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**Class 11
Chemistry**

Chapter 21
Organic Synthesis
Handwritten Notes

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①

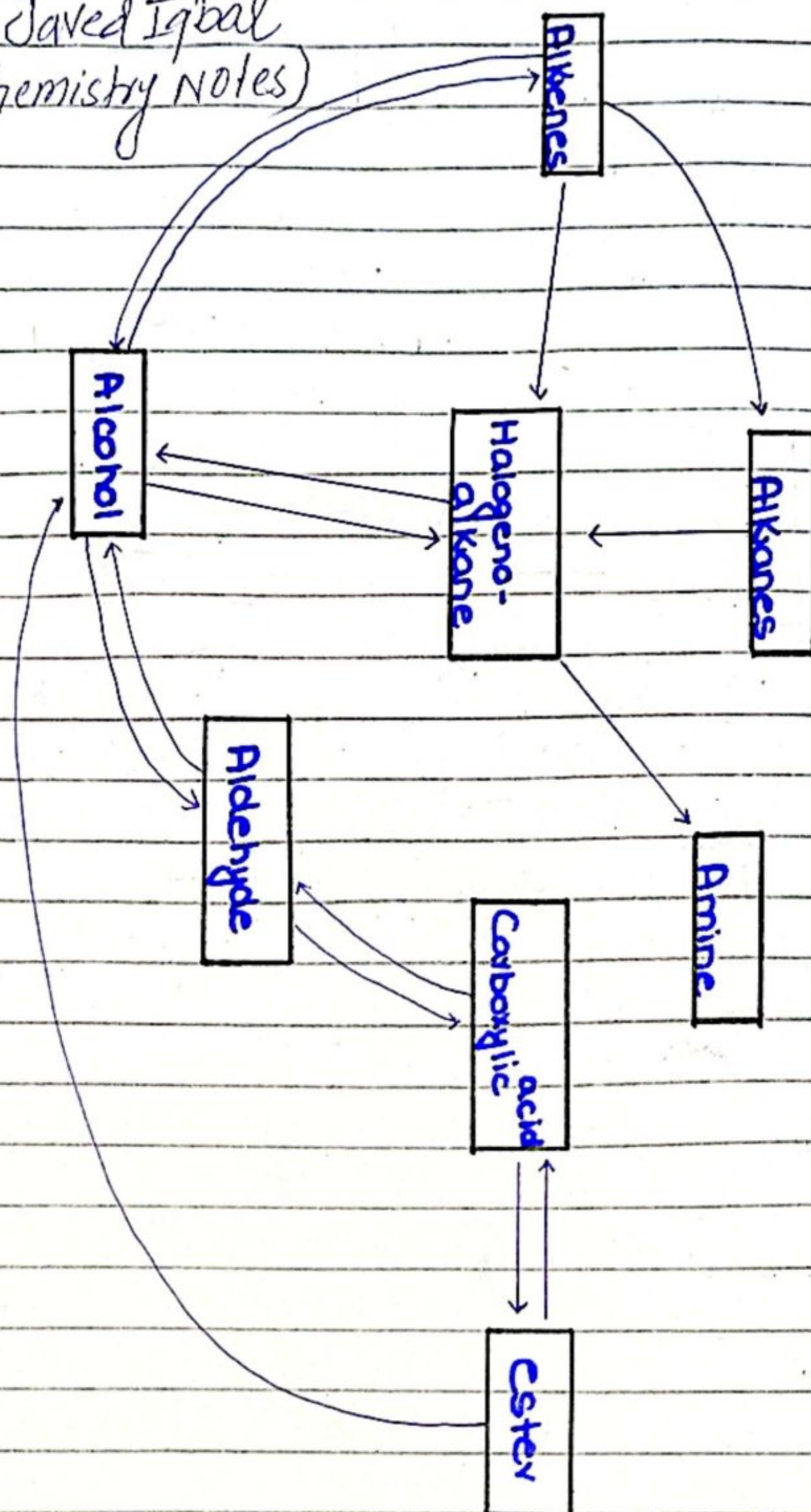
Chapter: 21

ASKARIA College PWD Islamabad

Organic Synthesis.

Important Organic Reactions.

Sir Javed Iqbal
(Chemistry Notes)



(2)

Applications:

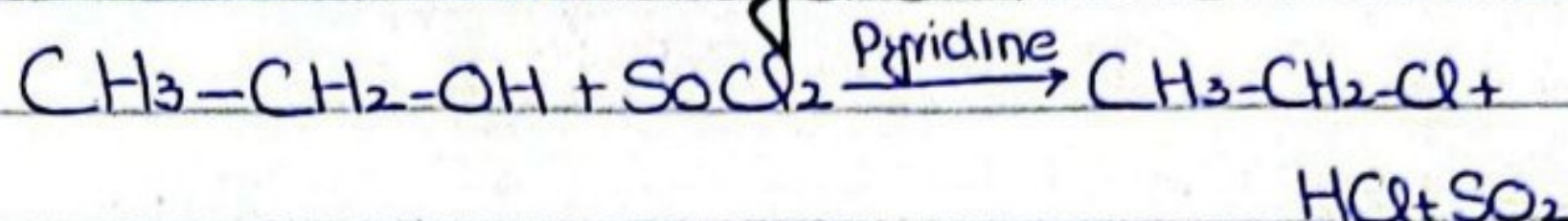
1. Halogenoalkane $\longrightarrow$ Amines



