

1. **Alkanes** [Saturated Hydrocarbons]

⇒ Alkanes are the simplest saturated organic compounds as they are also called paraffins.

⇒ General Formula: C_nH_{2n+2}

⇒ Hybridisation: sp^3 [tetrahedral shape]

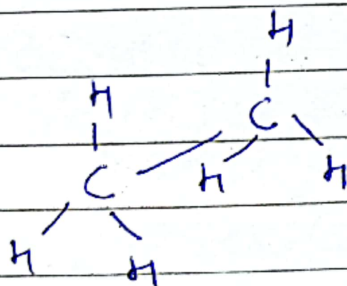
* **Conformation of Alkanes:**

⇒ Different structure or arrangement of molecule due to of carbon around 'C-C' bond.

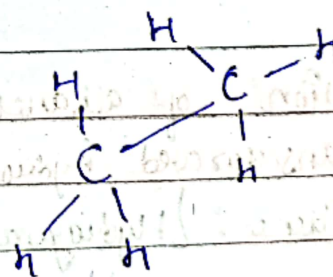
* **Conformation of Ethane: CH_3-CH_3**

Sawhorse

Projection.



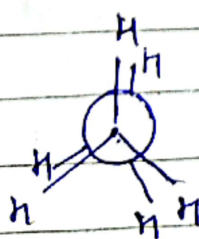
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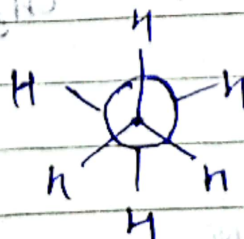
[Staggered]

Newman's

Projection.



[Eclipsed]



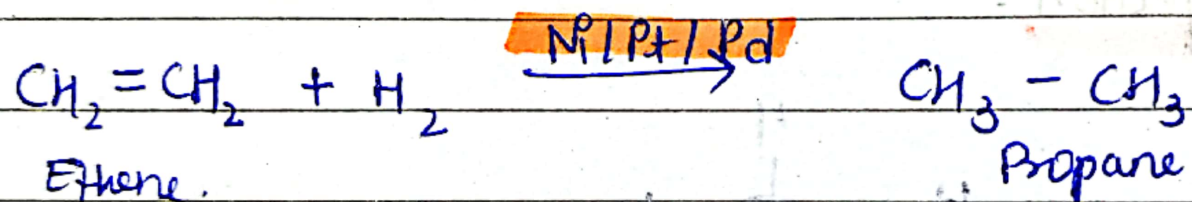
[Staggered]

* Preparation of alkanes.

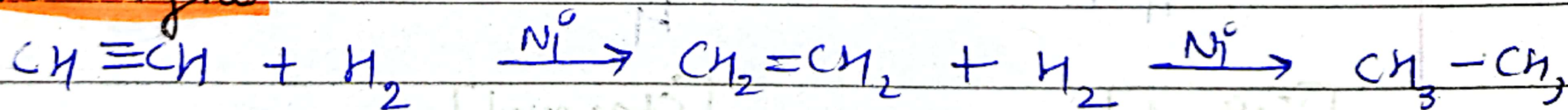
i. From unsaturated hydrocarbons

a) From alkene: [Hydrogenation]

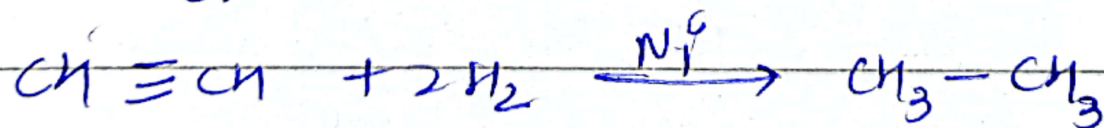
Dihydrogen gas adds to alkenes and alkynes in the presence of finely divided catalysts like platinum, palladium or nickel to form alkanes. This process is called hydrogenation.



b) From alkyne:



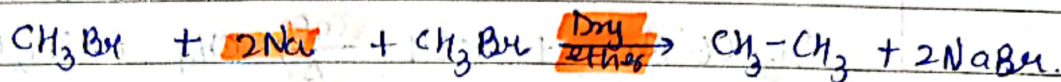
or



2.

Wurtz Reaction [From alkyl halides]

Alkyl halides on treatment with sodium metal in dry ether [free from moisture] solution give higher alkanes. This reaction is known as Wurtz Rxn & is used for the preparation of higher alkanes containing even no. of carbon atoms.



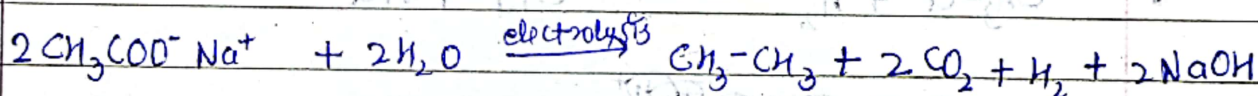
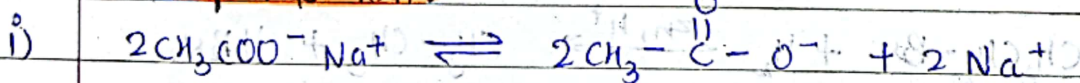
Note: We can't prepare alkane with odd no. of carbon in a chain by Wurtz Rxn.

From carboxylic acid

3.

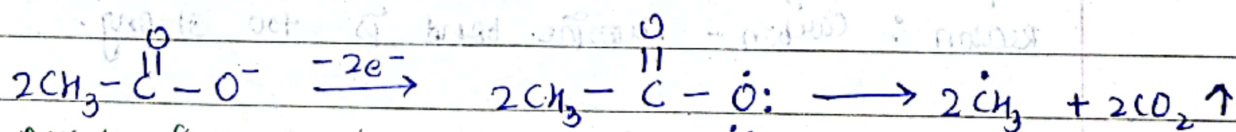
Kolbe's electrolysis

An aqueous solution of sodium or potassium salt of a carboxylic acid on electrolysis gives alkane containing even no. of carbon atoms at the anode.

**Path of this Rxn:**

ii)

At anode:

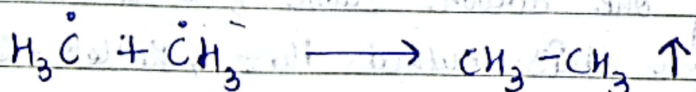


Acetate ion

Acetate Free Radical

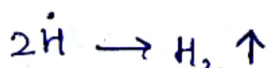
Methyl Free Radical

iii)



iv)

At cathode:



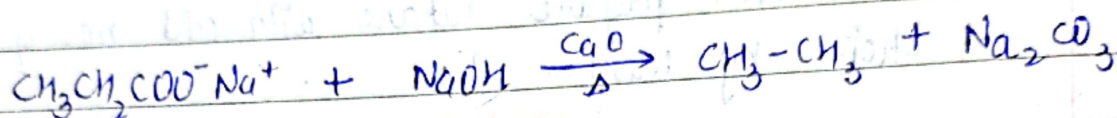
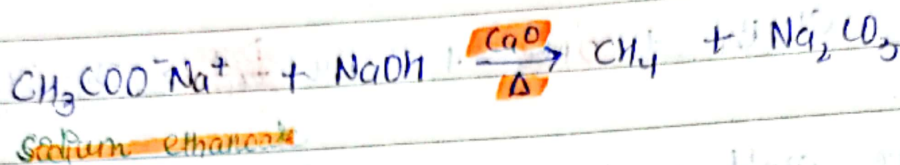
4.

Decarboxylation:

Removal of CO_2

Sodium salts of carboxylic acids on heating with soda lime [mixture of sodium hydroxide & calcium oxide] give alkanes containing one carbon atom less than the carboxylic acid. This process of elimination of carbon dioxide from a carboxylic acid is known as decarboxylation.

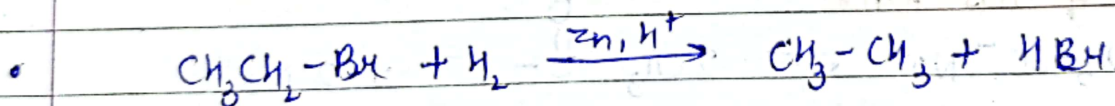
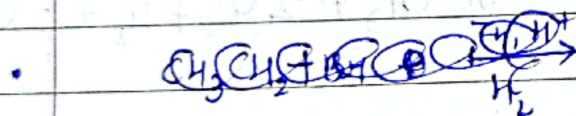
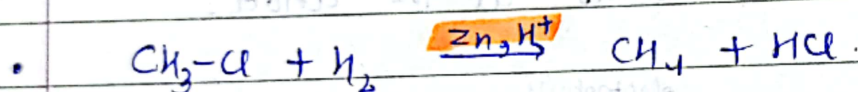
[NaOH (CaO)
soda lime]



5.

Using Alkyl halides [Haloalkanes] with Zn metal.

Alkyl halides [except fluorides] on reduction with zinc & dilute hydrochloric acid gives alkanes.



⇒ **Exception?** Alkyl fluorides can't be reduced to form alkanes.
Reason: Carbon-fluorine bond is too strong.

Q

Why methane can't be prepared by Kolbe's electrolytic method?

Ans

Methane having only one carbon atom, so it can't be prepared through this method. Hence, Kolbe's electrolytic method is useful for the preparation of ethane & higher members.

* Physical properties of Alkanes:

- Colourless
- Odourless
- Almost non-polar molecules
- They have weak Vander Waal forces [starting alkanes behave as gases]
- Higher alkanes behave as solids.
- Molecular mass is directly proportional to boiling point. [eg: C_2 is gas, C_{25} is solid]

=> Boiling Point

If more branched chains.

↓
surface area of contact decreases.

↓
weak Vander Waal forces.

↓
∴ Boiling point decreases.

=> melting Point

- They don't show smooth increase with increase in molecular mass.
- Depends on molecular mass & how the molecules are packed in its Lattice structure.

=> Solubility

- "like dissolves like"
- Alkanes are non-polar covalent compounds hence they dissolve in non-polar covalent compounds only.

Q Is Alkanes dissolve in water?

Ans

No, because water is polar compound & alkanes are non-polar.

⇒ Density $\left[\frac{\text{mass}}{\text{volume}} \right]$

• Density $\propto$ mass

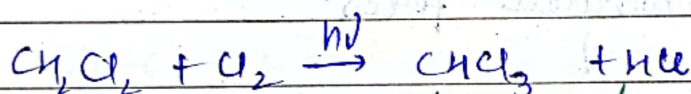
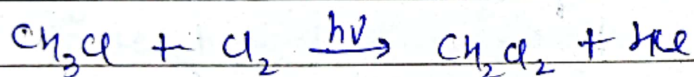
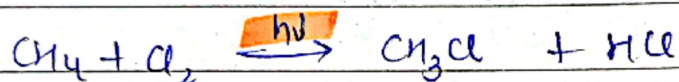
• Density $\propto \frac{1}{\text{volume}}$

* Chemical properties of Alkanes.

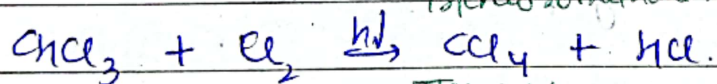
1. Substitution Reaction.

• Halogenation

⇒ Hydrogen atom of alkane is replaced by halogen group.



Chloroform/
Trichloromethane



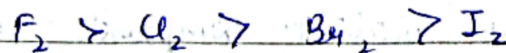
Tetrachloromethane

⇒ Bromination : slow reaction

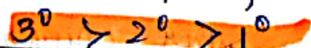
⇒ Iodination : Iodination is very slow & a reversible rxn

⇒ Fluorination : F is too reactive to be controlled.

∴ Rate of reaction of alkanes with halogens.

