⊛ Preparation of Alcohols :-

(3) Reduction of ~~aldeh~~ aldehydes, ketones, carboxylic acid and esters

(a) Reduction of aldehydes and ketones to alcohols

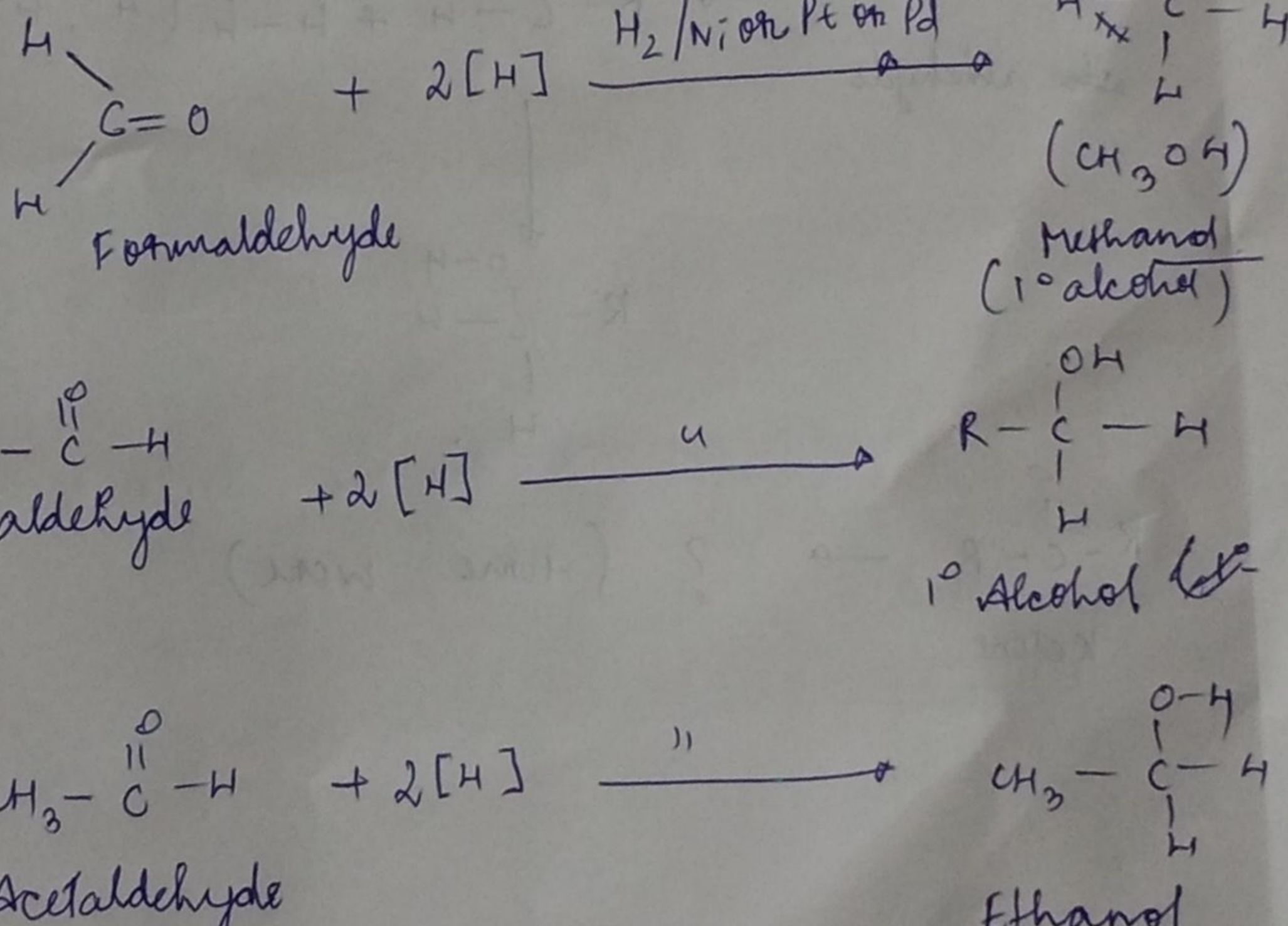
Aldehydes can be reduced to 1° alcohols and ketones to 2° - alcohol