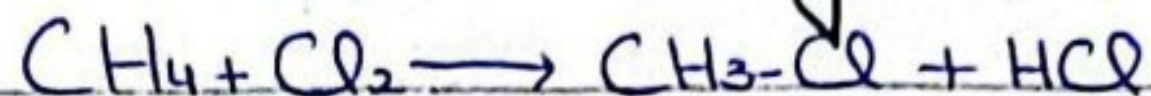
2. Halogenoalkane $\longrightarrow$ Alcohols



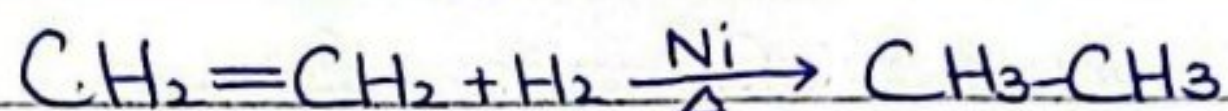
3. Alcohols $\longrightarrow$ Halogenoalkane



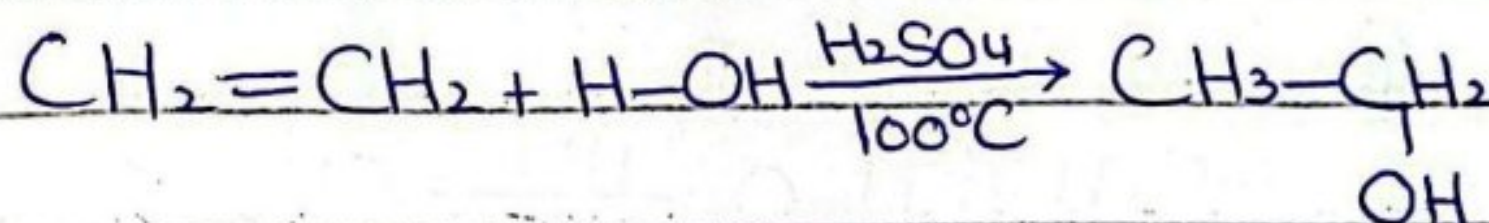
4. Alkane $\longrightarrow$ Halogenoalkane



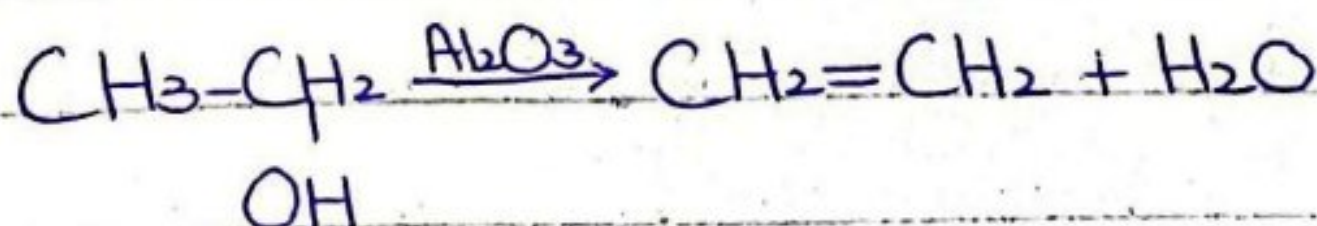
5. Alkene $\longrightarrow$ Alkane.



