

Reduction:

In term of atom:

- ① Removal of oxygen
- ② Addition of Hydrogen
- ③ Removal of most electronegative atom
- ④ Increase number of Hydrogen bond
- ⑤ Decrease number of oxygen Bond

In term of Electrons:

- ⑥ Gain of electron
- ⑦ Decrease in oxidation state

↳ Hydrogen is added in Hydrogen equivalent (H₂) form

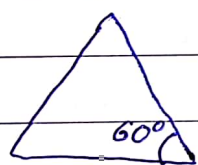
Hydrogen equivalent (H₂):

Three ways:

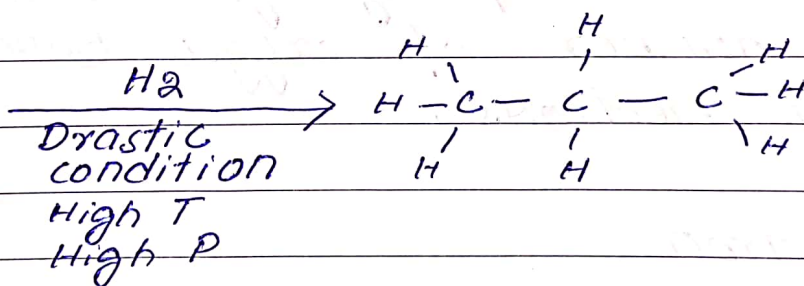
- ① \Rightarrow H_2 / metal as a catalyst
- ② \Rightarrow metal ions (NO^+) / NH_3
 source of e^- \leftarrow \rightarrow source of H
- ③ \Rightarrow Hydride ion and Hydrogen ion (H^+)
 $\rightarrow (H^-)$
 \rightarrow Both ions are used as a source of Hydrogen

$\rightarrow H^+$ ion \Rightarrow Bonded with non-metal
 H^- ion \Rightarrow Bonded with metal

(Reduction)



\rightarrow angle strain



Highly reduced \Rightarrow Alkanes
 Highly oxidized \Rightarrow carboxylic acid

Alkenes:

① Catalytic Hydrogenation:

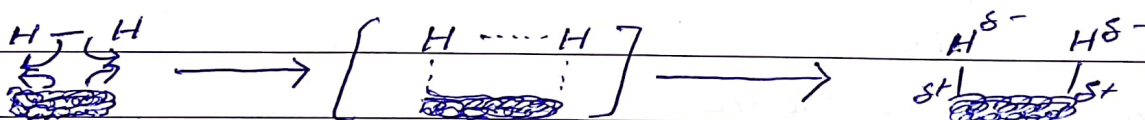
Hydrogenation \rightarrow Addition of Hydrogen
 Metal catalyst \rightarrow Pt, Pd, Ni

Pt \rightarrow most expensive metal $\left. \begin{array}{l} \nearrow \text{Highly} \\ \searrow \text{Reactive} \end{array} \right\}$
 Pd \rightarrow Poisonous

So, we mostly use Ni in our reactions

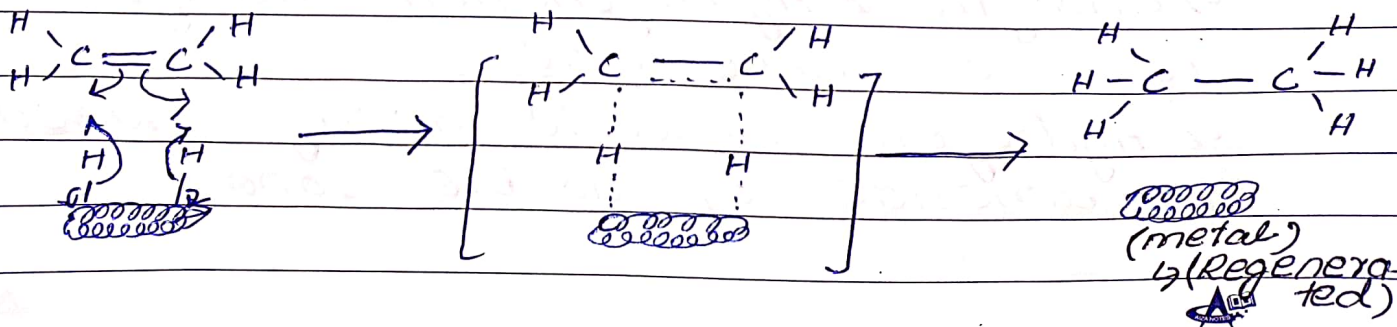
Steps:

① Chemosorption:



② Diffusion and Reaction:

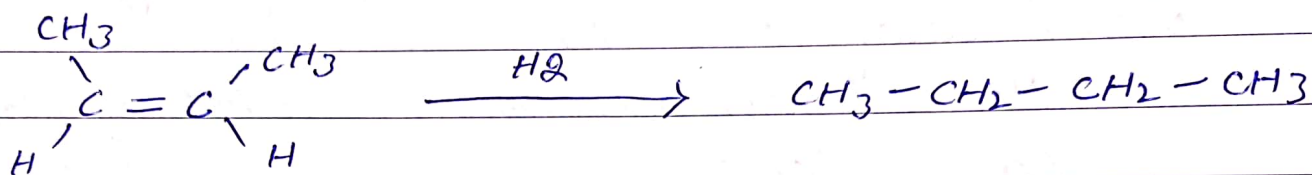
Substrate will move toward Hydride



③ ⇒ Desorption

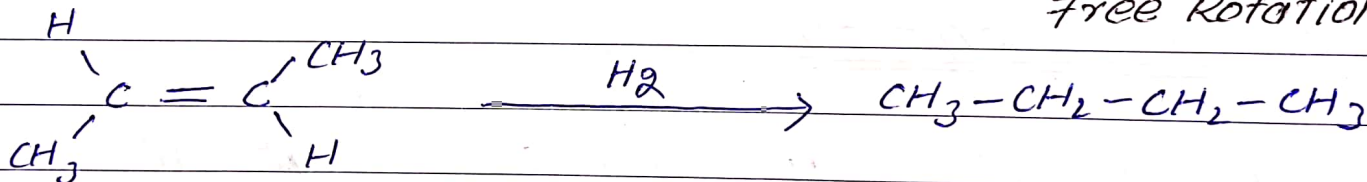
separation of product from catalyst (Metal) is called desorption.

Addition of Hydrogen:



(Cis) ⇒ steric strain
↳ unstable

(same product)
↳ Because just sigma bond is present
↳ that allow Free Rotation



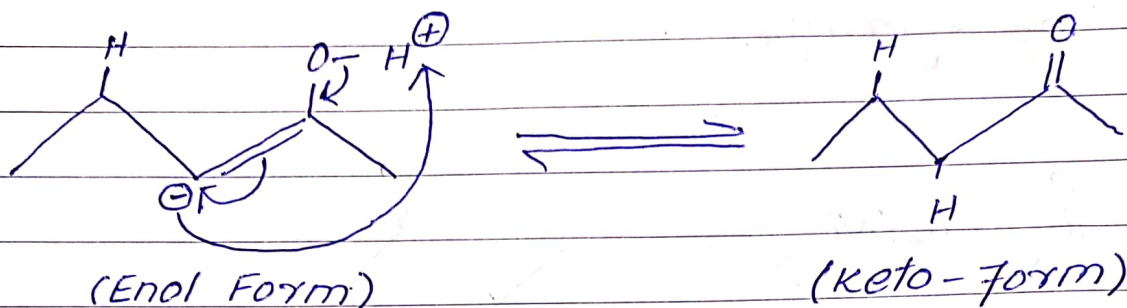
(Trans) ⇒ Less steric strain
stable than cis

Synaddition:

↳ catalytic Hydrogenation always occur on same side

↳ Hydrogen molecule always added in same side of double bond.





Reducing Agent:

- ↳ Reduced other
- ↳ oxidized itself

① ⇒ H_2 added

② ⇒ (a) source of electron (Na)

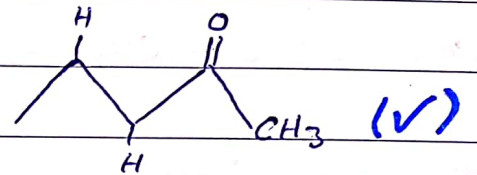
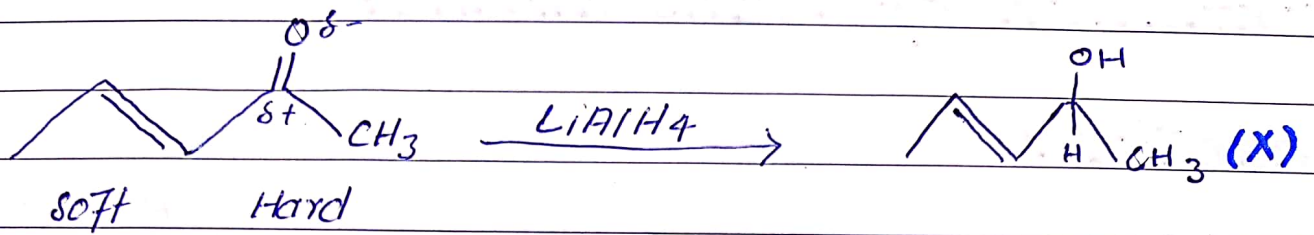
(b) source of Hydrogen (H^+ ion)