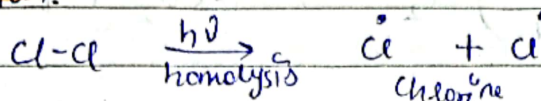


⇒ Rate of Replacement of Hydrogens of alkanes is

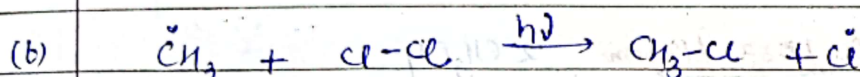
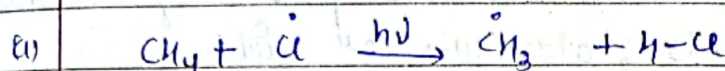


* Mechanism.

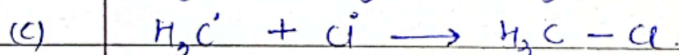
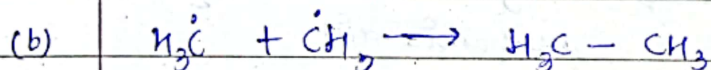
(i) Initiation.



(ii) Propagation.

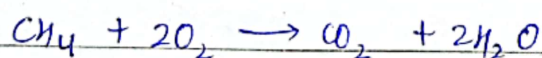


(iii) Termination.



* 2.4) Complete combustion of Alkanes.

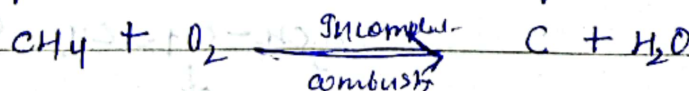
=> Alkanes on heating in the presence of air or oxygen are completely oxidized to carbon dioxide and water with the evolution of large amount of heat.



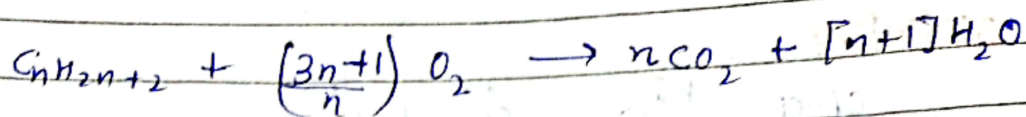
(b) Incomplete combustion.

=> In case of incomplete combustion of alkanes with insufficient amount of air or oxygen, black carbon is formed.

=> This is further used in the manufacture of ink.



General combustion eqn for any alkane:



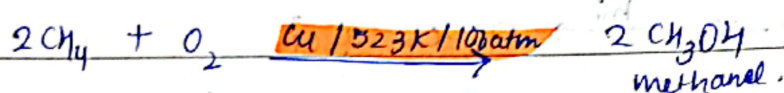
3.

Controlled Oxidation

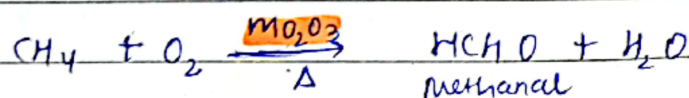
⇒

Alkanes on heating with a regulated supply of oxygen at high pressure and in the presence of suitable catalysts give alcohols, aldehydes or acids.

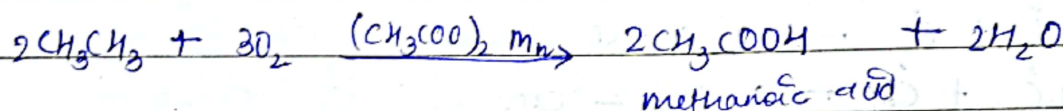
(i)



(ii)



(iii)



(iv)



4.

Isomerisation

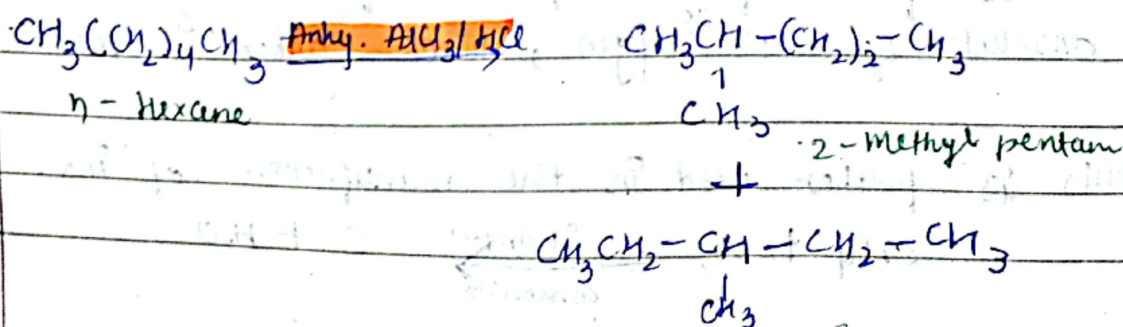
⇒

Isomerisation is a chemical process that transforms a molecule into another molecule with the same atoms but a different arrangement.

Isomerisation of Alkanes.

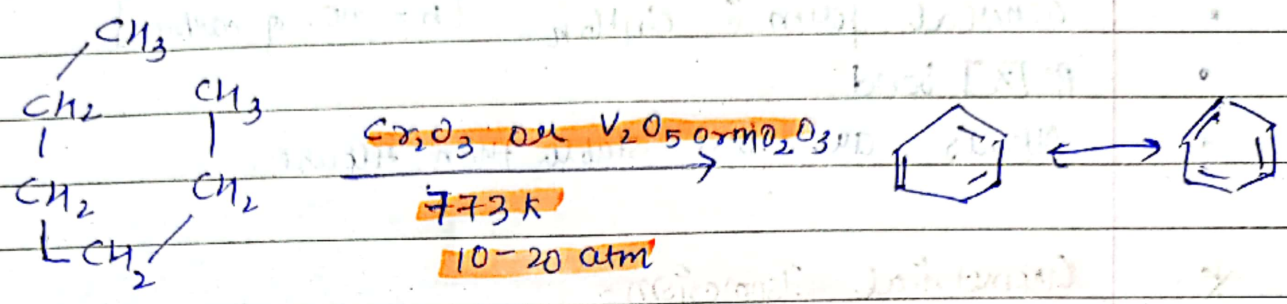
⇒

n-alkanes on heating in the presence of anhydrous aluminium chloride and hydrogen chloride gas isomerise to branched chain alkanes.



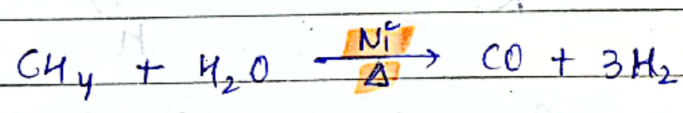
5. Aromatization

=> The process of converting aliphatic & Alicyclic hydrocarbon to aromatic hydrocarbons in the presence of suitable catalyst at high pressure & temp. is called aromatization.



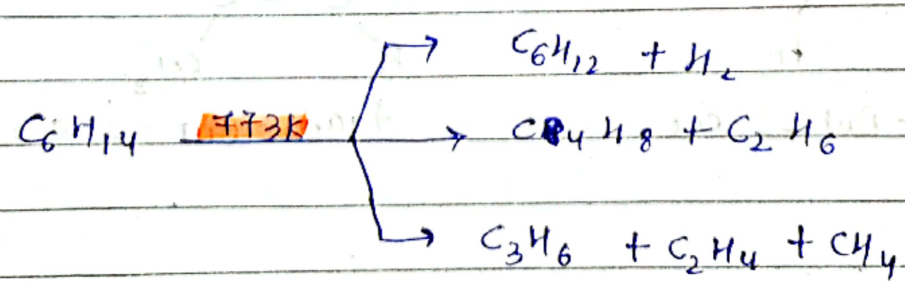
6. Reaction with steam

=> Methane reacts with steam at 1273K in the presence of nickel catalyst to form carbon monoxide and dihydrogen. This method is used for industrial preparation of dihydrogen gas.



7. Pyrolysis

=> Pyrolysis is defined as the conversion of a compound into smaller fragments in the absence of air through the application of heat.



2.

Alkenes.

- Contains at least one double bond.

- Also known as olefins

- Number of Hydrogens are less as compared to Alkanes

- First stable member of alkene is ethene.

- General form: C_nH_{2n} [n = no. of carbon]

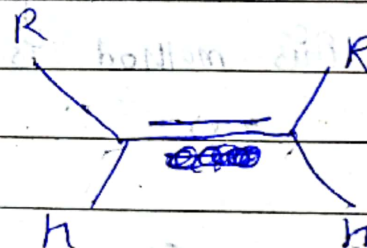
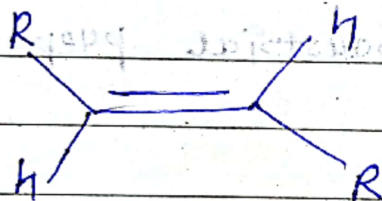
- π bond

- Alkenes are less stable than Alkane.

*

Geometrical Isomerism.

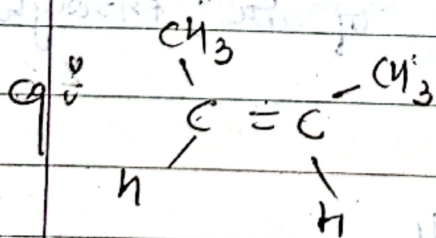
Different orientations - Different in properties.

Trans Isomers**Cis Isomers**

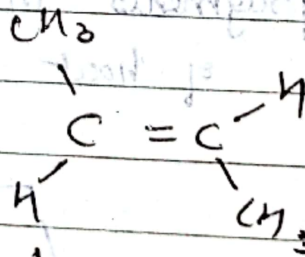
⇒ Less polar high melting point.

⇒ Geometrical isomers are only seen in

Alkenes.



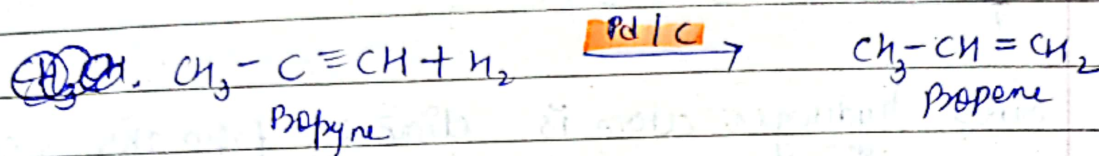
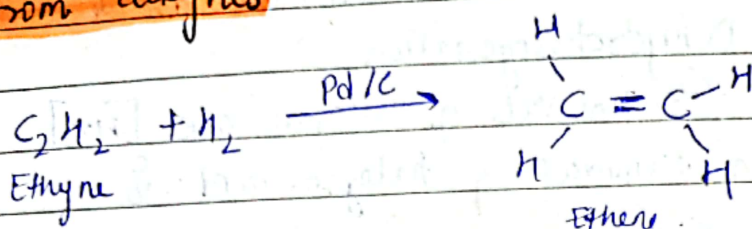
cis-But-2-ene



trans-But-2-ene

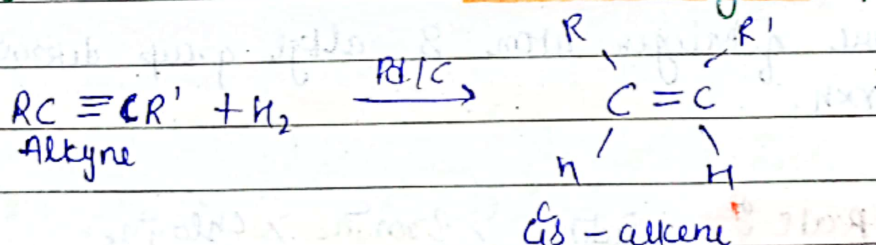
Preparation of Alkenes.

1. From alkynes

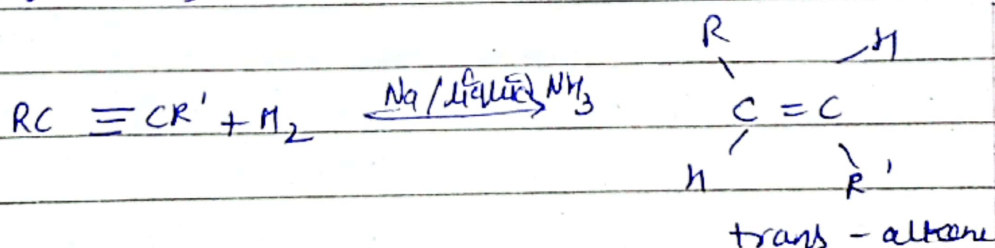


- Partial Reduction of Alkynes, addition of H_2 using Lindlar's catalyst.
- Lindlar's catalyst is partially deactivated ~~palladised~~ palladised charcoal. palladised charcoal = Palladium metal supported on charcoal. partially deactivated by poisons Quinoline, sulphur compounds.

⇒ Alkynes on Reduction with **Lindlar's reagent** form cis alkenes.



⇒ Alkynes on reduction with **sodium in liquid ammonia** form trans alkenes.



जिस carbon से halogen जुड़ा है उसे α carbon कहा जाता है

②

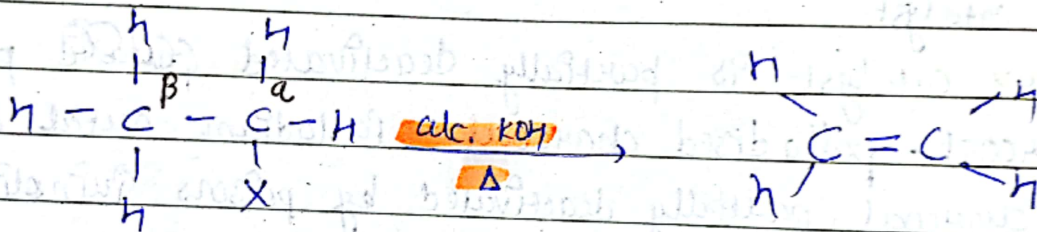
From alkyl halides (R-X)

Alkyl halides + Alcoholic Potassium hydroxide = Alkenes.
This is k/a Dehydrohalogenation

→ Removal of halogen acid [HX]

This example of removal of halogen acid is of β -elimination reaction.

Since hydrogen atom is eliminated from the β carbon atom [carbon atom next to carbon to which halogen is attached]



(X = Cl, Br, I)

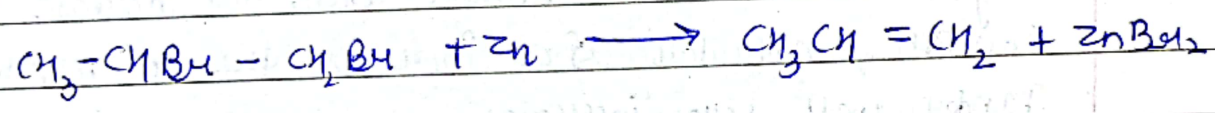
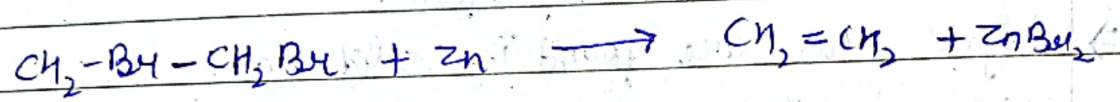
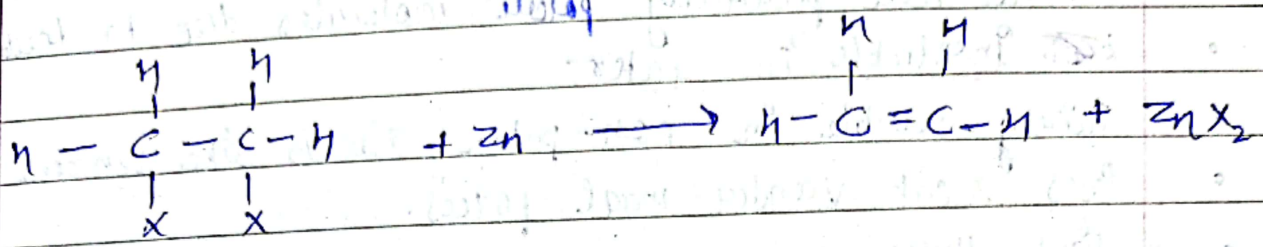
⇒ Nature of halogen atom & alkyl group determine rate of rxn.

→ **Rate of [Halogen]** Iodine > Bromine > Chlorine.

Rate [alkyl group]³ tertiary > secondary > primary.

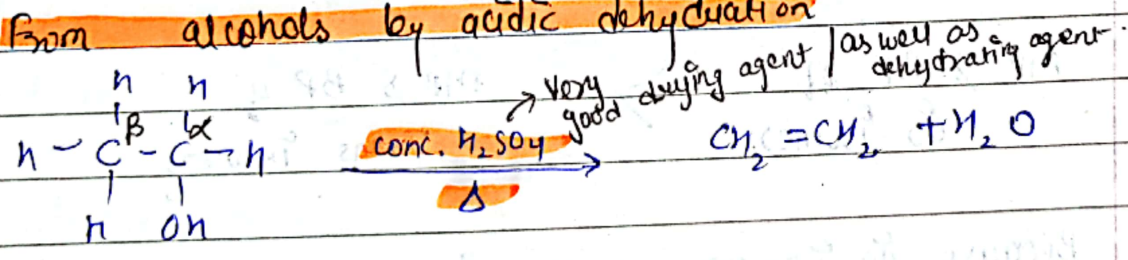
3) From Vicinal Dihalides.

Two halogen atoms are attached to two adjacent carbon atoms.



- ⇒ Vicinal dihalides + Zinc metal = Alkene.
- ⇒ Vicinal dihalides on treatment with zinc metal lose a molecule of ZnX_2 to form an alkene. This rxn is k/a "Dehalogenation."

4) From alcohols by acidic dehydration



Since a water molecule is eliminated from the alcohol molecule in the presence of an acid, this rxn is k/a acidic "dehydration" of alcohols.

This is β -elimination rxn.

*

Physical properties of Alkenes

- Higher alkenes are colourless & odourless.
 - Ethene is colourless with faint sweet smell.
 - Alkenes are partially polar molecules due to double bond.
 - ~~Insoluble~~ Insoluble in water.
 - Fairly soluble in non-polar solvents like benzene.
 - Posses weak Vander waal forces.
 - $\Rightarrow$ First three members, $C_2 - C_4$ are found in gaseous state.
 - $\Rightarrow$ Next 14 members are liquid.
 - $\Rightarrow$ Higher ones are found in solid state.
- changes in these state because when we increase no. of carbon, molecular size increases due to which Vander waal force increases.

$\Rightarrow$ Boiling point / melting point

If molecular size $\uparrow$ then melting point $\uparrow$ also
Vander waal force $\uparrow$

*

MP & BP of cis isomers



MP & BP of Trans isomers

- Because cis isomers polarity increases.

*

Straight chain alkenes have higher B.P

Branched chain alkenes have lower B.P

Because,

Area of contact
vander waal
m.p

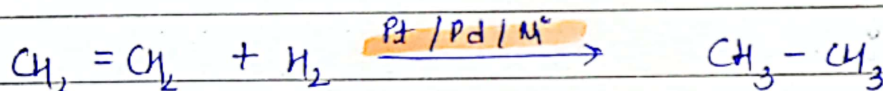


- Alkenes are electron rich species due to which attacking reagent attacks easily.

* Chemical properties of Alkenes

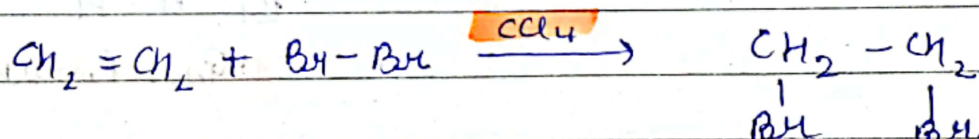
1. Addition of dihydrogen.

- Alkenes add up one molecule of dihydrogen gas in the presence of finely divided nickel, palladium or platinum to form alkanes.
- This process is known as "Hydrogenation".



2. Addition of Halogens.

- Halogens like Bromine or chlorine add up to alkene to form vicinal halides.
- "Reddish Orange" colour of bromine solution in CCl_4 is discharged when bromine adds up to an unsaturation site.
- This Rxn is used as test for unsaturation.

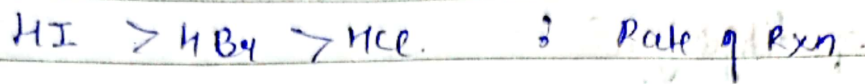


3)

Addition of Hydrogen halides

eg: Hydrogen chloride, Hydrogen Bromide

Alkenes + Hydrogen halide = Alkyl halides

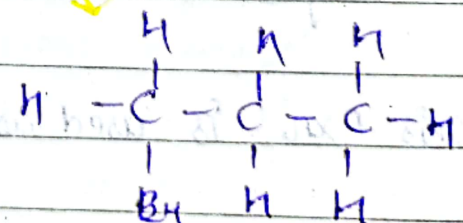
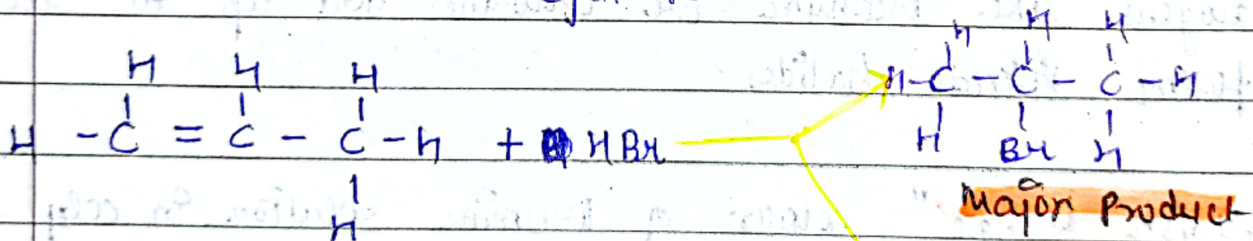
**Markovnikov's Rule** [Addition Rxn to unsymmetrical alkenes]

Hydrogen, Double bond के उस carbon पर जाएगा जहाँ पे Hydrogen ~~है~~ है। और Halogen, जहाँ पे कम है Hydrogen ज्यादा

Definition:

In case of unsymmetrical Alkenes, the negative part of the addendum [HCl , HBr , H_2SO_4] goes to that carbon atom of the double bond which has less no. of H-atoms.