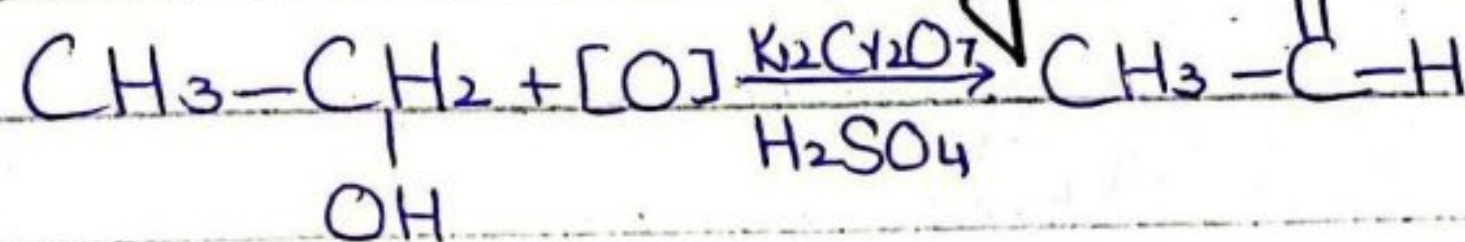
6. Alkene $\longrightarrow$ Alcohol



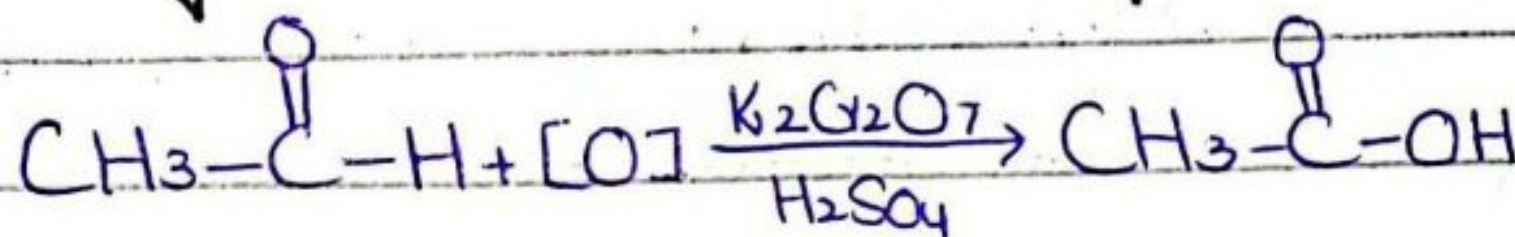
7. Alcohol $\longrightarrow$ Alkene



8. Alcohols $\longrightarrow$ Aldehyde

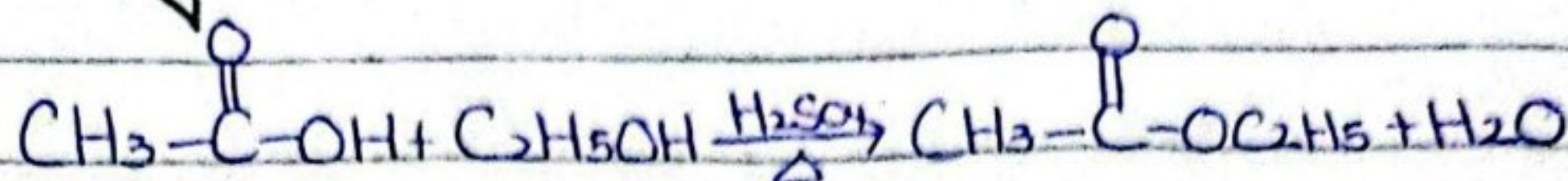


9. Aldehyde $\longrightarrow$ Carboxylic acid.

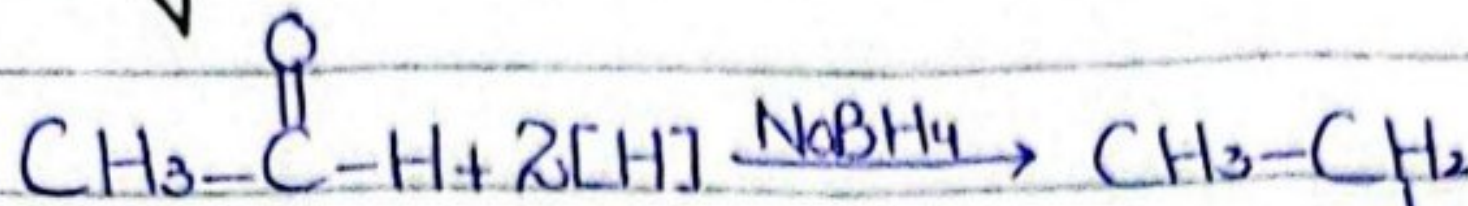


③

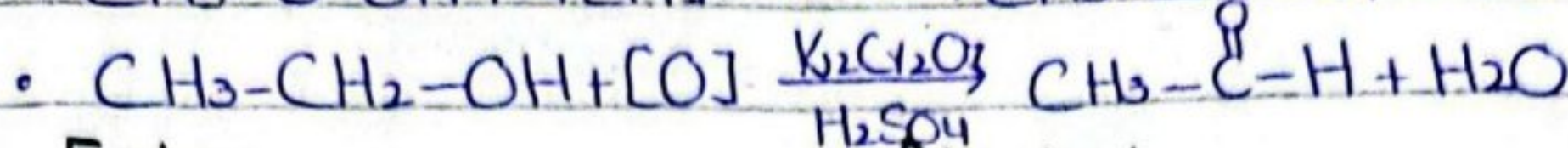
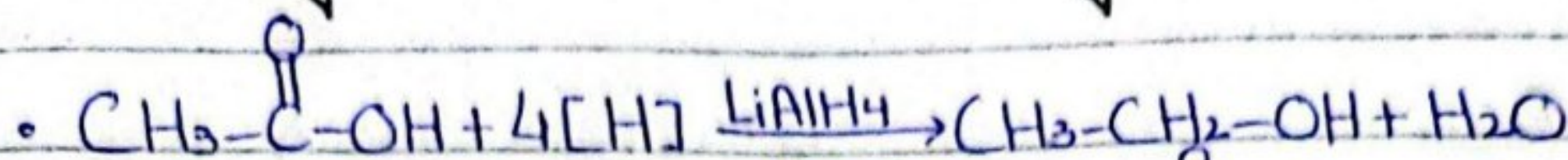
10. Carboxylic acid $\longrightarrow$ Ester