↳ Should bonded to non-metal

↳ Due to inductive effect, partial positive charge occurs on Hydrogen

↳ After reaction, it bears complete +ve charge

↳ Hydrogen that is bonded with metals, has -ve charge & released as Hydride ion (H^- ion)



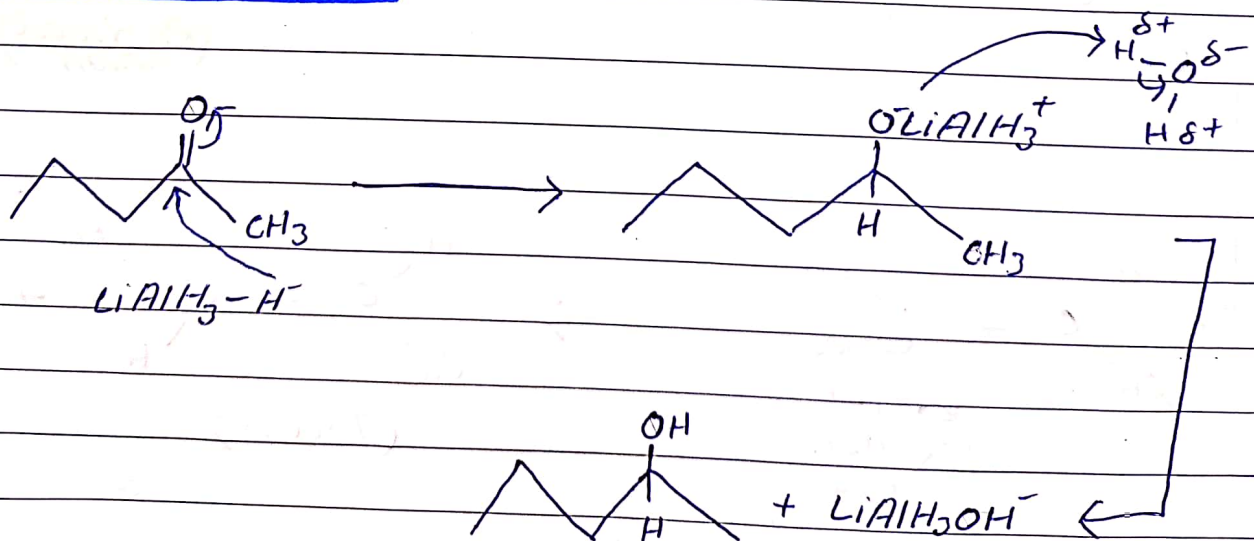
↳ H^- ion (Hard base) always act as nucleophile

↳ Soft acids react with soft bases

↳ Hard acids react with hard bases

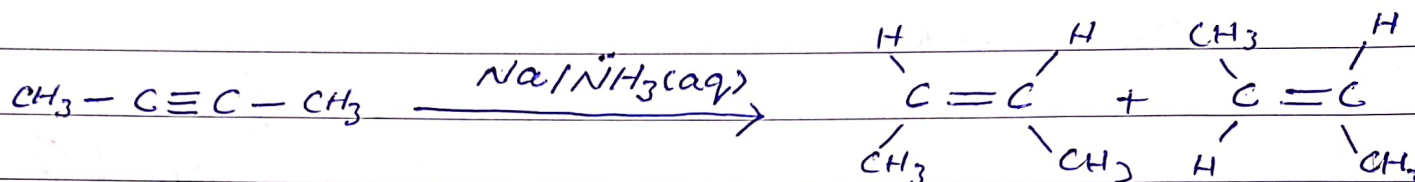
↳ Hydride ion always attack on carbonyl carbon (Electrophilic site) because Hydride ion is hard nucleophile and carbonyl carbon is hard electrophile.

Mechanism:

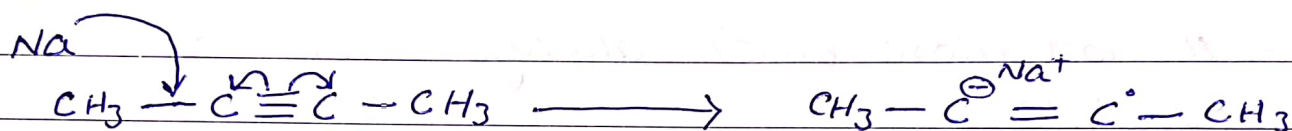


Formation of Trans alkene:

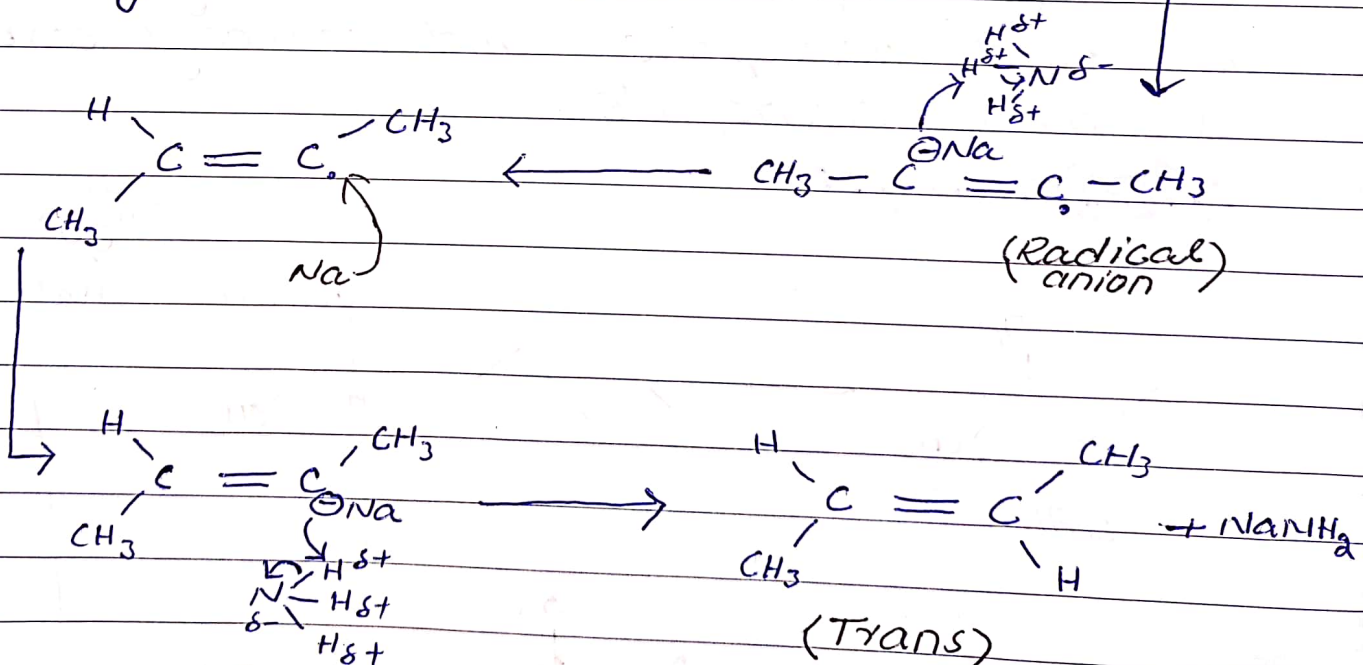
Reaction:



Mechanism:



↳ Electron Repulsion should be minimum
 ↳ thus electrons after breaking the bond rearranged themselves.



↳ Formation of cis-alkene:

↳ cis-alkene is formed from alkyne by poisoning the catalyst

Catalyst:

↳ substances that changes the rate of reaction (either increases or decreases) is called catalyst.