we can not prepare 3° alcohol

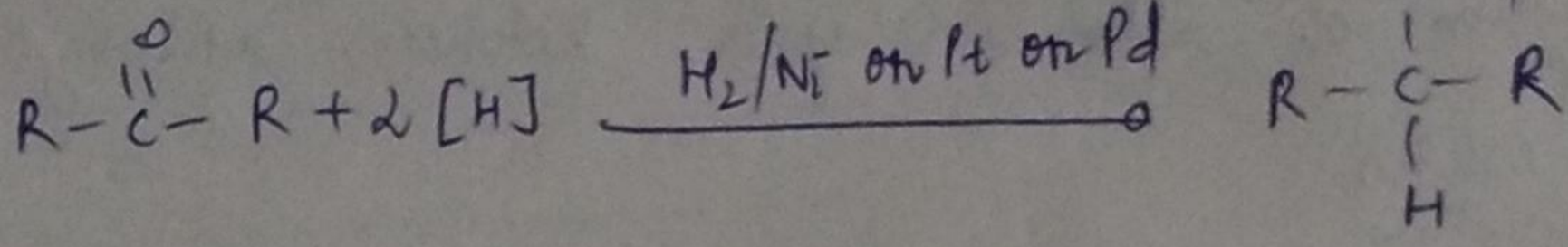
⊛ The various reducing agents are —

(i) H_2 in presence of Ni, Pd or Pt

This is a catalytic hydrogenation reaction using Raney Nickel as the catalyst

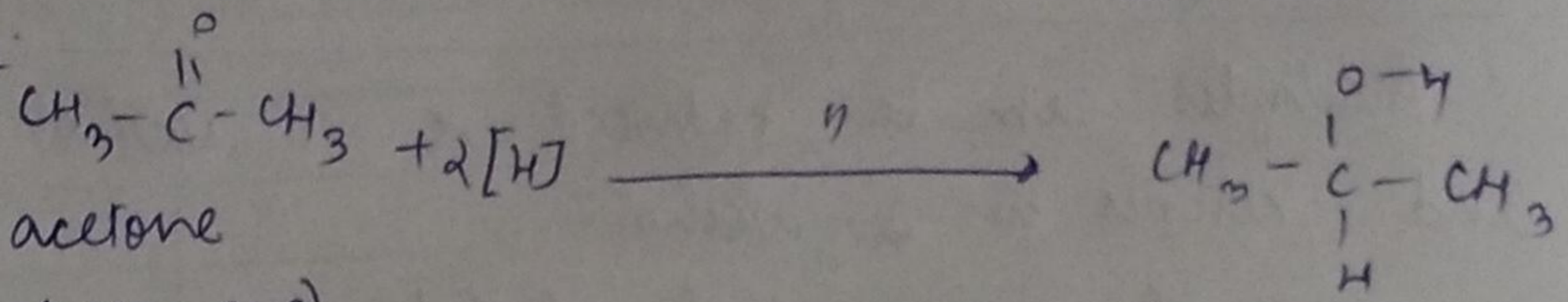


From Ketone :-



2°-alcohol

e.g.