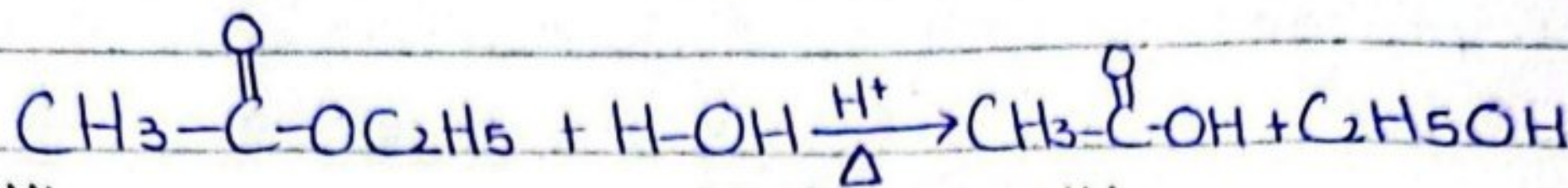
11. Aldehyde $\longrightarrow$ Alcohols



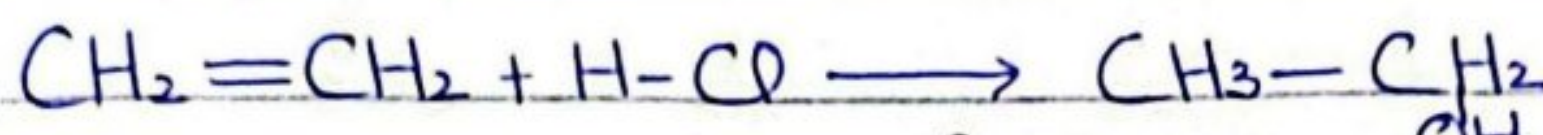
12. Carboxylic acid $\longrightarrow$ Aldehyde



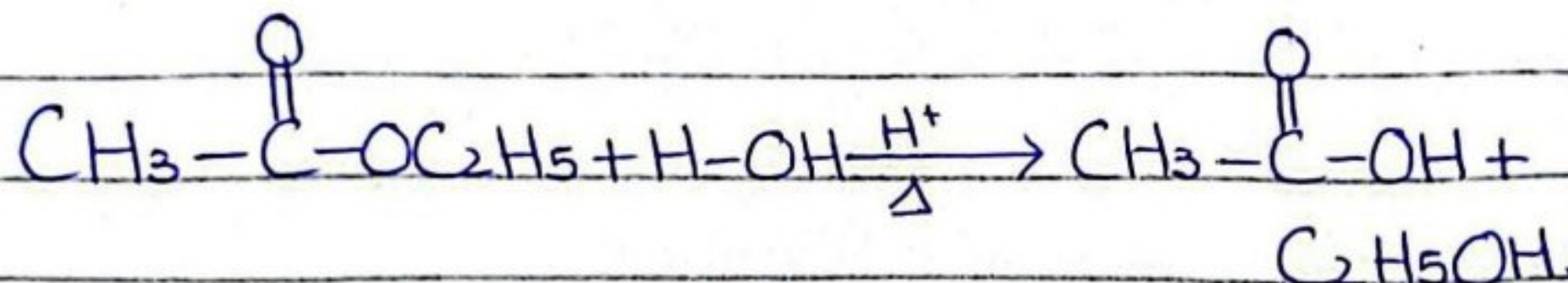
13. Ester $\longrightarrow$ Alcohol.



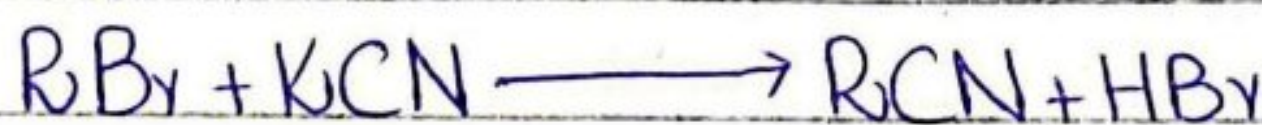
14. Alkene $\longrightarrow$ Halogenoalkane



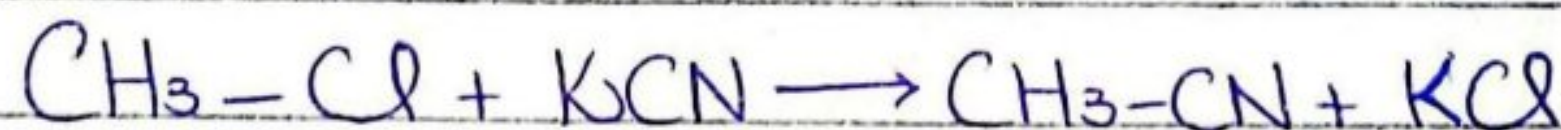
15. Ester $\longrightarrow$ Carboxylic acid.



Adding Carbon Atom
General Equation.



Reaction:



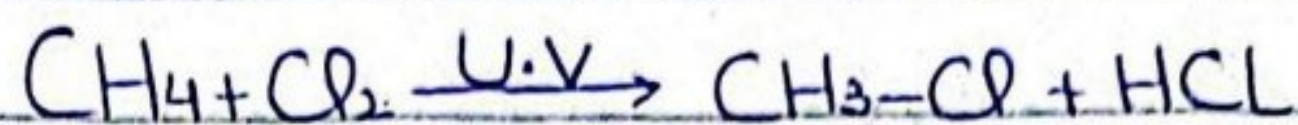
④

Preparation of Ethanoic Acid from Methane:



Step: 1

Methane to Chloromethane



Type of Reaction:

Free Radical Substitution

Step: 2

Chloromethane to Cyanomethane

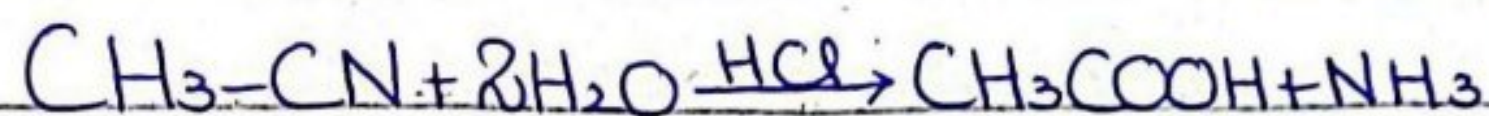


Type of Reaction:

Nucleophilic Substitution.