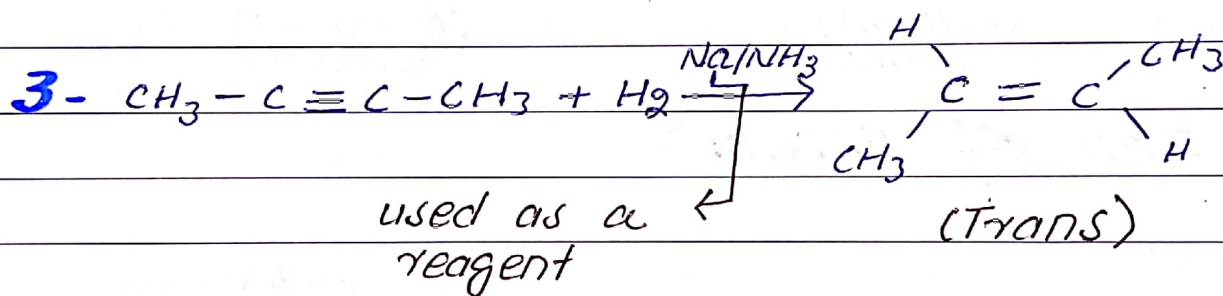
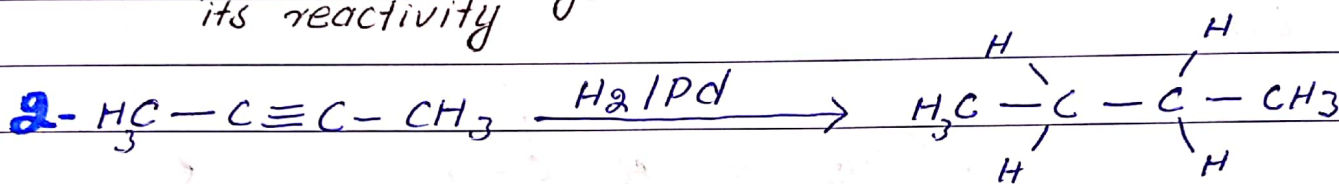
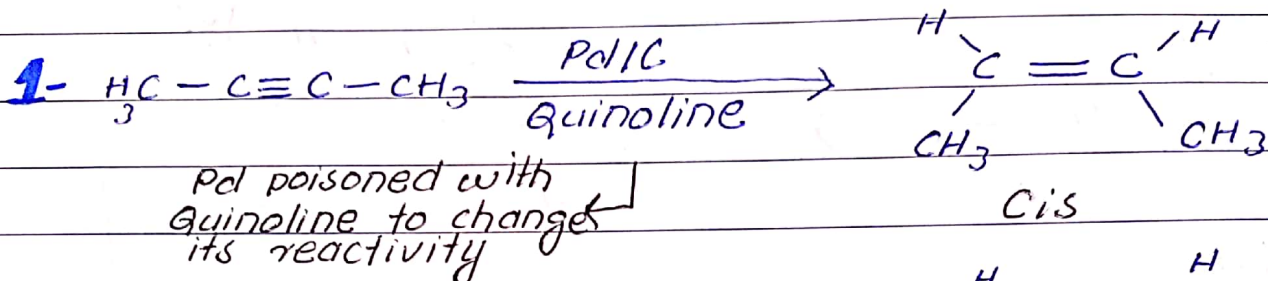
↳ Mostly we study that catalysts which increases the rate of reaction

↳ Increasing / Decreasing rate of reaction by providing alternative pathway (Increase or decrease the activation energy).

(Alkyne)

Date

Catalytical Hydrogenation:



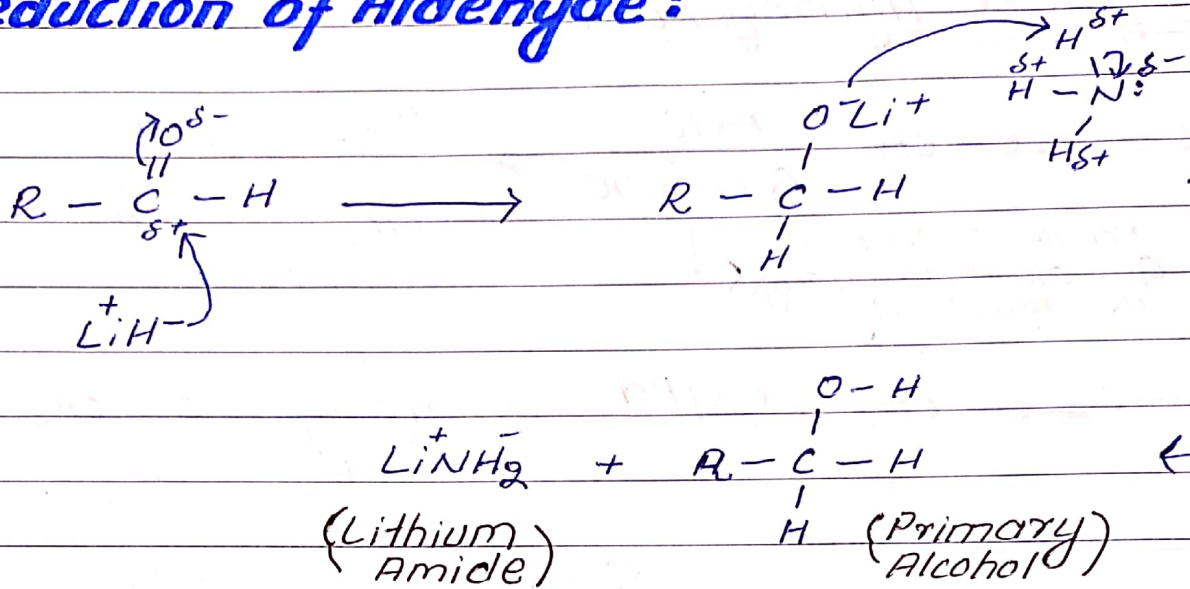
① ⇒ Poisoned Pd with quinoline convert Ethyne into cis-alkene

② ⇒ Pd (catalyst) convert Alkyne into alkane

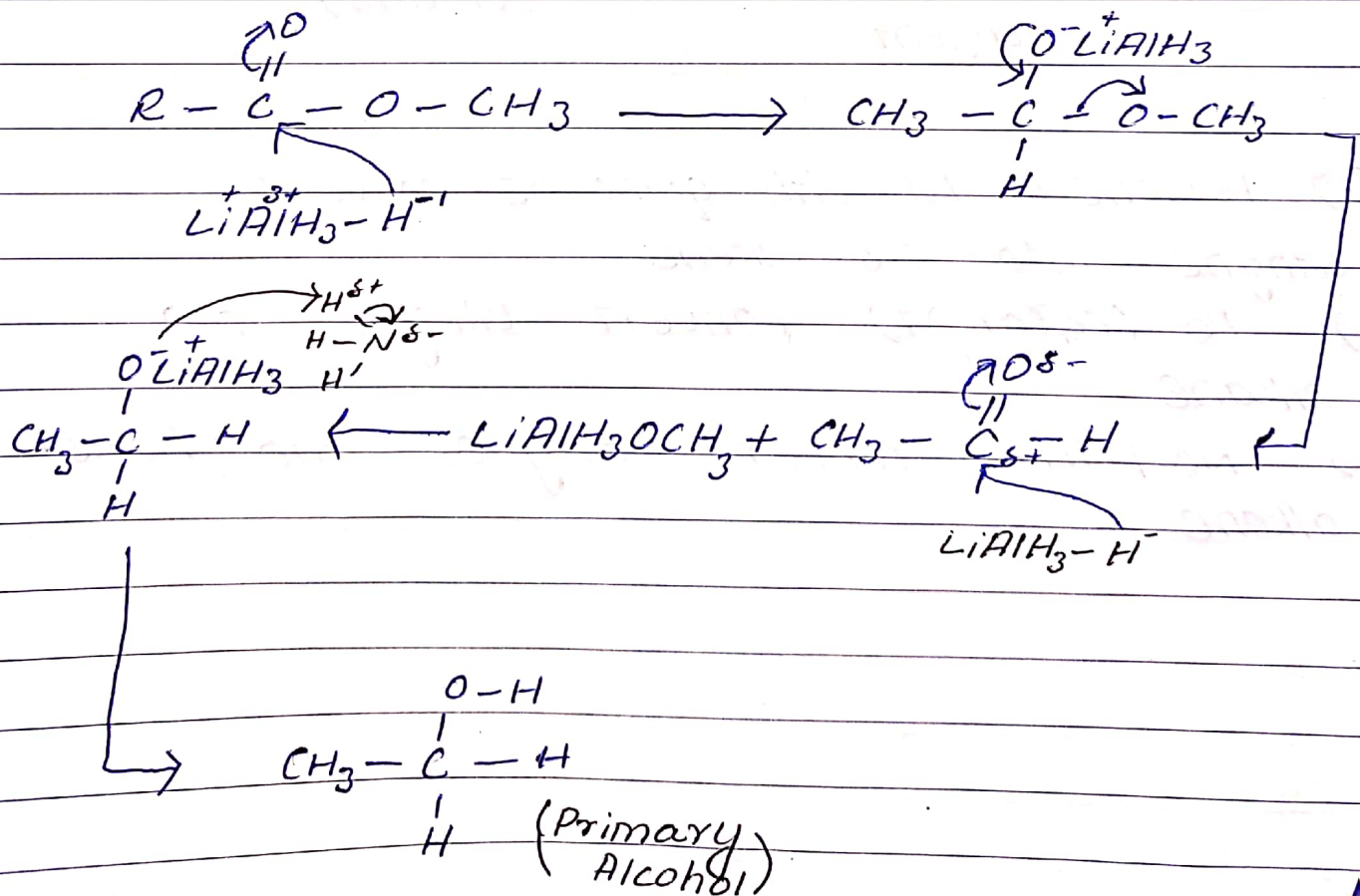
③ ⇒ Na/NH₃ convert alkyne into trans-alkene



Reduction of Aldehyde:



Reduction of Ester:



① ⇒ Oxidation state (Definition + Rules)