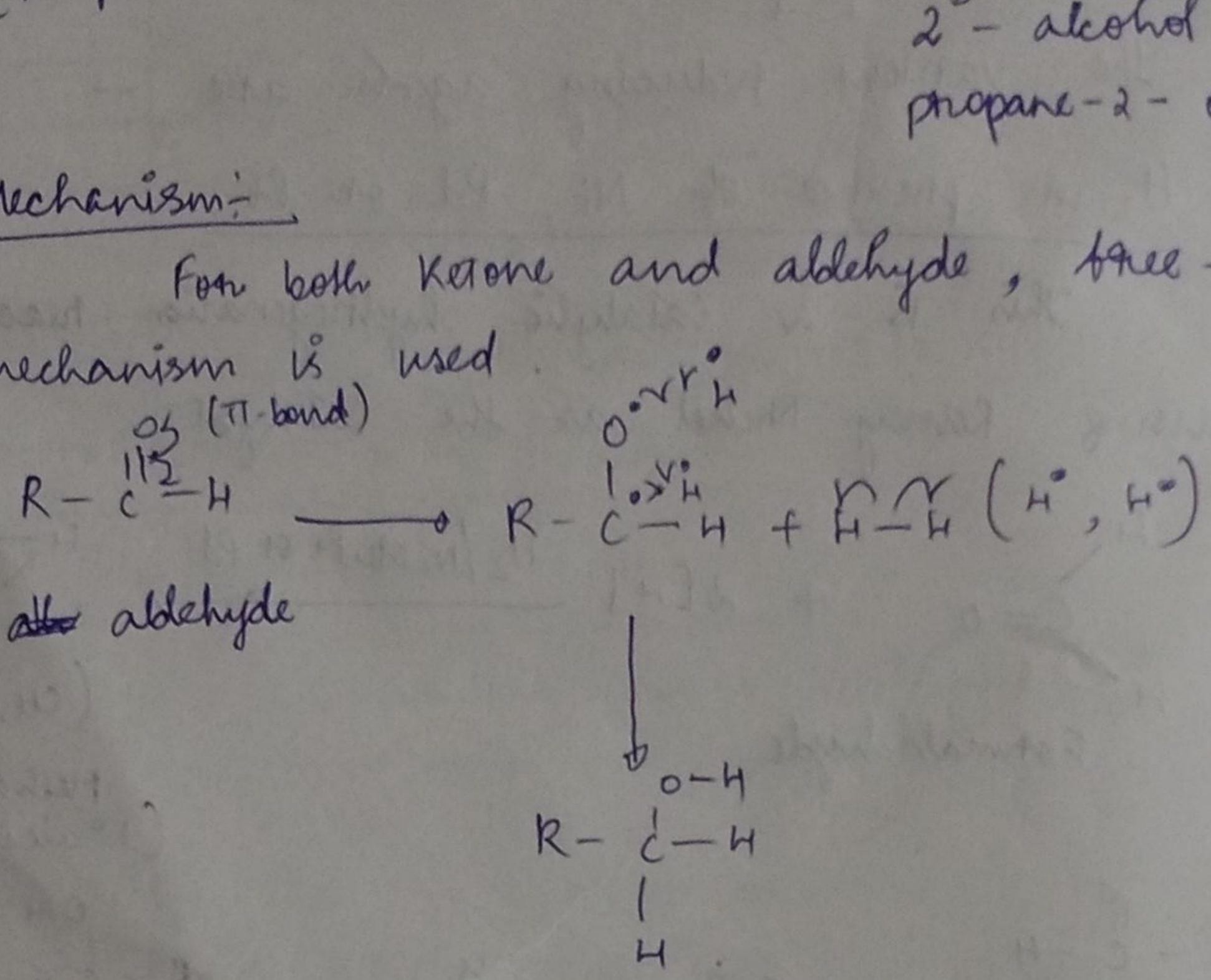


acetone
(propanone)

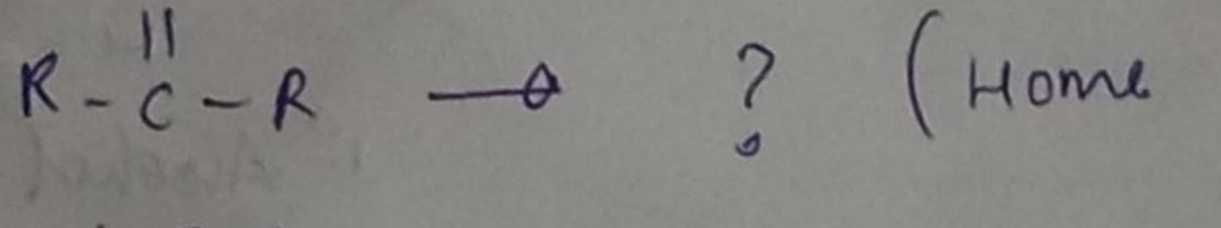
2°- alcohol
propane-2-ol.

Mechanism :-

For both Ketone and aldehyde, free-radical mechanism is used.



