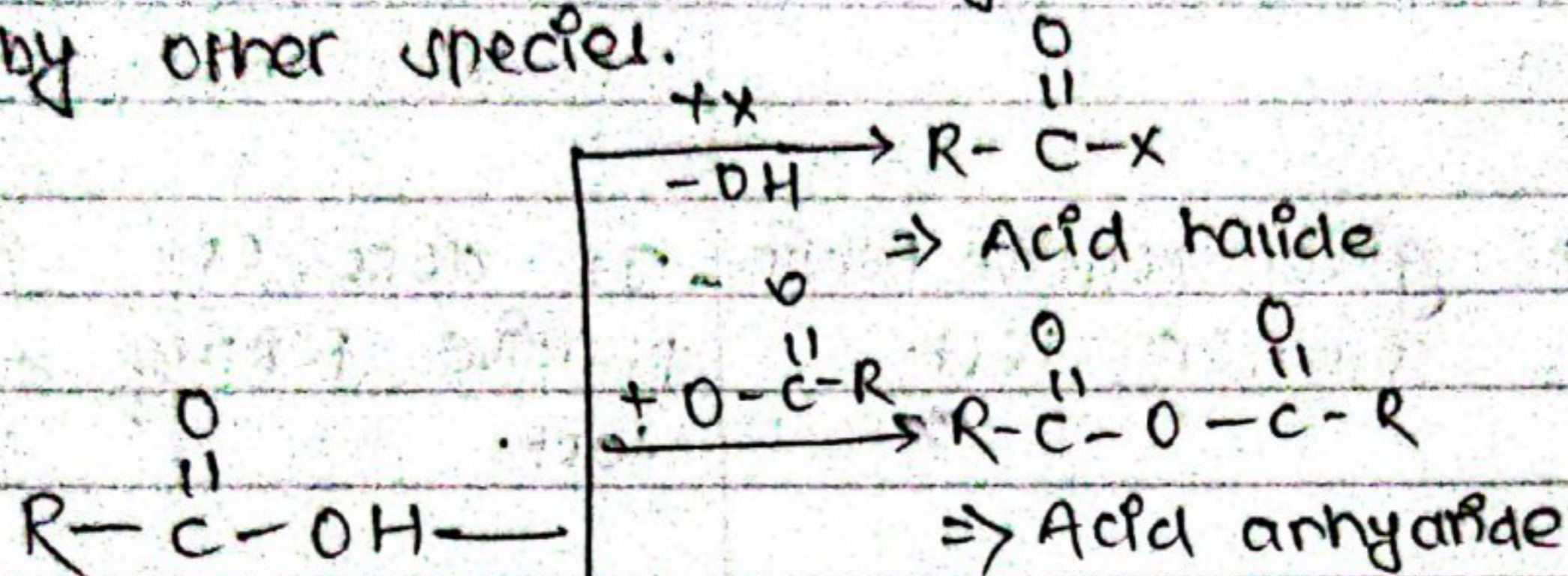
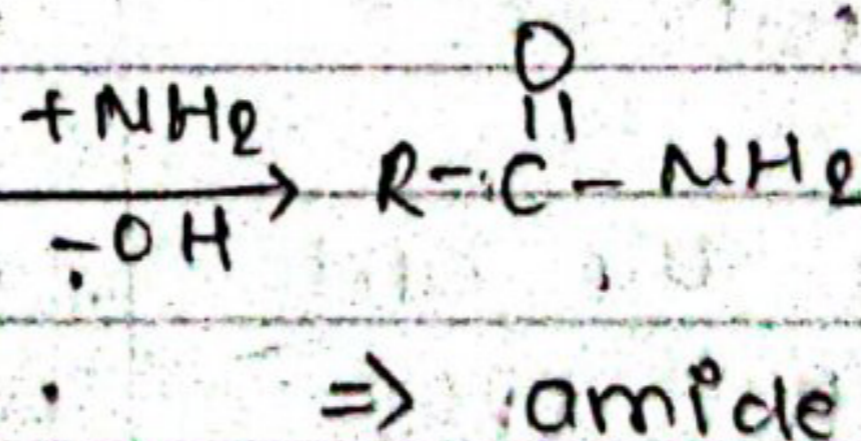
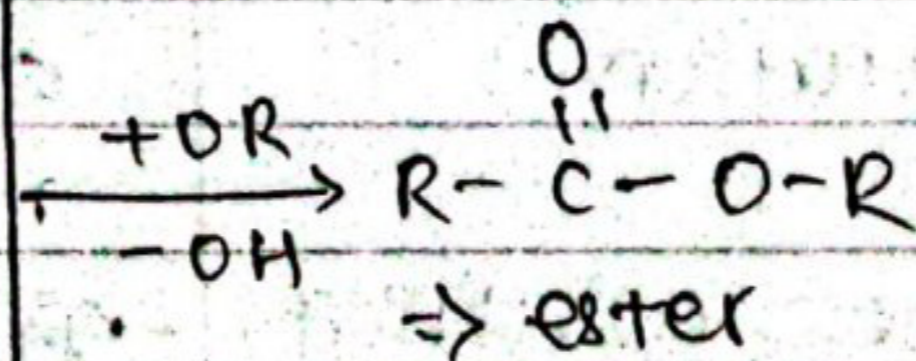


Derivatives of Carboxylic acid :- The compounds obtained from carboxylic acid by the replacement of OH group of COOH part by other species.

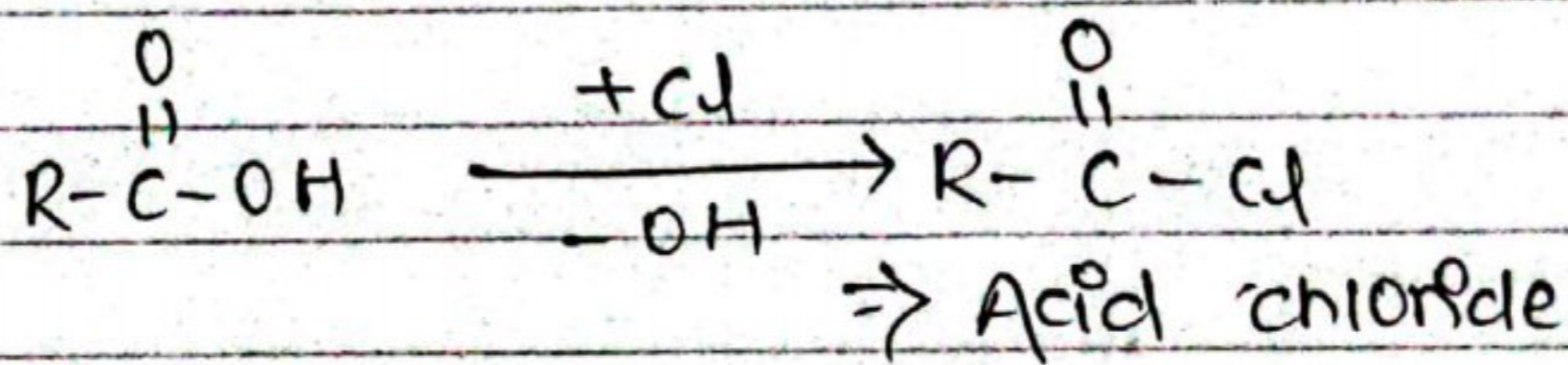


Carboxylic acid



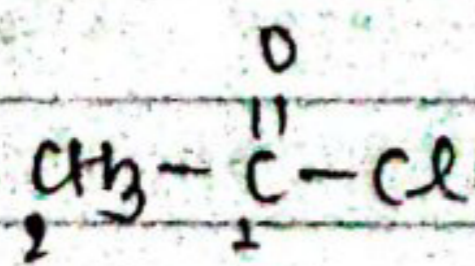
Acid Halide

⇒ Acid halide ($R-\overset{\overset{O}{\parallel}}{C}-X$) :- The compound obtained by replacing OH group of COOH group by halogen [Cl, Br, I].

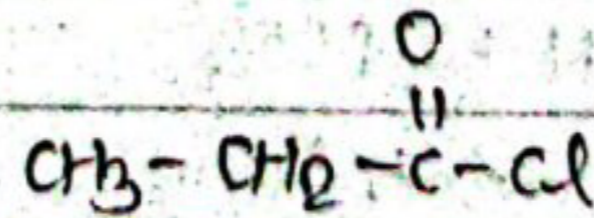


⇒ Nomenclature :-

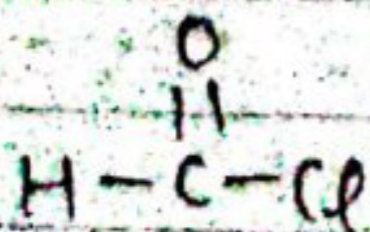
Alk + an + oyl halide
↓ ↓ ↓
w.r p.s s.s



⇒ Ethanoyl chloride



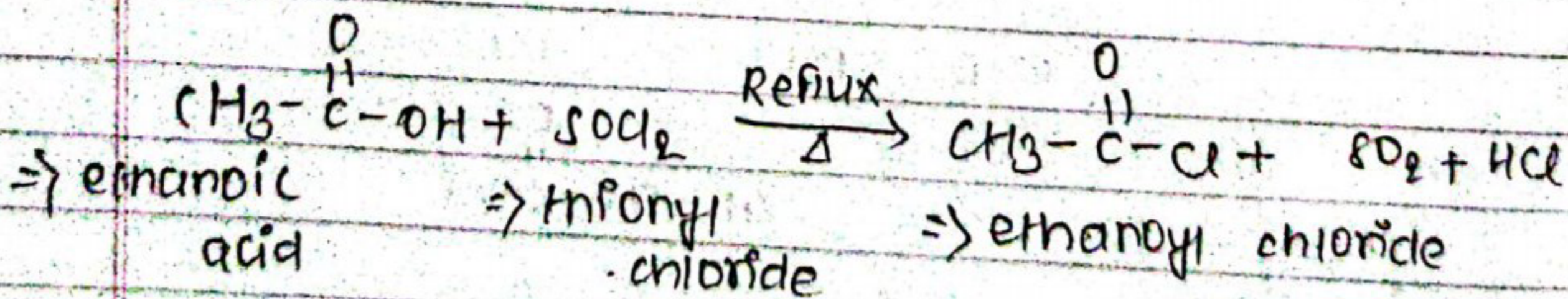
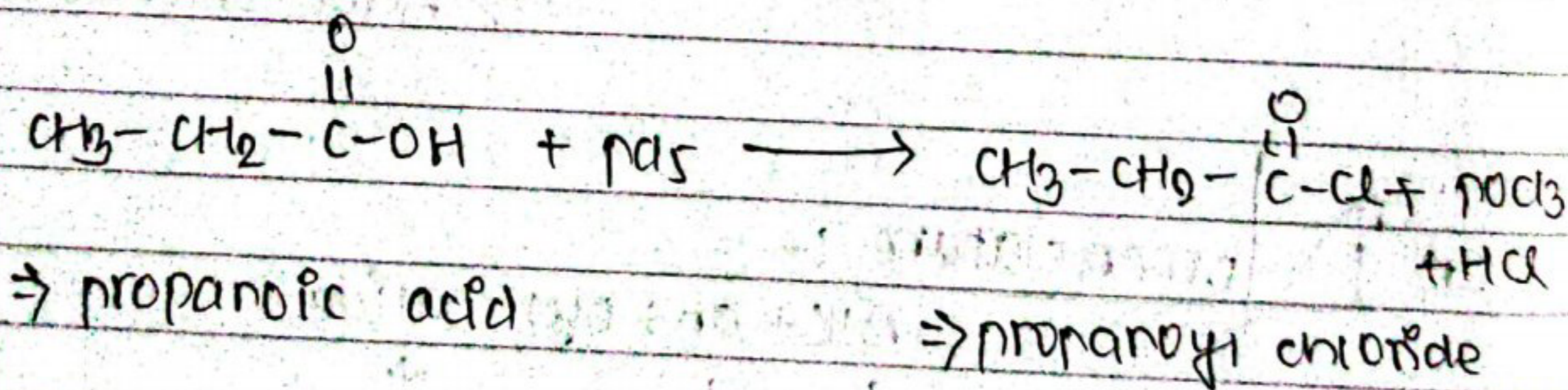
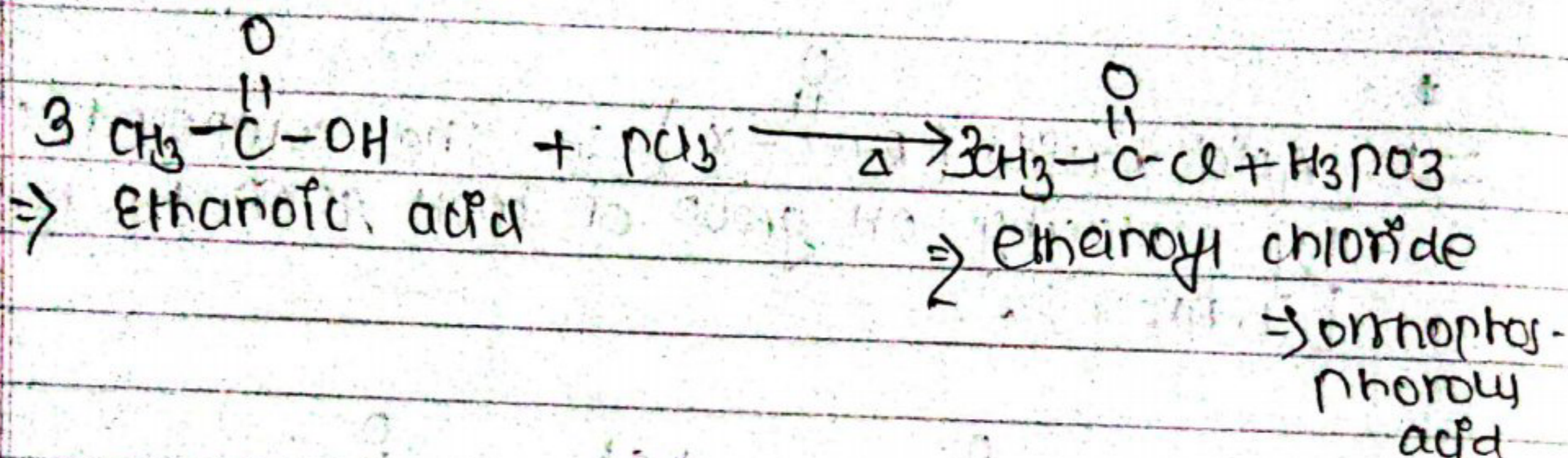
⇒ Propanoyl chloride



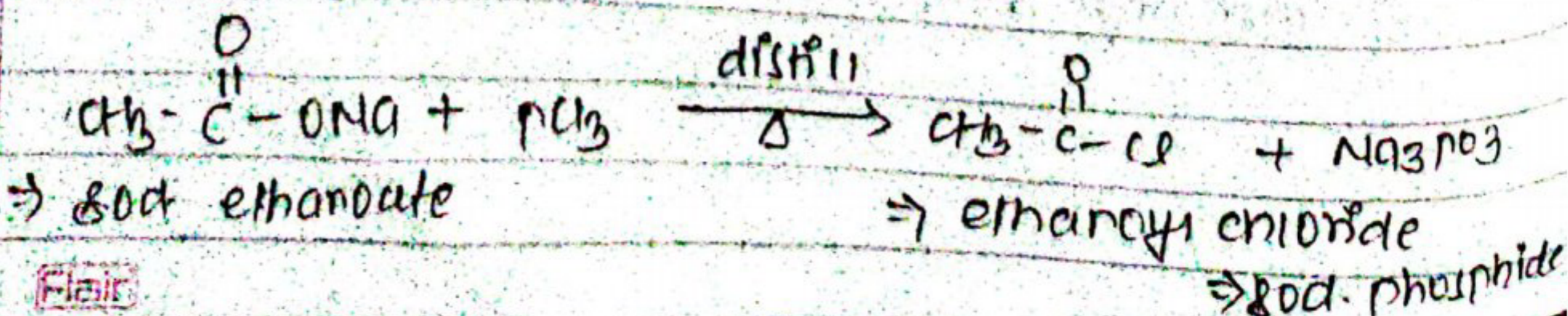
⇒ Methanoyl chloride

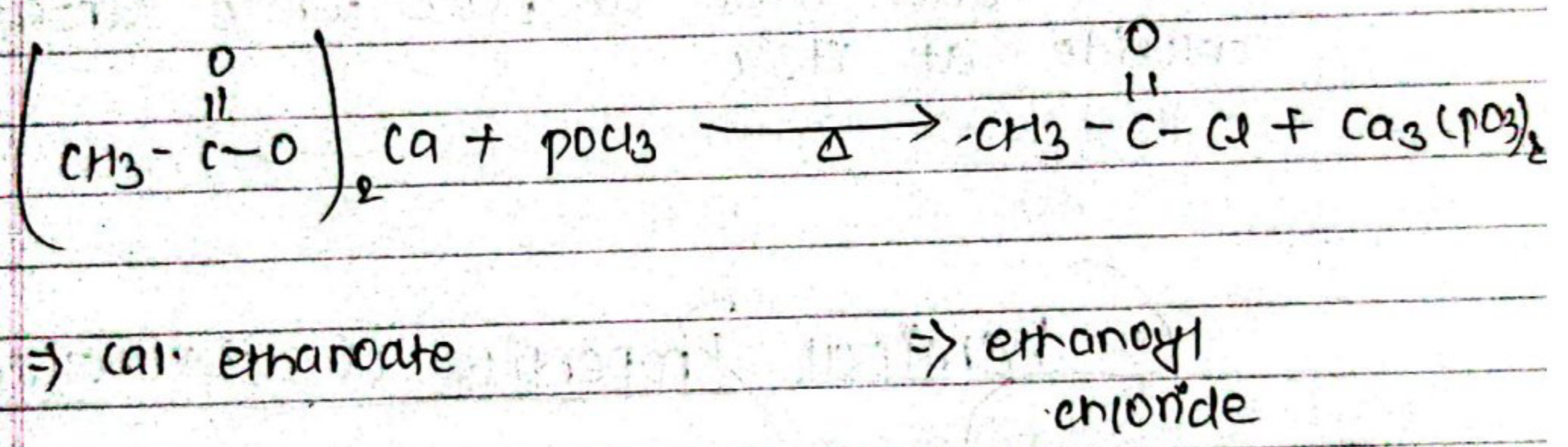
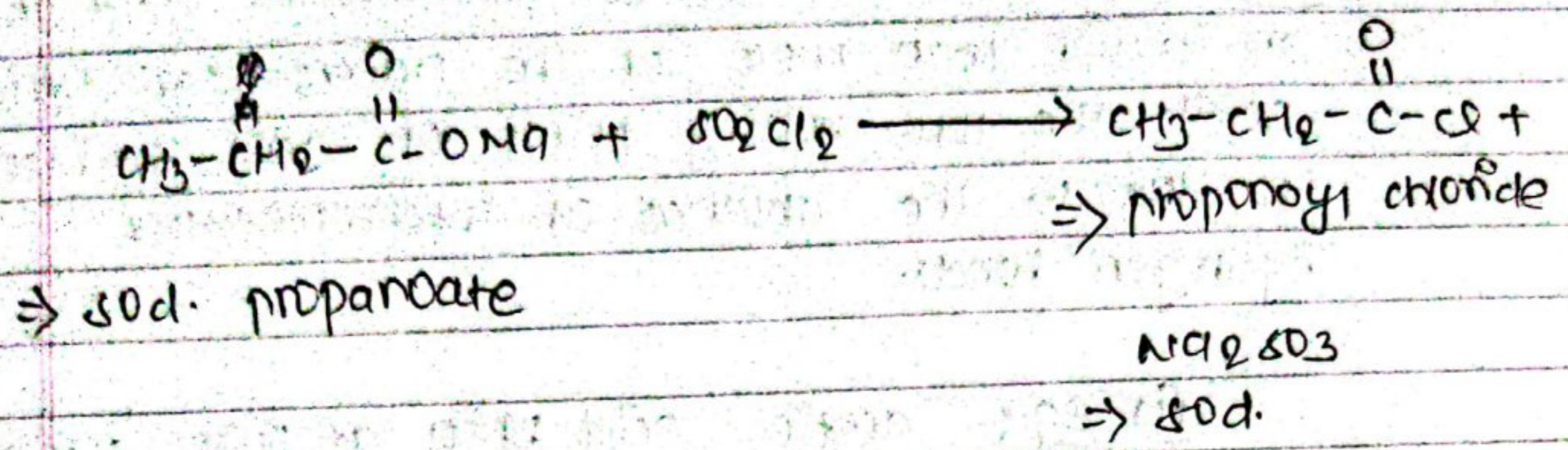
General Method of Preparation

① From carboxylic acid :- when carboxylic acid is treated with PCl_3 or PCl_5 or SOCl_2 acid chloride is formed.



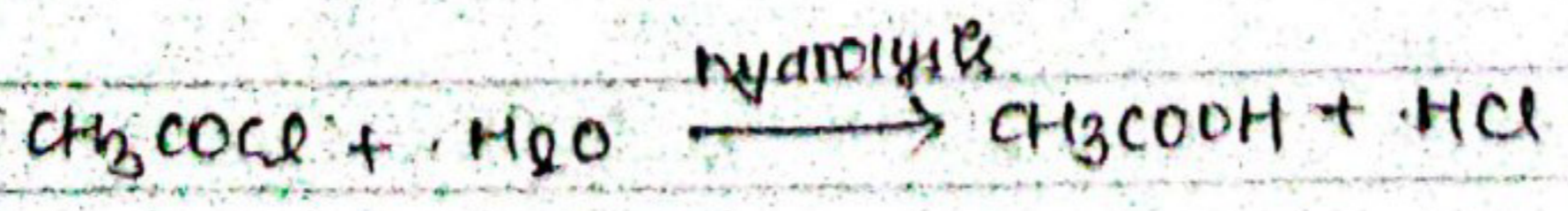
② From salt of carboxylic acid :- when salt of carboxylic acid is treated with PCl_3 or SOCl_2 or POCl_3 acid chloride is formed.





Physical properties of acid halide

① Physical state :- The lower members of the family are colourless liquids whereas the higher members are colourless, low melting solids with pungent and irritating odours. They fume in air due to the formation of HCl acid by hydrolysis.