② ⇒ Acid Derivative

↳ Reaction with $\text{LiAlH}_4 / \text{H}_2\text{O}$

(i) ⇒ Acid anhydride

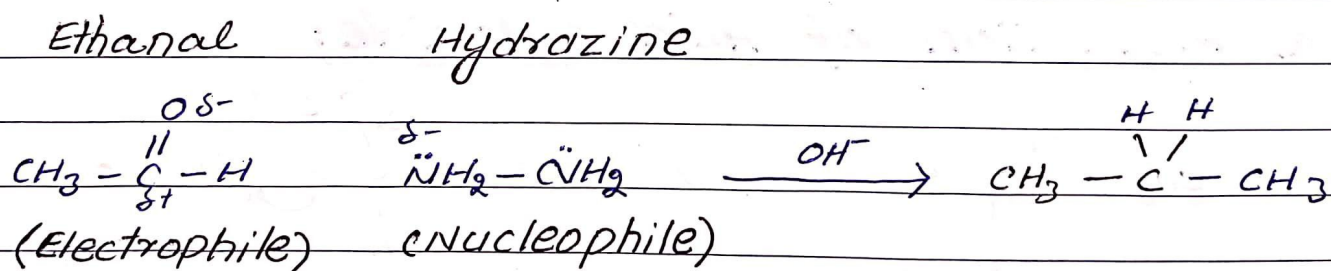
(ii) ⇒ acid chloride

(iii) ⇒ Acid amide

↳ Acidic catalyst ⇒ Always activate Electrophilic side

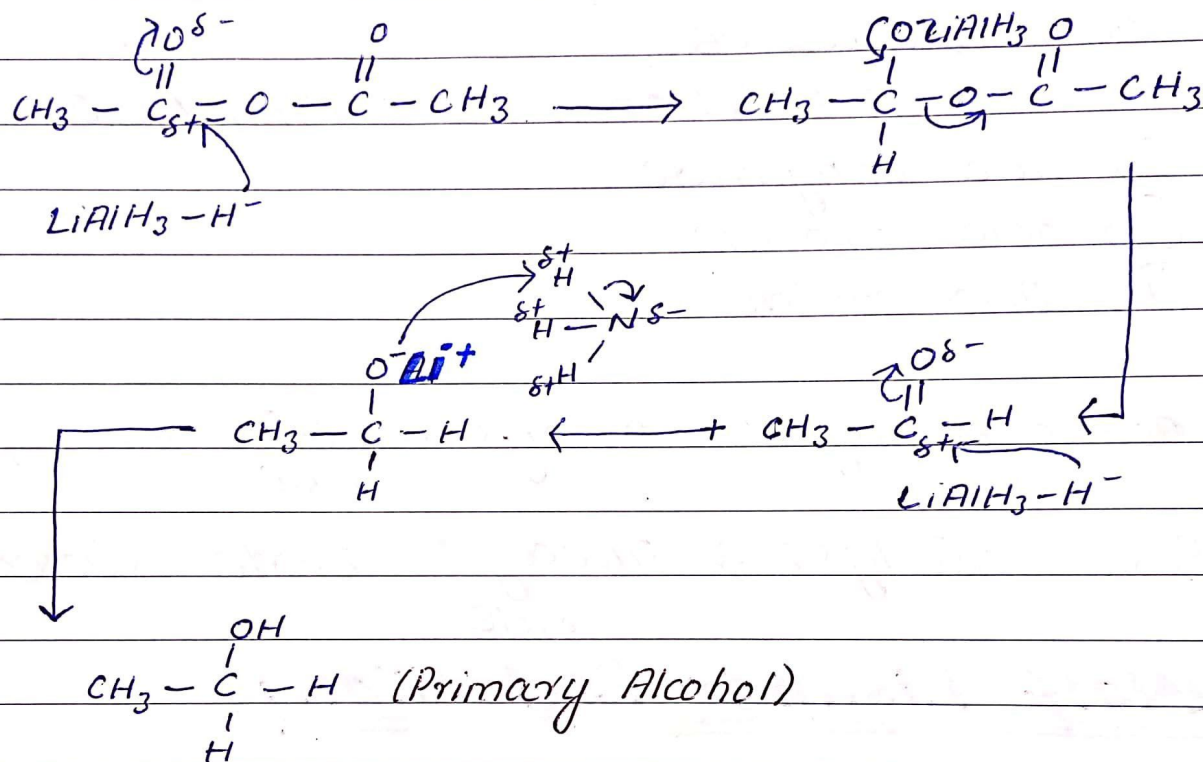
↳ Basic catalyst ⇒ Always activate Nucleophilic side

Wolff Kishner Reduction:

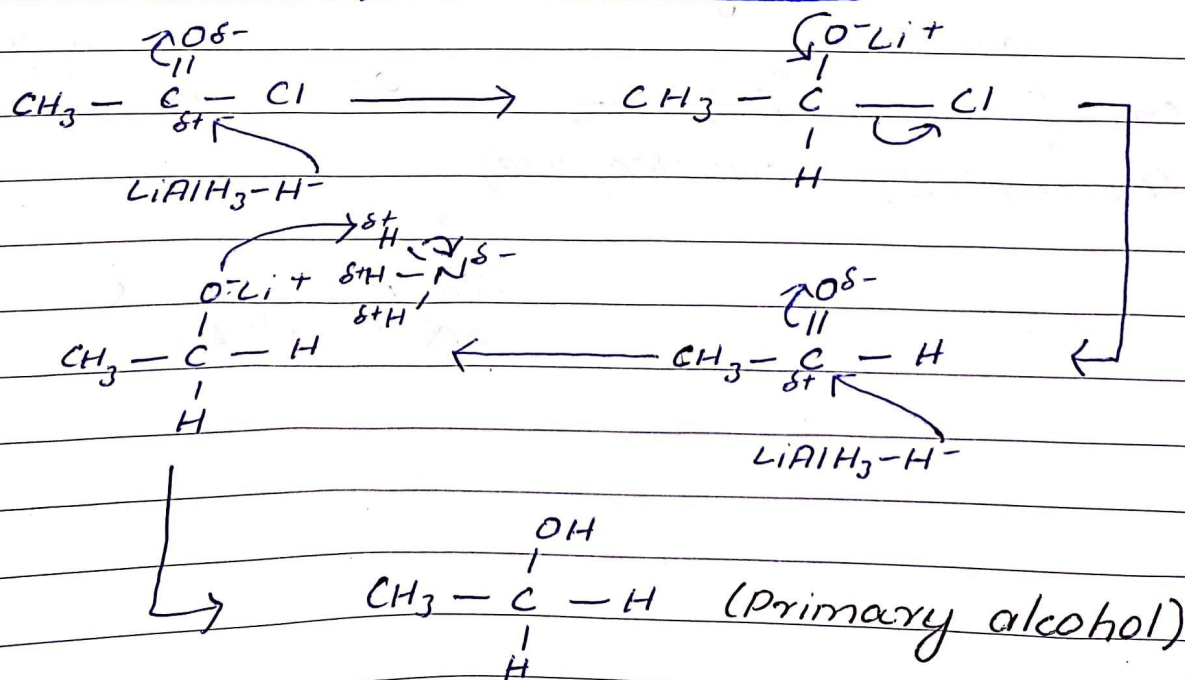


Both hydrogen added as H^+

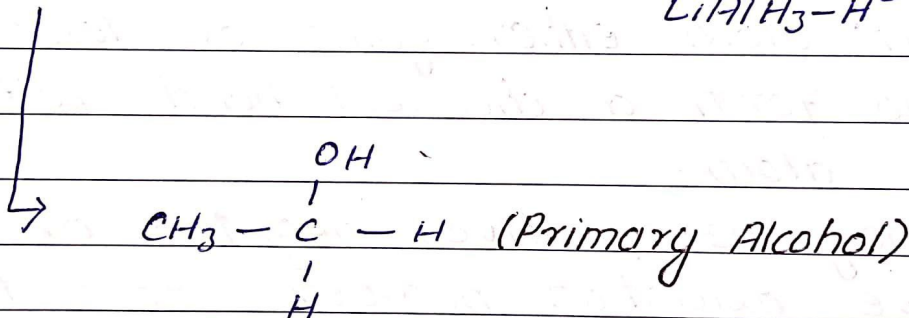
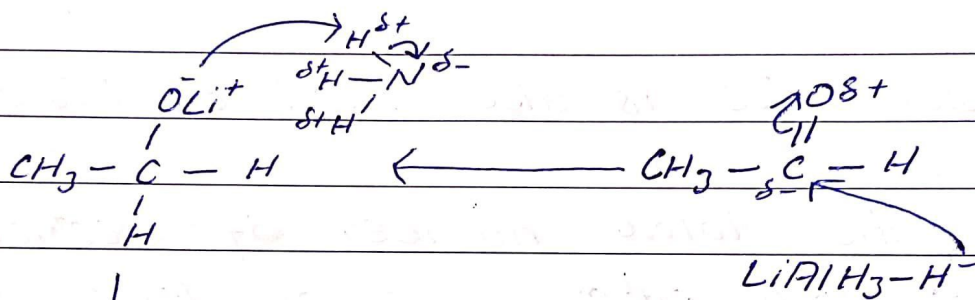
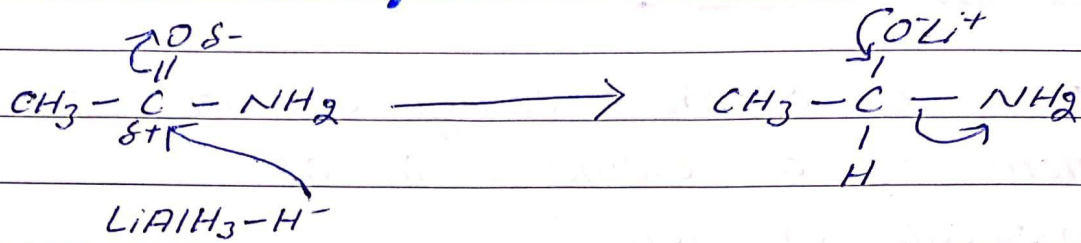
(1) Reduction of Acid Anhydride:



(2) Reduction of Acid Chloride:

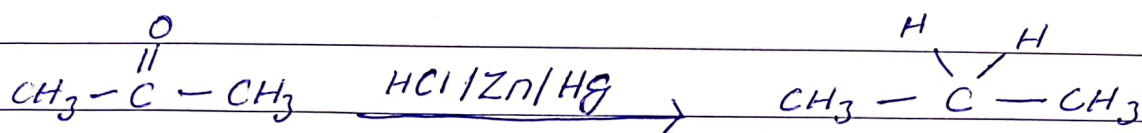


(3) Reduction of Acid Amide:



Organic Chemistry:

Clemmenson's Reduction:

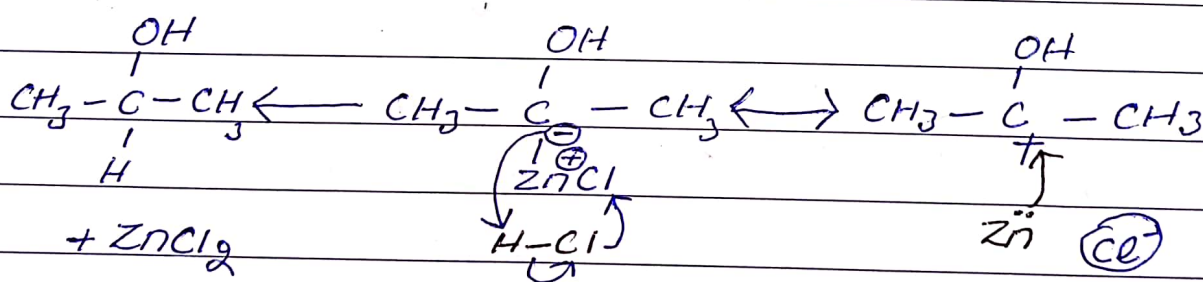
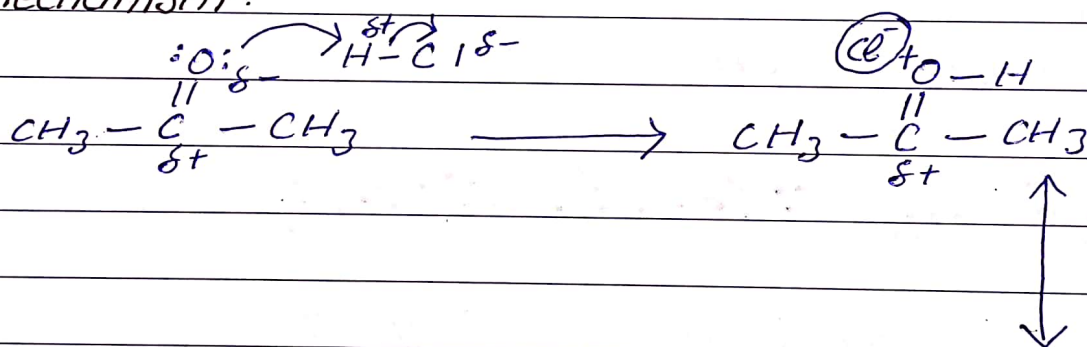


Here metals are used as reagent

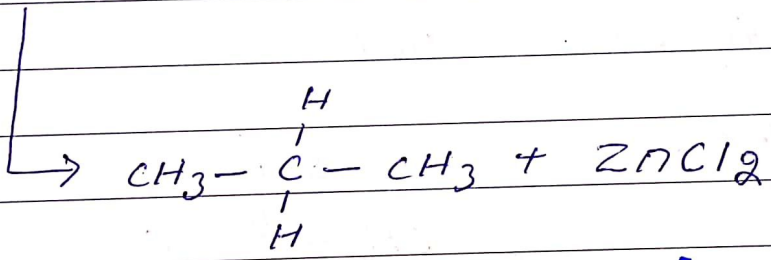
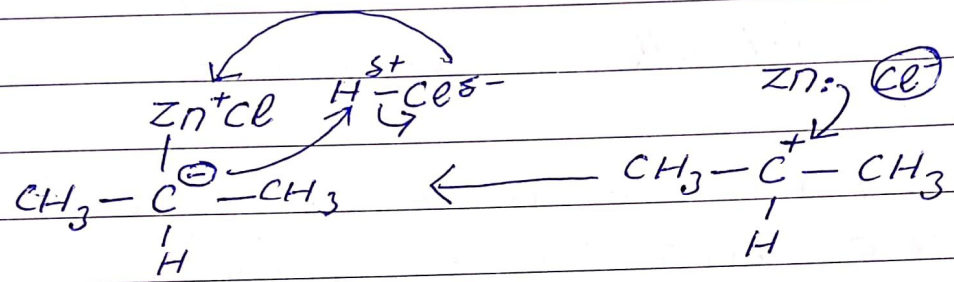
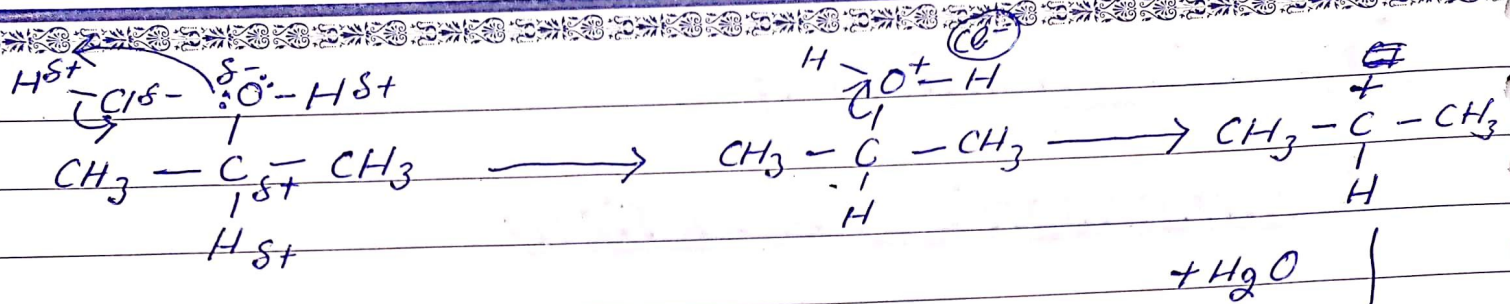
Electron source $\rightarrow \text{Zn} \rightarrow 2e^-$

Proton donor $\rightarrow \text{HCl}$

Mechanism:

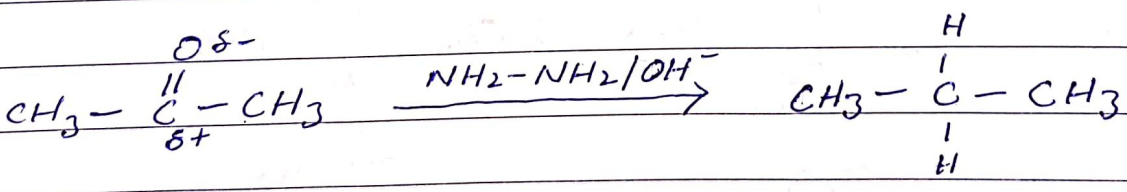


Secondary alcohol can be reduce into alkane by the same mechanism



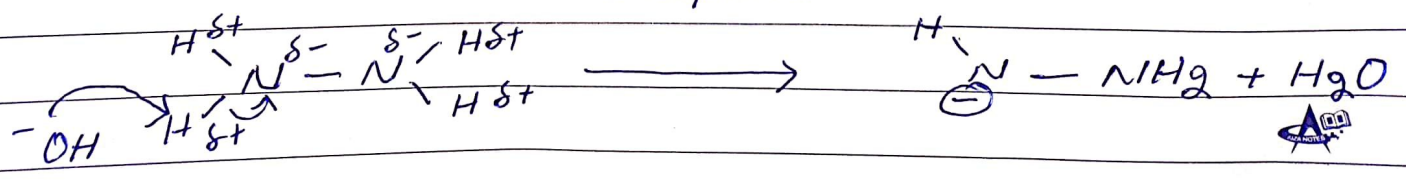
Wolf-Kishner: (Reduction):