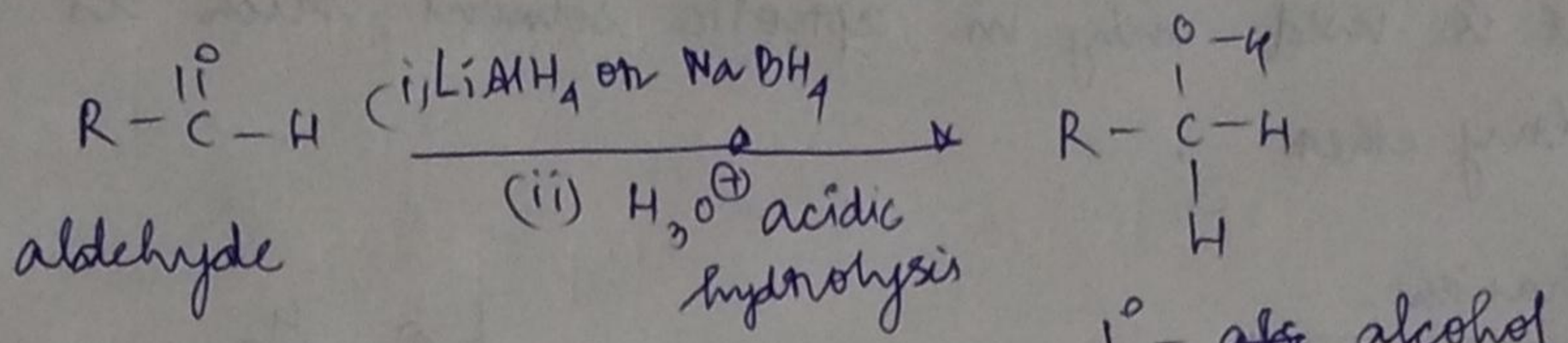
aldehyde

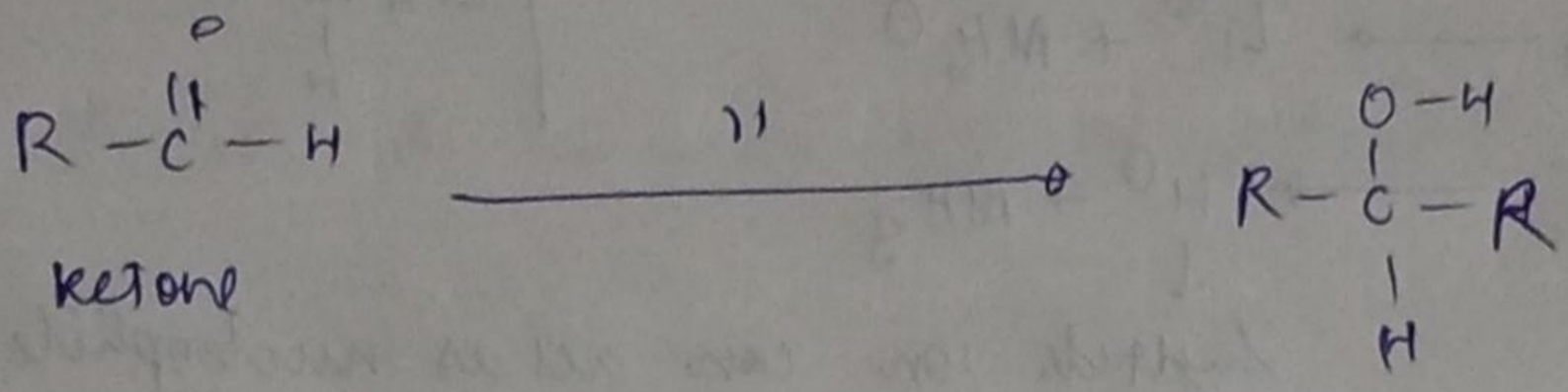


Ketone

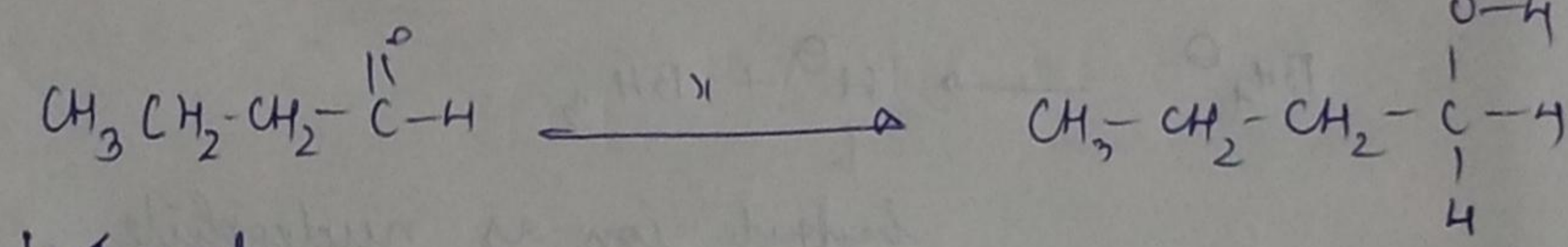
(ii) Reduction by using metal complex hydrides :-