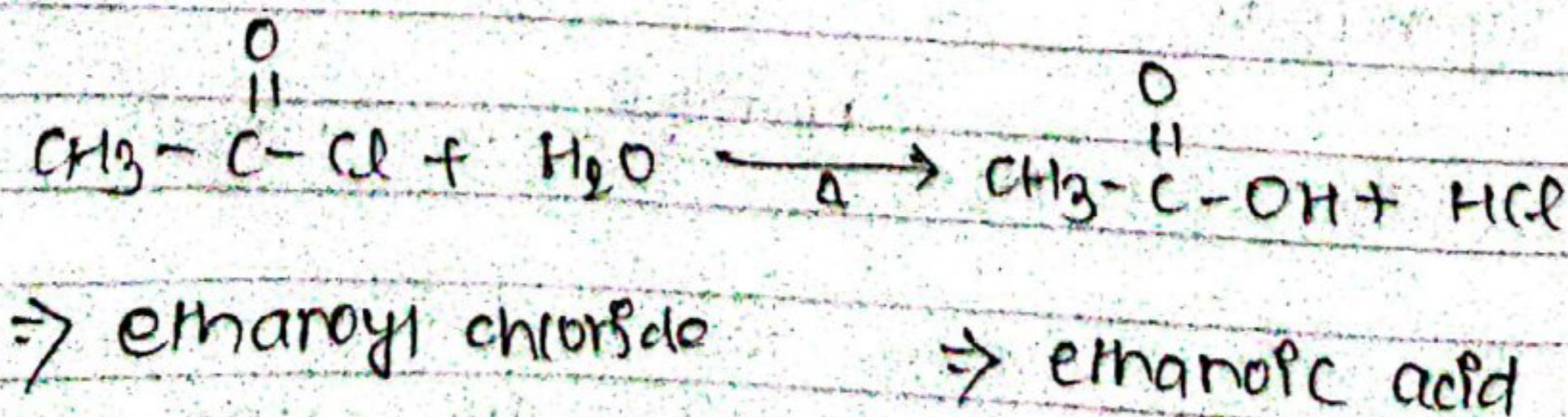
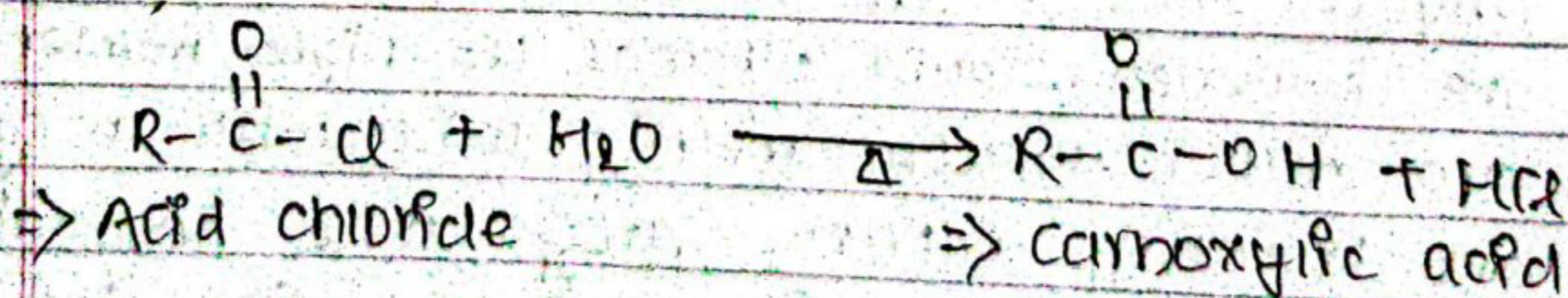
② Solubility :- These are soluble in water due to lack of hydrogen bonding with water molecules. However, they are soluble in common organic solvents such as ether, chloroform etc.

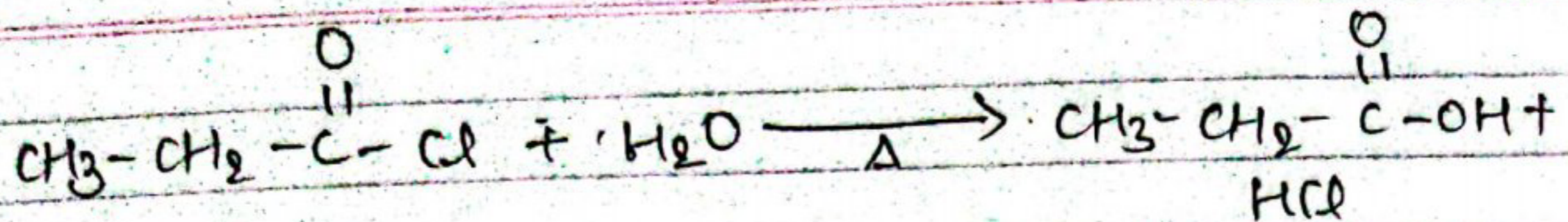
(3) Boiling point :- The boiling points of acid chlorides are lower than those of the parent carboxylic acids. The low boiling points of acid halides is due to the absence of intermolecular hydrogen bonds.

for eg :- acetic acid boils at 118°C while acetyl chloride boils at 53°C . Similarly benzoic acid boils at 250°C while benzoyl chloride at 173°C .

Chemical Properties of acid halide

(1) Hydrolysis (Reaction with water) :- Acid halide reacts with water to form carboxylic acid and mineral acid.

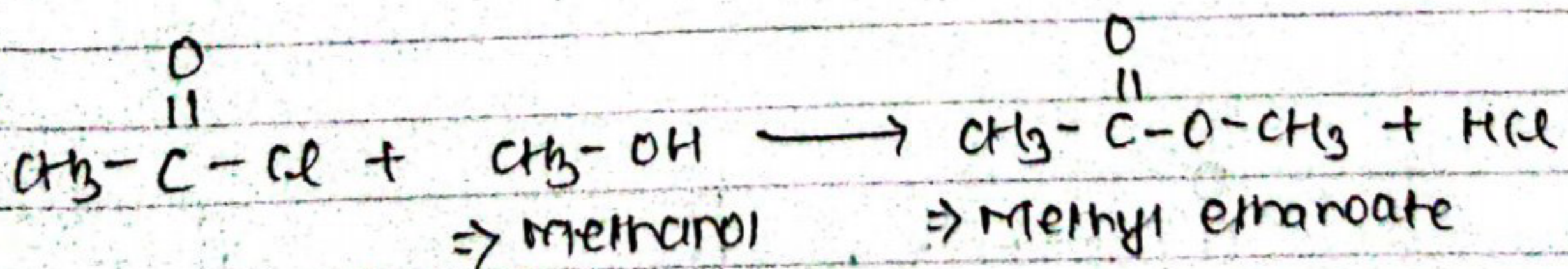
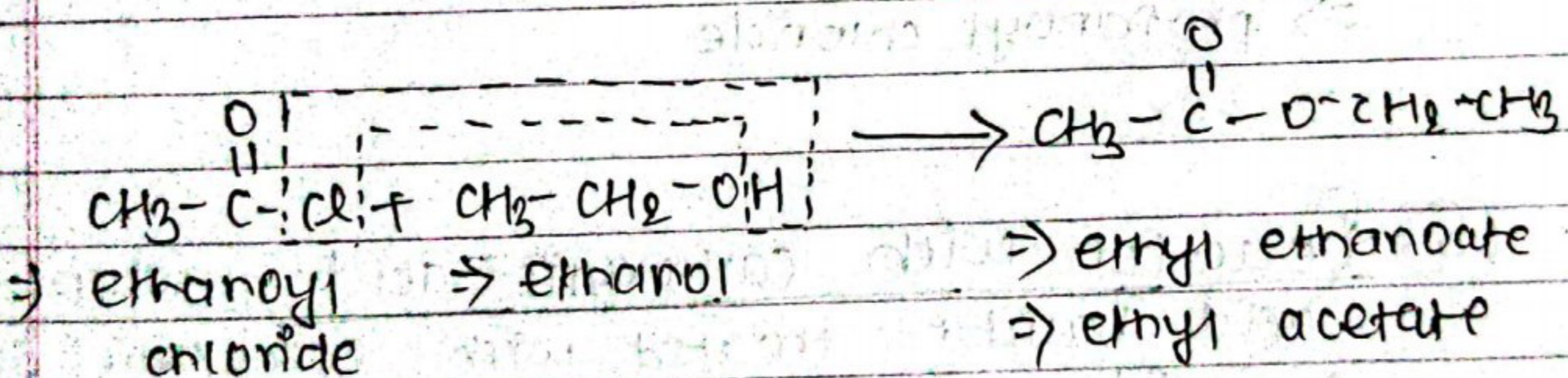
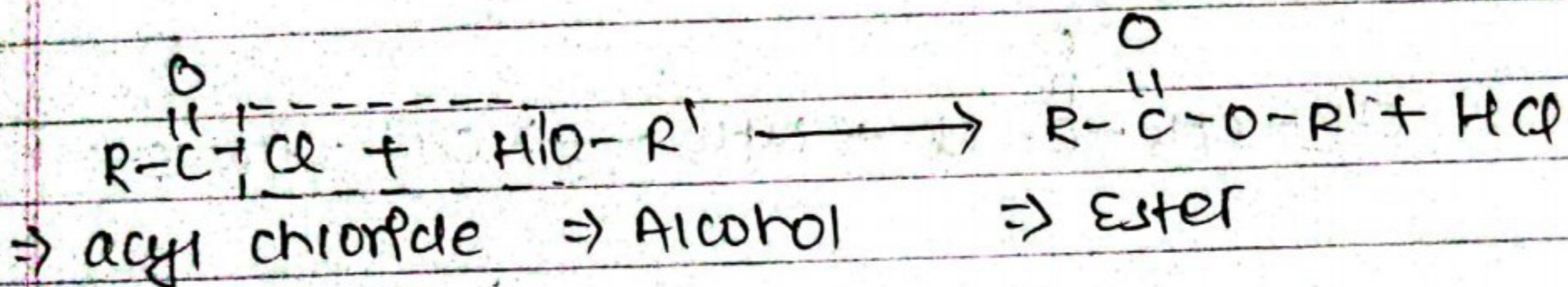




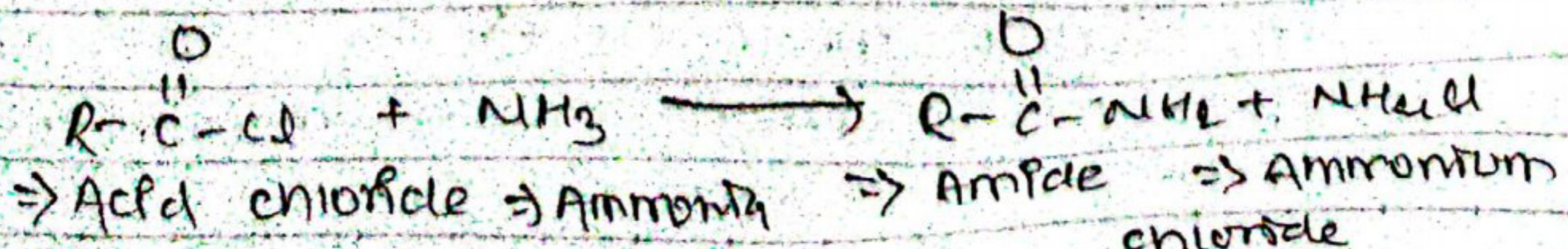
⇒ propionyl chloride

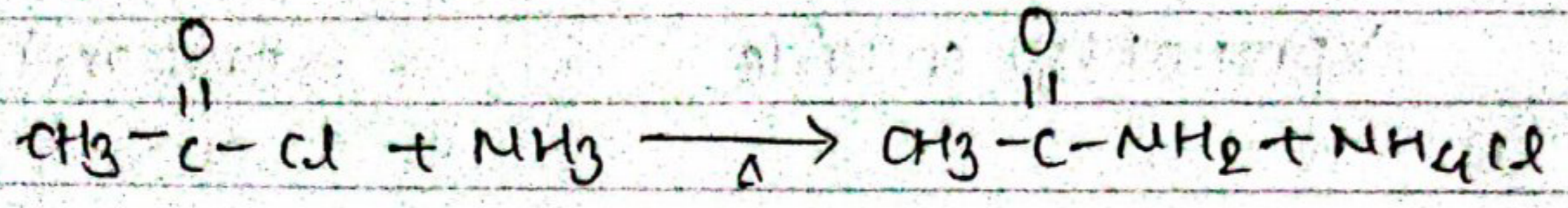
⇒ propanoic acid

② Reaction with alcohol :-



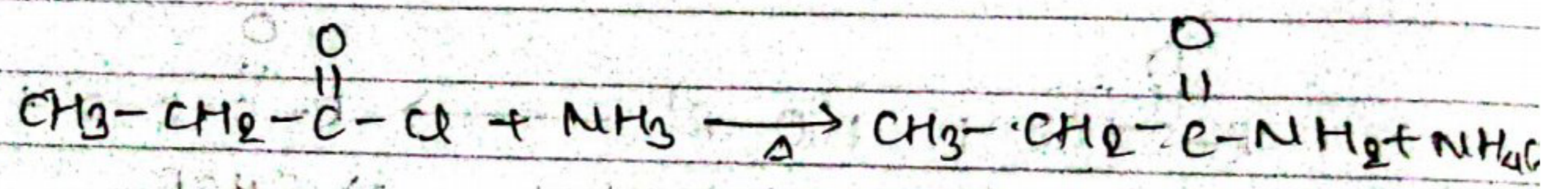
③ Reaction with NH₃ (Ammonolysis) :- when acid halide is treated with ammonia, amide is obtained.





⇒ ethanoyl chloride

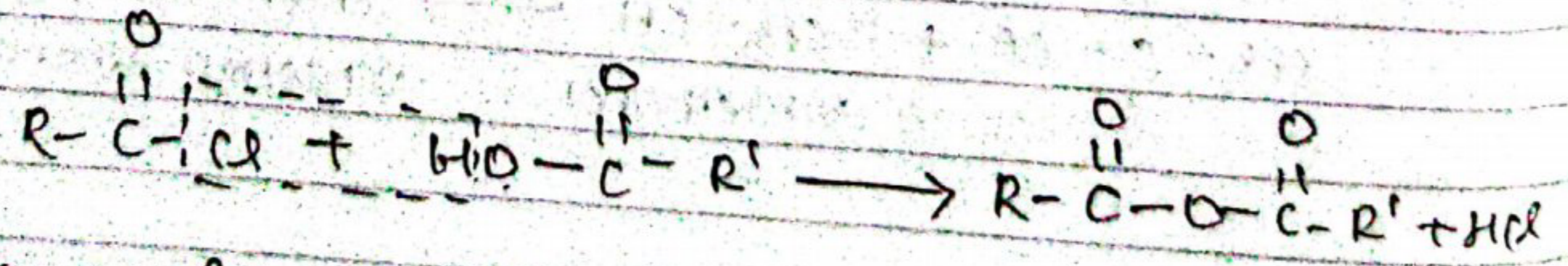
⇒ ethanamide



⇒ propanoyl chloride

⇒ propanamide

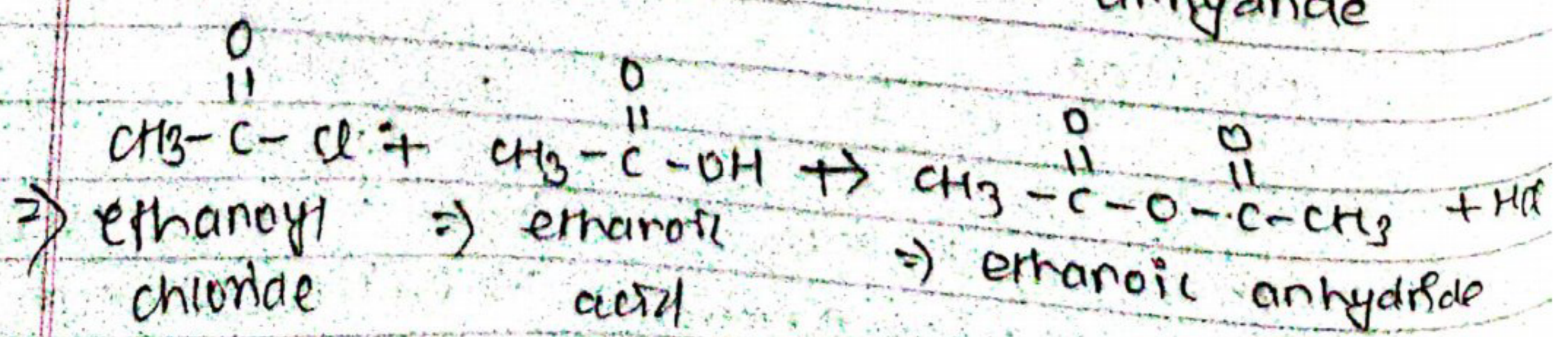
④ Reaction with carboxylic acid :- when acid halide is treated with carboxylic acid, acid anhydride is formed.



⇒ acyl halide

⇒ Carboxylic acid

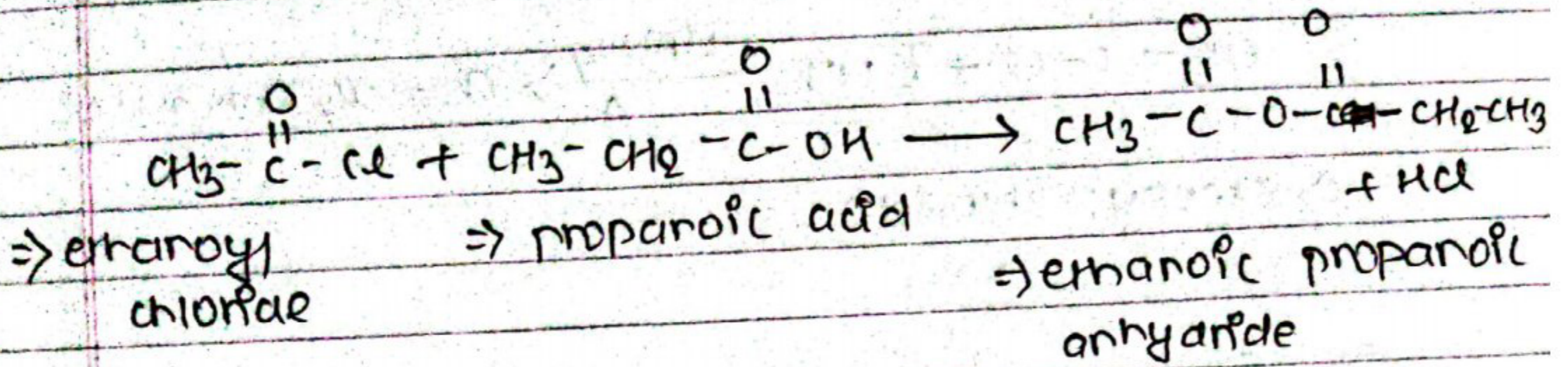
⇒ acid anhydride



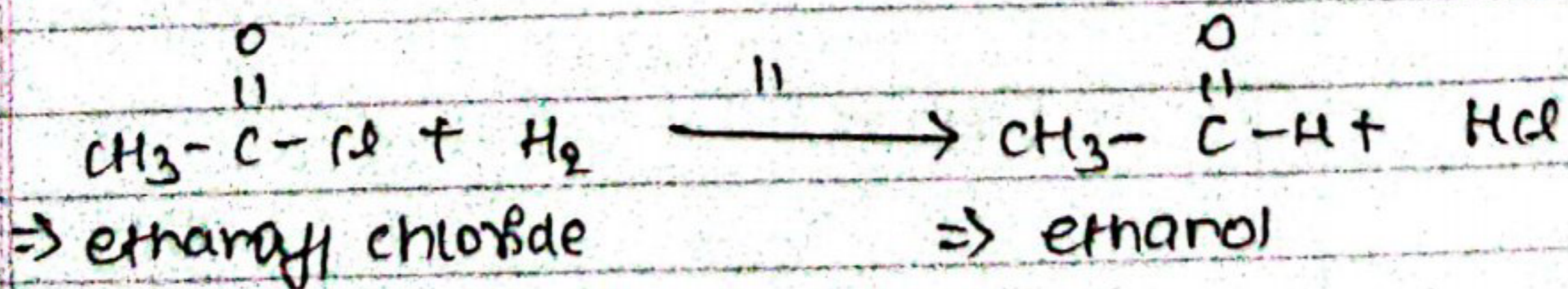
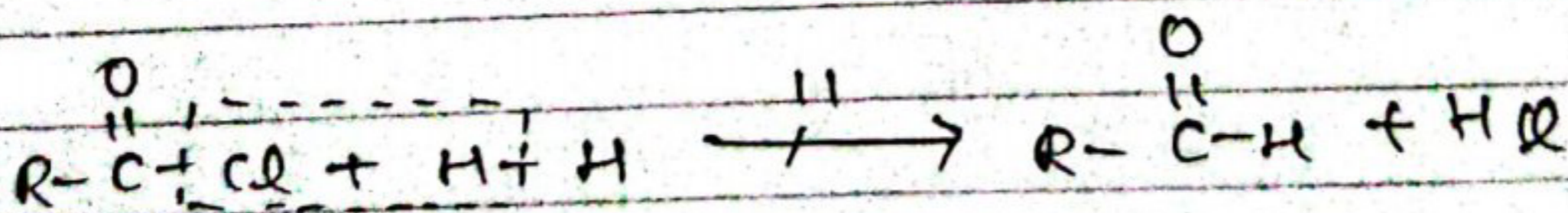
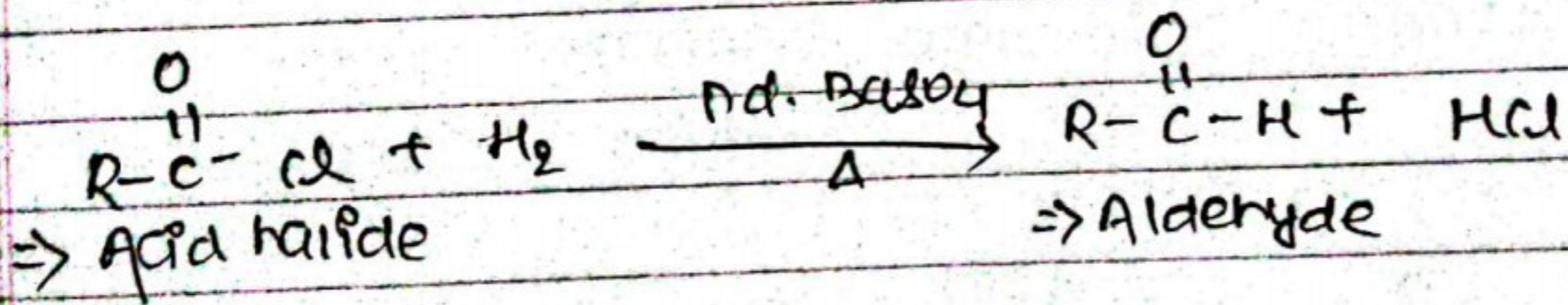
⇒ ethanoyl chloride

⇒ ethanoic acid

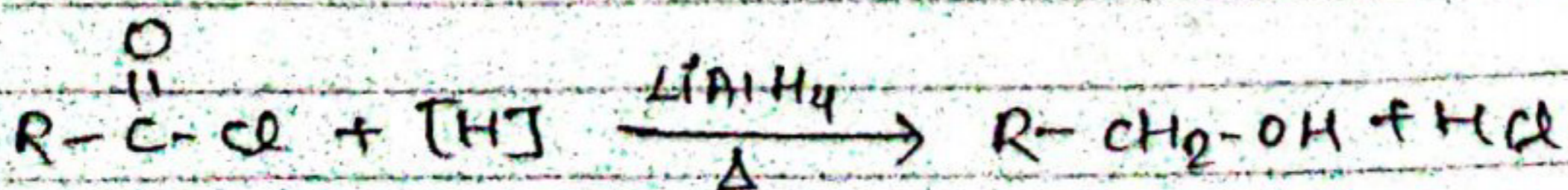
⇒ ethanoic anhydride

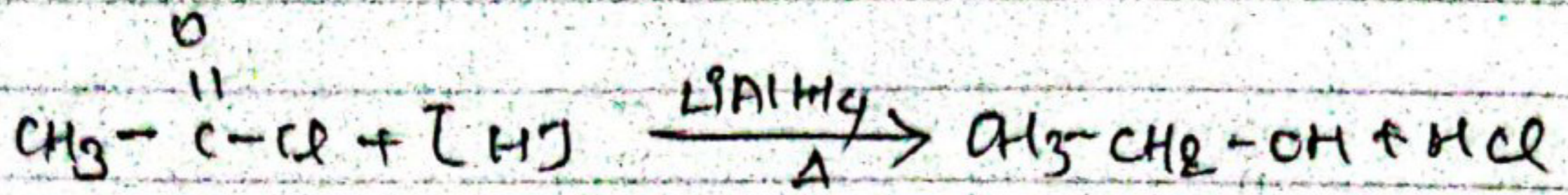


⑤ Rosenmund's reduction :- when acid halide is treated with hydrogen gas in the presence of Pd/BaSO₄ as a catalyst forms aldehyde



⑥ Reduction of Acid halide :- when acid halide is reduced in presence of LiAlH₄ it is converted into alcohol.