Step: 3

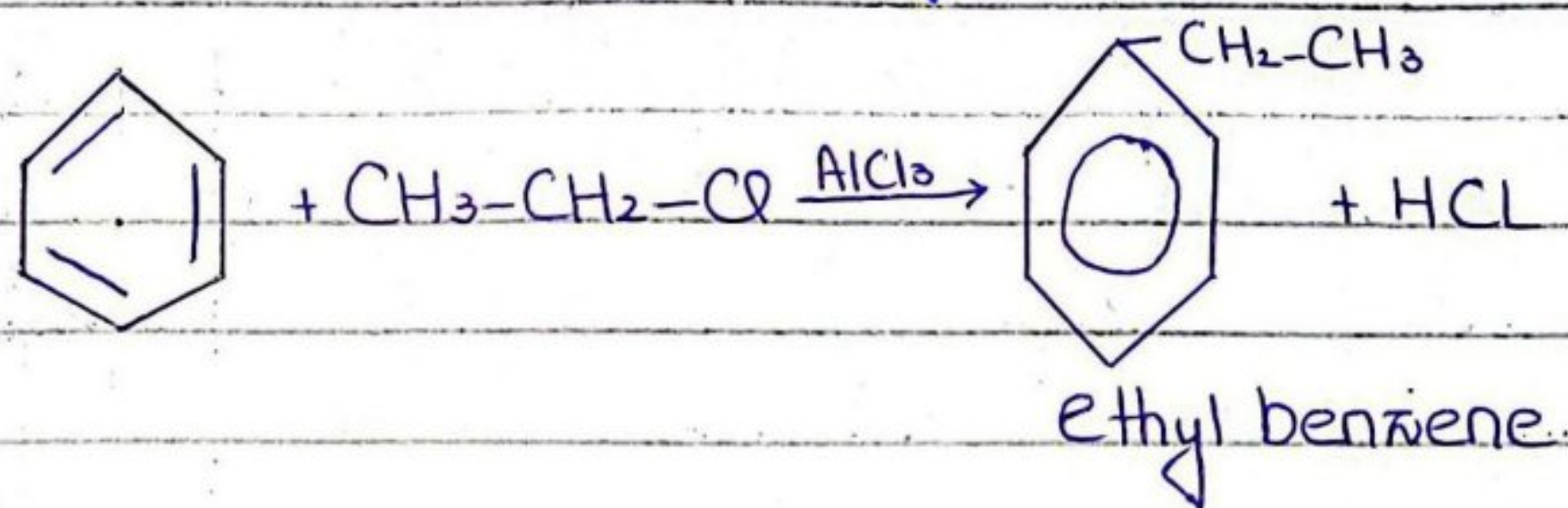
Cyanomethane to Ethanoic acid.



Type of Reaction:

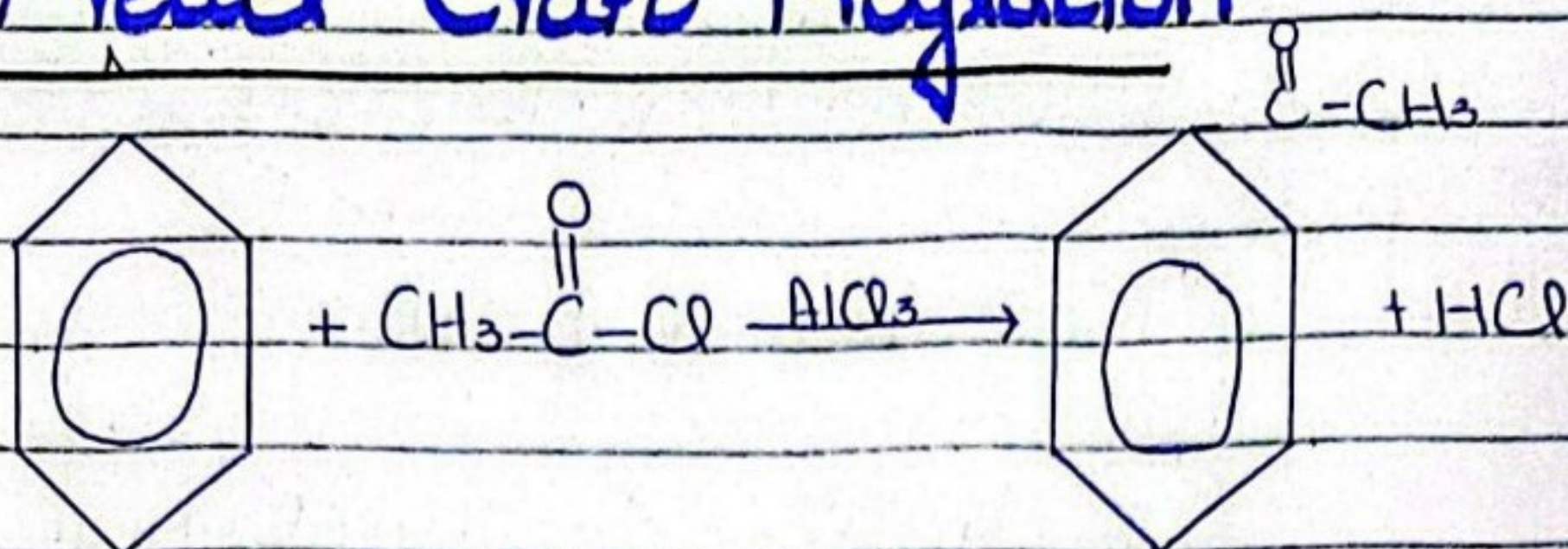
Hydrolysis.

Friedel Craft Alkylation:



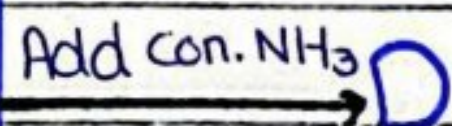
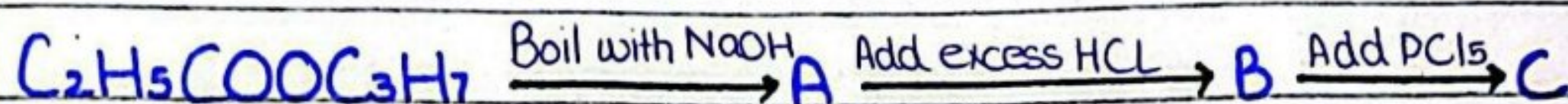
5

Friedel Craft Acylation

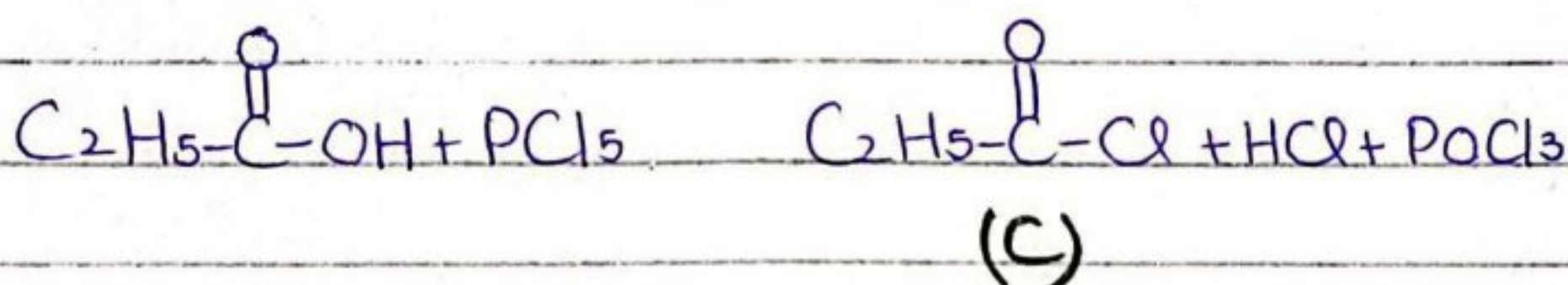
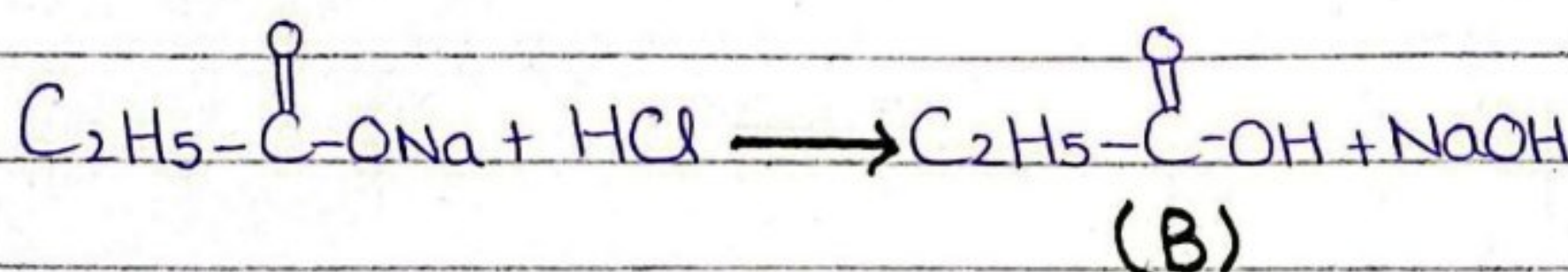
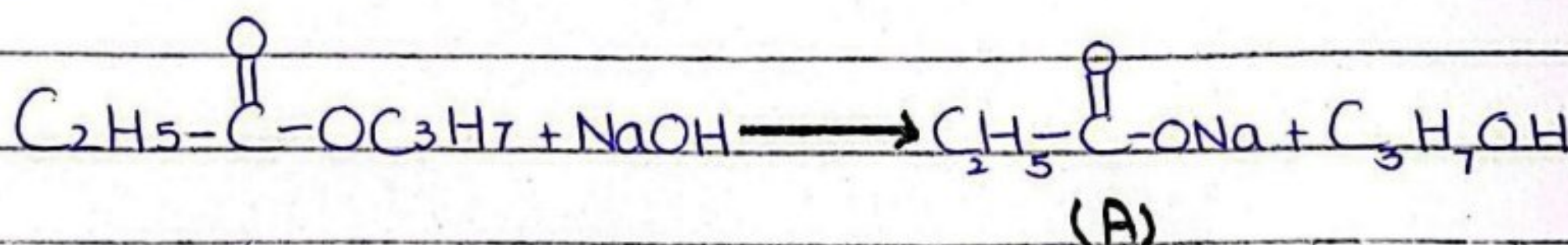


Concept Assessment: 21.1

Q1 (a) Name the organic products A to D in the synthetic route below:



Solution:



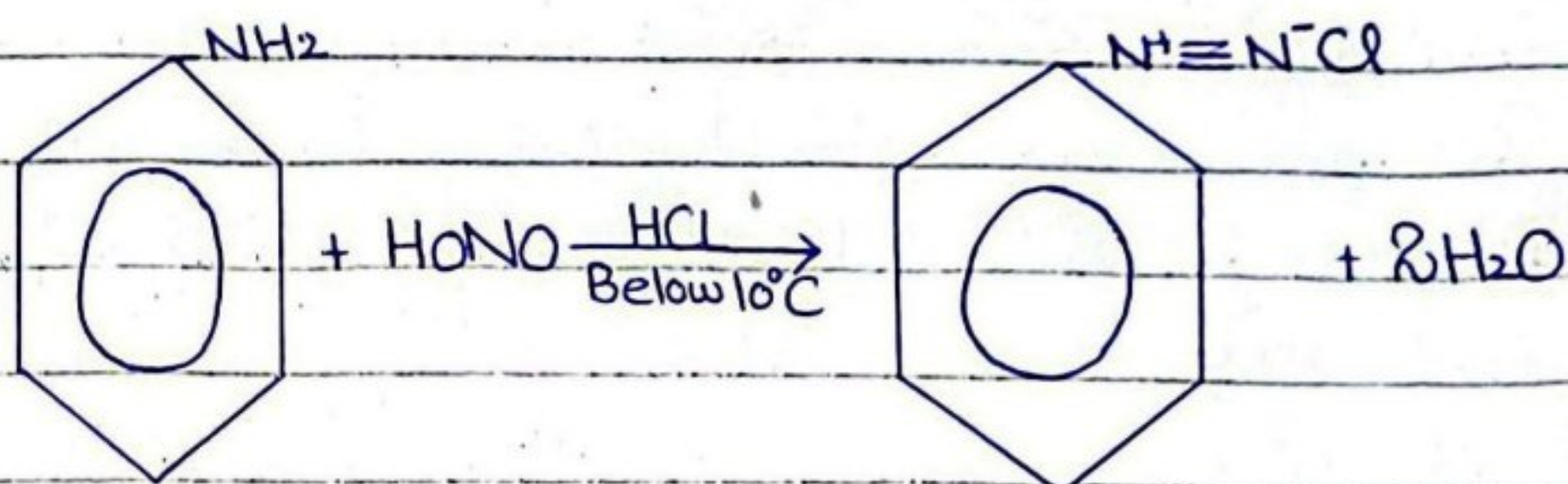
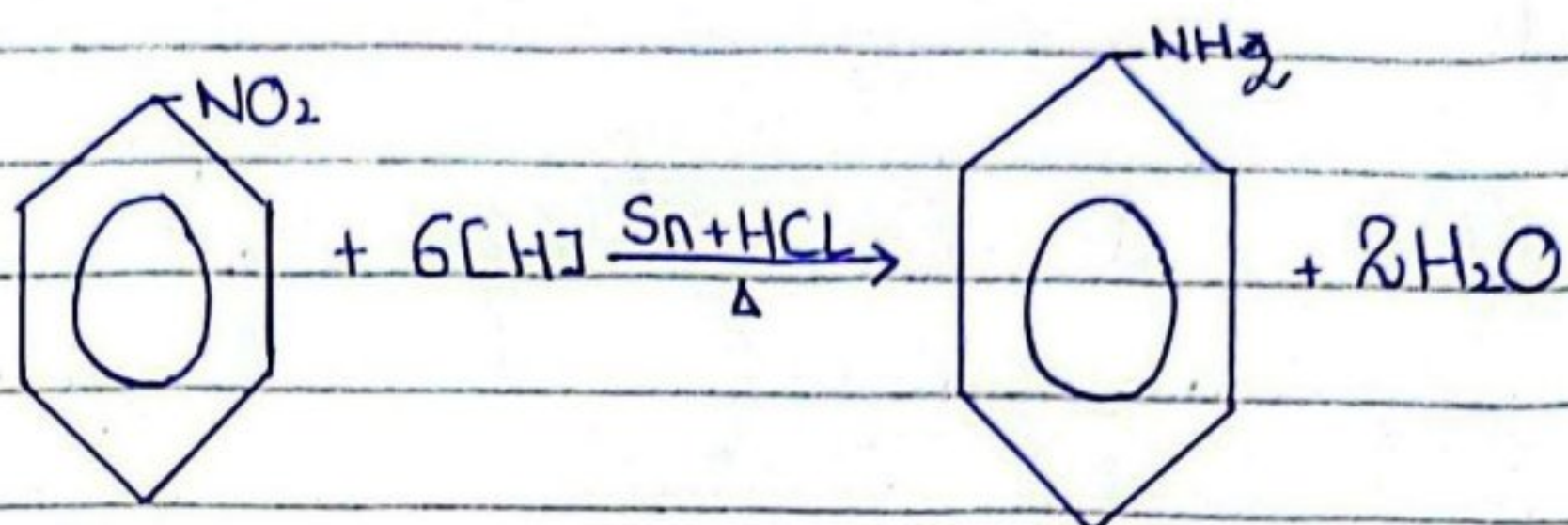
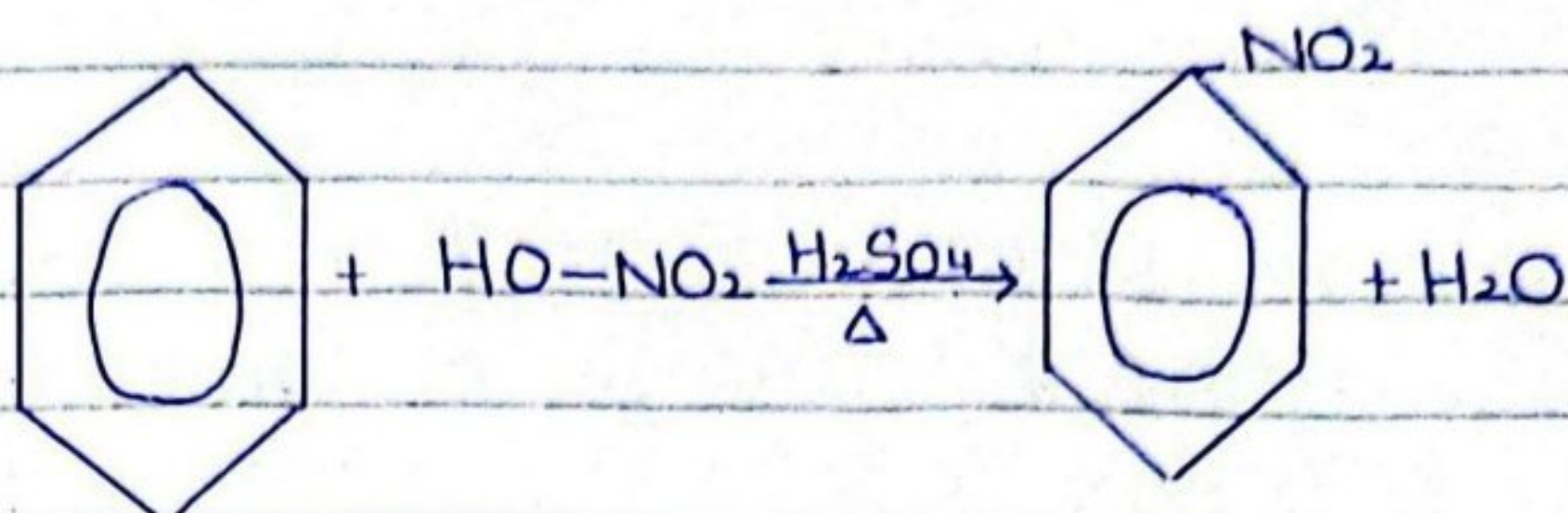
⑥