↳ Base is used as a catalyst

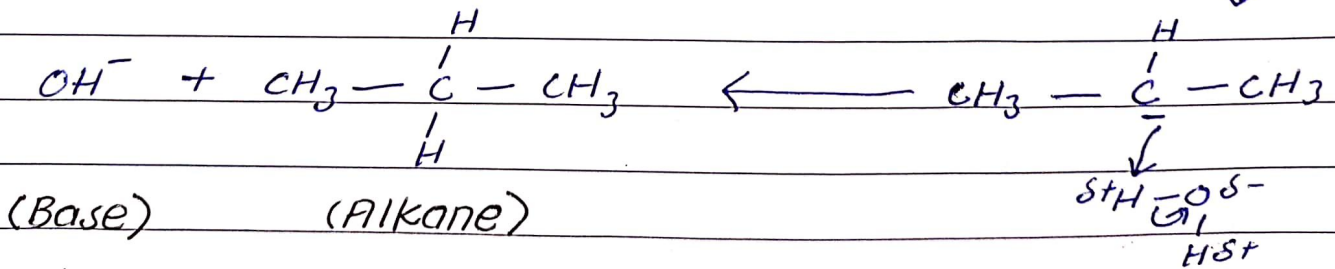
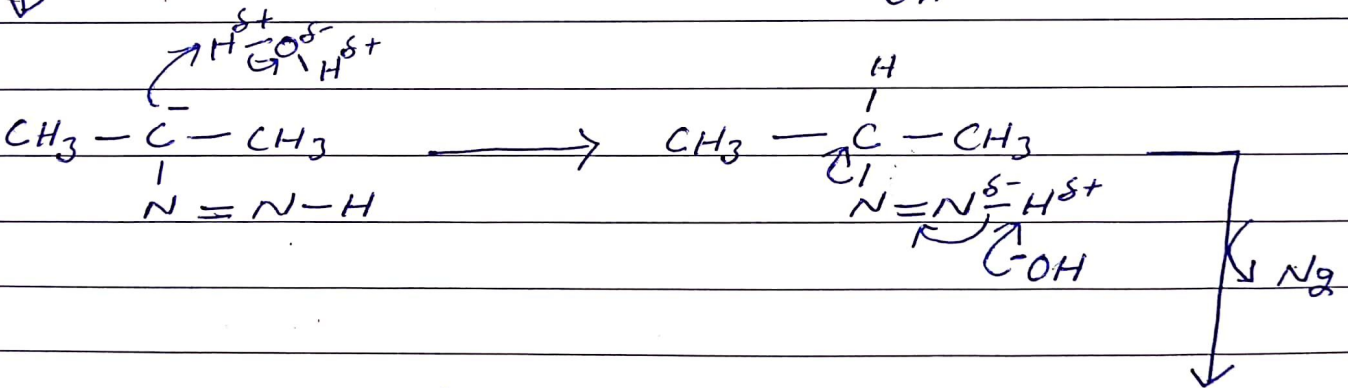
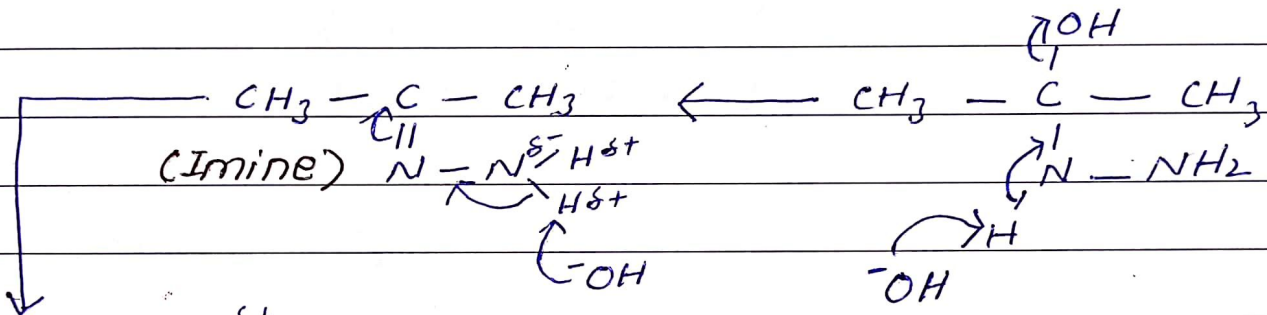
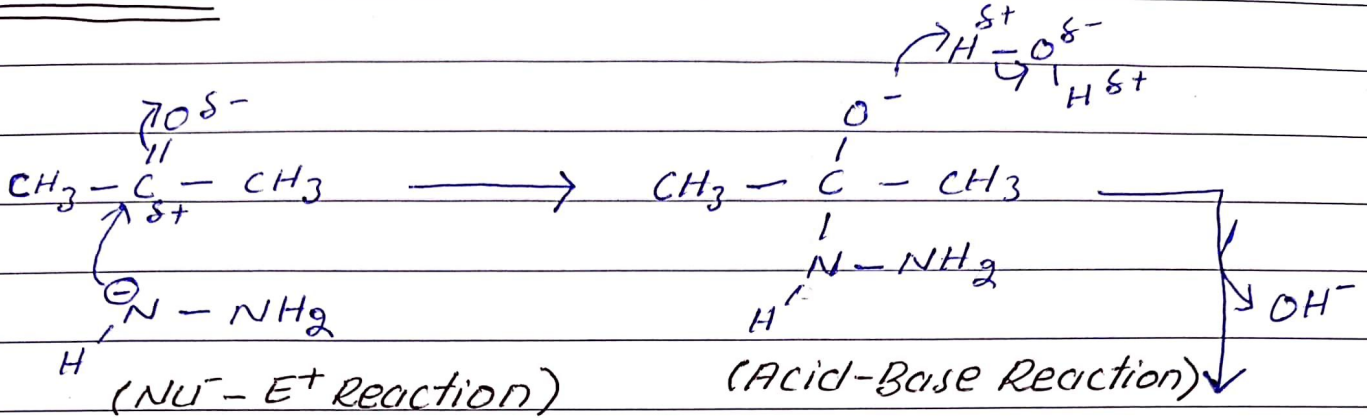


Hydrazine (NH₂-NH₂) → nucleophile

Base activates nucleophile



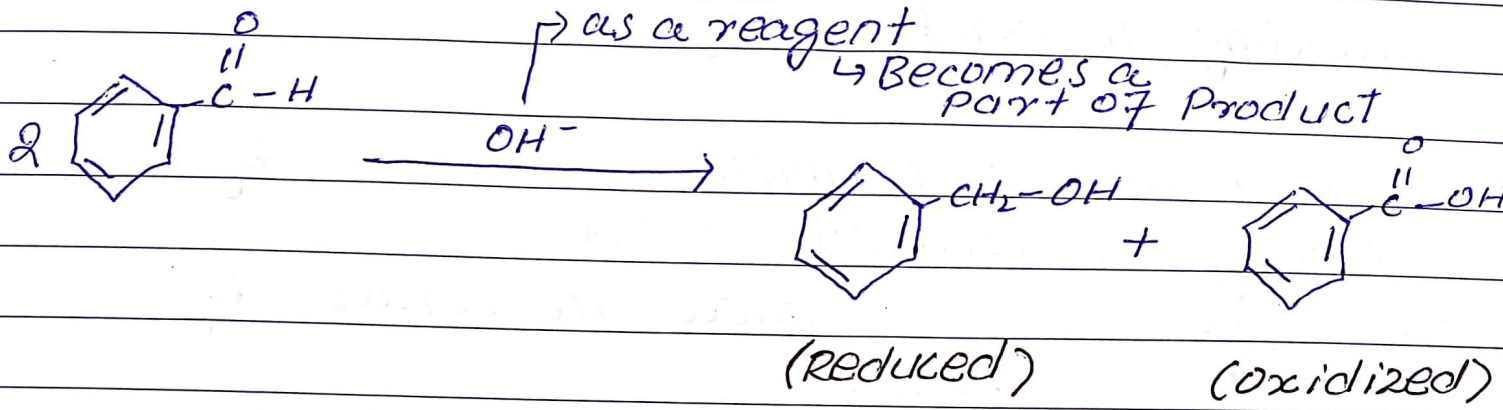
Mechanism:



↳ Regenerated

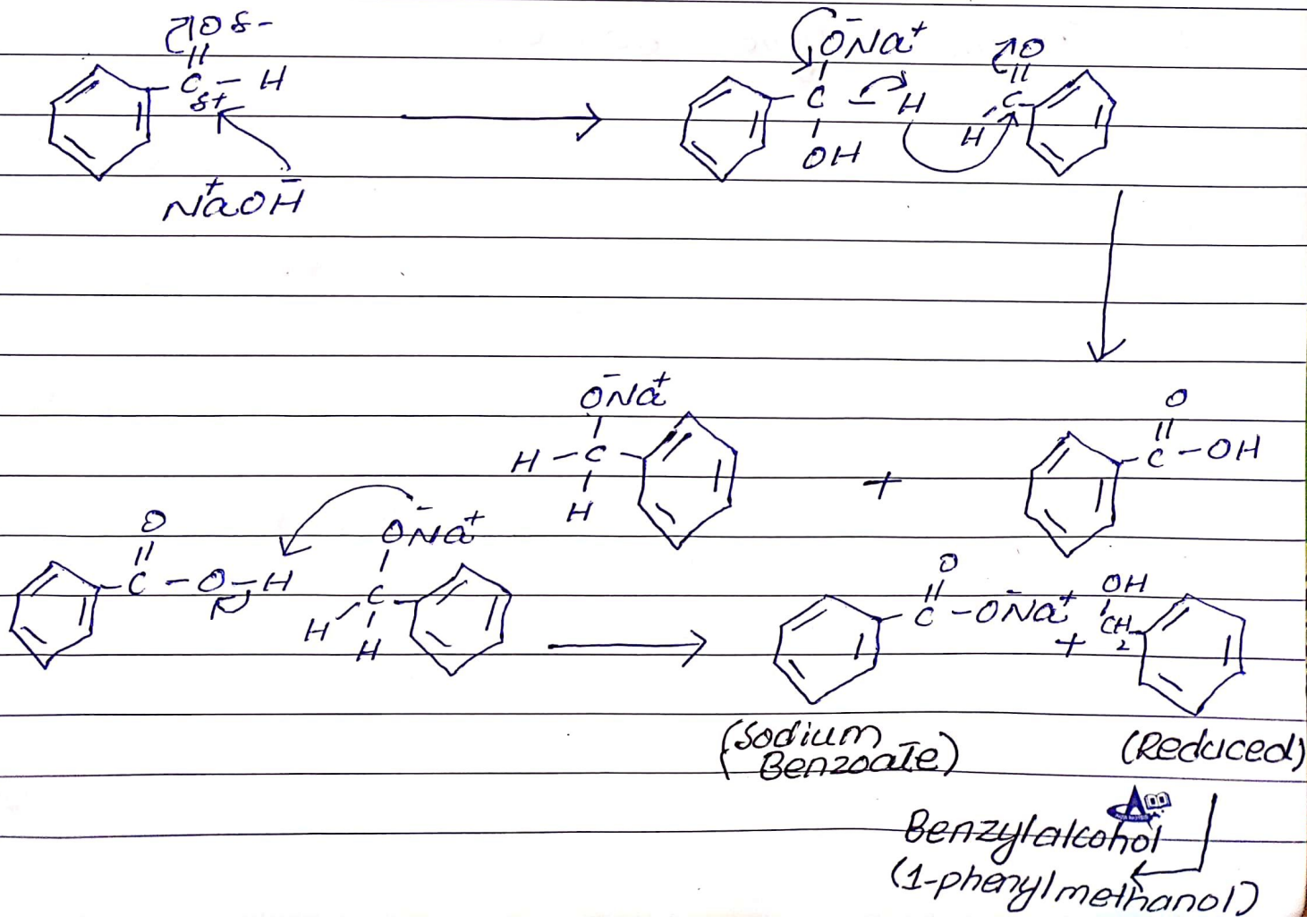


Canizaro's Reaction:

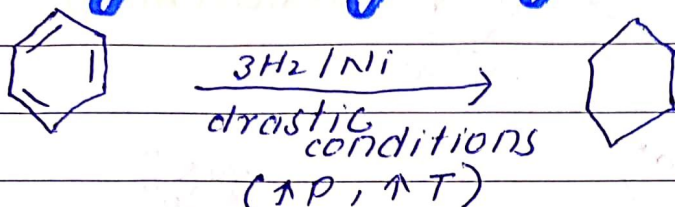


\rightarrow 2 molecules of aldehyde are used (having no α -Hydrogen), one molecule is oxidized other will reduce.

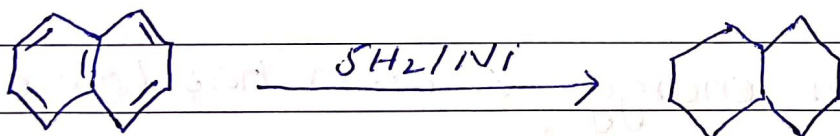
Mechanism:



First Mechanism: Catalytic Hydrogenation:

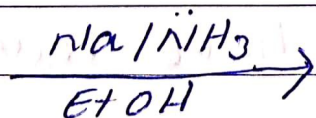


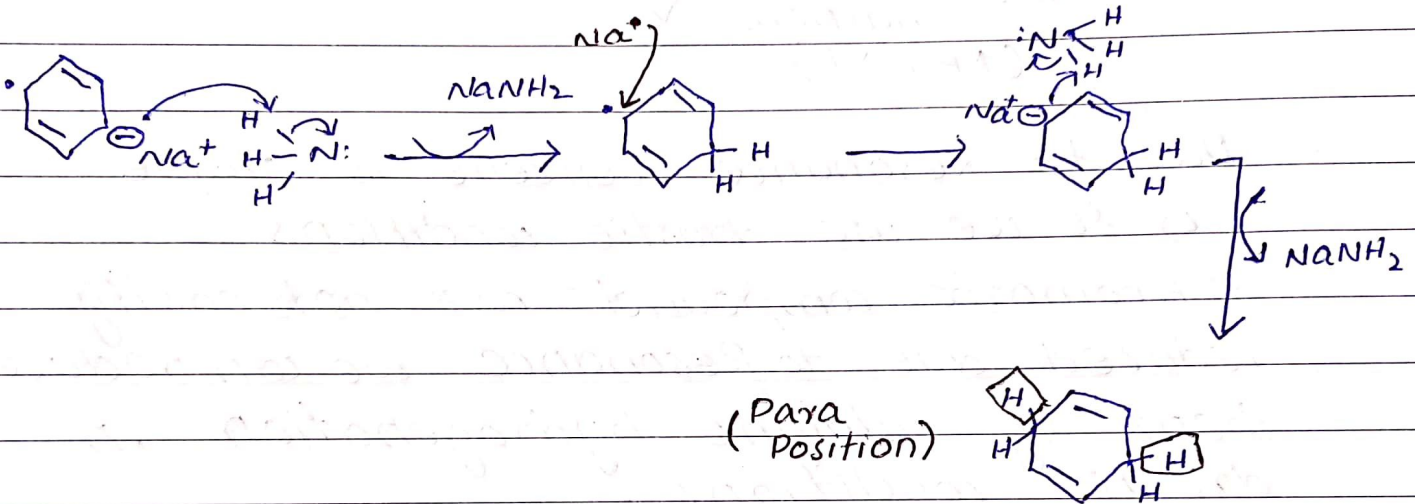
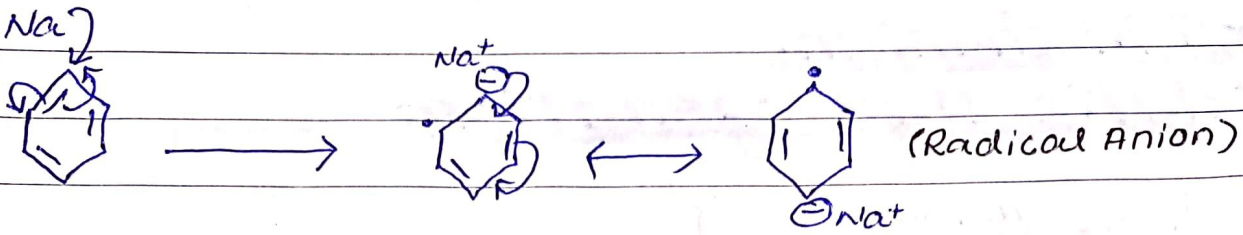
Due to Resonance Benzene is stable
↳ So we use drastic conditions
↳ Aromatic compound are not easily reduced due to Resonance we can reduce them by catalytic hydrogenation in drastic conditions.



Second Mechanism:

- ↳ (Metal as a source of electron)
- ↳ (NH_3 & EtOH as a source of H^+)





Feasible (Possible) Reaction:

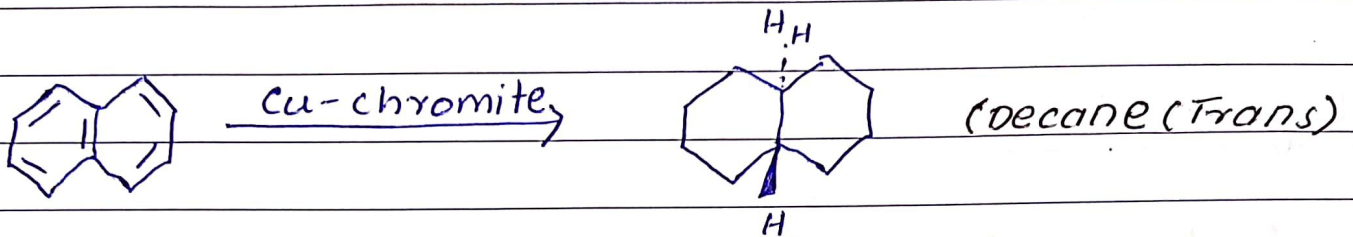
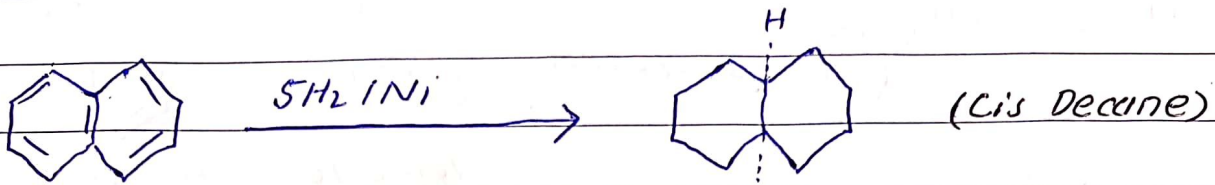
Two Types

- ① \Rightarrow one has high energy & other has low energy
- ② \Rightarrow Both have intermediate energy