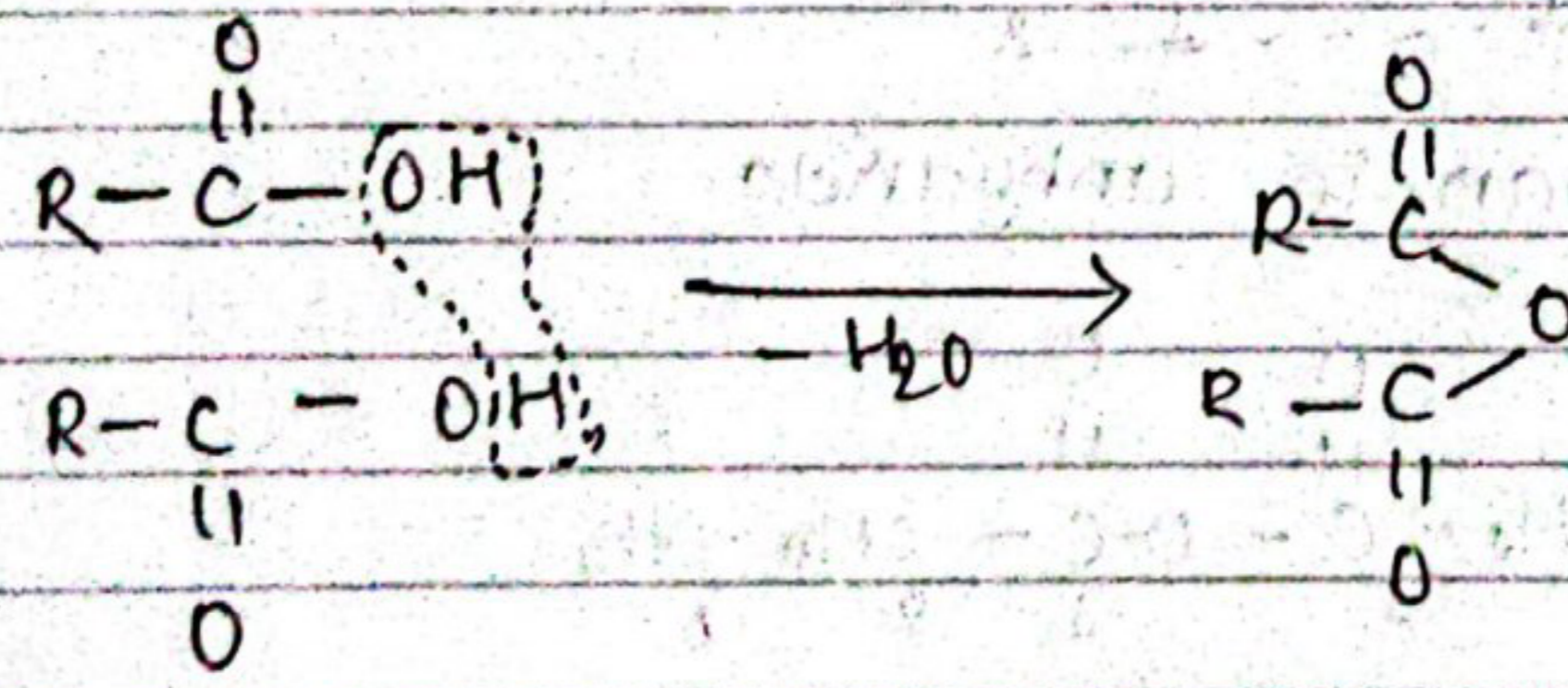


→ ethoxy chloride

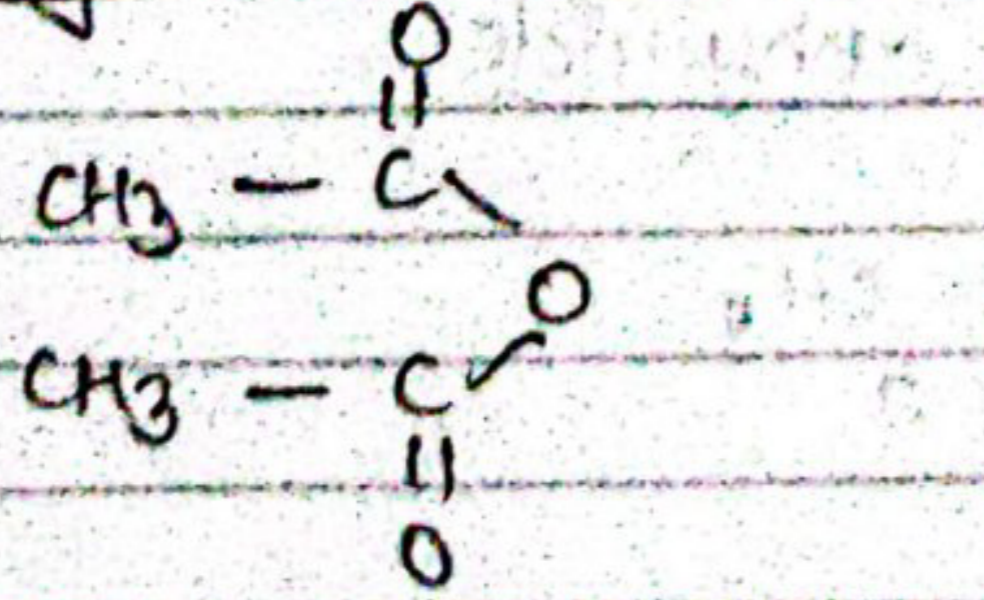
⑦ Reaction with benzene Friedel crafts acylation

~~Acid Anhydride~~

Acid Anhydride :- Acid anhydride are the derivatives of carboxylic acid that are formed by removal of H₂O from two similar or different carboxylic acid

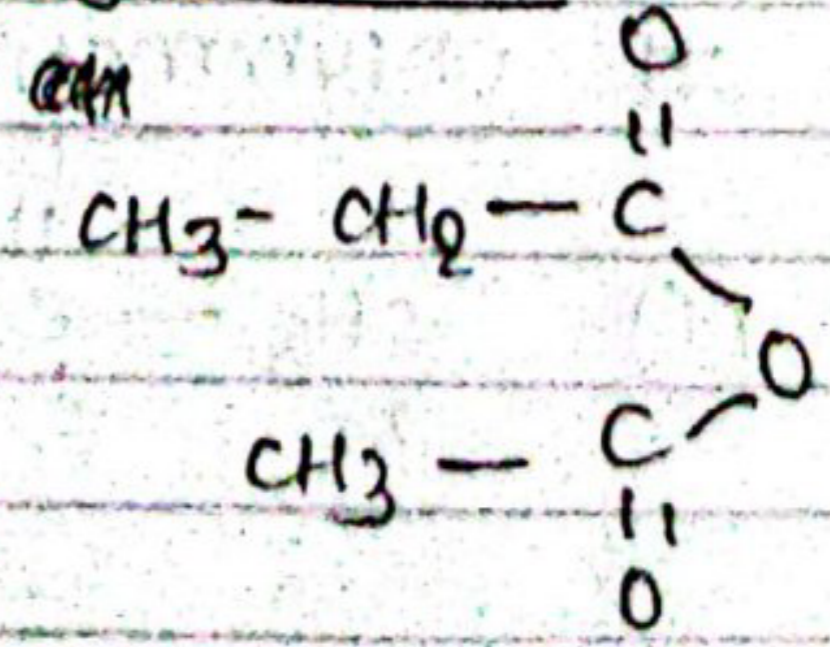


Symmetrical :-



⇒ ethanoic anhydride

Unsymmetrical



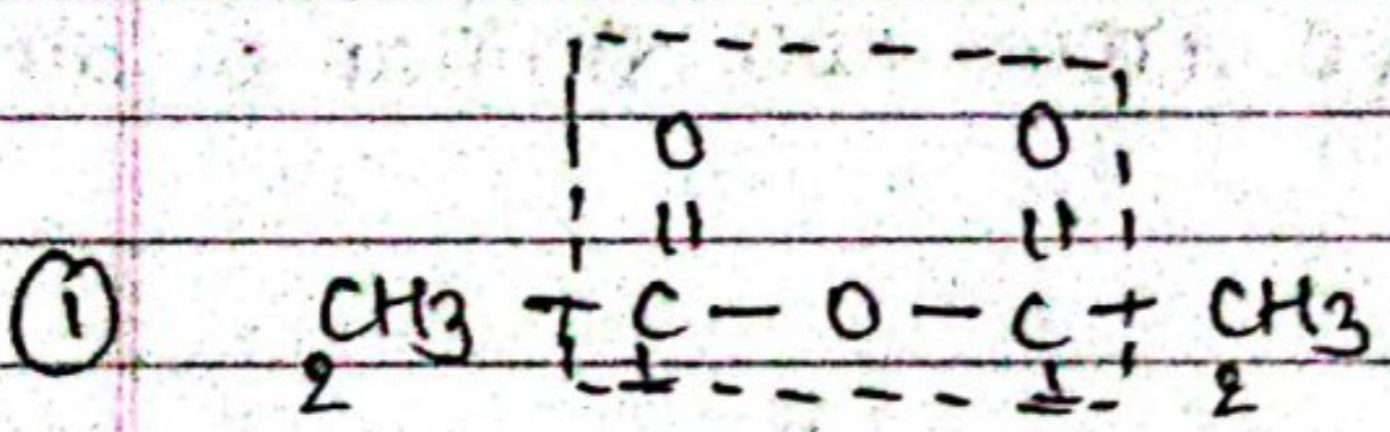
⇒ ethanoic propanoic acid anhydride

Nomenclature of Acid Anhydride :-

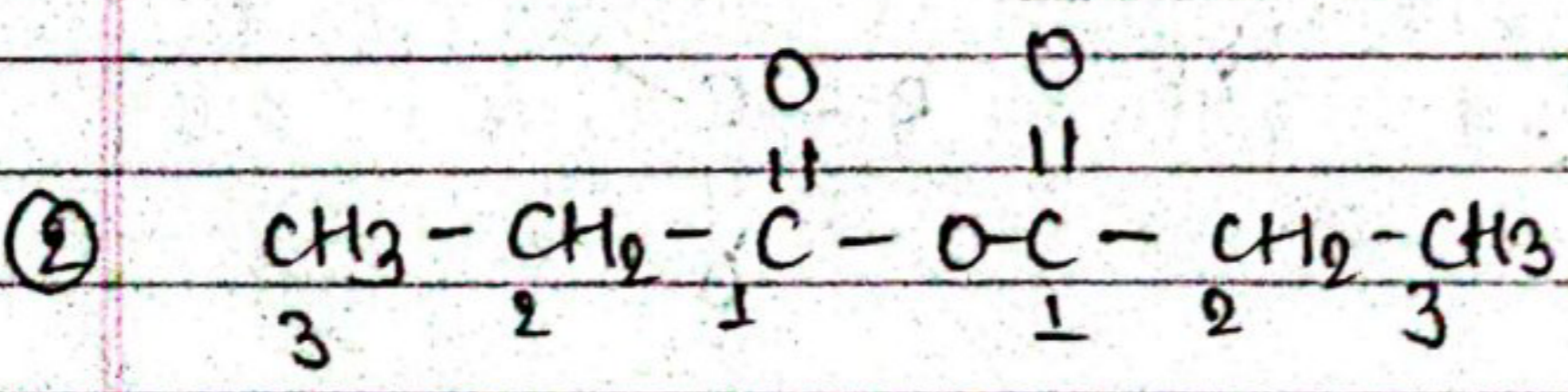
Symmetrical acid anhydride :-

Alk + an + oic anhydride

↓ ↓ ↓
word root P.C S.C

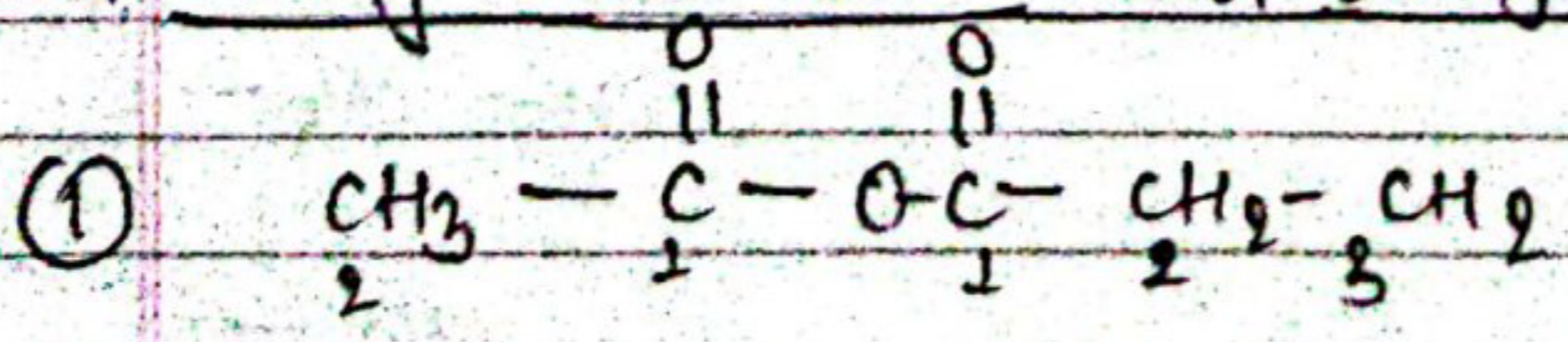


⇒ ethanoic anhydride

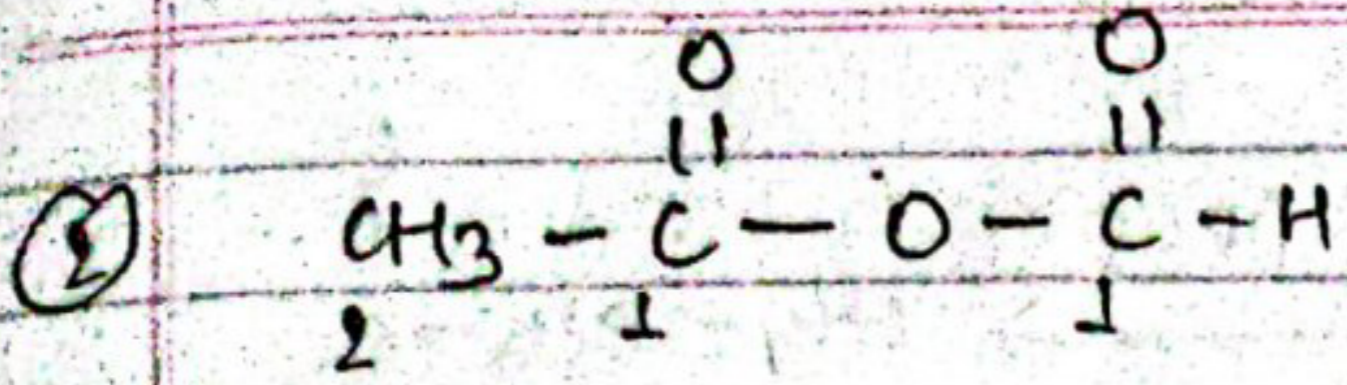


⇒ ~~Hex~~ propanoic anhydride

Unsymmetrical acid anhydride :-



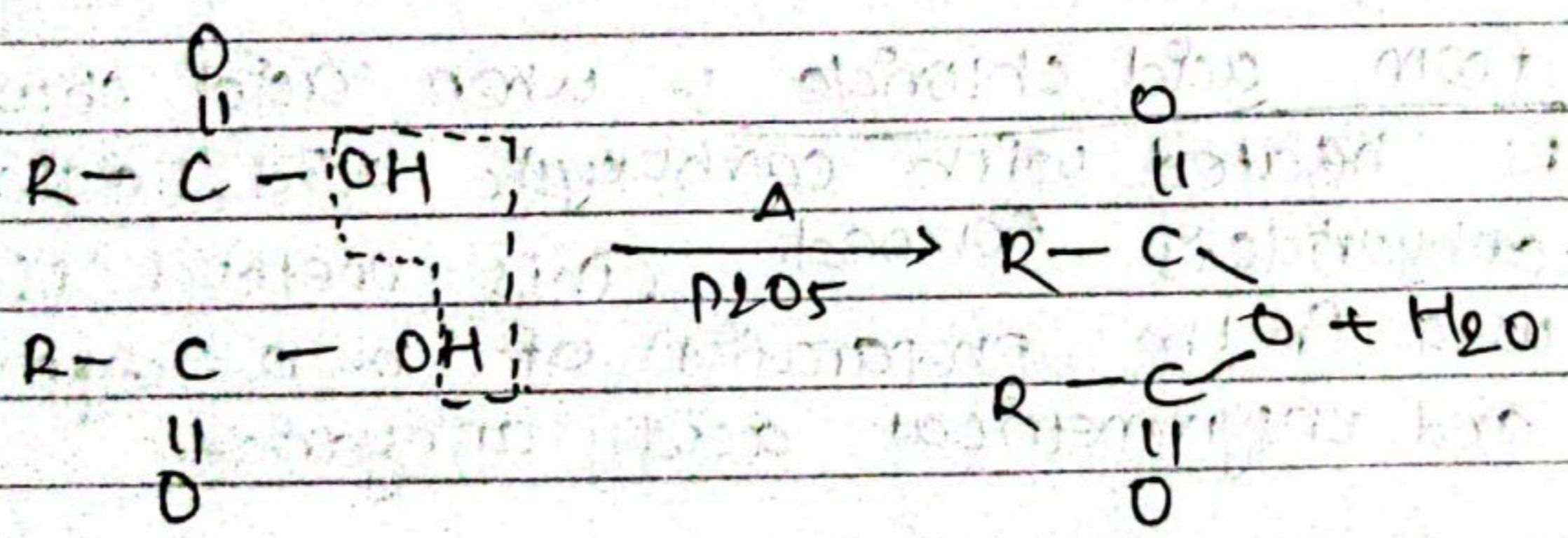
⇒ ethanoic propanoic anhydride



⇒ ethanoic methanoic anhydride

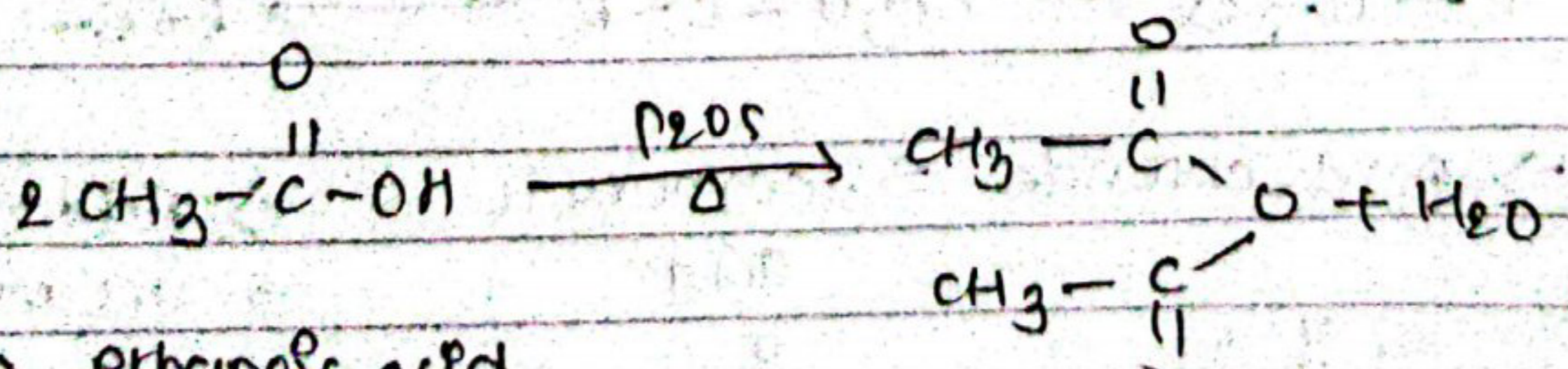
General Methods of Preparation :-

① From carboxylic acid :- when carboxylic acid is heated with P₂O₅, acid anhydride is formed