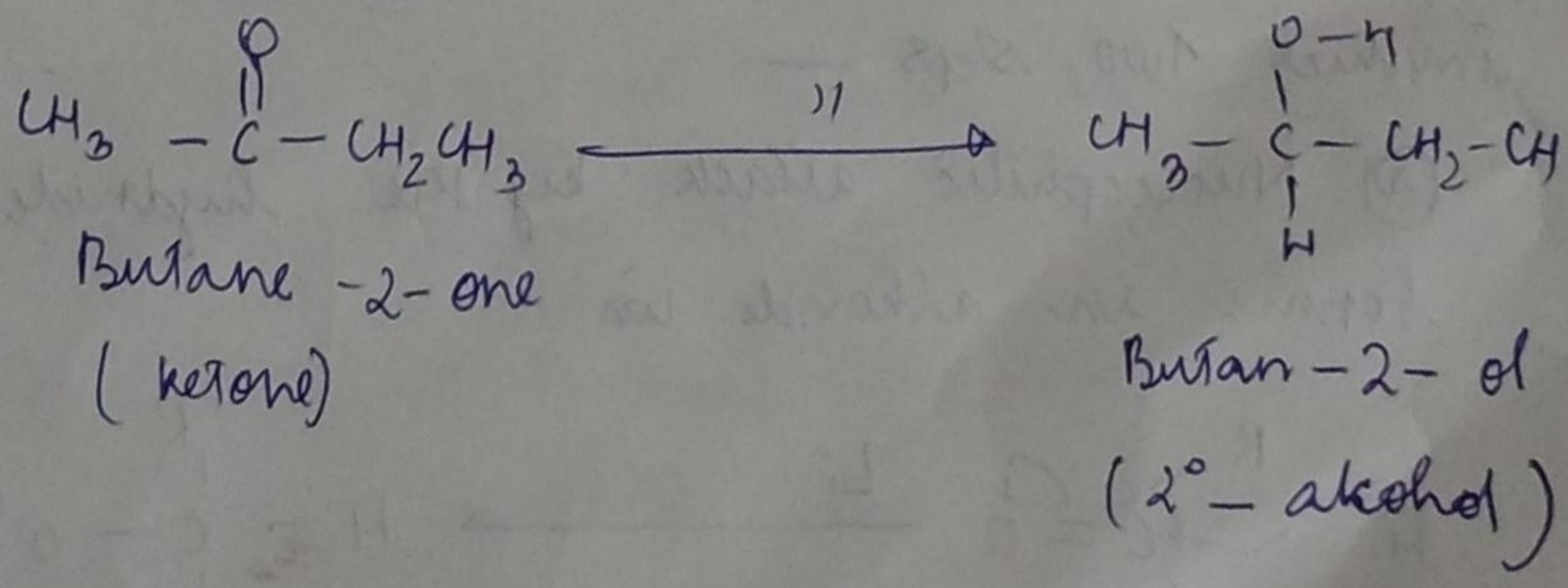
The reduction of aldehydes and ketones to prepare alcohols is usually carried out complex metal hydrides such as Lithium aluminium hydride ($LiAlH_4$) and sodium borohydride ($NaBH_4$)





e.g.





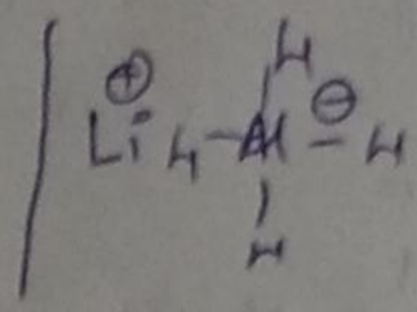
⊛ About the reducing agents :-

⊛ $NaBH_4$ is easier to handle and can be used either in water or alcohol solution ~~The reduction product initially formed gets~~

♡ $LiAlH_4$ reacts violently with water and alcohol It is used only in aprotic solvent such as dry ether .

Mechanism :-

$$LiAlH_4 \longrightarrow Li^{\oplus} + AlH_4^{\ominus}$$



$$AlH_4^{\ominus} \longrightarrow \underset{\text{hydride ion}}{H^{\ominus}} + AlH_3$$

hydride ion can act as nucleophile .

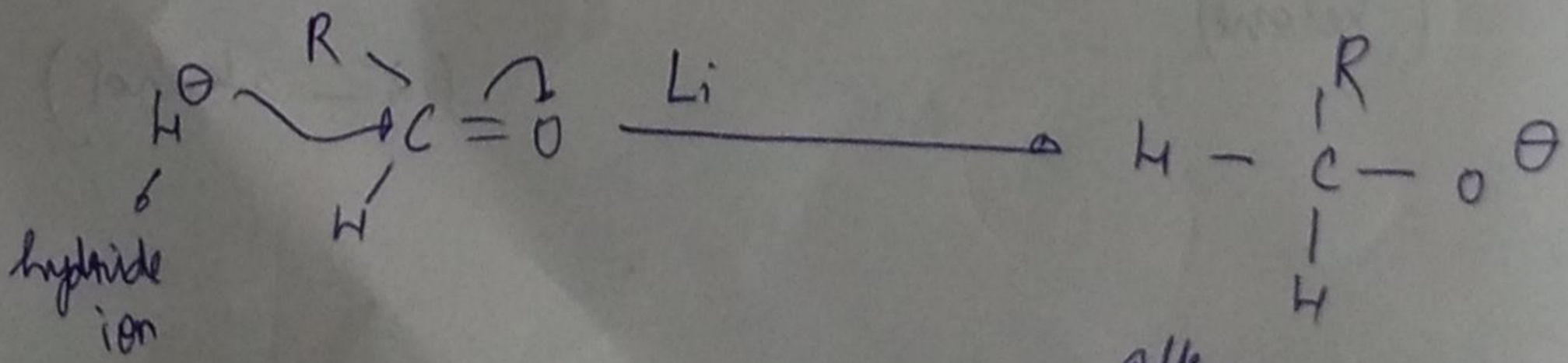
$$NaBH_4 \longrightarrow Na^{\oplus} + BH_4^{\ominus}$$

$$BH_4^{\ominus} \longrightarrow \underset{\text{hydride ion}}{H^{\ominus}} + BH_3$$

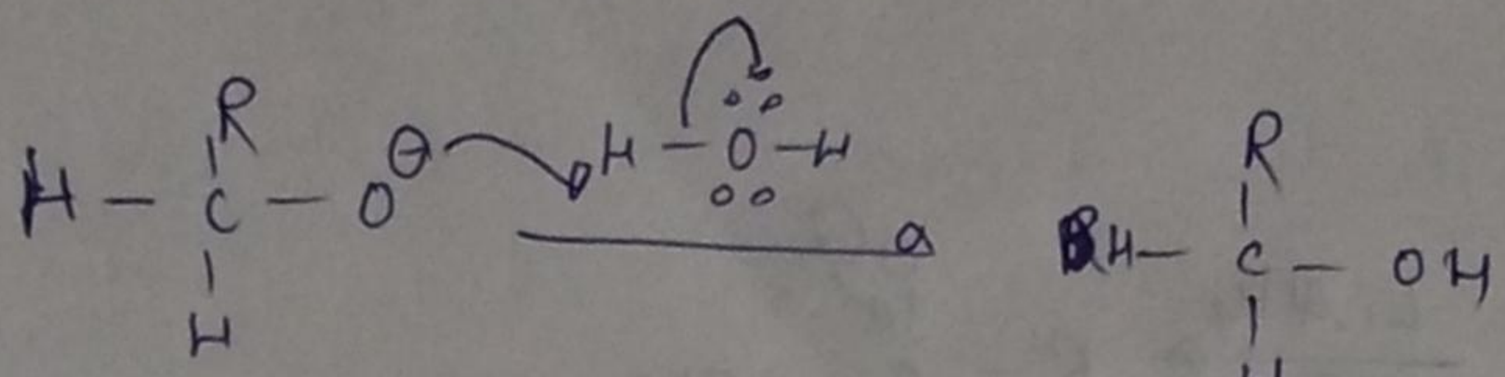
hydride ion as nucleophile .