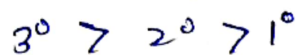
Negative part

**Minor Product**

c)

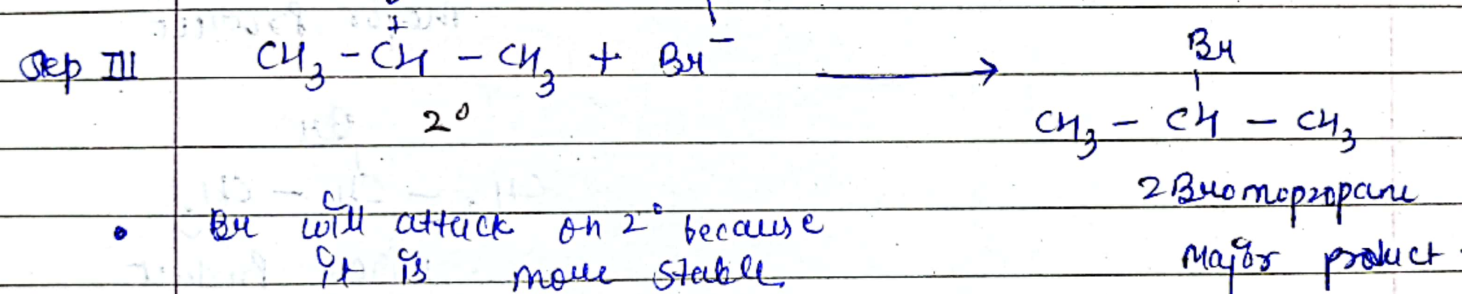
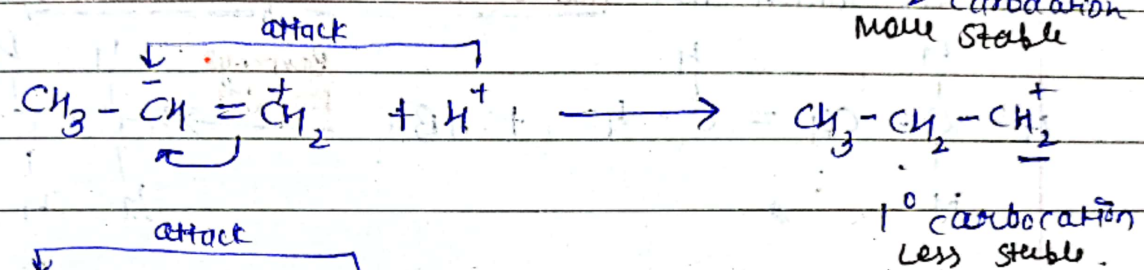
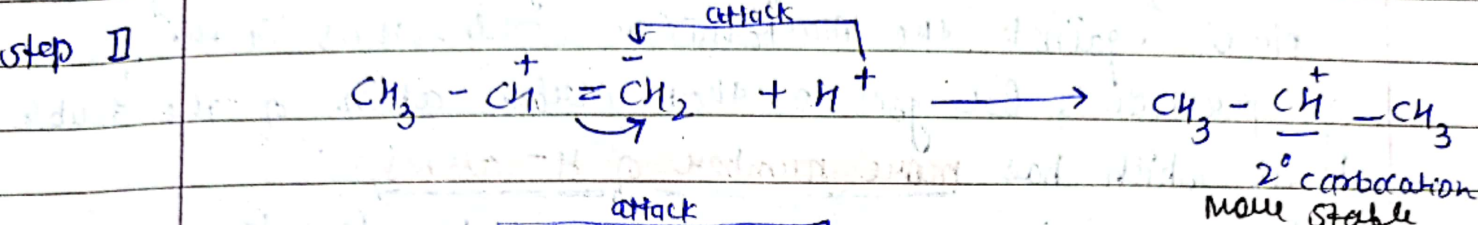
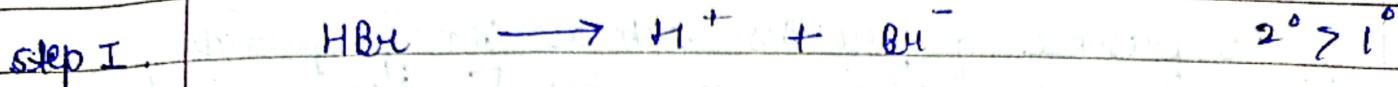
Markovnikov's rule show electrophilic addition Rxn.

Carbocation stability :



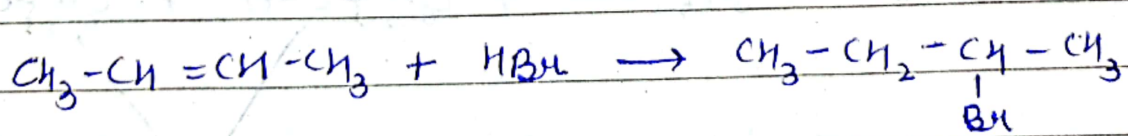
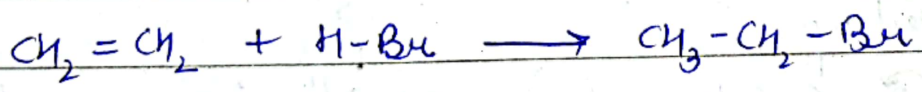
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Mechanism of Markovnikov's Rule



Br⁻ will attack on 2° because it is more stable

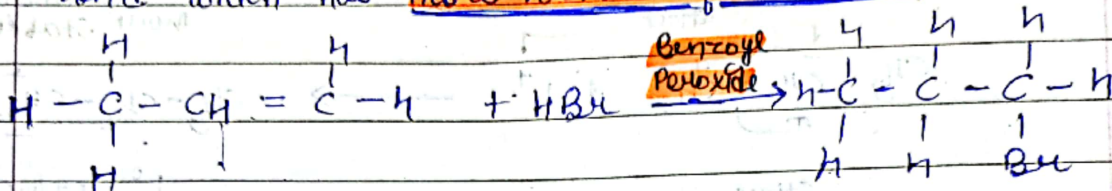
* Addition Rxn to symmetrical alkenes.



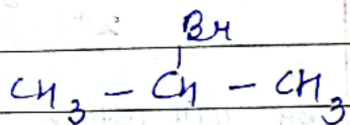
*

Anti Markovnikov addition / Peroxide effect / Kharasch effect.

- In the presence of peroxides such as benzoyl peroxide $[C_6H_5COO]_2$, the addition of HBr only [not HCl or HI] takes place against the Markovnikov's rule. Thus in the presence of peroxide, Br goes to that carbon atom of the double bond which has more number of H -atoms.



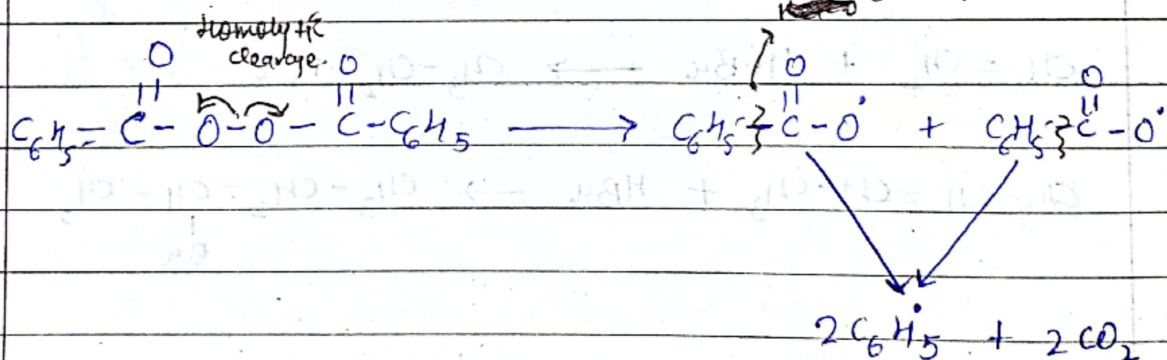
Major Product



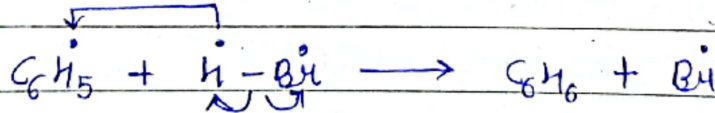
Minor Product

Mechanism

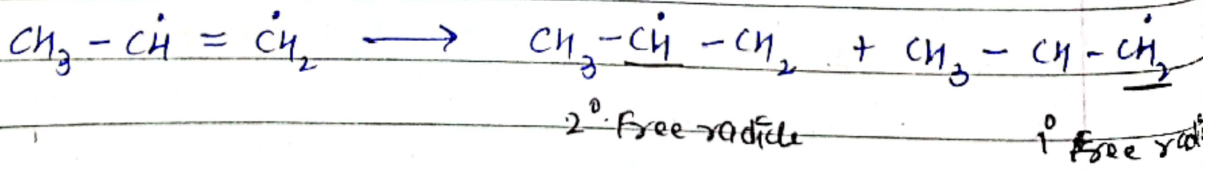
Step 1



Step 2

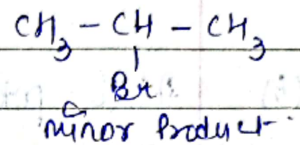
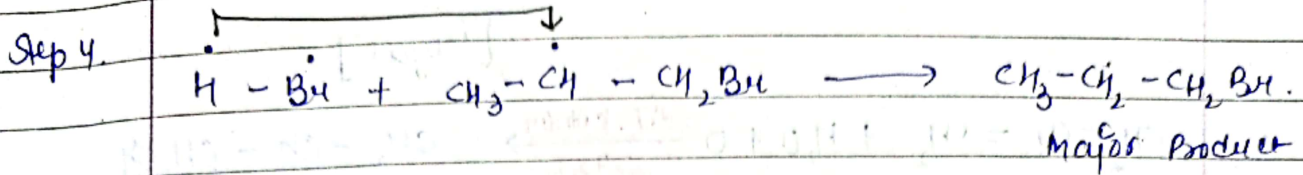
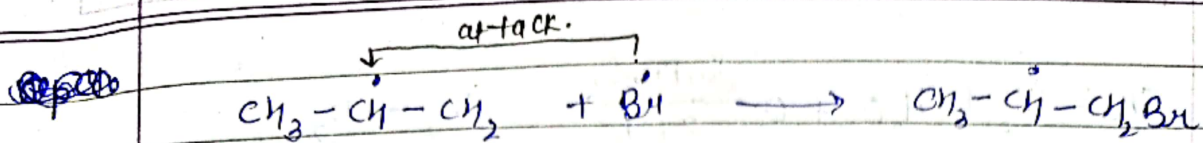


Step 3



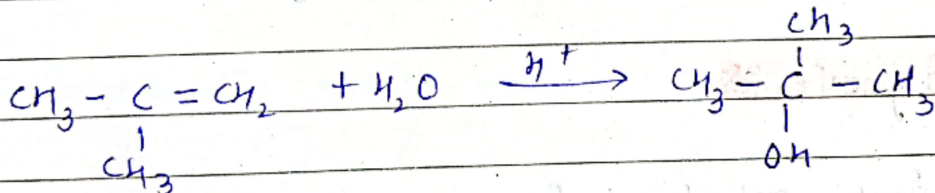
$2^\circ > 1^\circ$
Stability.

- The free radical of Bromine will attack on 2° free radical because 2° is more stable.



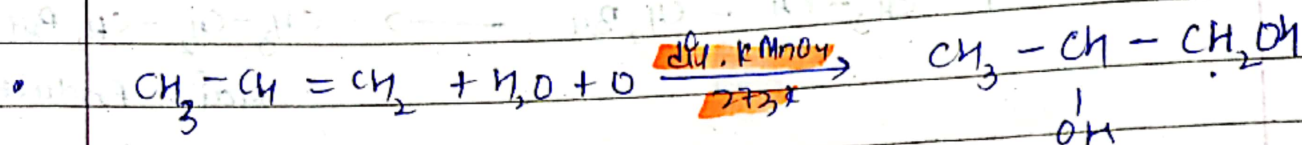
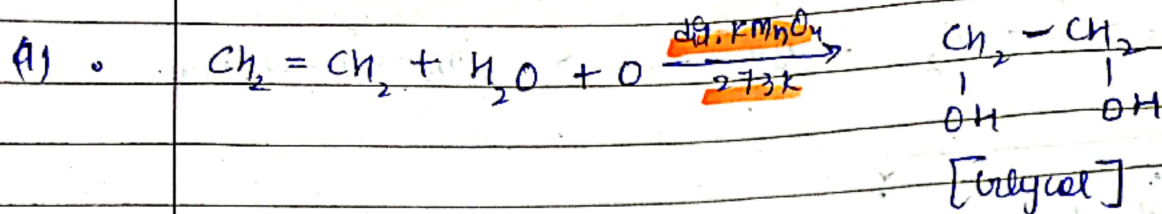
4) Addition of water

- In the presence of a few drops of concentrated sulphuric acid alkenes react with water to form alcohols, in accordance with the Markovnikov rule

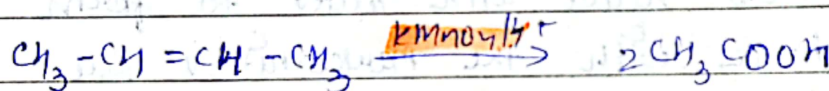
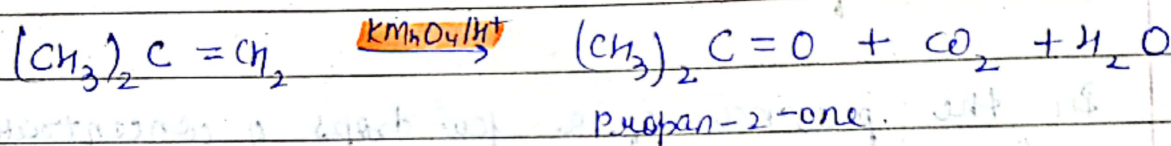


5) Oxidation

- Alkenes can be oxidised to vicinal diols, ketones, carboxylic acids using different reagents.
- Alkenes on rxn with cold, dilute, ~~aqueous~~ aqueous solution of potassium permanganate [Baeyer's reagent] produce vicinal glycols.
- Decolorisation of KMnO_4 solution is used as a test for unsaturation.

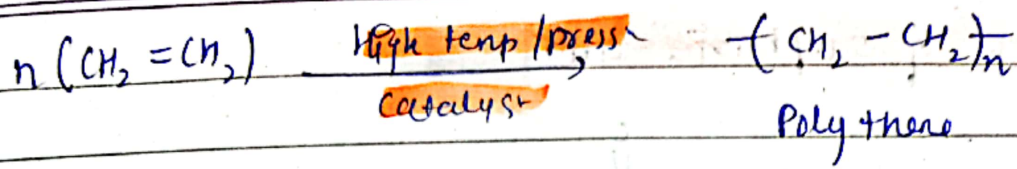


(b) Acidic potassium permanganate or acidic potassium dichromate oxidises alkenes to ketones and/or acids depending upon the nature of the alkene & the experimental conditions.

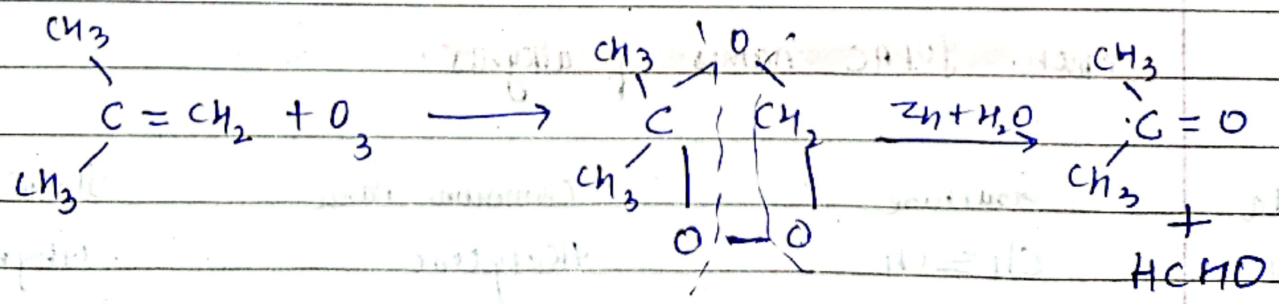
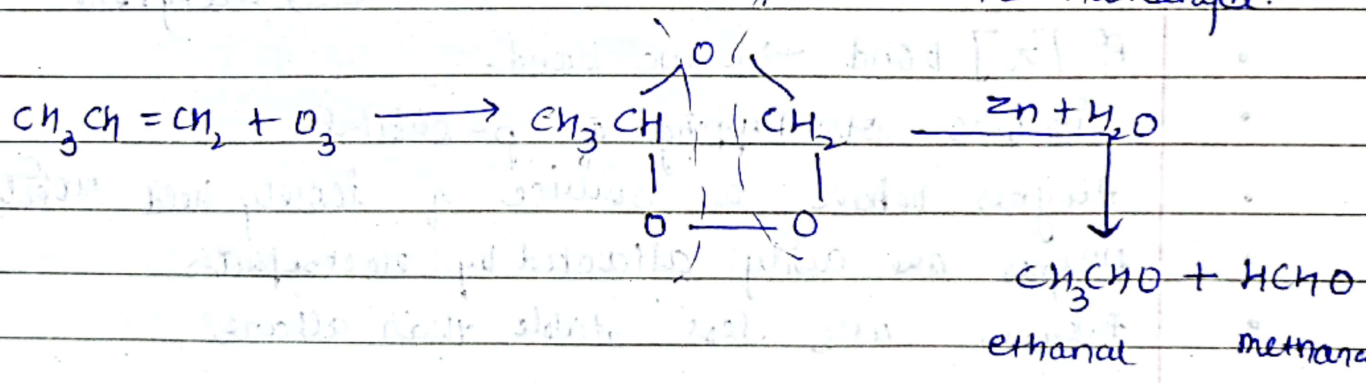
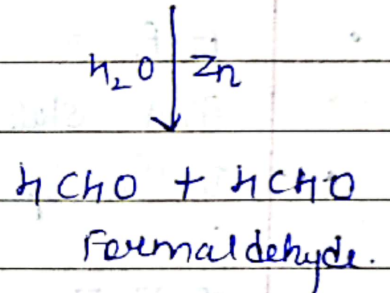
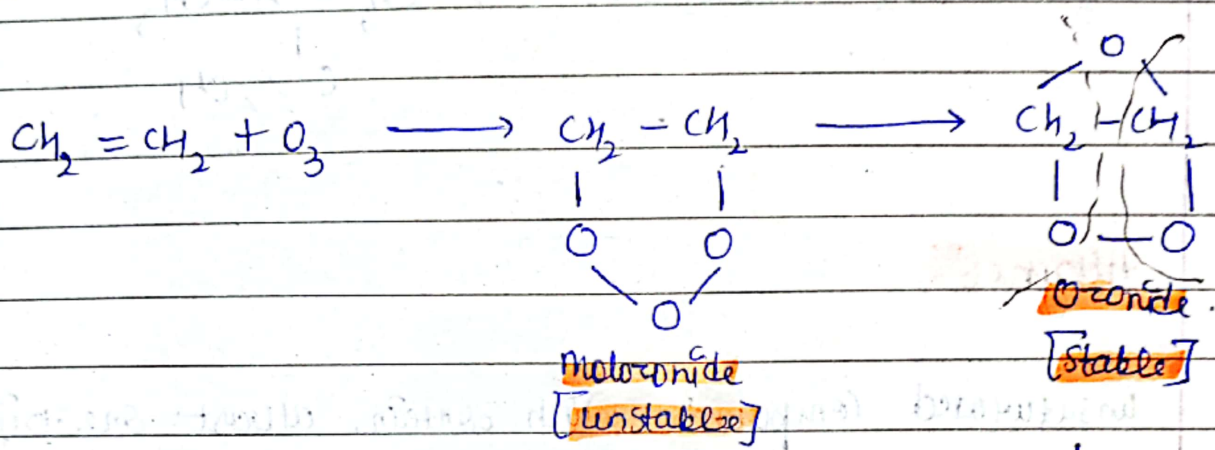


b) Polymerization

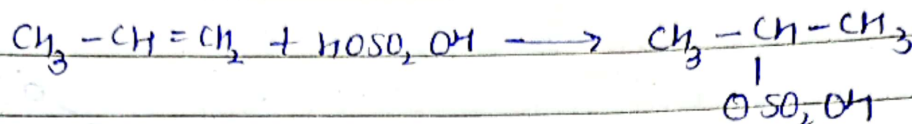
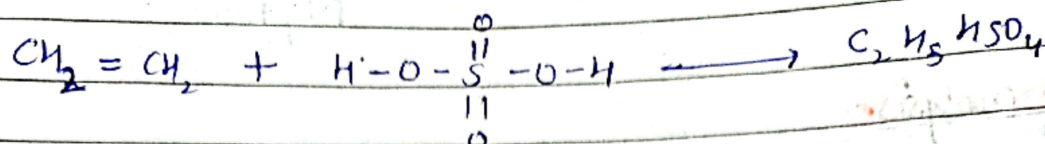
- Simple molecule + Simple molecule $\longrightarrow$ Compound molecule
Requires,
- High temp, pressure, catalyst
- used to make plastic bags
- Polythene is obtained by the combination of large no. of ethene molecules at high temperature, high pressure and in the presence of catalyst. The large molecules thus obtained are called "polymers". This rxn is k/a "polymerisation". The simple compounds from which polymers are made are called monomers.



4) Ozonolysis
 ↓
 ozone (O_3) → Breaking



8)

Addition of sulphuric acid.

3.

Alkynes.

- unsaturated compounds which contain atleast one triple bond

- G.F = $\text{C}_n\text{H}_{2n-2}$ [n = no. of carbons]

- First stable member is Ethyne. $[\text{H}-\text{C}\equiv\text{C}-\text{H}]$

- It is sp hybridised. $[\text{CH}\equiv\text{CH}]$
 $\text{C} \rightarrow$ acetylene

- π [π] bond $\rightarrow$ weak bond.

- side wise overlapping of p -orbital.

- Alkynes behave as source of loosely held mobile electron

- Alkynes are easily attacked by electrophiles

- Alkynes are less stable than alkenes.

Common IUPAC names of alkynes.

Formula	Structure	Common name	IUPAC name
C_2H_2	$\text{CH}\equiv\text{CH}$	Acetylene	Ethyne
C_3H_4	$\text{CH}_3-\text{C}\equiv\text{CH}$	methylacetylene	Propyne
C_4H_6	$\text{CH}_3\text{CH}_2-\text{C}\equiv\text{CH}$	Ethylacetylene	But-1-yne
C_4H_6	$\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_3$	Dimethylacetylene	But-2-yne

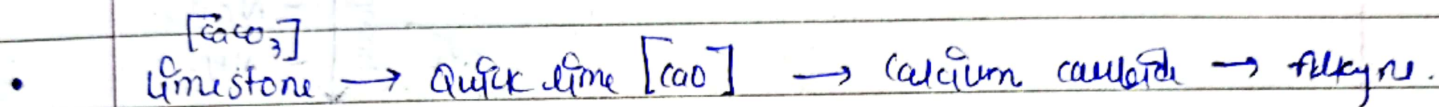
* Preparation of Alkynes.

1) From calcium Carbide.

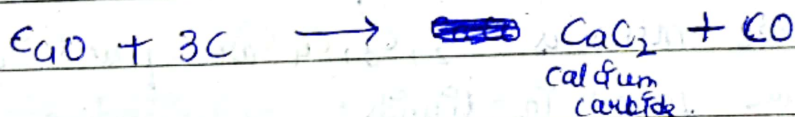
From calcium carbide involves electrolysis.

Calcium carbide + water = Alkyne.

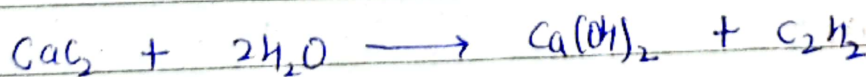
- On industrial scale, ethyne is prepared by treating calcium carbide with water.



a) Prepare calcium carbide: Heat quicklime [CaO] with coke to produce calcium carbide.



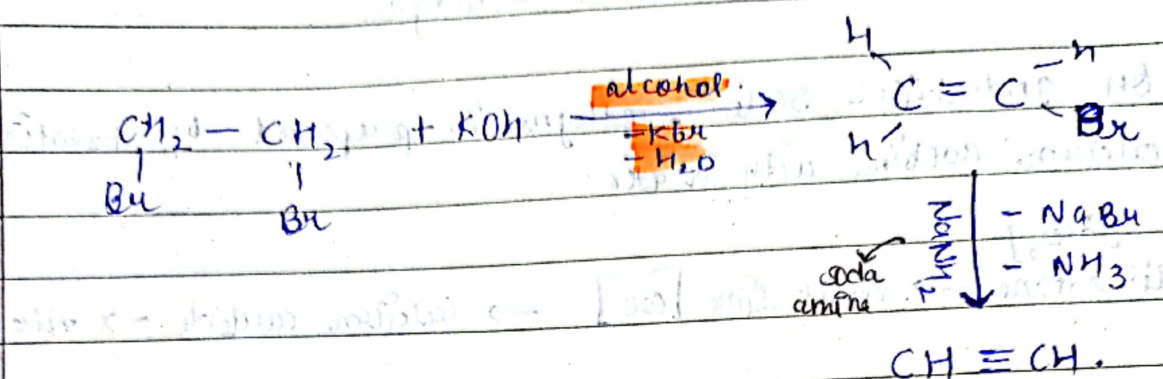
b) React calcium carbide with water: To form calcium hydroxide & acetylene



2.

From Vicinal Dihalides.

- Two halogen atoms are attached to two adjacent carbon atoms. This process is called dehydrohalogenation.



* Physical properties.

- Alkynes are partially polar molecules.
- Assess weak Vander Waal forces.
- First three members - $\text{C}_2, \text{C}_3, \text{C}_4$ are found in gases. Next 8 are found in liquids. Higher carbon are found in solid state.
- Higher alkynes are colourless & odourless.
- Ethyne - Colourless with characteristic smell.

⇒ Boiling point

- molecular size $\uparrow$ Boiling point $\uparrow$
- Straight chain alkynes $\rightarrow$ higher B.P.
- Branched chain alkynes $\rightarrow$ low B.P.

⇒ Solubility.

- like dissolves like.
- Alkynes float on water [Insoluble in water]
- Partly soluble in polar solvents like Benzene, ether.

Density.

molecular size $\uparrow$ Density $\uparrow$

Density of alkynes $<$ Density of water

Alkynes are electron rich

$\Rightarrow$ Electrophilic rxn, free radical mechanism.

$\Rightarrow$ Nucleophilic rxn only in heavy metal ions.

*** Chemical properties of Alkynes.****1) Acid-Base Reaction.**

- Alkynes are weak acid
- Alkynes + Strong base = Acid Base Rxn
- Acid-Base rxn is not seen in Alkanes & Alkenes.

Q Why Alkynes are Acidic?

Ans Due to hybridisation of carbon.

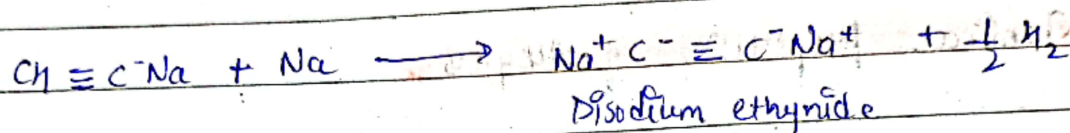
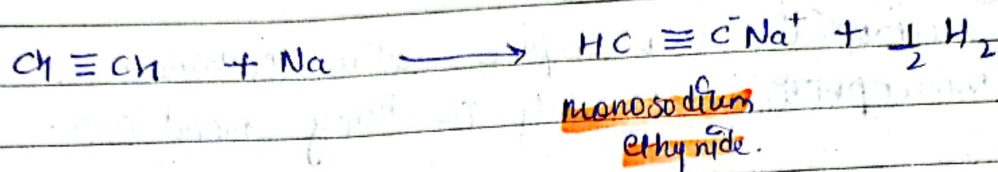
- Due to maximum percentage of s character [50%], the sp hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity. Hence, attraction of e^- is more & release of H^+ is more.
(Tendency of electron to attract an electron).

Acidic nature:

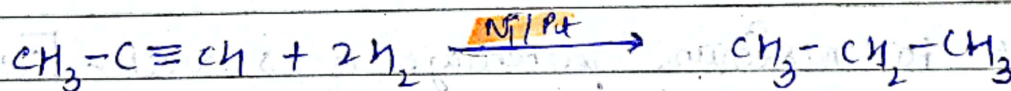
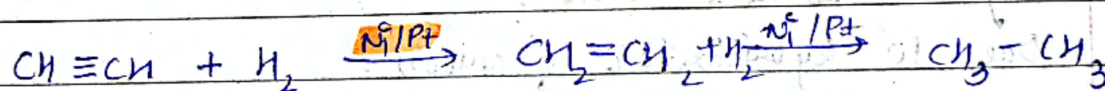
Alkynes $>$ Alkenes $>$ Alkanes.

1) Acid - Base Reactions.

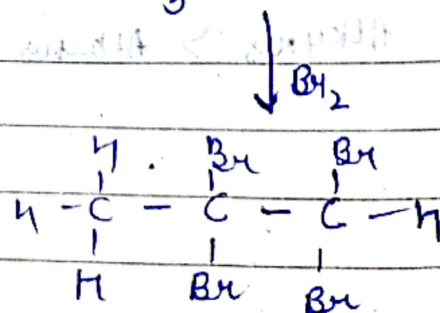
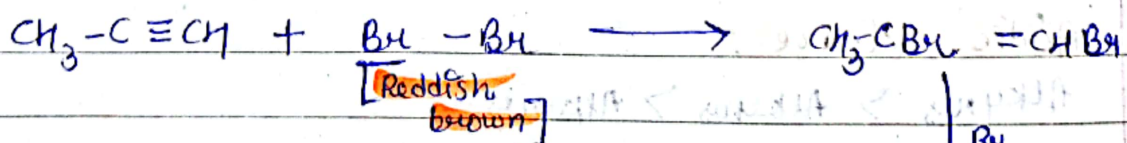
⇒ Sodium metal and sodamide $[\text{NaNH}_2]$ are strong bases. They react with ethyne to form acetylide with the liberation of dihydrogen gas.

2) Addition of Dihydrogen.

Alkynes add up one molecule of dihydrogen gas in the presence of finely divided nickel, palladium or platinum to form alkanes -

3) Addition of Halogens $\xrightarrow{\text{Cl}_2, \text{Br}_2}$

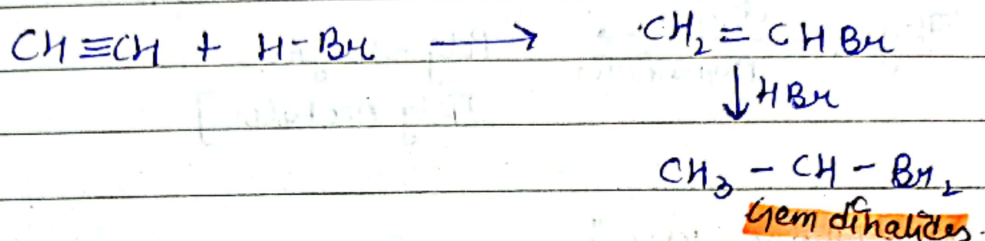
H_2S is used as a test for unsaturation.



1,1,2,2 - Tetra bromo propane
[colourless]

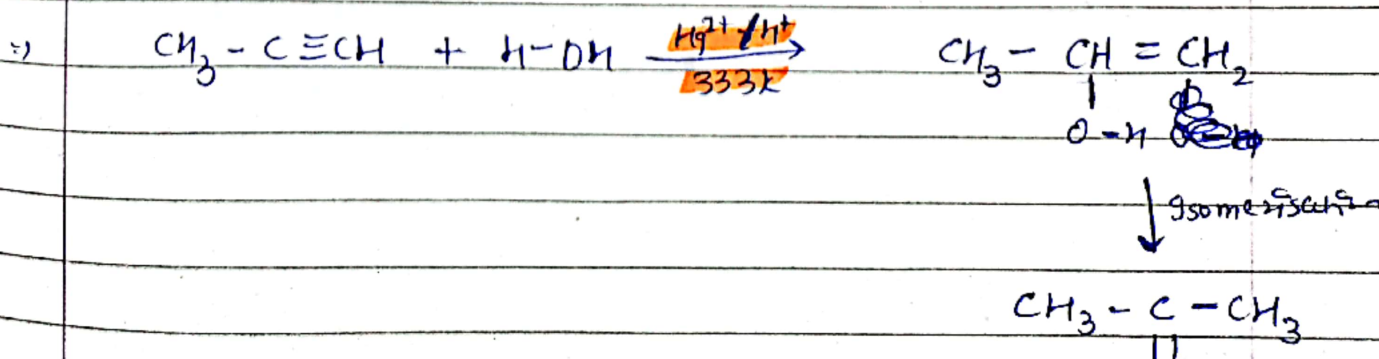
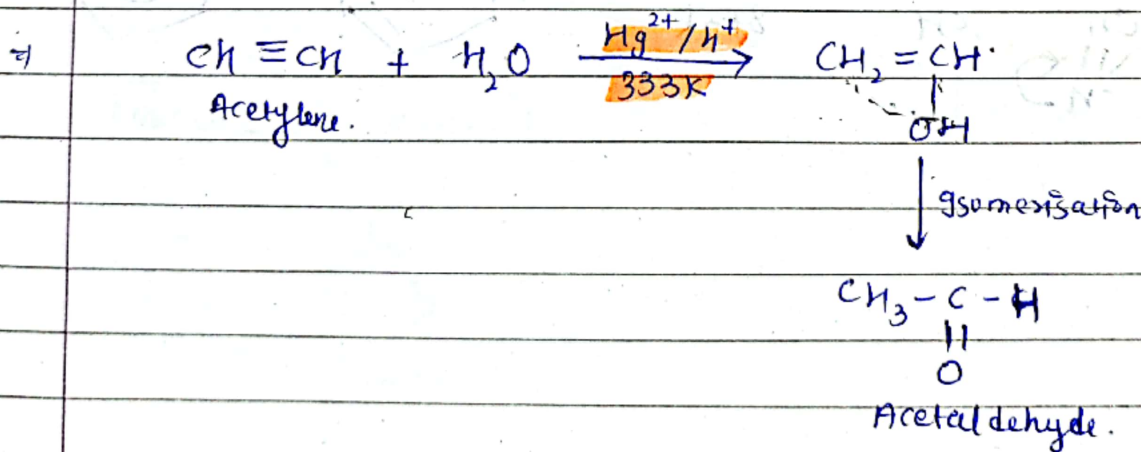
3) Reaction with Hydrogen Halide [HX]

- Two molecules of hydrogen halides [HCl, HBr, HI] add to alkynes to form gem dihalides.

4) Reaction with water

- Alkynes do not react with water BUT Alkynes when warmed with mercuric sulphate and dilute sulphuric acid at 333 K. Alkynes + H_2O = carbonyl compounds.

~~However, one molecule of water adds to alkynes on warming with~~



5)

PolymerisationSmall unit + small unit $\longrightarrow$ large unit.

(a)

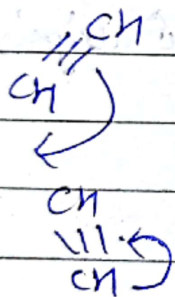
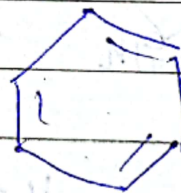
Linear polymerisationEthyne $\xrightarrow[\text{polymerisation}]{\text{linear}}$ Poly-Ethyne
[Poly acetylene]• **Poly-Ethyne uses:**

=) Good conductor of electricity

=) Lighter & cheaper than metal conductor

=) Used as electrodes in batteries

(b)

Cyclic PolymerisationRed hot Iron
tube
873K

or

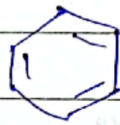


* Aromatic Hydrocarbons. [Arenes]

⇒ These hydrocarbons are also k/a "arenes"

⇒ Aroma means pleasant-smelling that's why these are k/a aromatic compounds.

⇒ most of such compounds were found to contain benzene ring.



⇒ there are eg of aromatic hydrocarbon which don't contain a benzene ring but instead contain other highly unsaturated ring.

Aromatic compounds

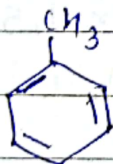
Benzenoids

[Benzene ring present].

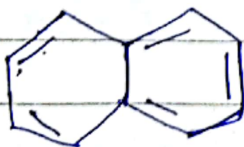
eg:



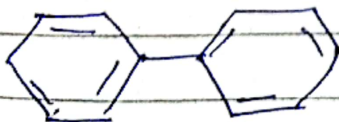
Benzene



Toluene



Naphthalene



Biphenyl.

Non-Benzenoids

[No benzene ring present]

eg:



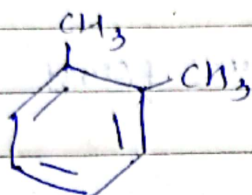
Azulene

*

Nomenclature and Isomerism

- 2 hydrogen atoms in benzene are replaced by 2 similar or different monovalent atoms or groups.
- 3 different position isomers are possible.

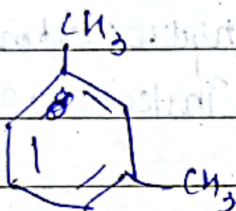
eg:



1,2-Dimethylbenzene

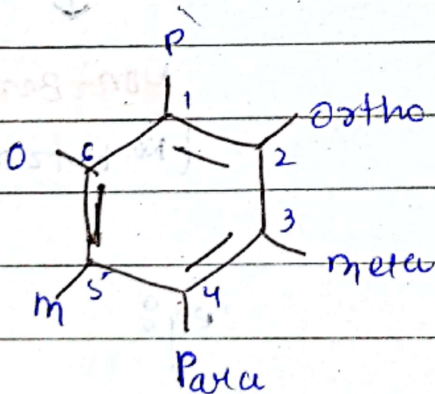


1,4-Dimethylbenzene



1,3-Dimethylbenzene

Position isomers



1,2 or 1,6 as ortho

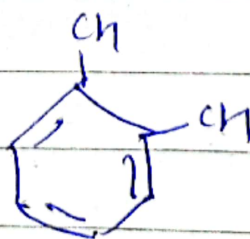
1,3 or 1,5 as meta

1,4 as para

eg:

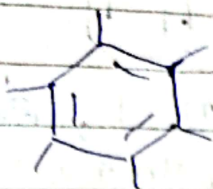


methylbenzene
[Toluene]



Xylene

* Structure of Benzene



→ High unsaturation.

* Resonance & Stability of Benzene

3 double bonds



Delocalised π -electrons



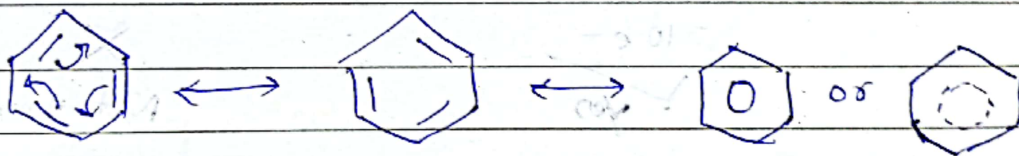
stable



π electrons [σ bonds] are not fixed in position



moving around the structure



* Conditions for Aromaticity

3 conditions to decide aromatic compound.

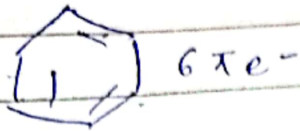
(i) Planarity, X-ray diffraction data reveals that benzene is planar.

(ii) Delocalisation of the π electrons in the ring.



(iii) "Hückel Rule" : Presence of $(4n+2)$ π electrons in the ring
 where $[n = \text{no. of rings}]$
 $\hookrightarrow 0, 1, 2, \dots$

eg.



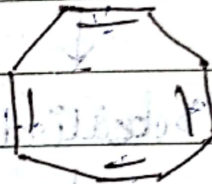
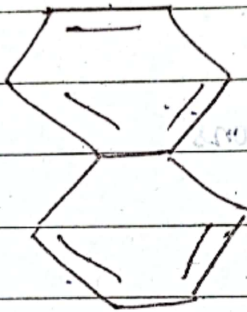
Apply Hückel's Rule

$$\begin{aligned} &= 4n + 2 \\ &= 4(1) + 2 \\ &= 6 \pi e^- \end{aligned}$$

$$\begin{aligned} n &= 1, \quad 4 \pi \text{ electrons} \\ &= 4n + 2 \\ &= 4(1) + 2 \\ &= 6 \pi e^- \end{aligned}$$

Not an aromatic compound

Are they aromatic?



$$n = 2, 10 e^-$$

$$\begin{aligned} &= 4n + 2 \\ &= 4(2) + 2 \\ &= 8 + 2 \\ &= 10 e^- \end{aligned}$$

yes

$$n = 1, 8 e^-$$

$$\begin{aligned} &= 4n + 2 \\ &= 4(1) + 2 \\ &= 6 e^- \end{aligned}$$

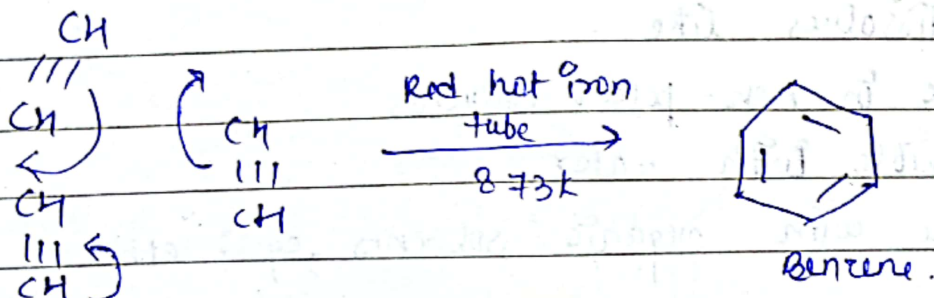
X

Not Aromatic

* Preparation of Benzene.

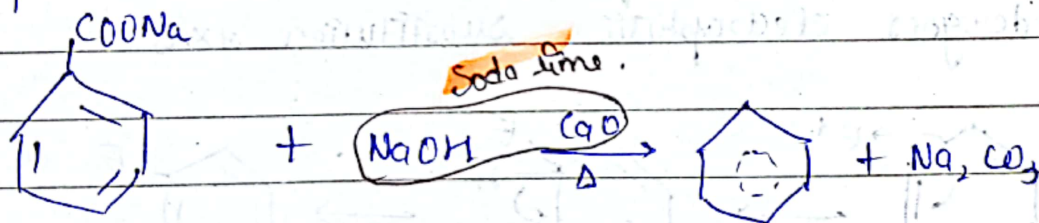
Laboratory method.

(i) Cyclic polymerisation of ethyne



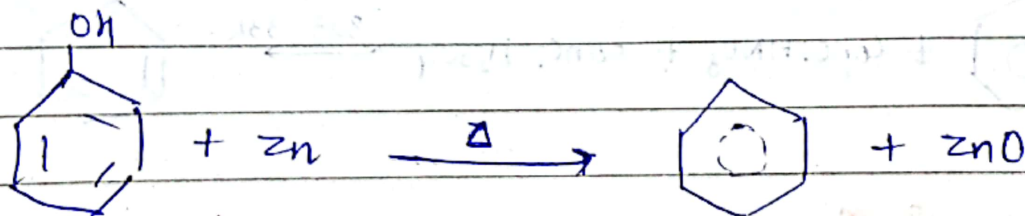
(ii) Decarboxylation of aromatic acids:

⇒ Sodium salt of benzoic acid on heating with soda lime gives benzene



(iii) Reduction of phenol.

⇒ Phenol is reduced to benzene by passing its vapours over heated zinc dust.



* Physical properties of aromatic hydrocarbons / Arenes.

- Non-polar molecules.
- Colourless with a characteristic aroma.

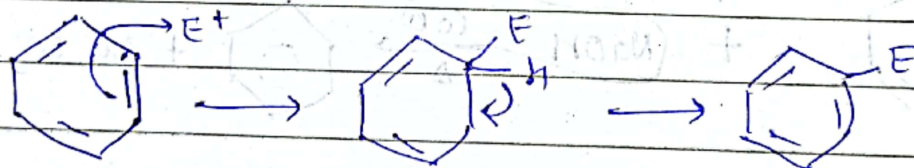
⇒ Solubility.

- Like dissolves like.
- Dissolve in non-polar solvents.
- Immiscible with water.
- Miscible with organic solvents, eg: ether.

- Burn with a sooty flame [Yellow colour]
- Incomplete combustion in lack of oxygen.

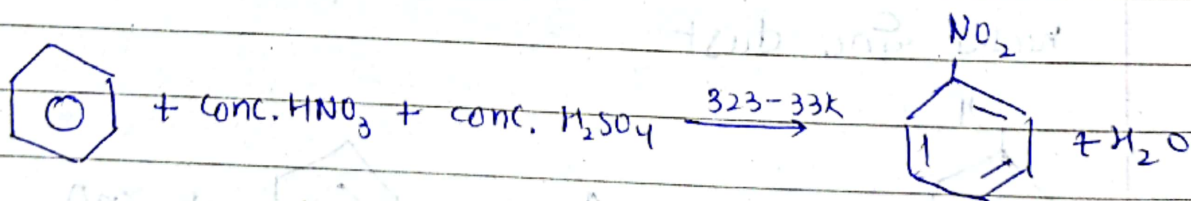
* Chemical properties of Arenes.

⇒ Undergoes electrophilic substitution rxns.



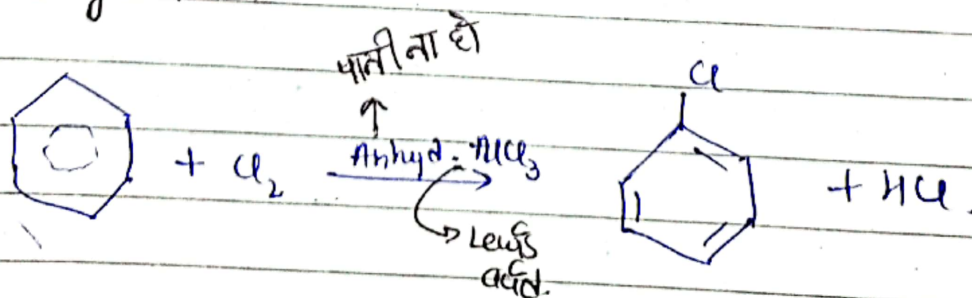
1)

Nitration



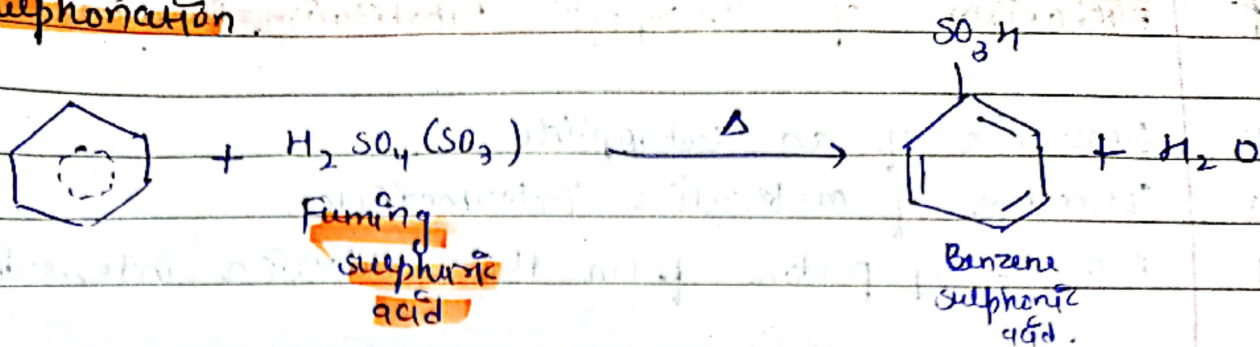
2)

Halogenation



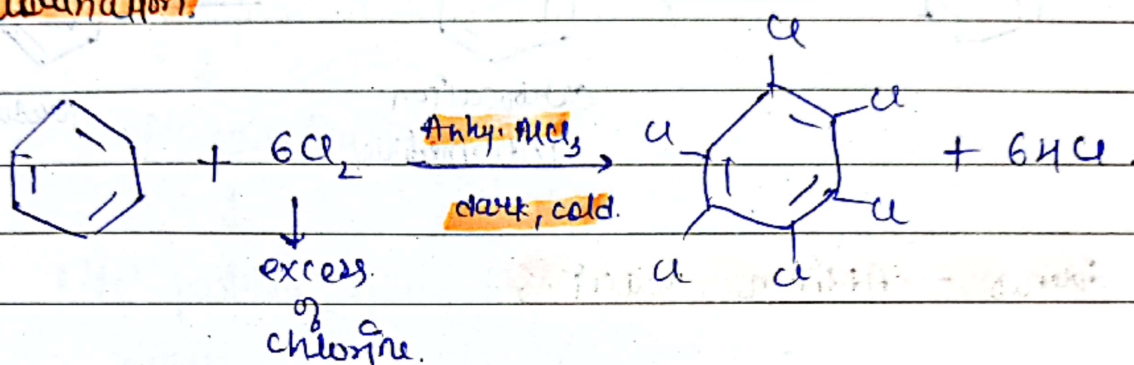
(iii)

Sulphonation



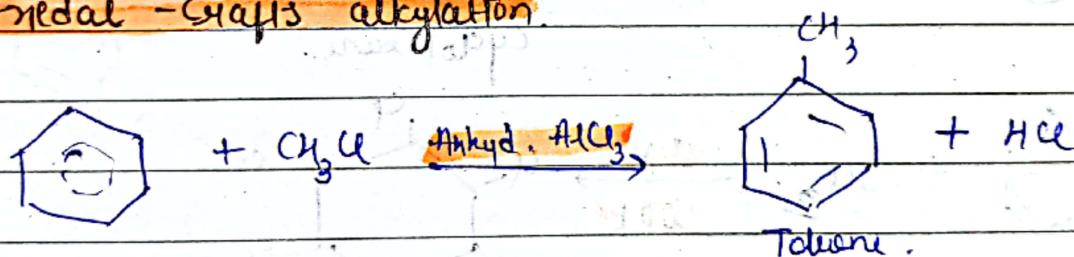
(iv)

Chlorination



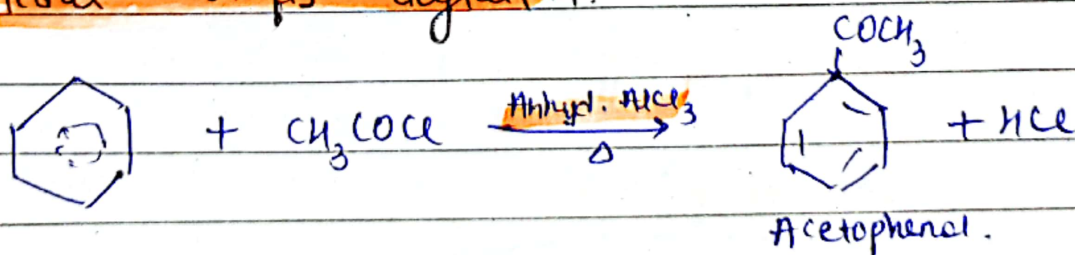
(v)

Friedel-Crafts alkylation



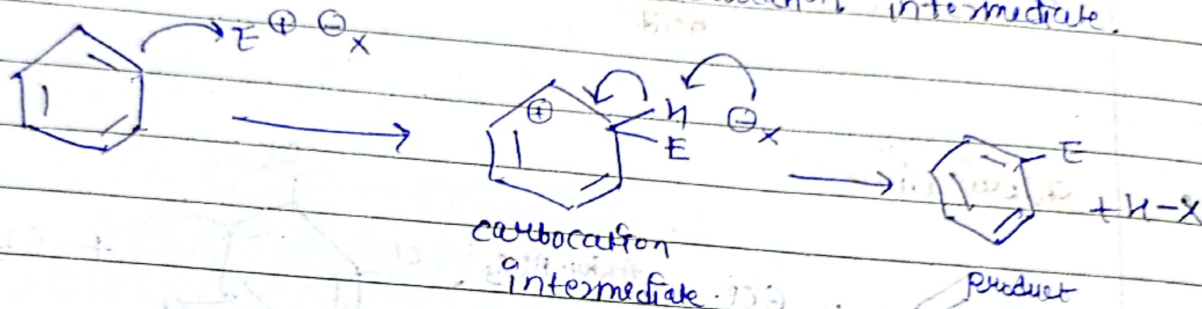
(vi)

Friedel-Crafts acylation

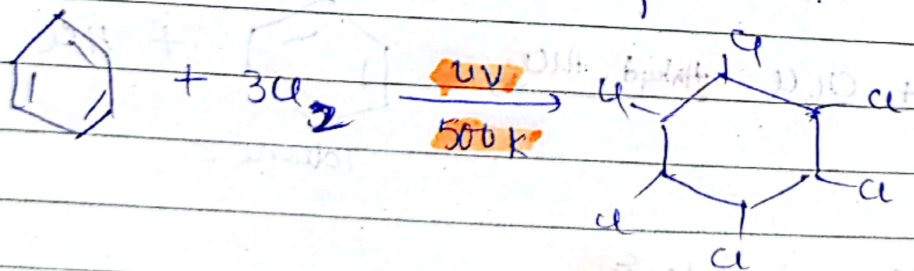
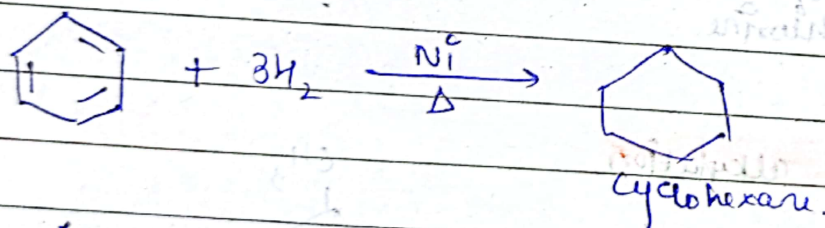


Mechanism of electrophilic Substitution Reactions

- Generation of an electrophile
- Formation of carbocation intermediate.
- Removal of proton from the carbocation intermediate.



Arenes - Addition Reactions



* Directive influence of a functional group in monosubstituted benzene.

Aromatic compounds.



Existing functional group direct.



Entering functional group.

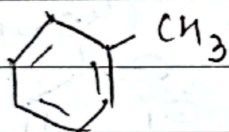


Monosubstituted Benzene



1 'H' position of the ring is substituted with another functional group.

eg:



methyl Benzene

$\text{CH}_3 \Rightarrow$ existing functional group $\rightarrow$ Directs the entering of functional group.

Two types of behaviours



Directing towards.



(m-directing groups)



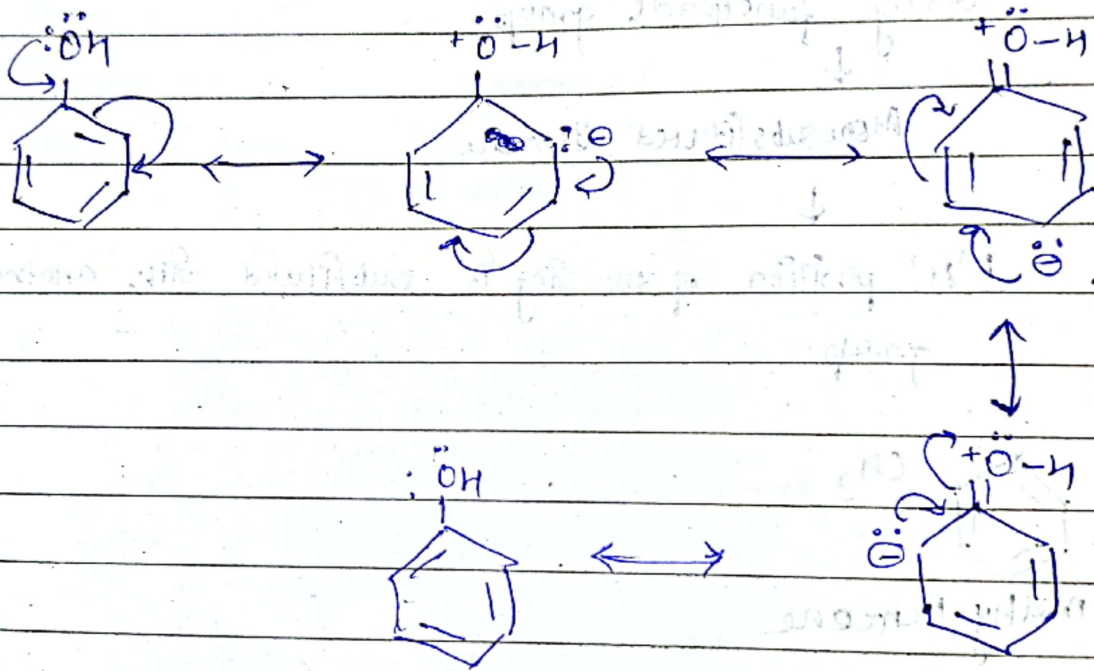
(o & p-directing groups)

* Ortho & para directing groups.

Groups which direct the incoming group to ortho & para position.

NH_2 , $-\text{NHR}$, $-\text{NHCOCH}_3$, $-\text{OC}_2\text{H}_5$, $-\text{OH}$, $-\text{CH}_3$, $-\text{C}_2\text{H}_5$ etc.

electron density is more in ortho & para positions.



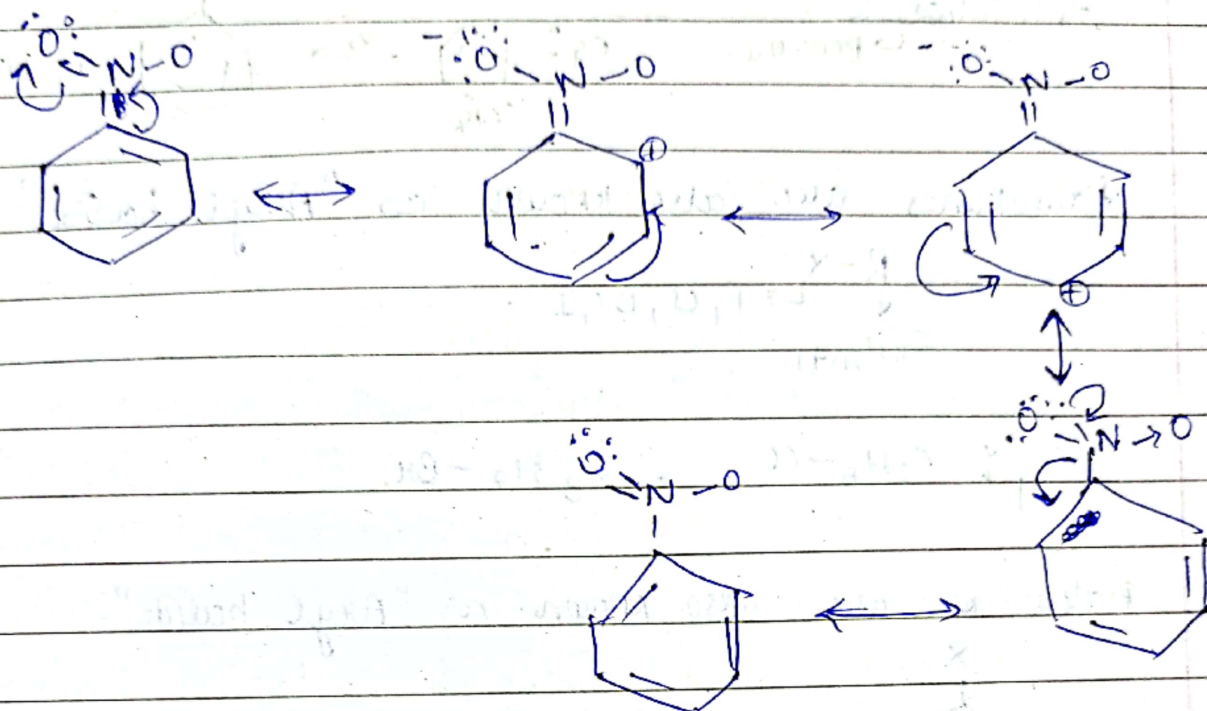
exception

Cl shows strong I-effect, acts as deactivating group but due to resonance it also behaves as o/p directing group.

* Meta directing group.

7. $-NO_2$, $-CN$, $-CHO$, $-COR$, $-COOH$, $-COOK$, $-SO_3H$ etc

⇒ Electron density is more in meta positions.



*	Carcinogenicity & Toxicity.
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⇒ More than two benzene rings fused together are toxic & poses cancer producing [Carcinogenic] property.

7 Incomplete combustion : Tobacco, coal & Petroleum.

4) In Human Body

↓

Biochemical Rxns

↓

Damage DNA & causes cancer.