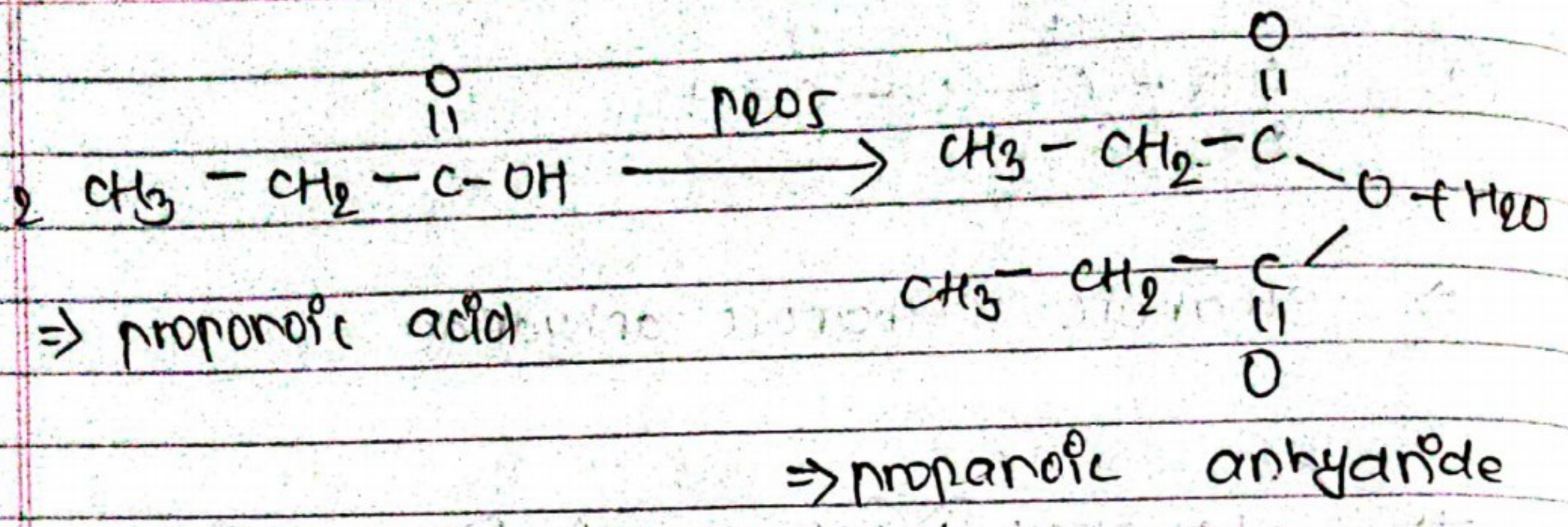
⇒ carboxylic acid

⇒ acid anhydride



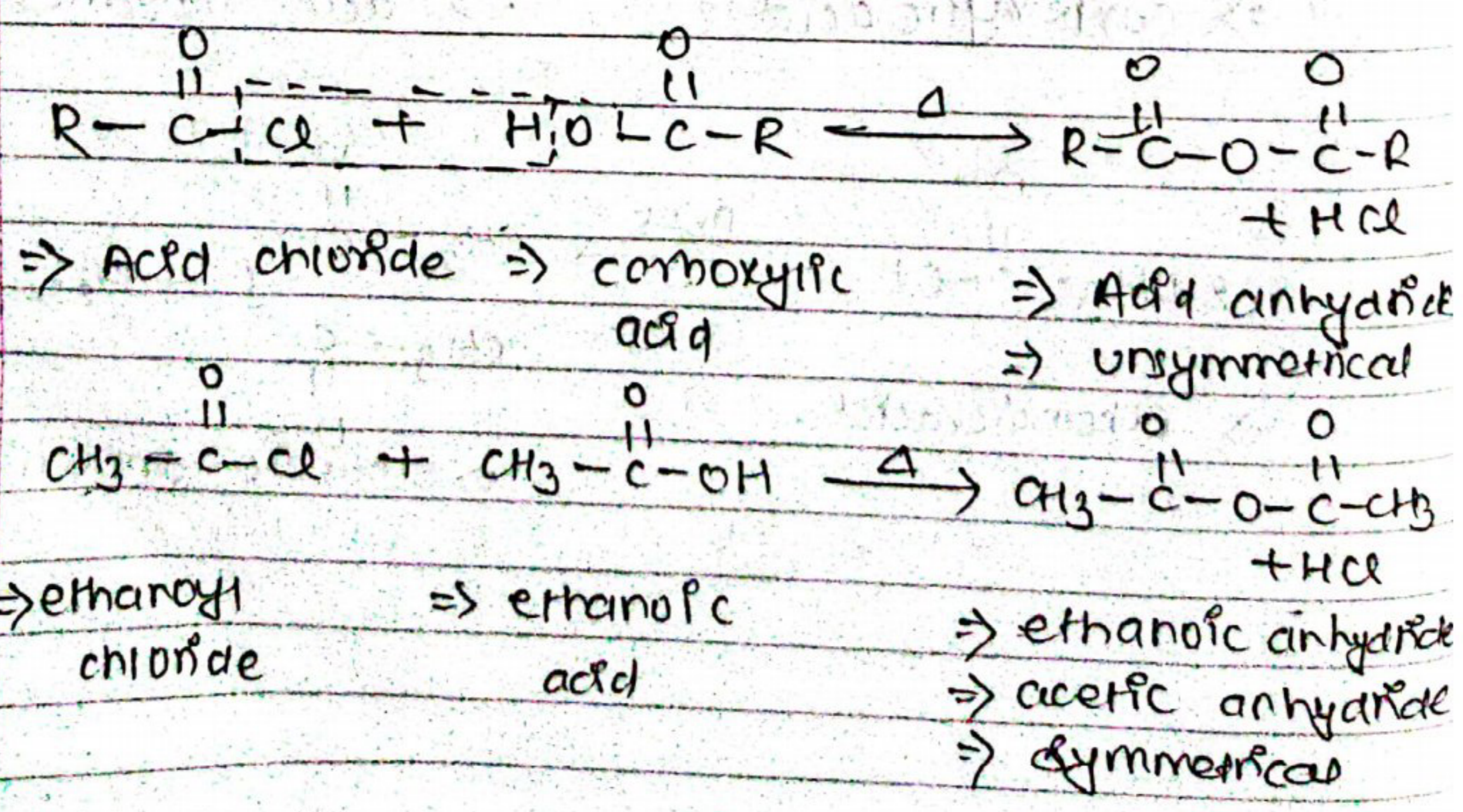
⇒ ethanoic acid

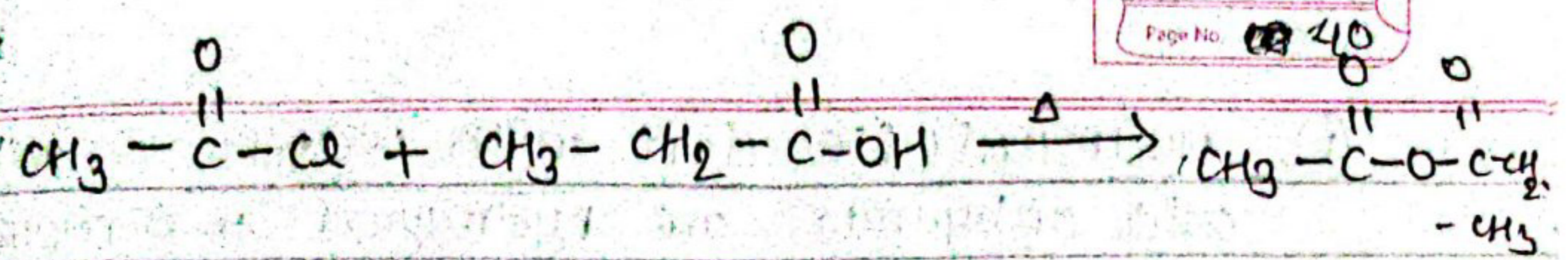
⇒ ethanoic anhydride



Note :- Methanoic acid cannot be used in the preparation of acid anhydride because it decomposes into CO_2 and H_2O .

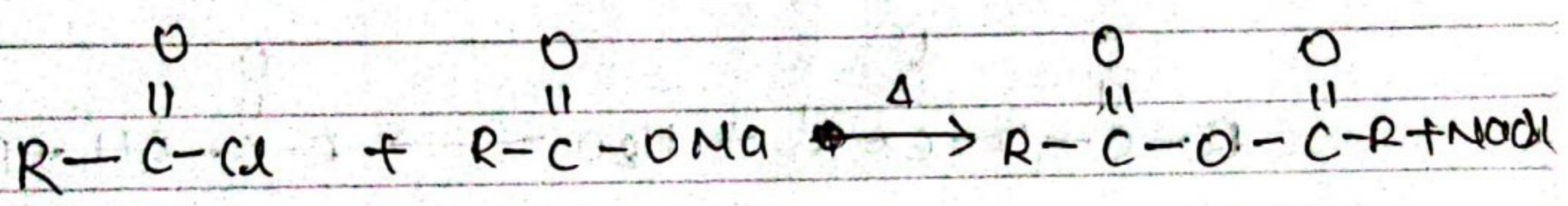
② from acid chloride :- when acid chloride is heated with carboxylic acid, acid anhydride is formed. This method is used in the preparation of both symmetrical and unsymmetrical acid anhydride.



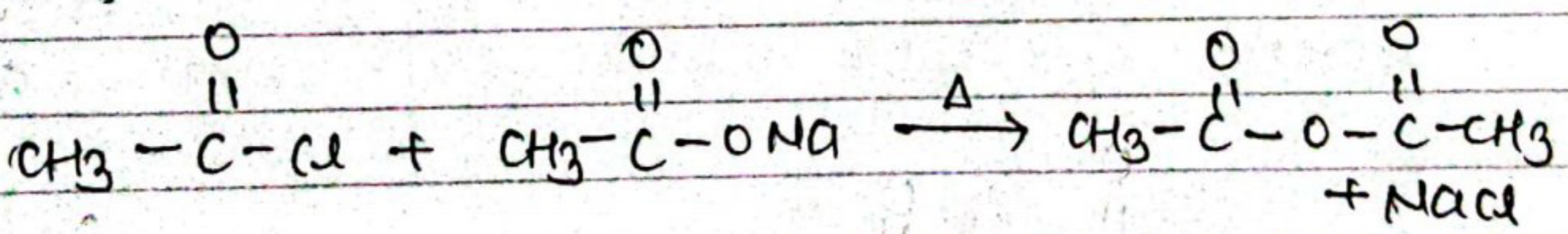


⇒ ethanoyl chloride ⇒ propanoic acid ⇒ ethanoic propanoic anhydride
 ⇒ unsymmetrical

Acid anhydride may be prepared by following 1 method :-



⇒ Acid chloride ⇒ sod. carboxylate ⇒ Acid anhydride

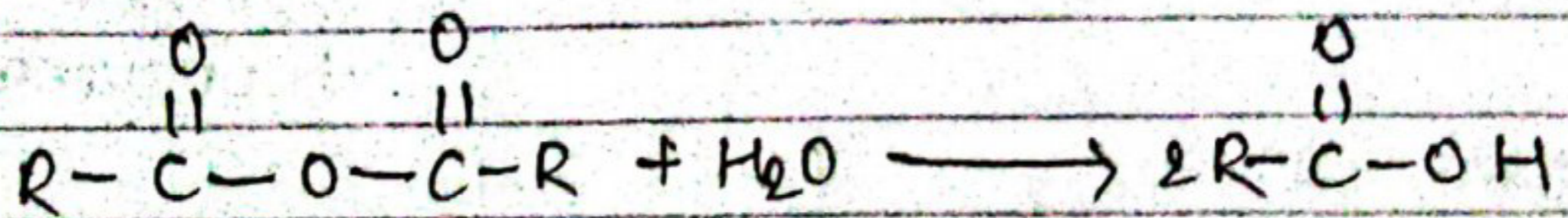


⇒ ethanoyl chloride ⇒ sod. ethanoate ⇒ ethanoic anhydride

Chemical Properties acid Anhydride

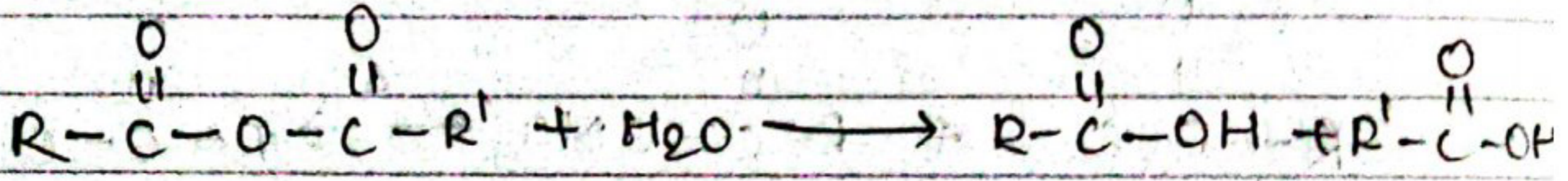
Note :- Acid anhydrides are less reactive than acid chloride

① Hydrolysis (reaction with water) :- when acid anhydride are hydrolysed two molecules of carboxylic acid are formed.



⇒ symmetrical

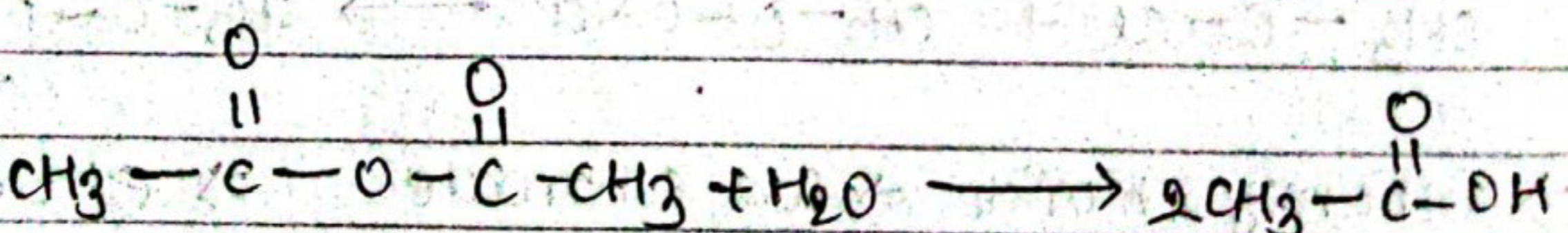
⇒ carboxylic acid



⇒ unsymmetrical

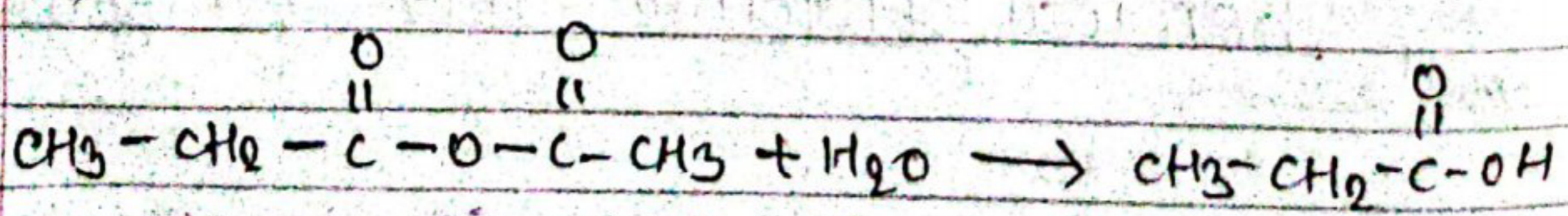
⇒ carboxylic acid

⇒ carboxylic acid

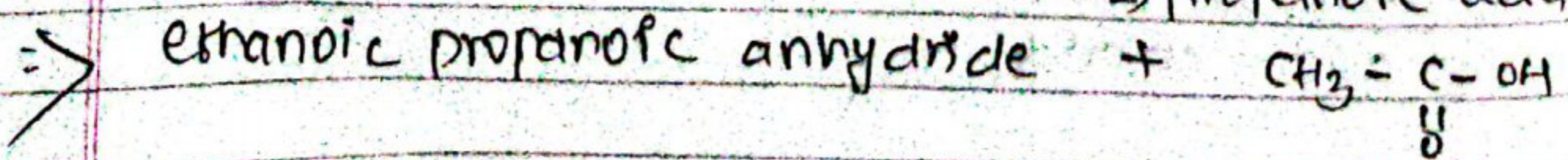


⇒ ethanoic anhydride symmetrical

⇒ ethanoic acid

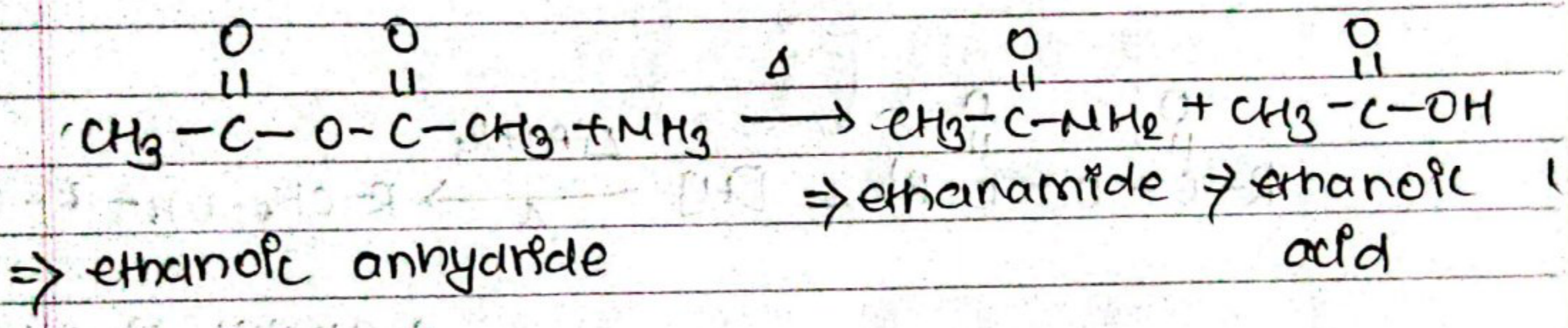
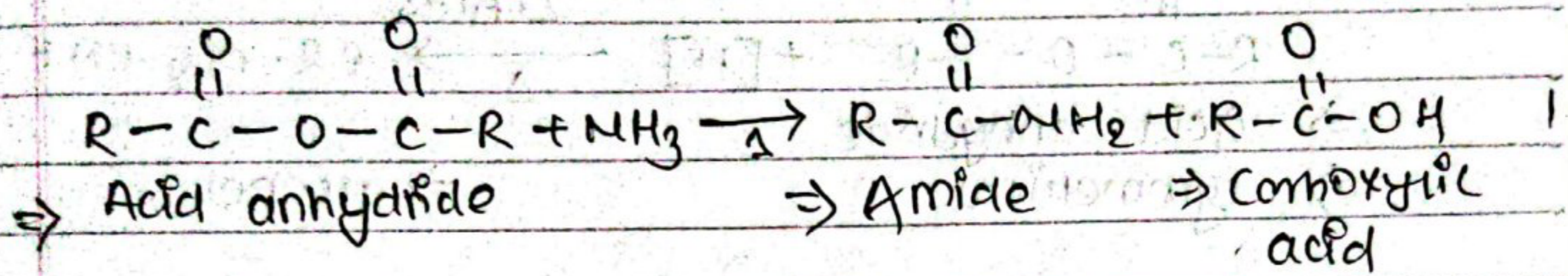


⇒ propanoic acid

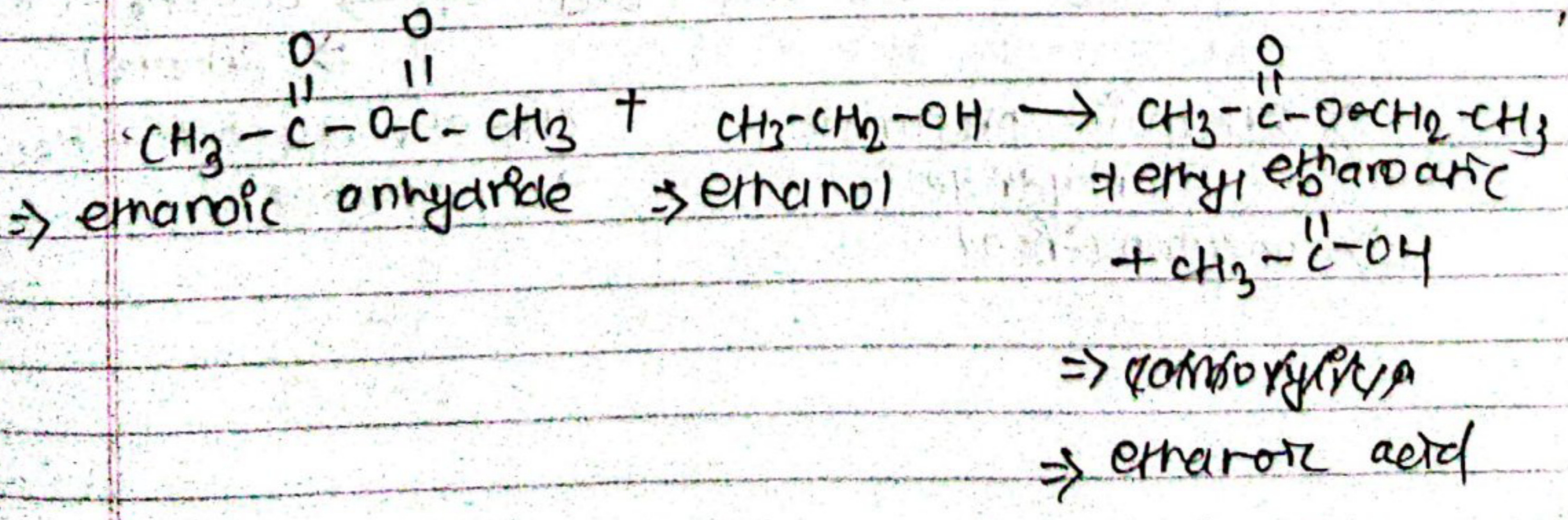
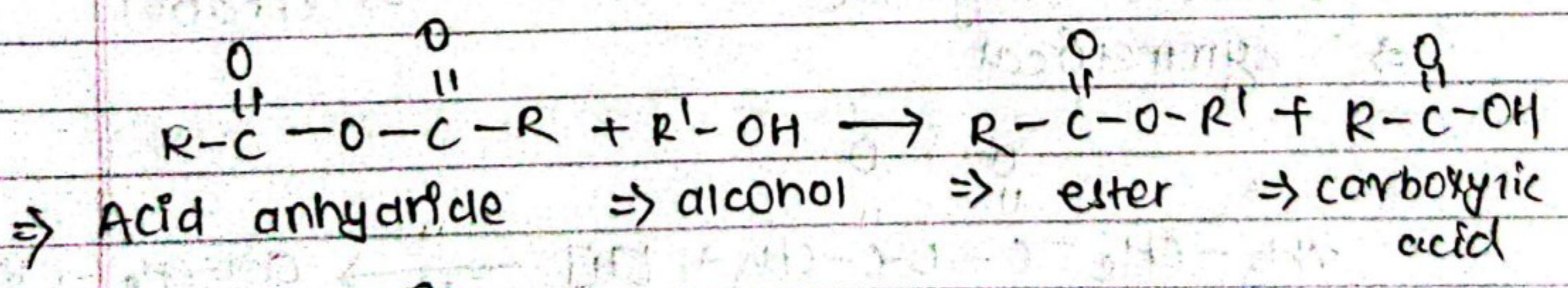


⇒ ethanoic acid

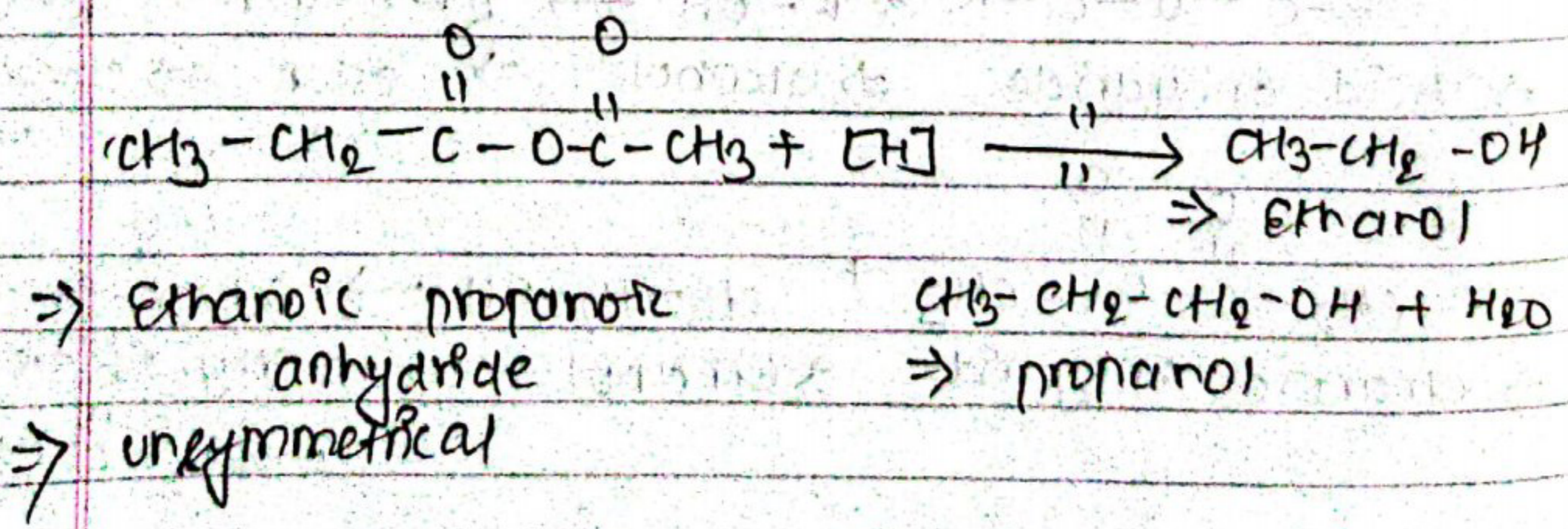
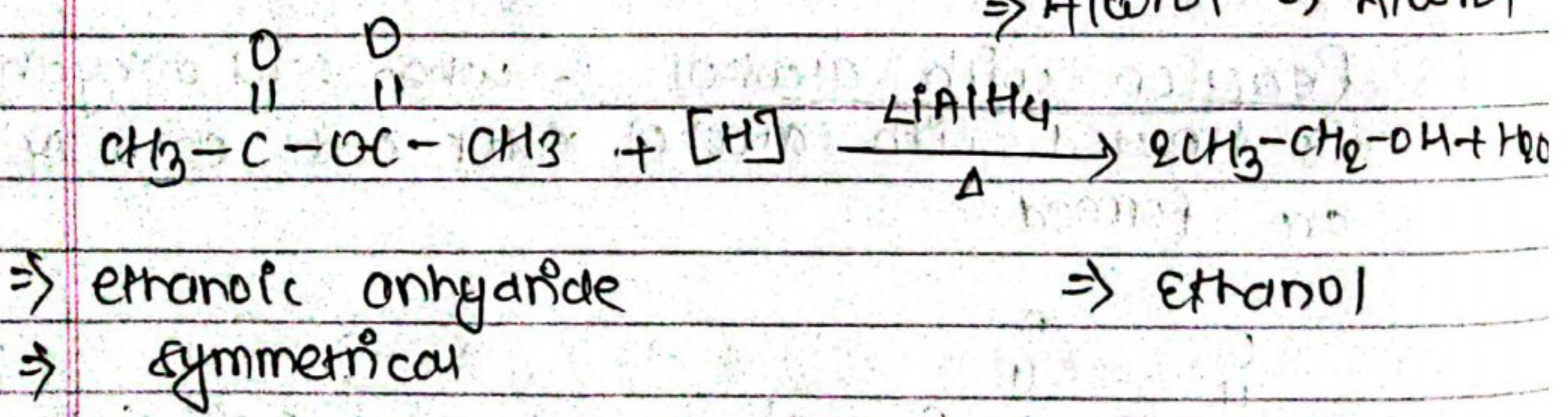
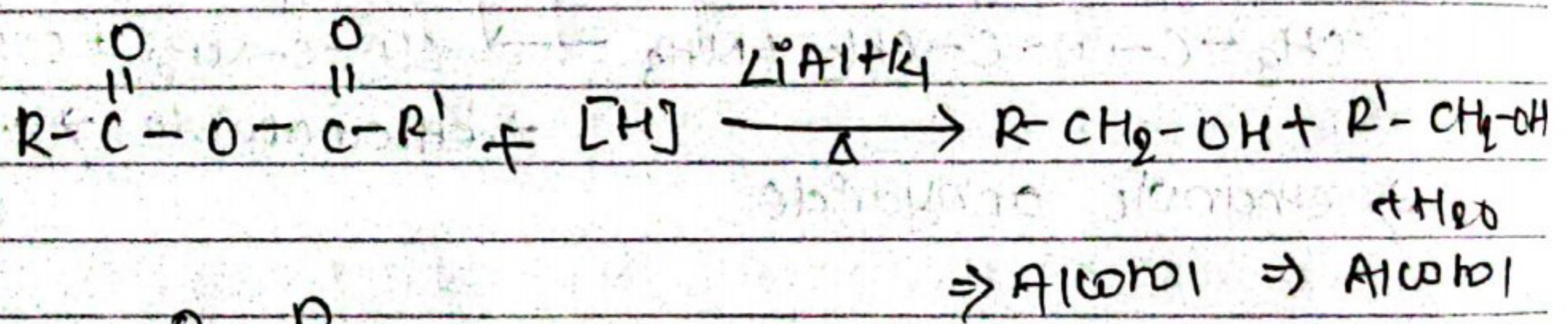
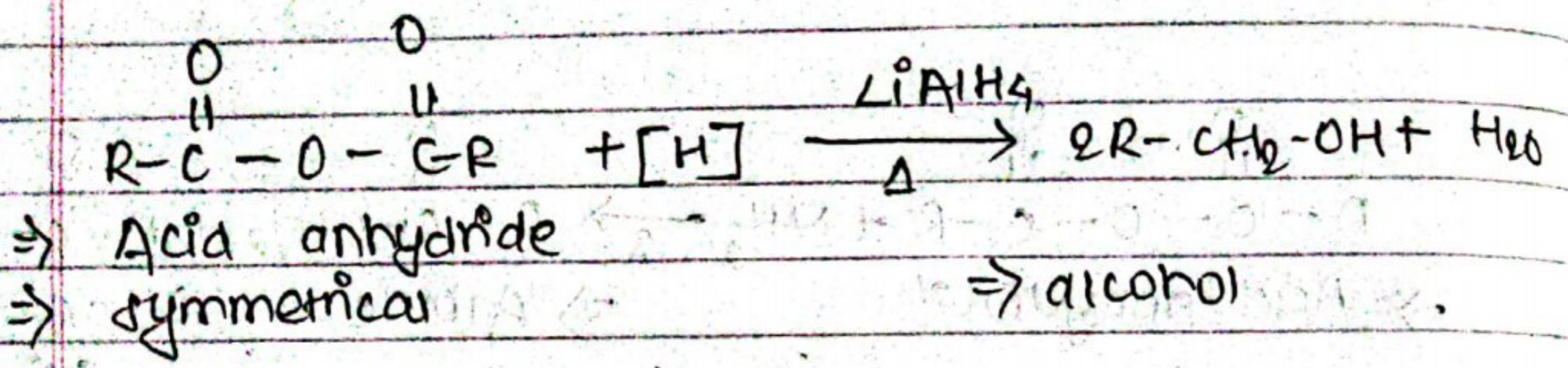
② Reaction with Ammonia (NH₃) [Ammonolysis] :-
when acid anhydride is heated with ammonia
amides are formed.



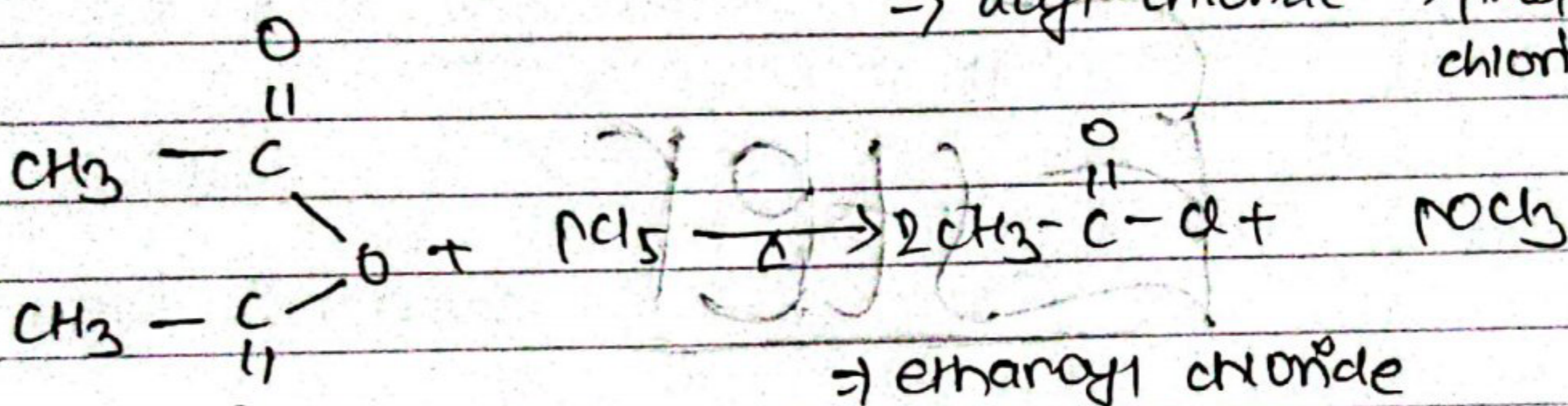
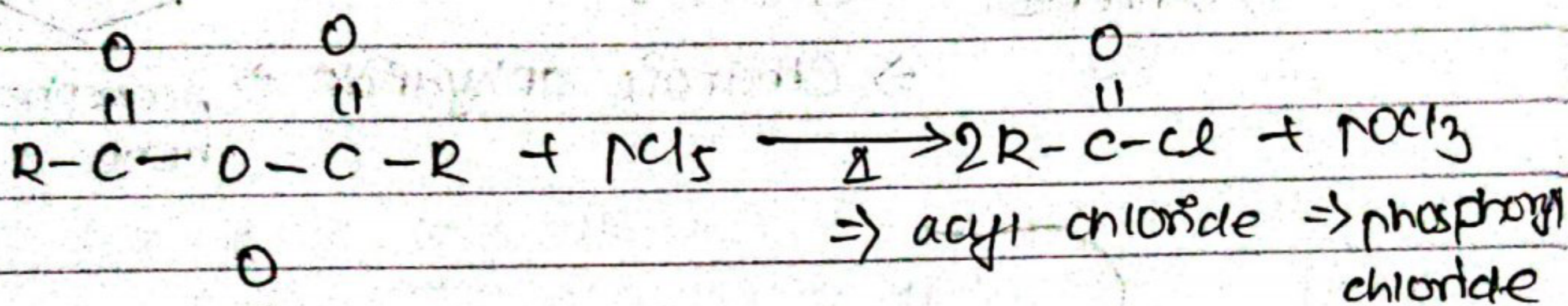
③ Reaction with alcohol :- when acid anhydride
is treated with alcohol ester and carboxylic
are formed.



④ Reduction of acid anhydride :- when acid anhydride is reduced by using LiAlH_4 or NaBH_4 , alcohols are formed.

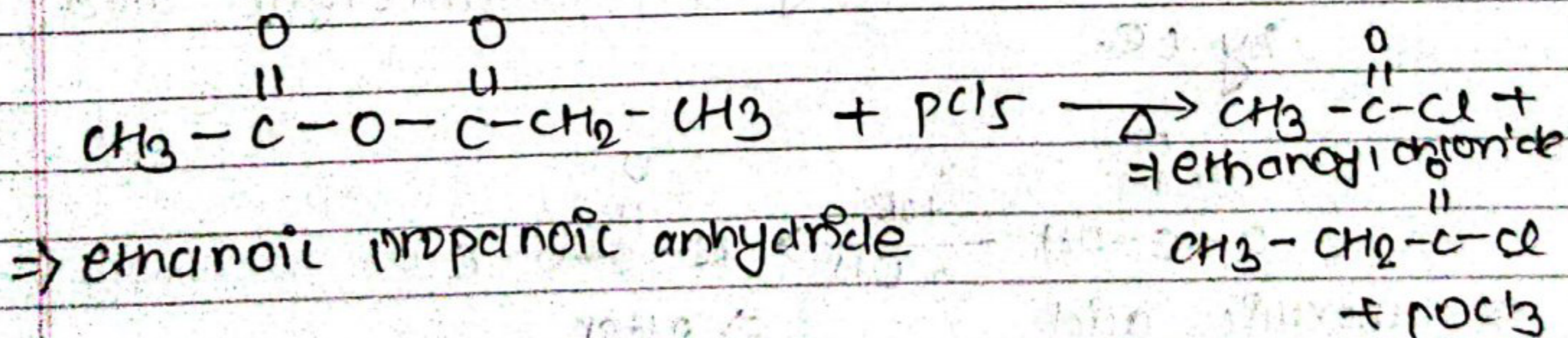


⑤ Reaction with PCl₅ :- when acid anhydride is treated with PCl₅, acid chlorides are formed.

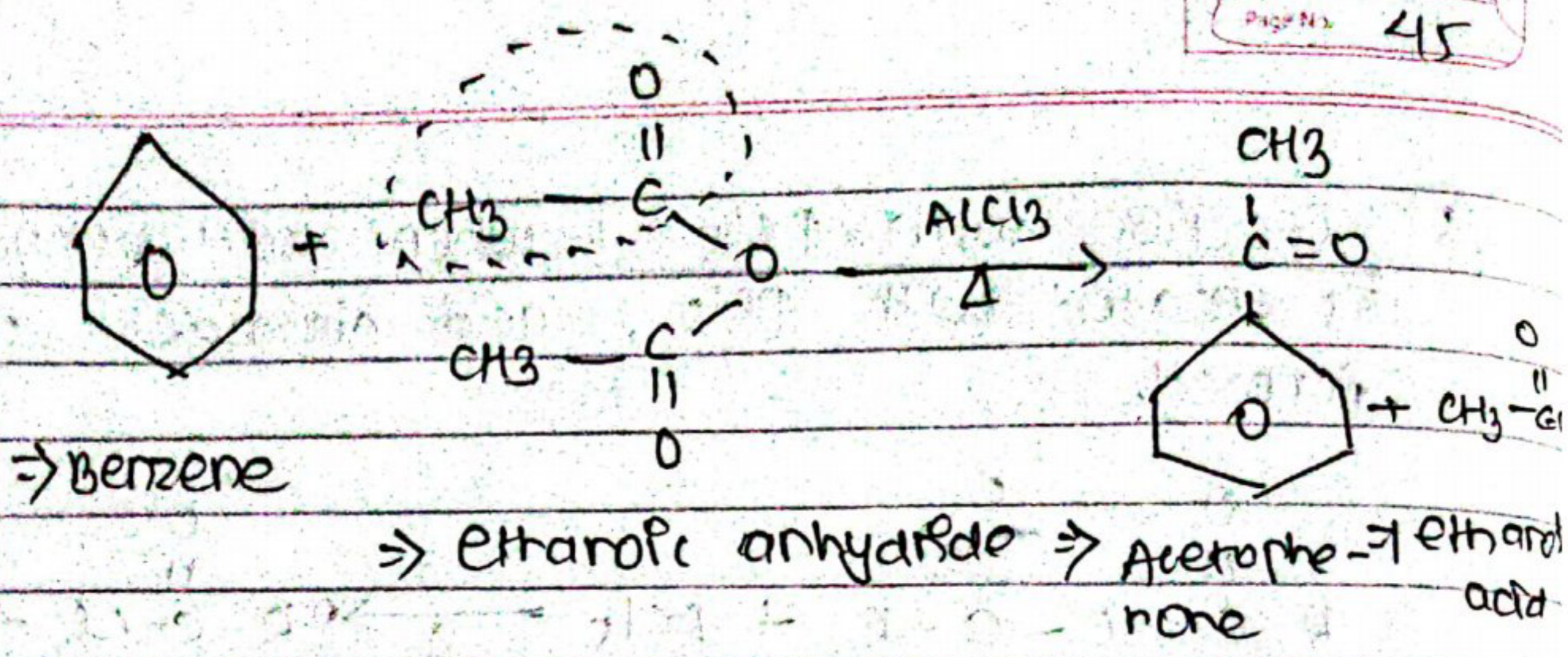


⇒ ethanoic anhydride

if unsymmetrical is used :-

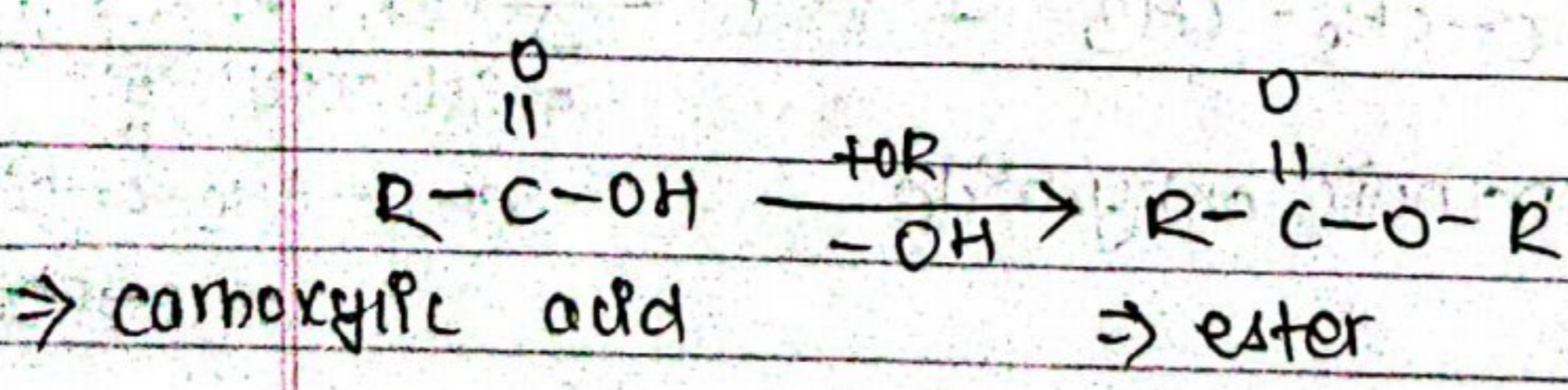


⑥ Reaction with benzene (Friedel Crafts acylation) :- when benzene is heated with acid anhydride in presence of Lewis acid aromatic ketone is formed.



ESTER

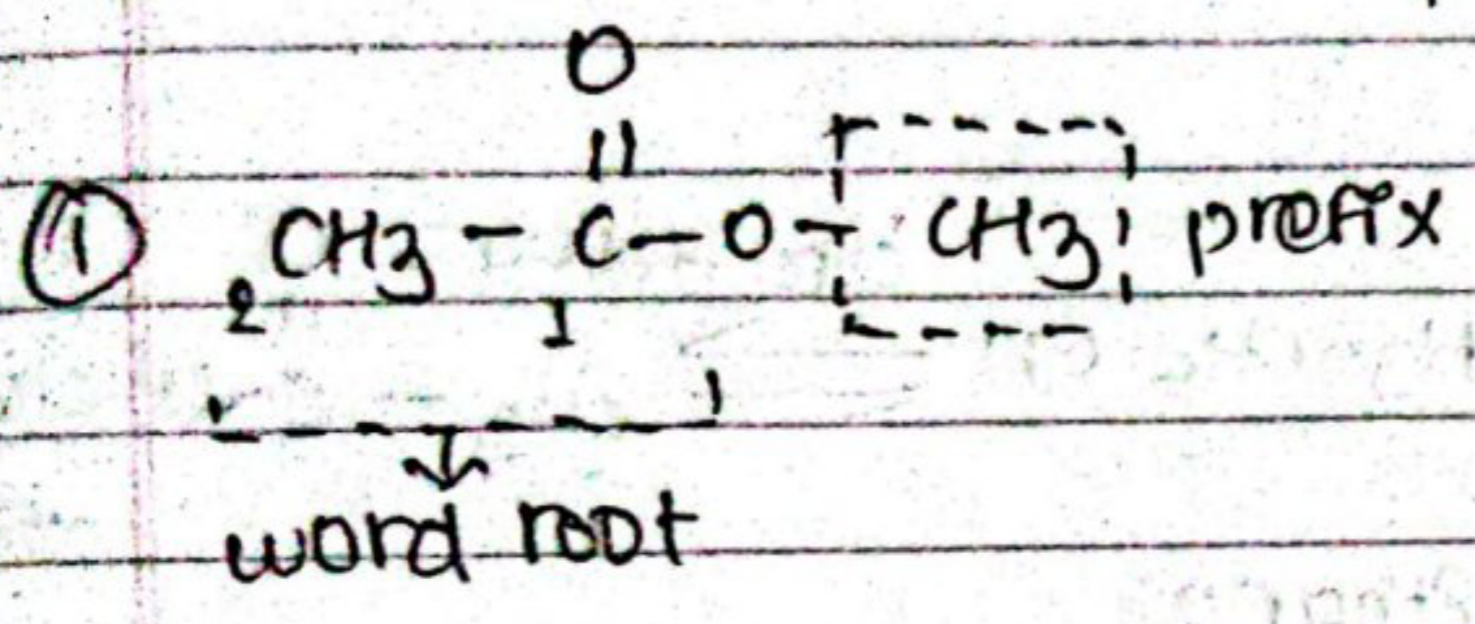
Ester :- Esters are derivatives of carboxylic acid which are obtained by replacement of OH and -COOH group of carboxylic acid by OR.



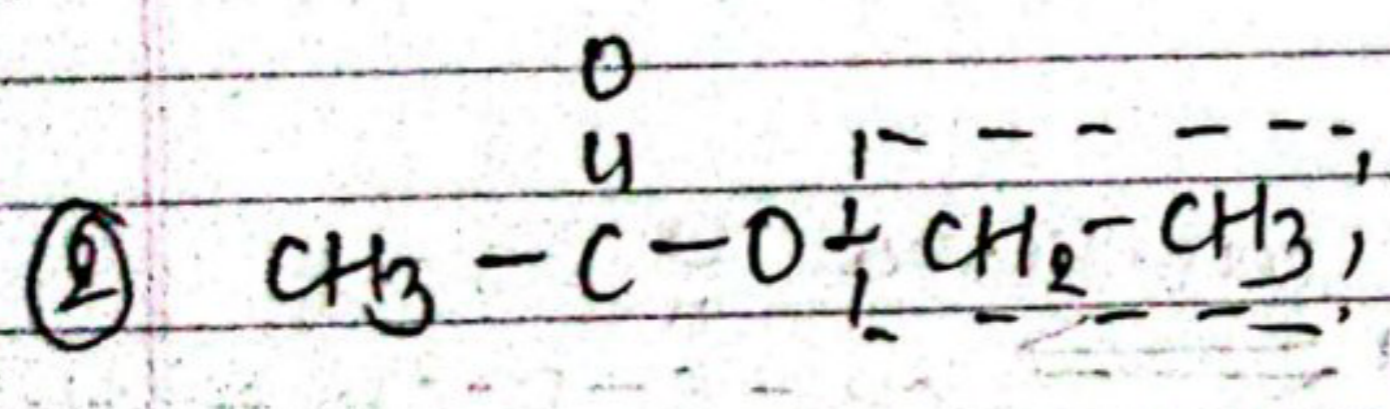
Functional group of ester :- $\begin{array}{c} O \\ || \\ -C-O- \end{array}$

Nomenclature of Ester :-

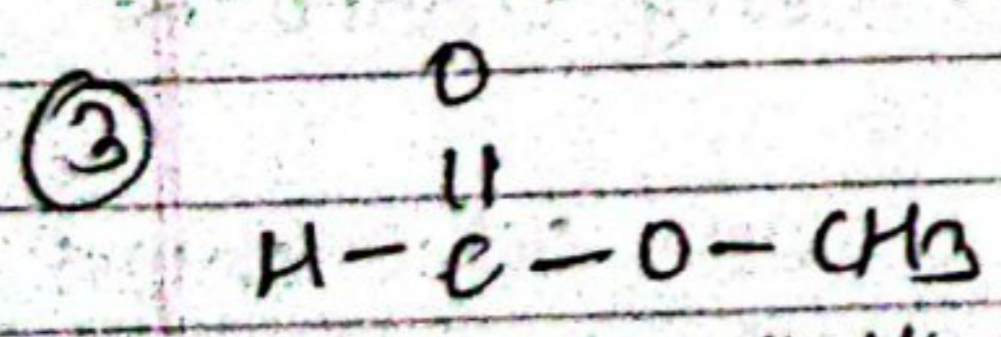
General formula :- $\underbrace{Alk + yl}_{\text{prefix}} + \underbrace{Alk + an}_{\text{W.R}} + \underbrace{Oate}_{\text{P.C}} \downarrow \text{S.S}$



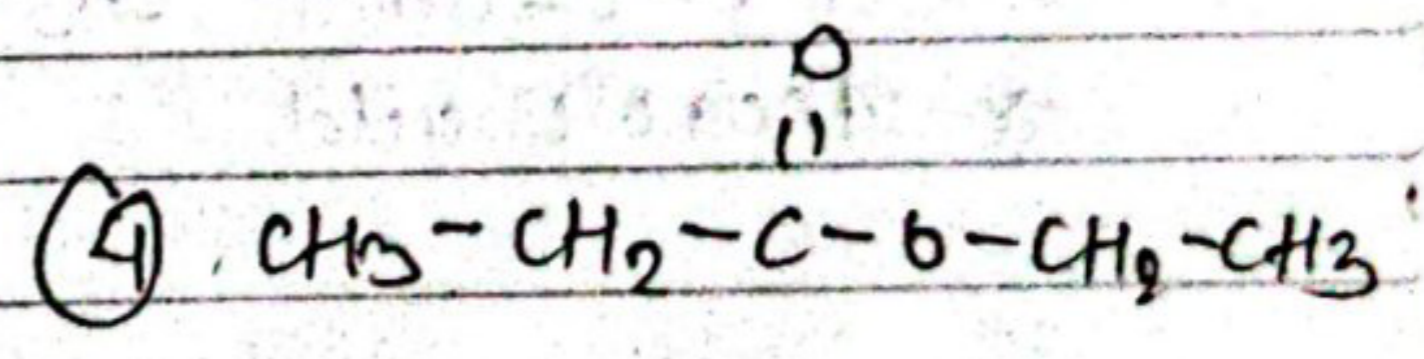
⇒ methyl ethanoate



⇒ Ethyl ethanoate



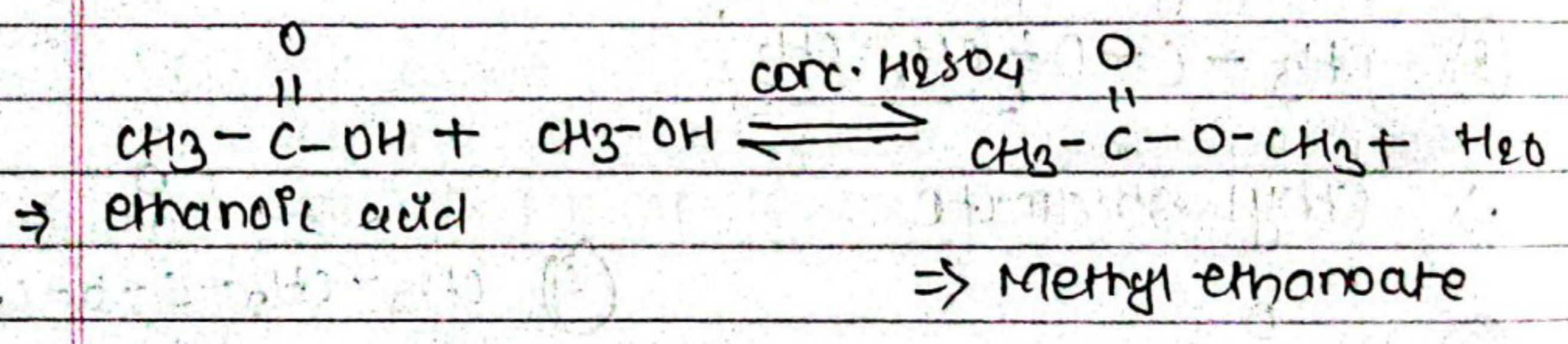
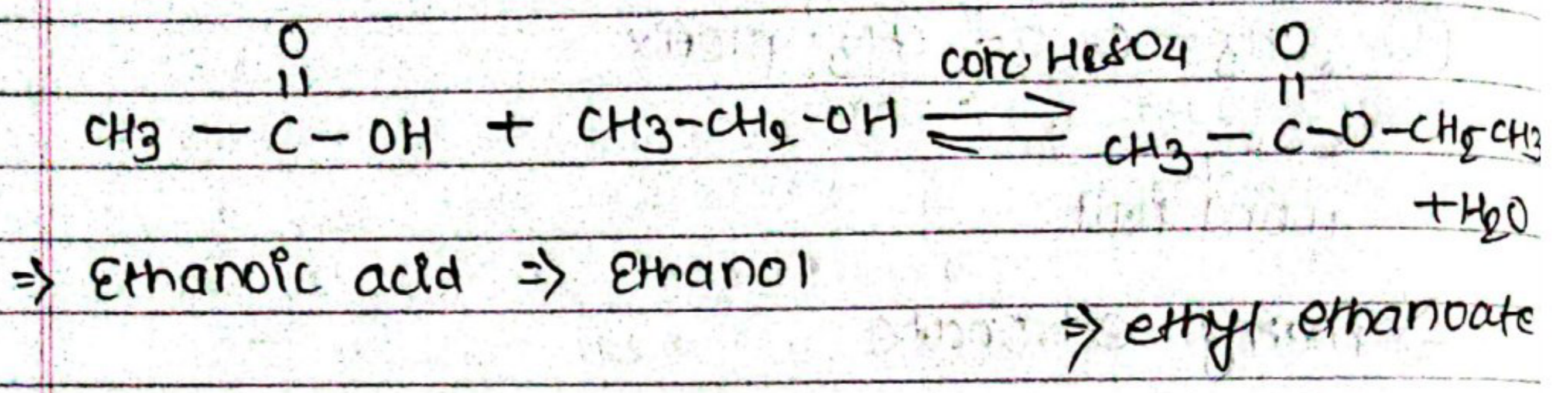
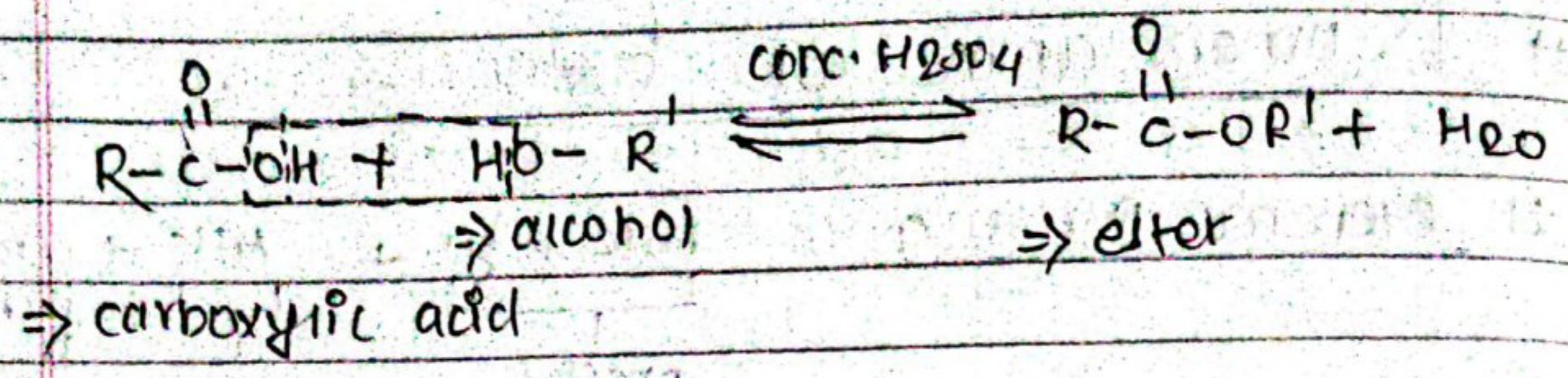
⇒ Methyl methanoate



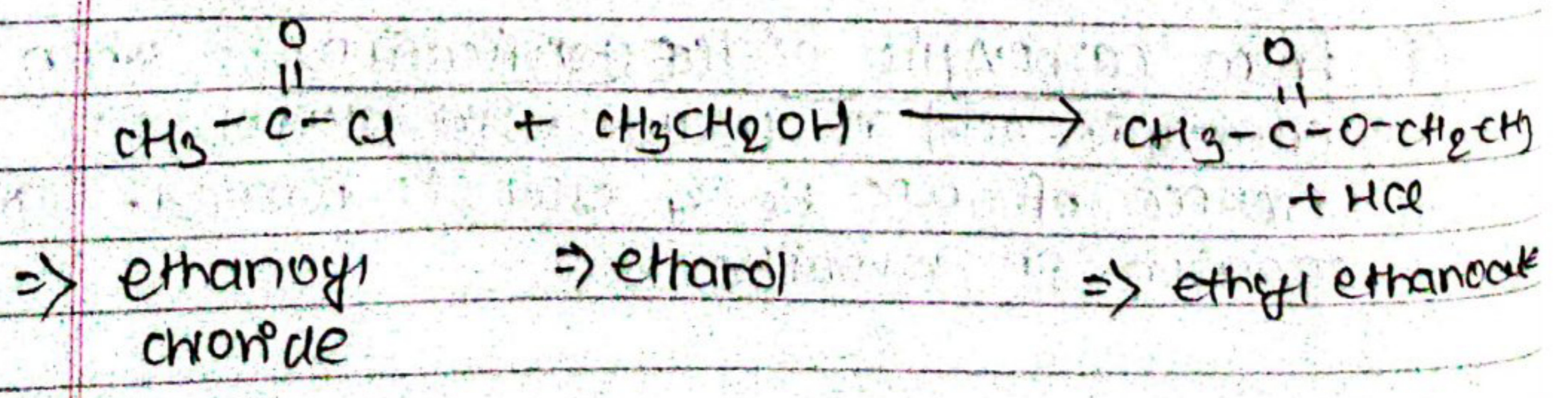
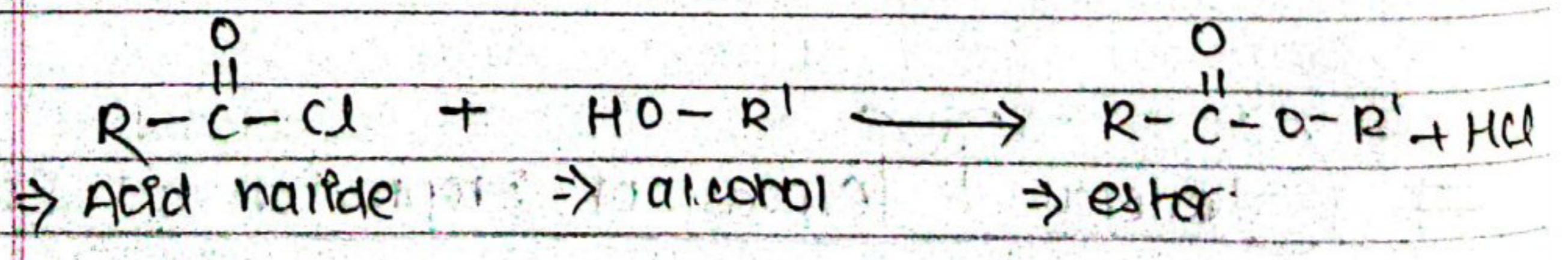
⇒ Ethyl propanoate

General Methods of Preparation of Esters :-

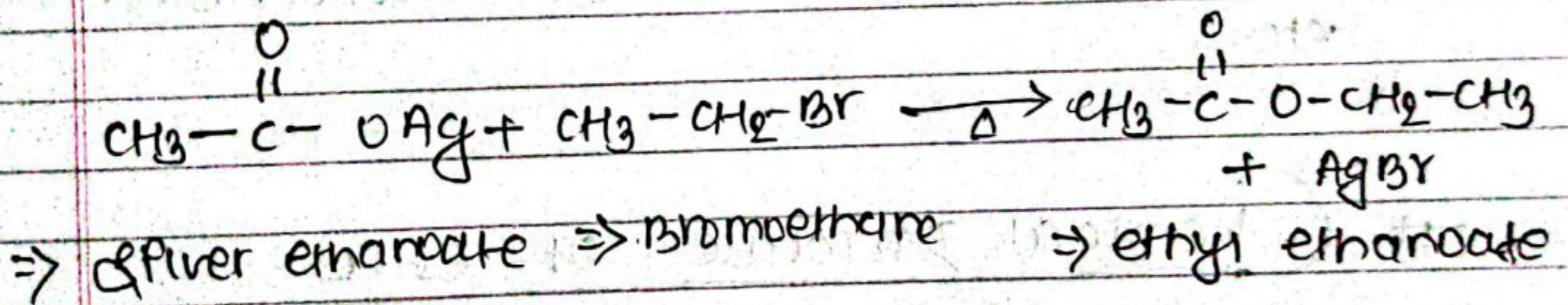
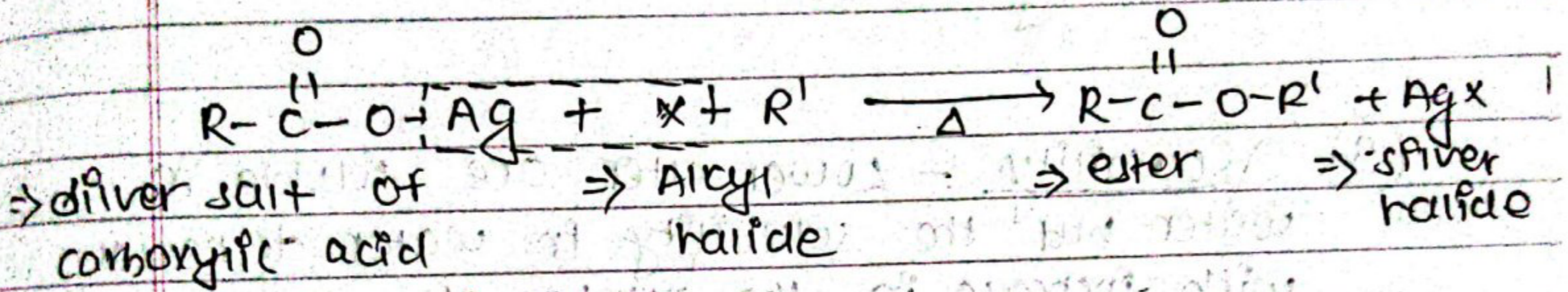
① From carboxylic acid (esterification) :- when carboxylic acid is treated with alcohol, in presence of conc. H_2SO_4 , ester is formed. The reaction is reversible.



② From acid chloride :- when acid chloride is treated with alcohol, ester is formed.



③ From Silver salt of carboxylic acid :-
when silver salt of carboxylic acid is heated with alkyl halide ester is formed.



Physical properties of esters

① Physical state :- Lower members of esters are pleasant smelling, neutral liquids but higher members are colourless and odourless solids. It has characteristic fruity smell.

Ester : Amyl acetate Amyl butyrate Ethyl butyrate
Flavor : Banana Apricot Pineapple

Octyl acetate Benzyl acetate
orange Jasmine

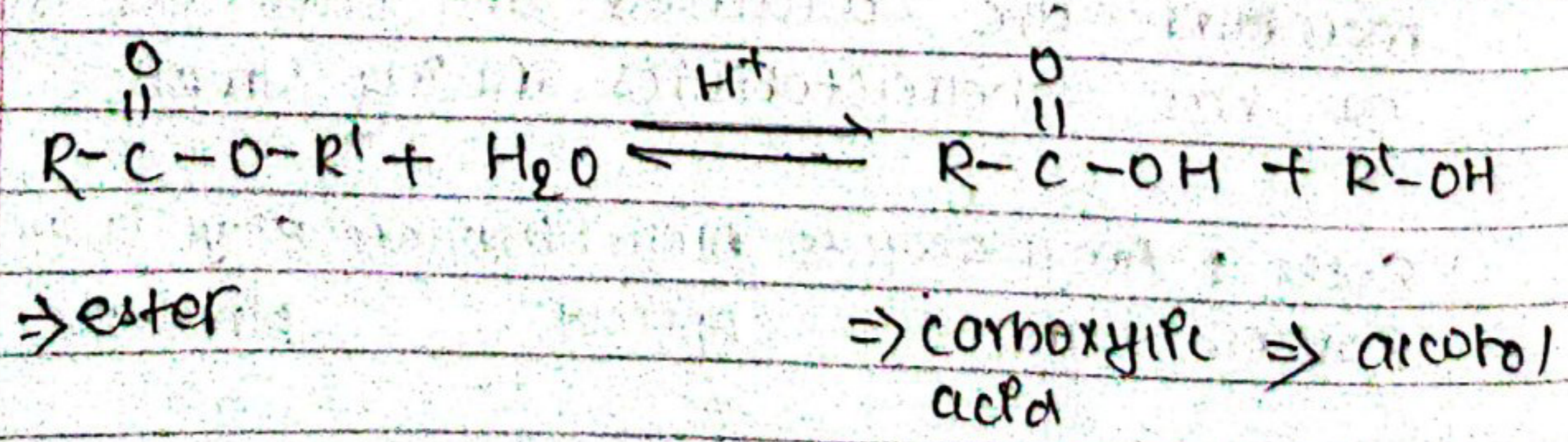
② Boiling points :- The boiling points of ethyl and methyl esters are lower than those of corresponding acids. This is due to the absence of intermolecular H-bonding in esters.

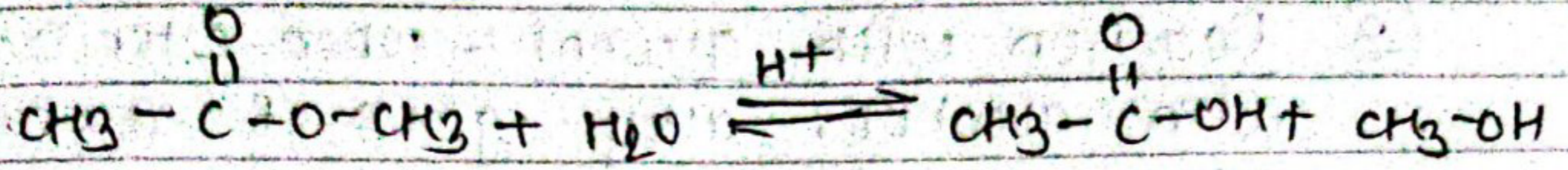
③ Solubility :- Lower ester are soluble in water but the solubility in water decreases with increase in the number of carbon atoms in the molecule. Esters are soluble in organic solvents like:- alcohol, ether etc.

Chemical properties of esters

Note :- esters are less reactive than acid chlorides and acid ~~hydroxides~~ anhydride.

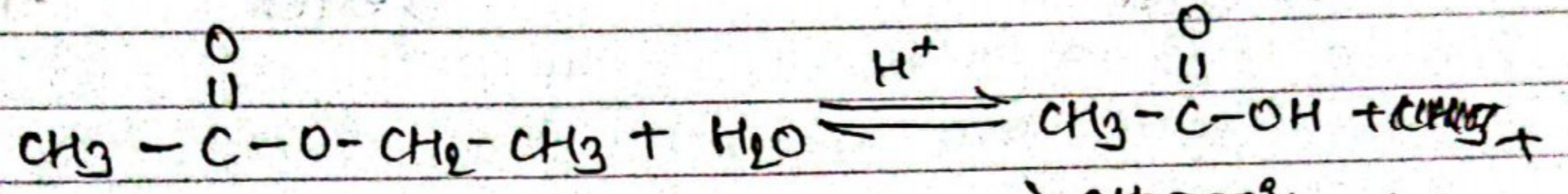
① Hydrolysis :- when ester is hydrolysed in acidic medium alcohol and carboxylic are formed.





⇒ methyl ethanoate

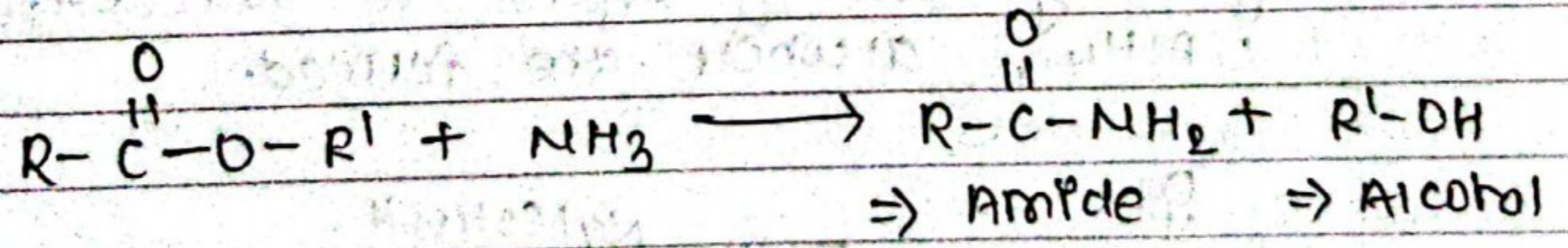
⇒ ethanoic acid ⇒ methanol



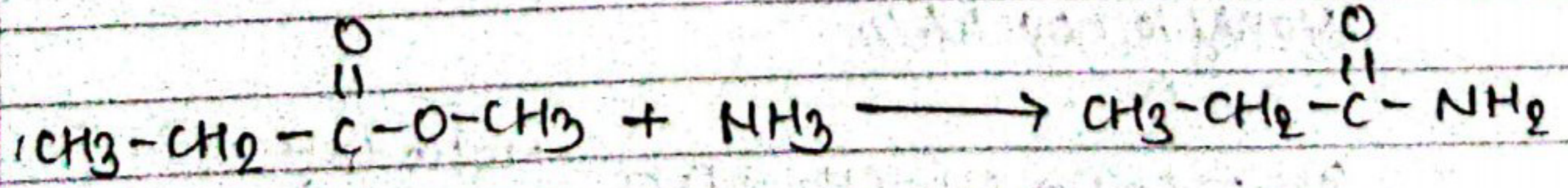
⇒ ethanoic acid

⇒ ethanol

② Reaction with NH₃ [Ammonolysis] :- when ester is treated with NH₃, amide and alcohol is formed.



⇒ ester

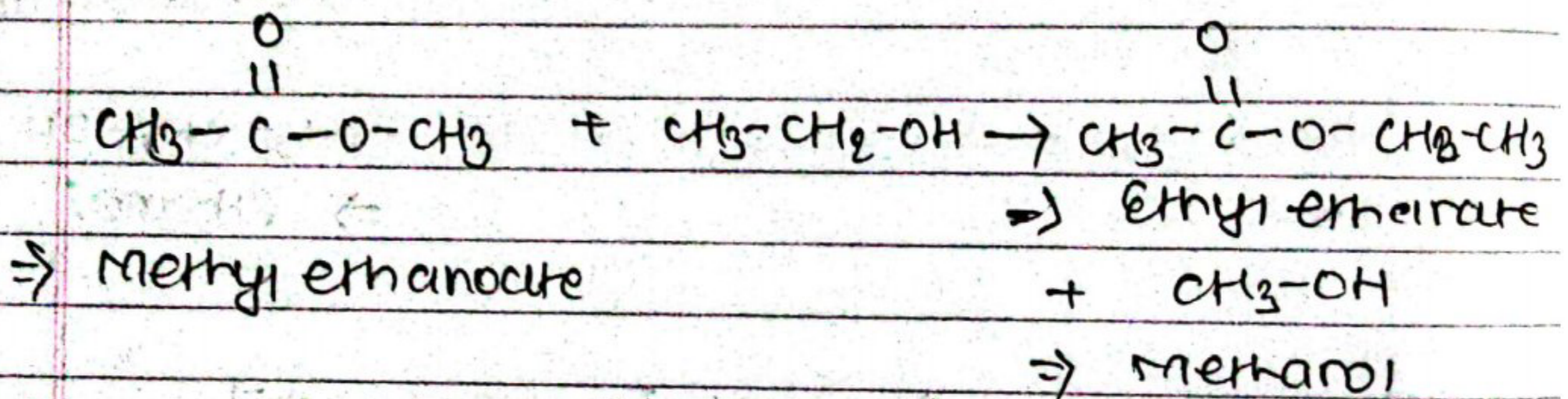
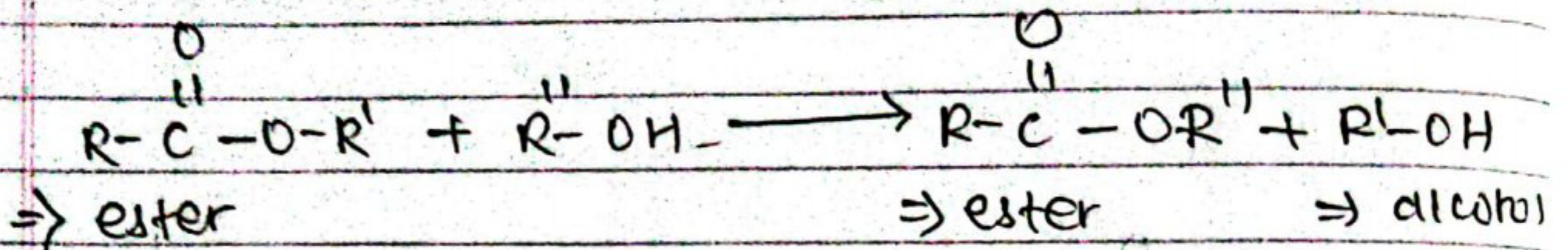


⇒ methyl propanoate

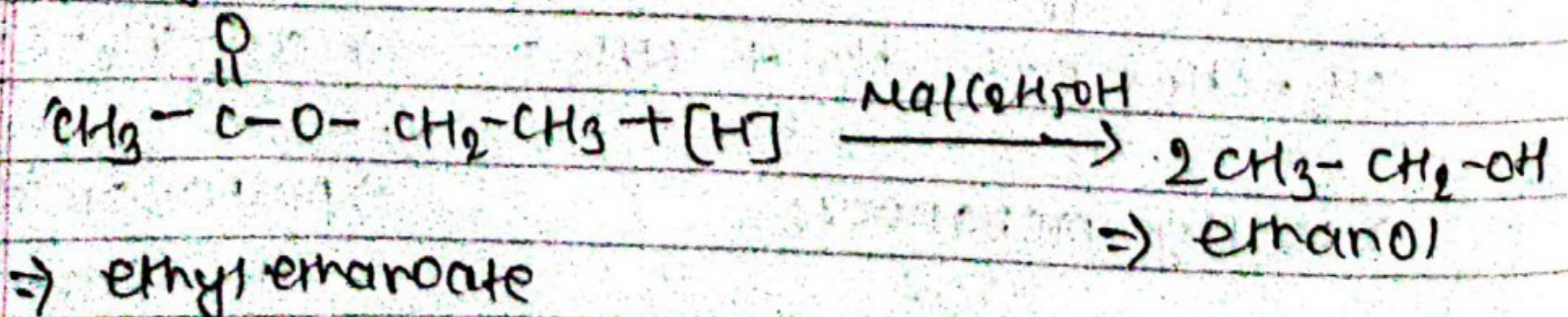
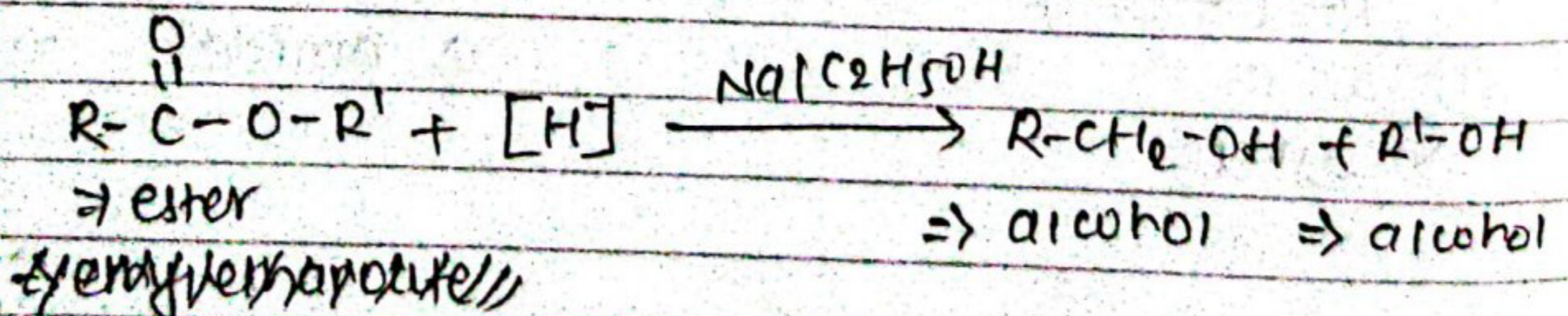
⇒ propanamide

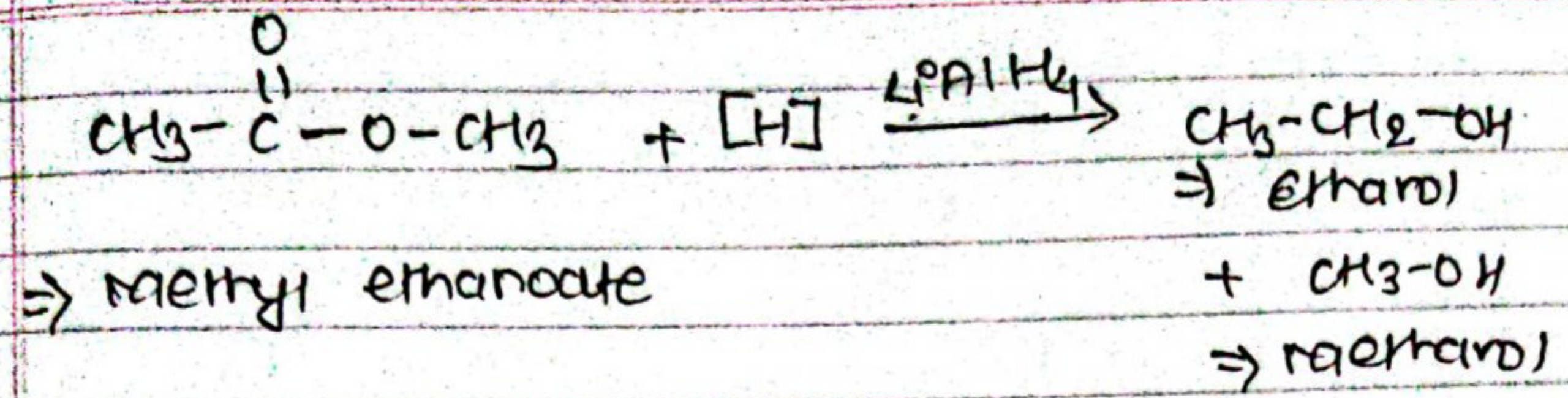
+ CH₃-OH
⇒ methanol

③ Reaction with alcohol :- when ester is treated with alcohol, alkyl group of alcohol is exchanged with alkyl group of ester.

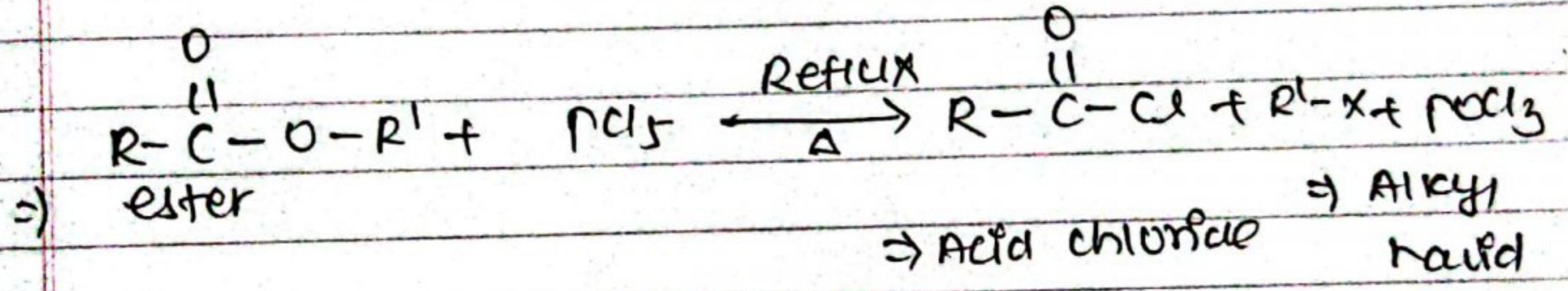


4) Reduction of ester :- when ester is reduced by using reducing agent like $\text{Na/C}_2\text{H}_5\text{OH}$ or LiAlH_4 , alcohols are formed.

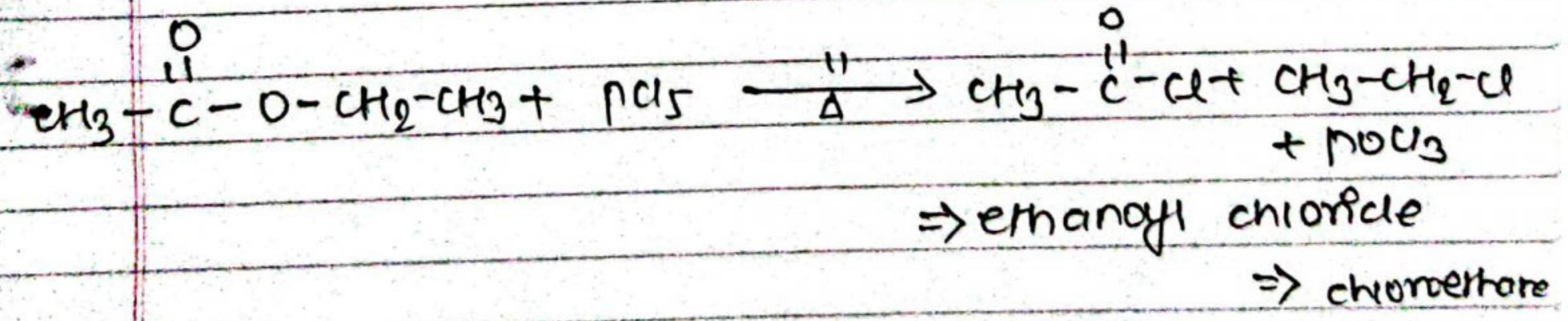


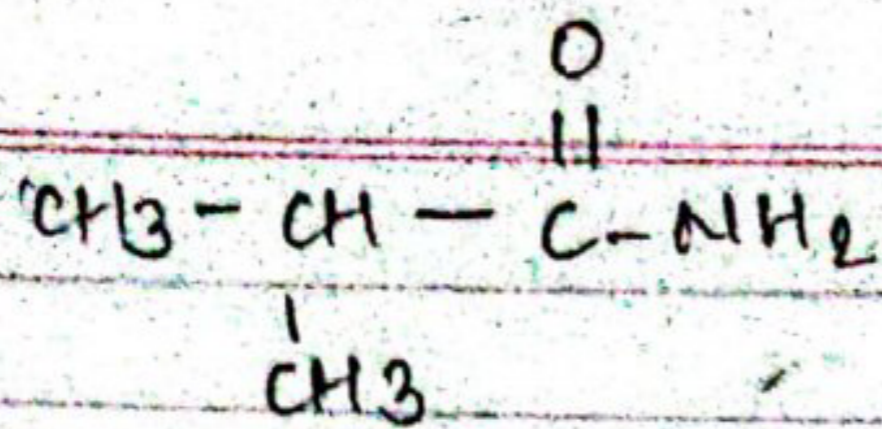


(f) Reaction with PCl_5 :- when ester is treated with PCl_5 , acid chloride and alkyl halide are formed.



\Rightarrow phosphoryl chloride



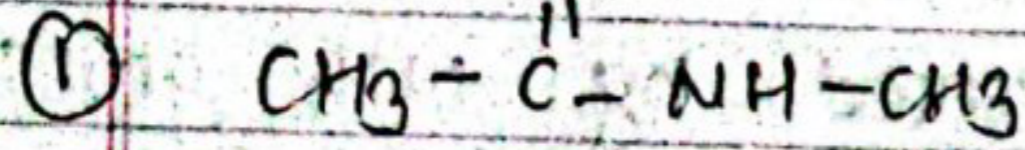


⇒ 2-methyl propanamide

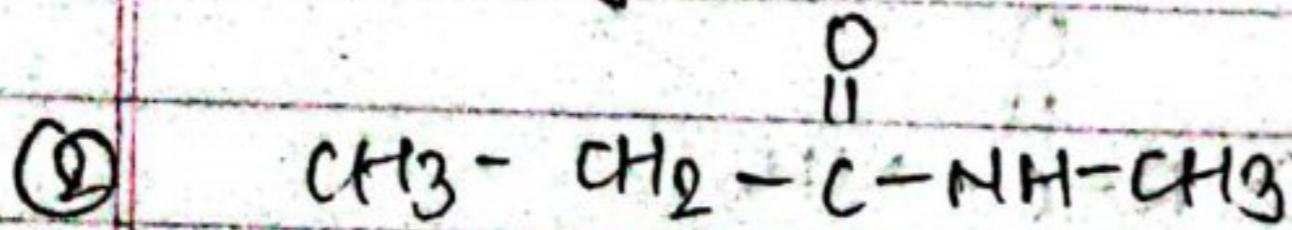
(b) Secondary

General formula :- N-alkyl alk + an + amide

↓ ↓ ↓ ↓
prefix with P.I S.B



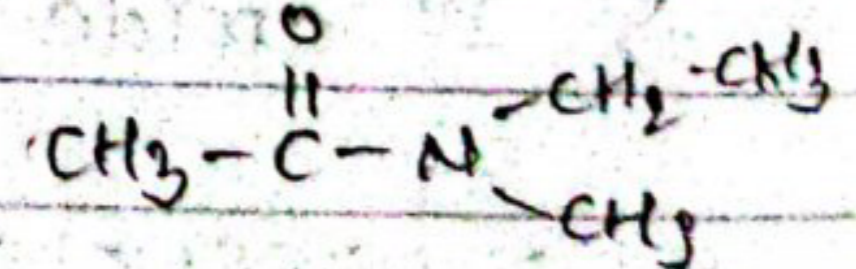
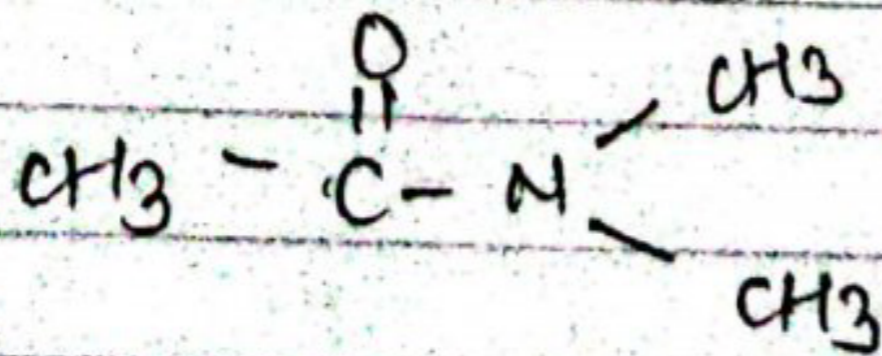
⇒ N-methyl ethanamide



⇒ N-methyl propanamide

(c) Tertiary :-

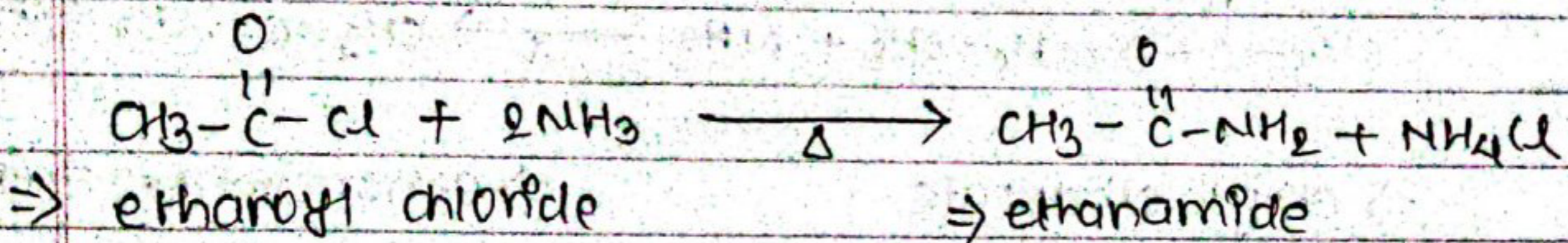
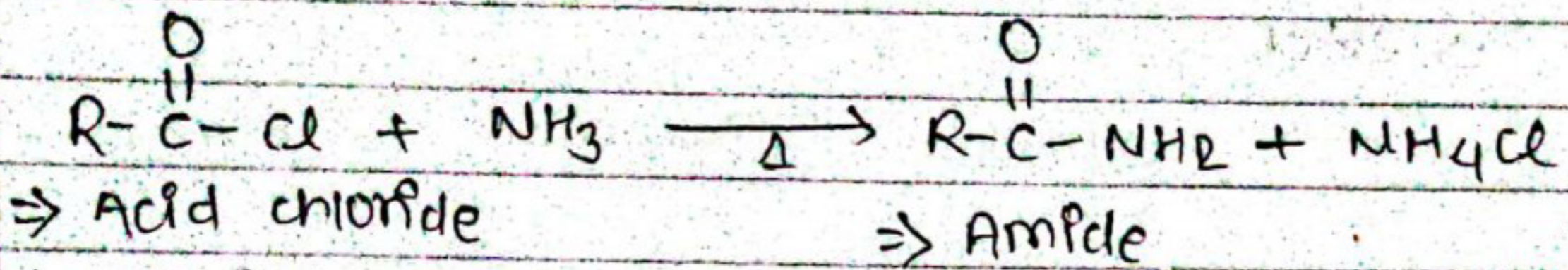
General



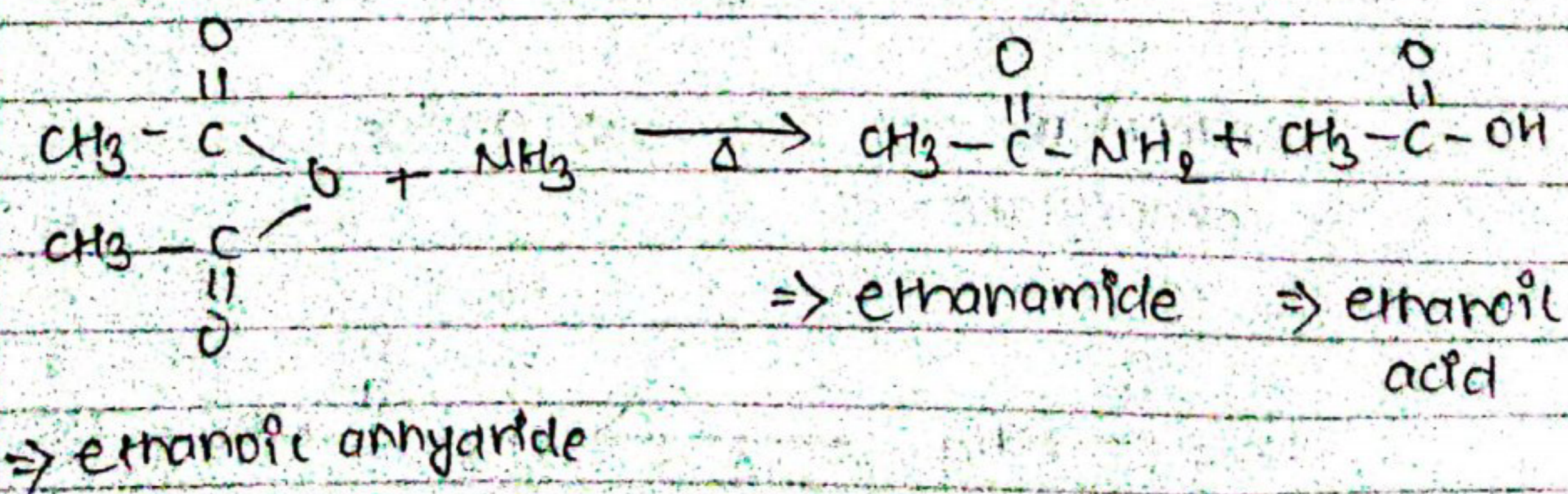
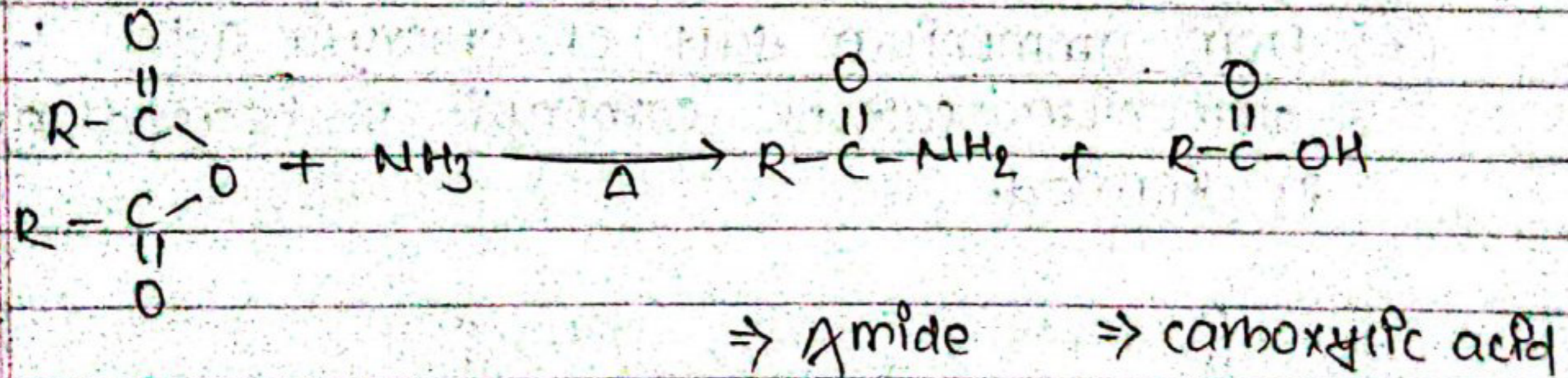
⇒ N,N-dimethyl ethanamide ⇒ N-ethyl N-methyl ethanamide

General Methods of Preparation of Amides

① From derivatives of carboxylic acid :- when derivatives of carboxylic acids are treated with NH_3 amides are formed.

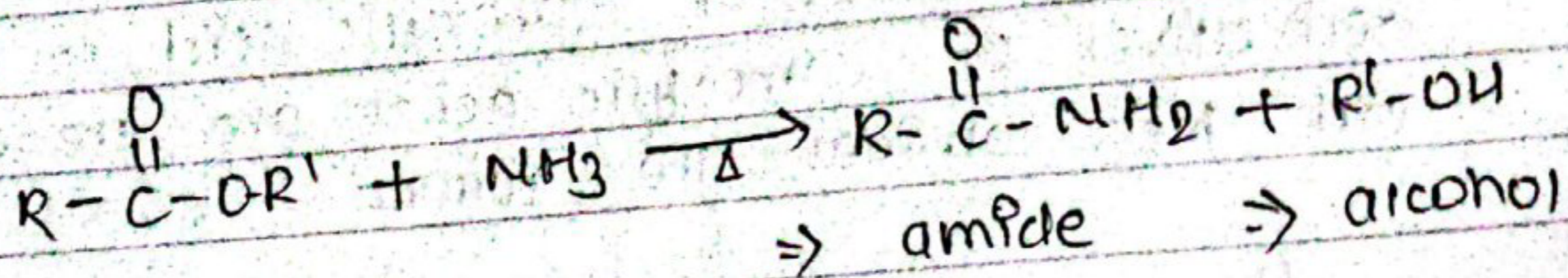


from acid anhydride

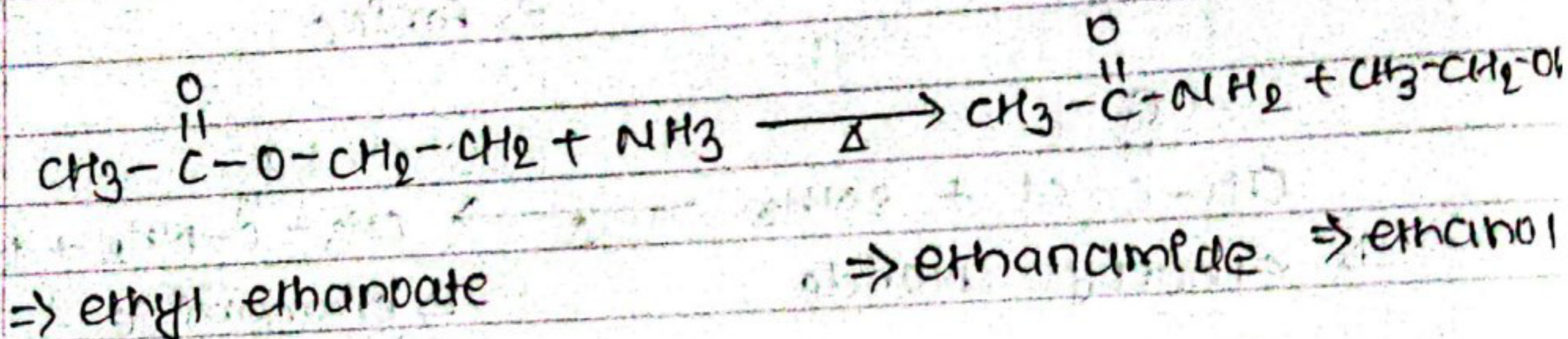


(3) Reaction

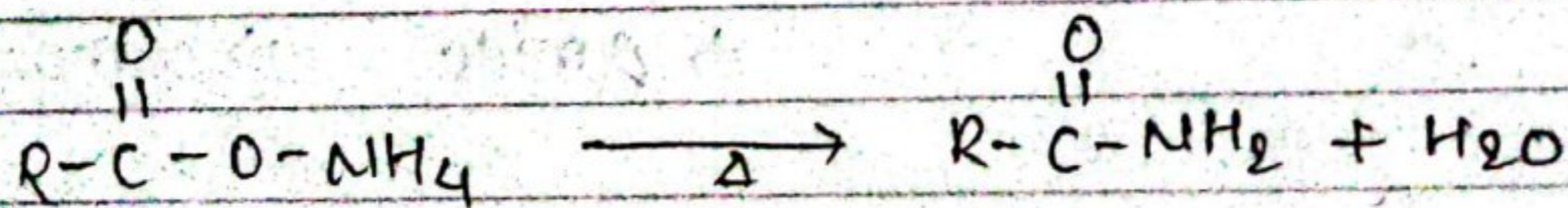
from ester :-



⇒ ester

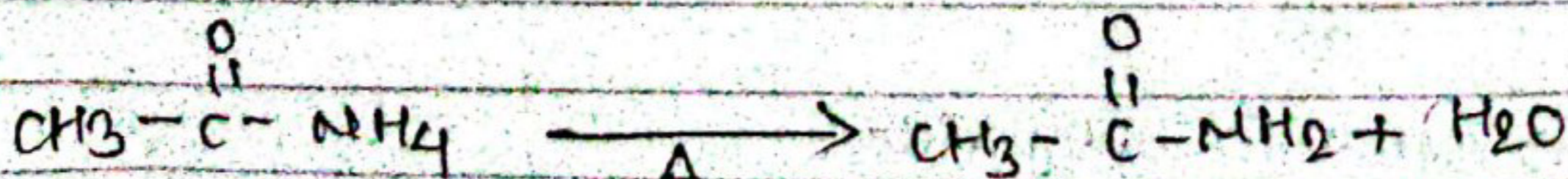


(2) From ammonium salt of carboxylic acid :- when ammonium salt of carboxylic is heated amide is formed.

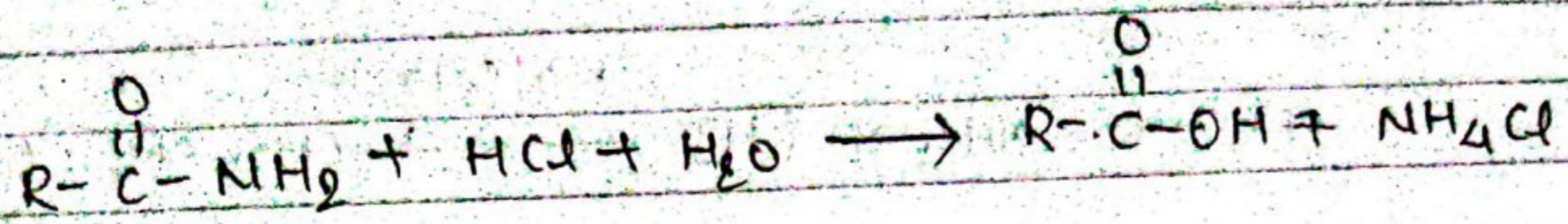


⇒ Ammonium
carboxylate

⇒ amide

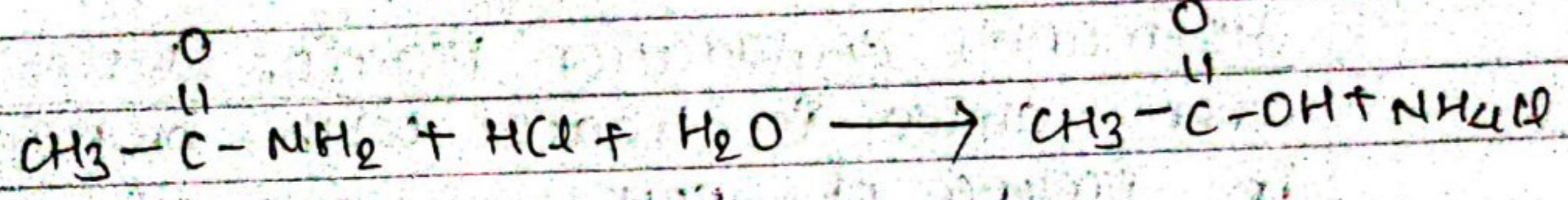


(a) In acidic medium :-



⇒ amide

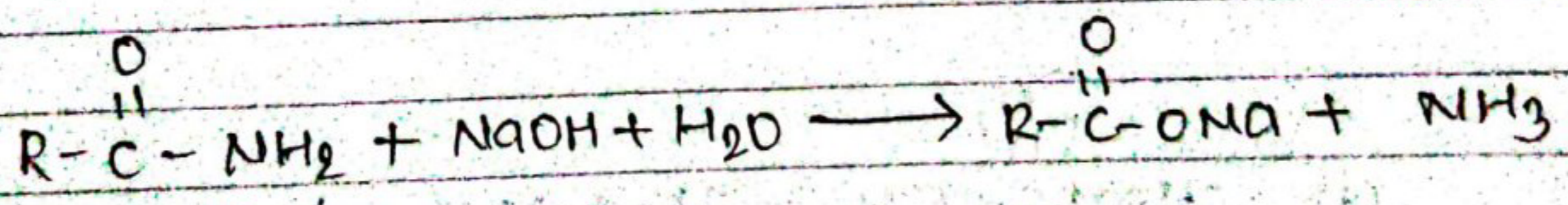
⇒ carboxylic acid



⇒ ethanamide

⇒ ethanoic acid

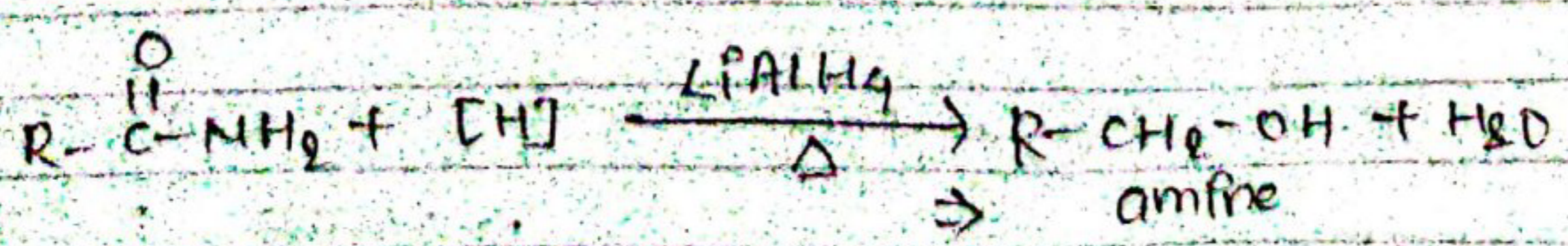
(b) In alkaline medium :-



⇒ ethanamide

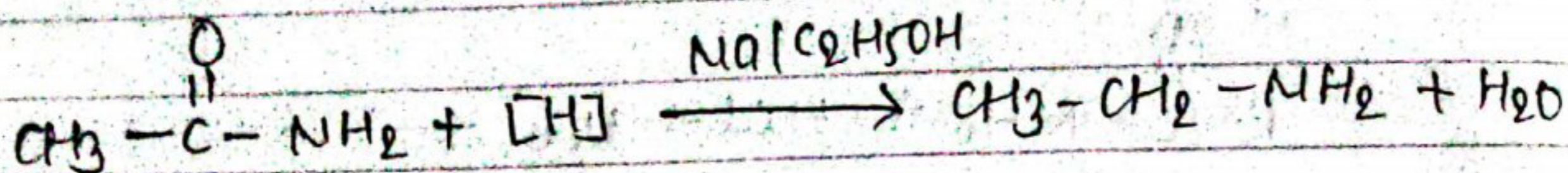
⇒ sod. ethanoate

(c) Reduction :- when amide is reduced by using $LiAlH_4$ or Na (or H_2 or $LiAlH_4$) amine is obtained.



⇒ Amide

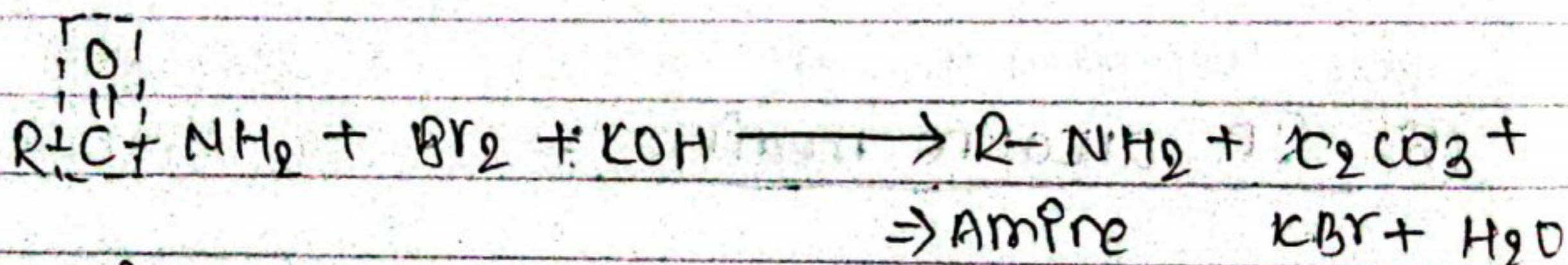
⇒ amine



⇒ ethanamide

⇒ ethanamine

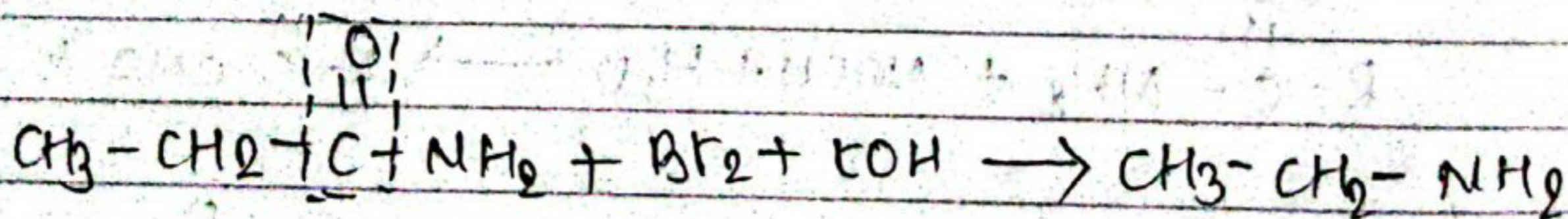
- ③ Hofmann's degradation reaction (Bromamide) :-
when amide is treated with bromine (Br₂)
in presence of KOH or NaOH primary
amine is formed.



⇒ Amide

⇒ Amine

KBr + H₂O

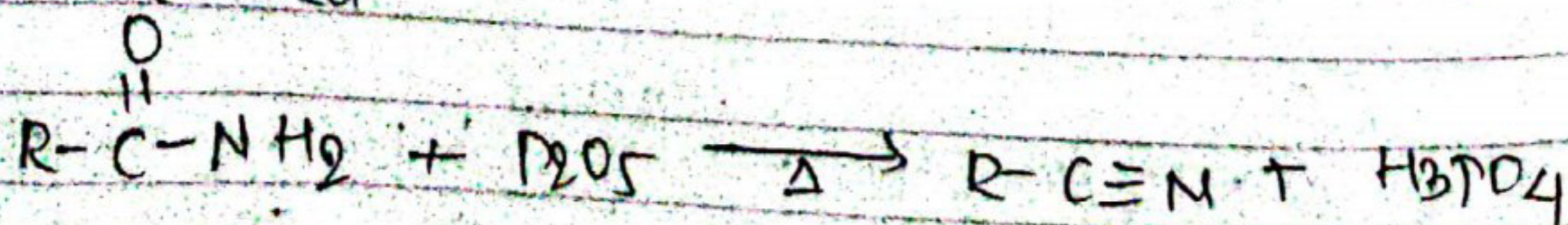


⇒ propanamide

⇒ ethanamine

+ KBr + K₂CO₃ + H₂O

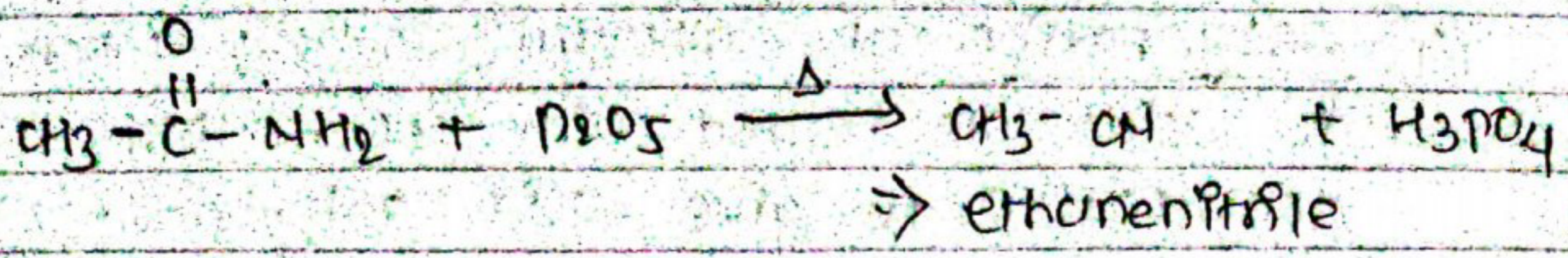
- ④ Reaction with P₂O₅ (dehydration of amide) :-
when amide is heated with P₂O₅, nitrile
is formed.



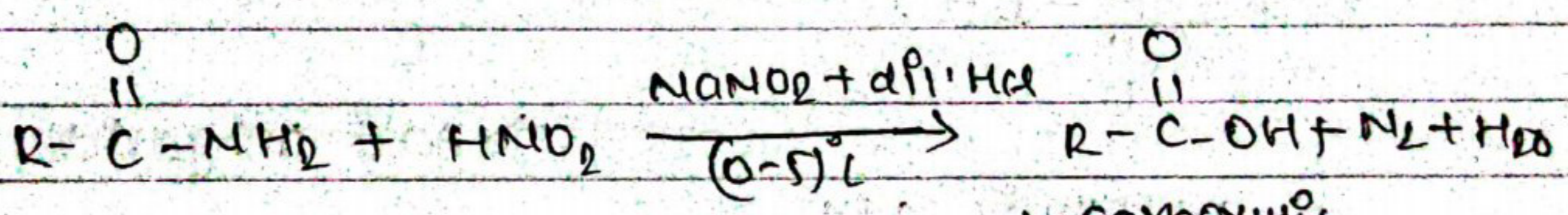
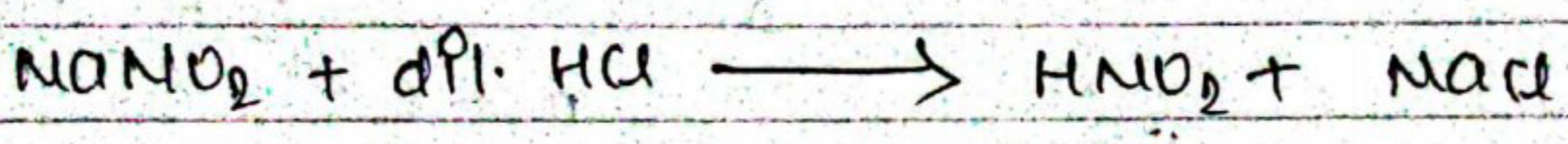
⇒ amide

⇒ nitrile

⇒ phosphoric acid



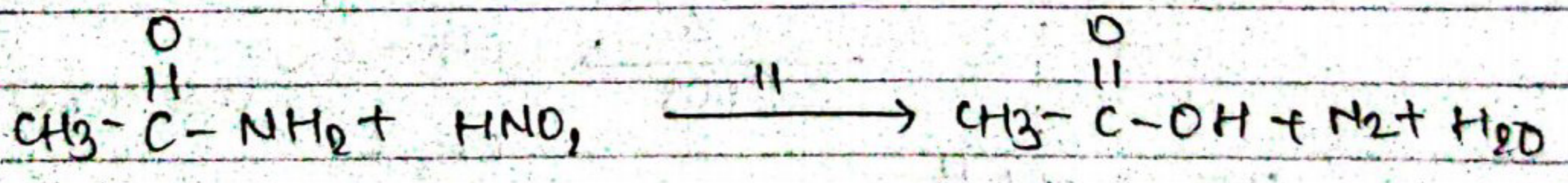
⑤ Reaction with HNO₂ (nitrous acid) :- when amide is treated with HNO₂, carboxylic acid is formed.



⇒ amide

⇒ nitrous acid

⇒ carboxylic acid



⇒ ethanamide

⇒ ethanoic acid