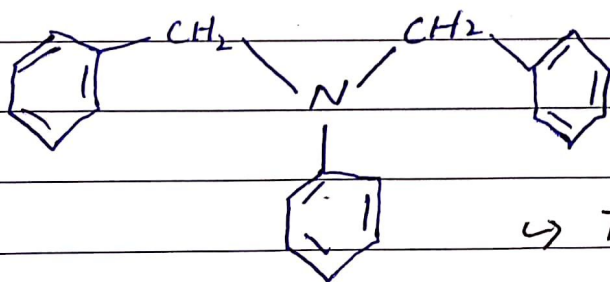
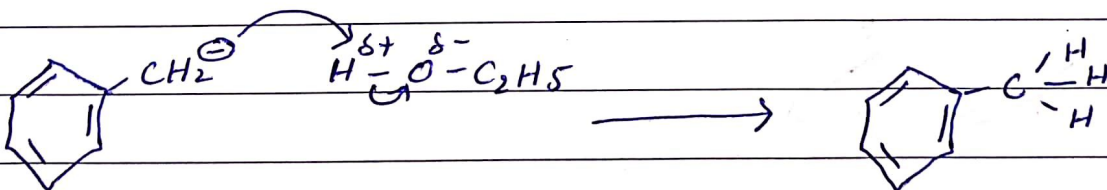
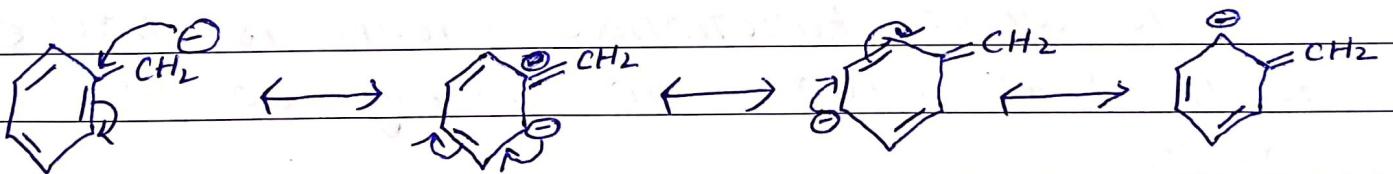
Not Feasible Reaction:

- \hookrightarrow If both reactants are highly reactive or highly unstable
- \hookrightarrow If both reactants have low energy.



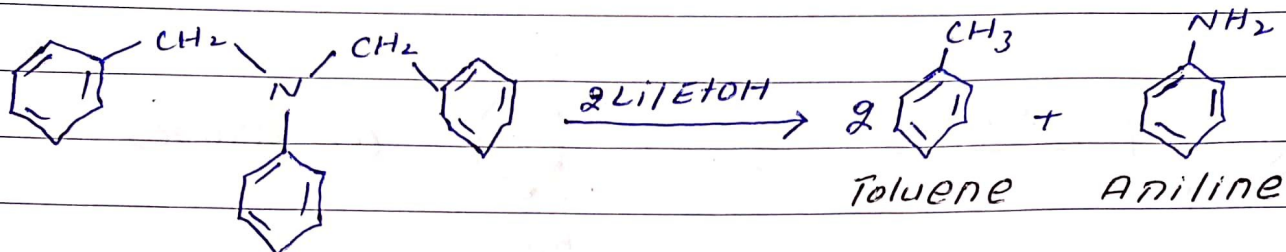


Benzylic group:



↳ There are two Benzylic groups





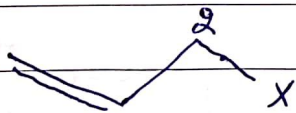
Vinylic Position:

↳ To which Functional group is attached with doubly bonded atom

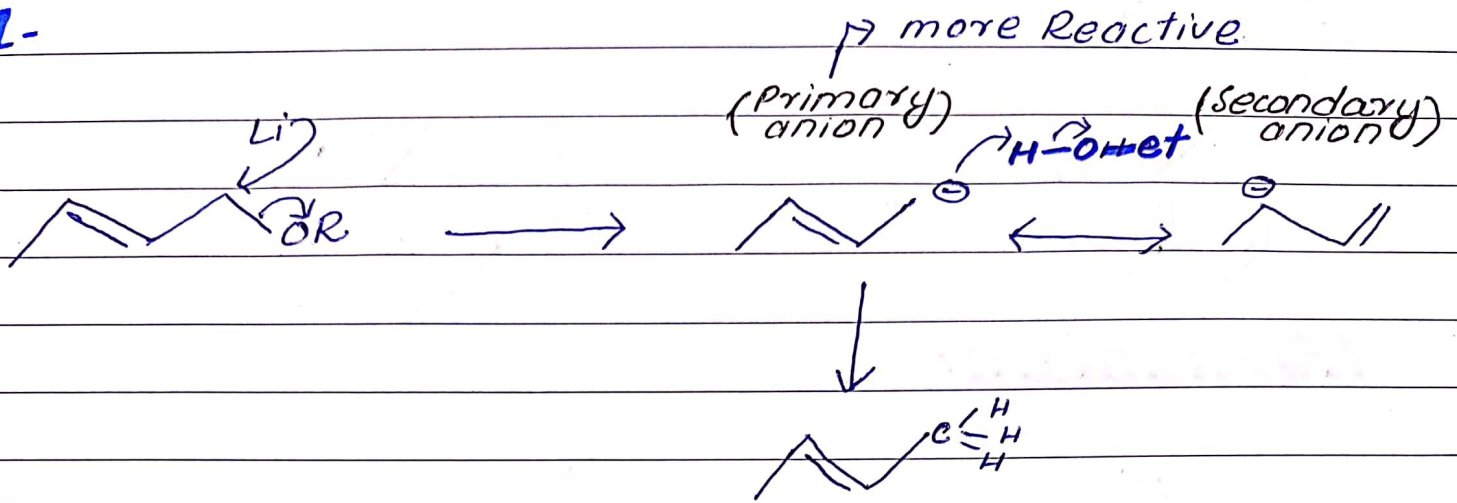


Allylic Position:

↳ To which Functional group is attached with 2nd carbon to doubly bonded atom

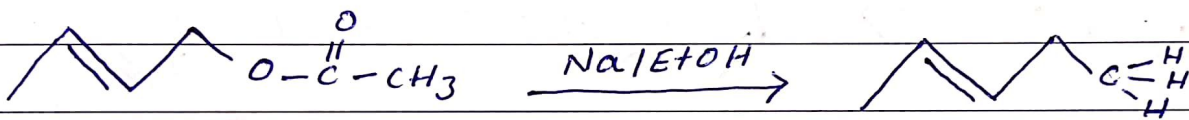


1-

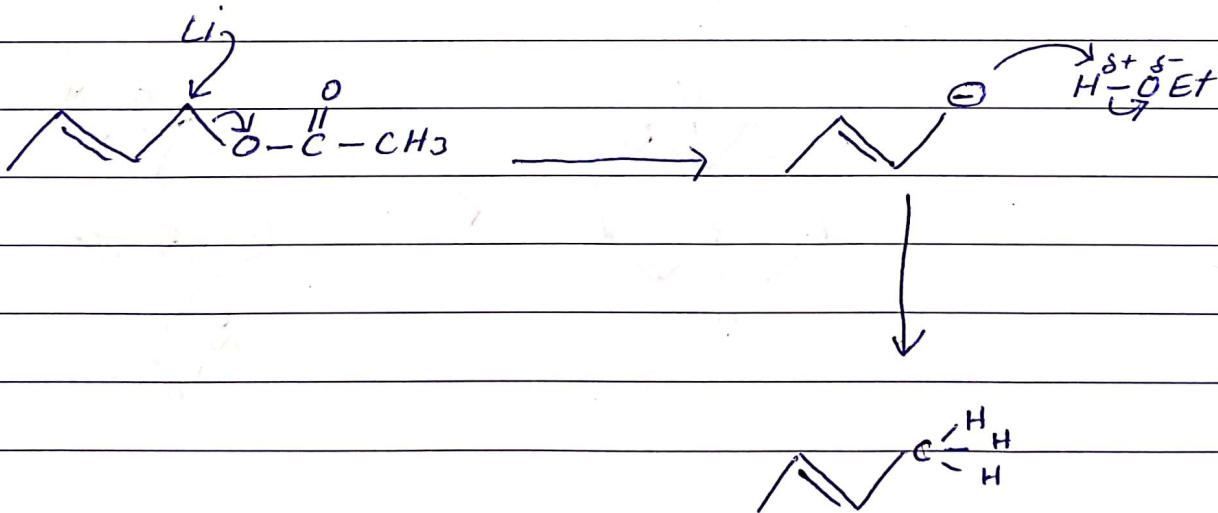


2-

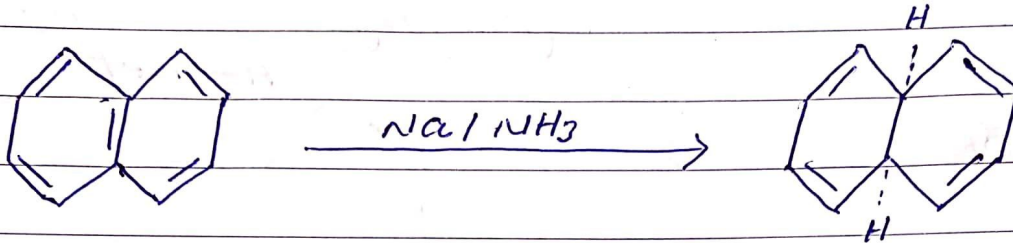
Reaction:



Mechanism:



Equation:



Mechanism:

