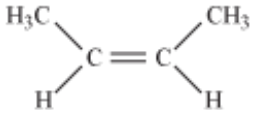
Pent −1− ene

$$\overset{1}{CH_3}-\overset{2}{CH}=\overset{3}{CH}-\overset{4}{CH_2}-\overset{5}{CH_3}$$

Pent −2− ene

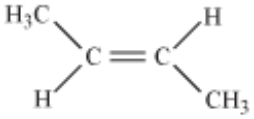
2. Geometrical isomerism

- *Cis*-isomer: Two identical atoms or groups are on the same side of the double bond



cis-But-2-ene

- *Trans*-isomer: Two identical atoms or groups lie on the opposite side of the double bond

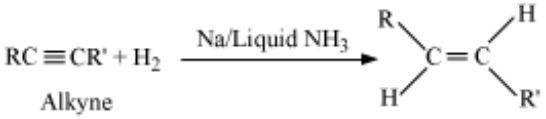


trans-But-2-ene

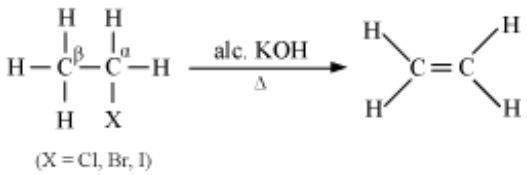
Preparation

1. From alkynes

Pd/C →Lindlar's catalyst



2. From alkyl halides (Dehydrohalogenation)

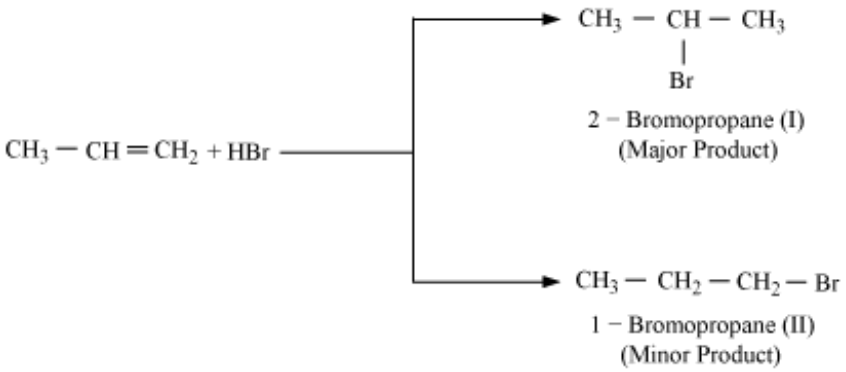


- **Physical properties**

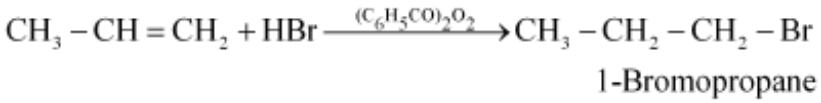
1. **Boiling point decreases with increase in number of branched chains.**

- **Chemical properties**

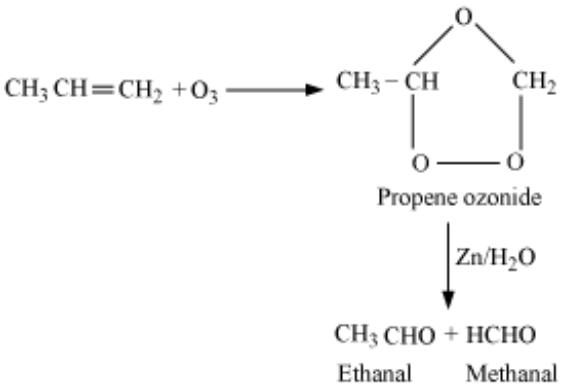
1. Addition of HBr to unsymmetrical alkenes (Markovnikov rule)



2. Anti-Markovnikov addition (Peroxide effect or Kharash effect)



3. Ozonolysis



General formula is CnH_{2n-2}

They are named as the corresponding alkanes replacing ‘ane’ by the suffix ‘yne’.

Each carbon atom of ethyne has two *sp* hybridised orbitals.

Preparation of Ethynes

- From calcium carbide (CaC_2)
- From vicinal dihalides

Chemical Properties of Alkynes

- Acidic Nature of hydrogen
- Addition Reactions of Alkynes
- Addition of dihydrogen
- Addition of halogens

- Addition of hydrogen halides (HX; X = Cl, Br, I)
- Addition of water
- Polymerisation

Aromatic hydrocarbon:

Aromaticity

1. Planarity

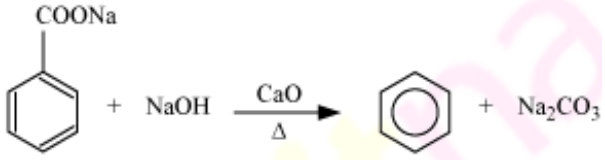
2. Complete delocalization of the electrons in the ring

3. Huckel rule → Presence of $(4n + 2)\pi$ electrons in the ring (n = 0, 1, 2…)

- **Preparation of benzene**

1. Cyclic polymerization of ethyne

2. Decarboxylation of aromatic acids



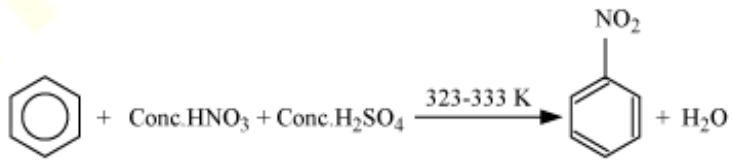
- **Physical properties**

  Immiscible with water but readily miscible with organic solvents

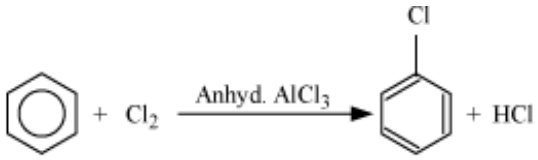
- **Chemical properties**

1. Electrophilic substitution

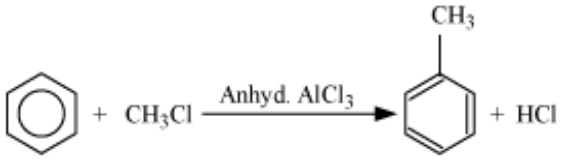
2. Nitration



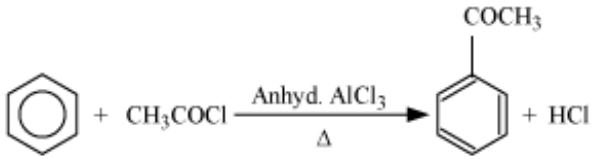
3. Halogenation



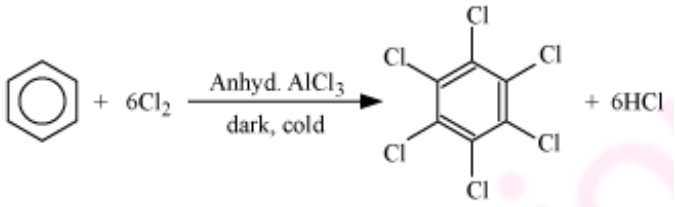
4. Friedel-Crafts alkylation



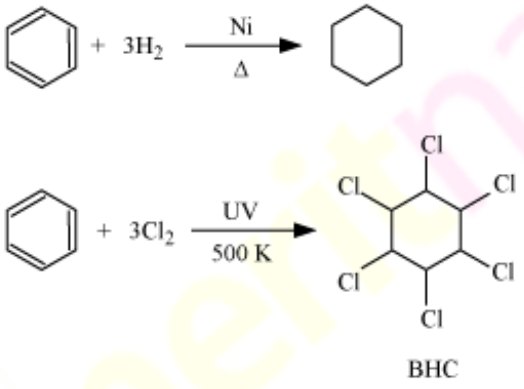
5. Friedel-Crafts acylation



6. On treatment with excess of chlorine



7. Addition reaction



- **Directive influence of functional group in benzene ring**

1. Ortho and para directing groups:

$$-OH, -NH_2, -NHR, -NHCOCH_3, -OCH_3, -CH_3, -C_2H_5$$

2. Meta directing groups:

$$-NO_2, -CN, -CHO, -COR, -COOH, -COOR, -SO_3H$$

- **Carcinogenicity and toxicity**

Benzene and polynuclear hydrocarbons containing more than two benzene rings are toxic and can cause cancer