The mechanism for both aldehyde and ketone involves two steps —

(a) Nucleophilic attack by the hydride ion forms an alkoxide ion

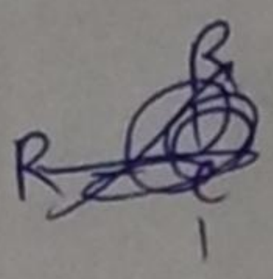


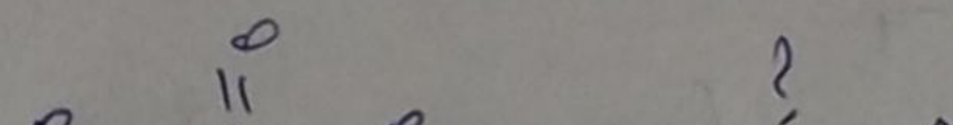
(b) ~~Alkoxide~~ water or dilute acid is added to protonate the alkoxide

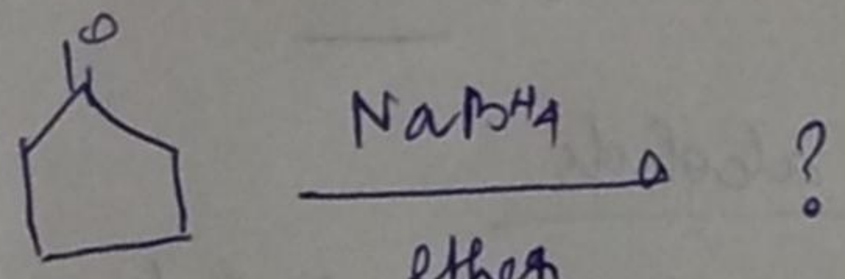


alkoxide

1° alcohol



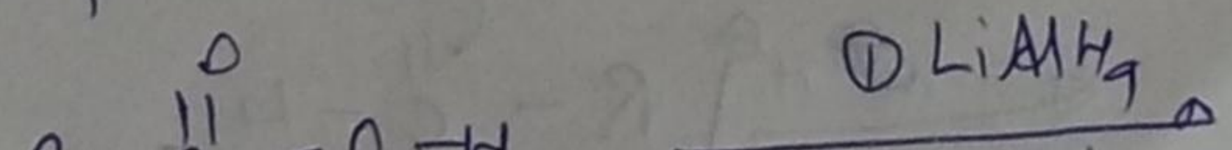




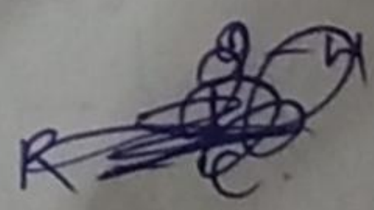
(b) Reduction of carboxylic acid to alcohol

$LiAlH_4$ reduces carboxylic acid to 1°-alcohol the aldehyde is an intermediate in this reduction, but it can not be isolated because it is reduced more easily than the original acid

$NaBH_4$ does not reduced carboxylic acid.

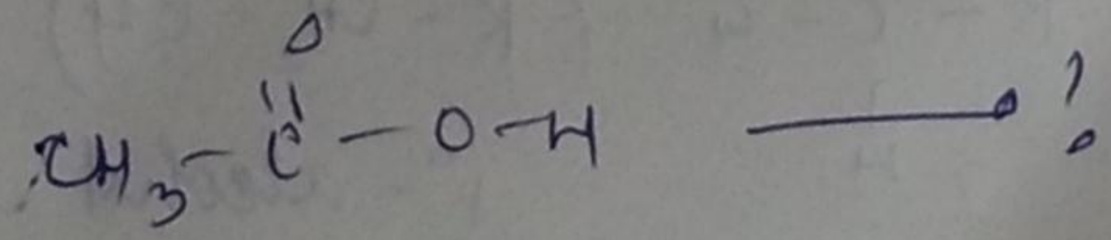


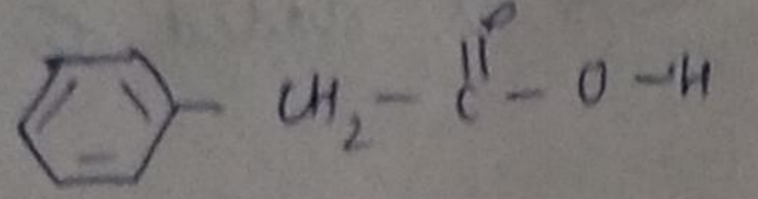
carboxylic acid



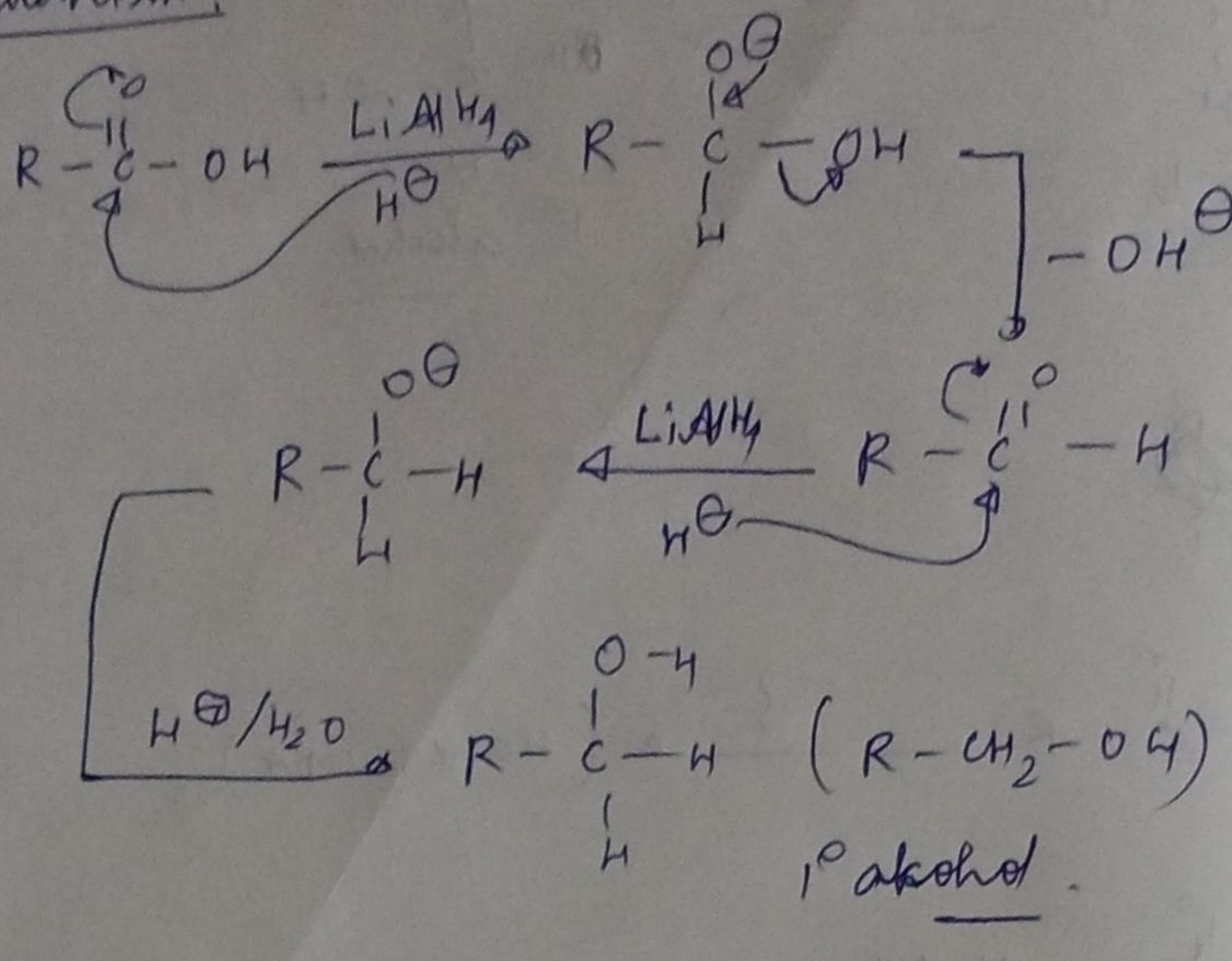
$R-CH_2-OH$

1°-alcohol





Mechanism :-



(c) Reduction of esters to alcohols

$LiAlH_4$ reduces esters to 1°- alcohol