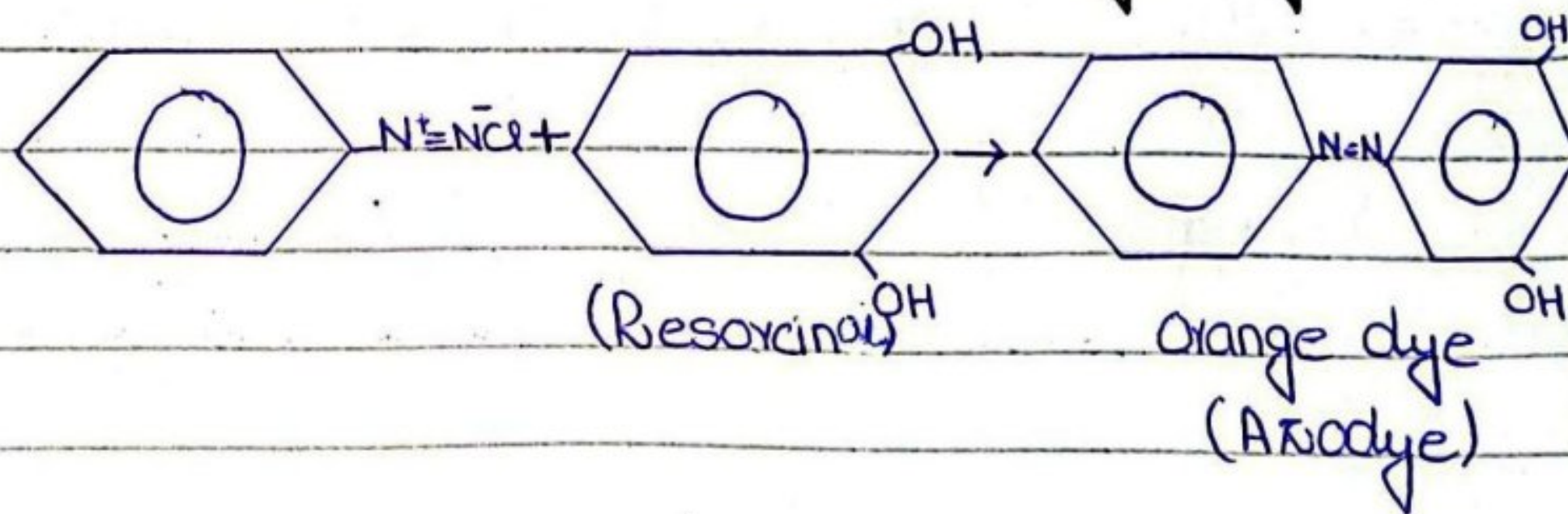
Q1(b)

(i) Devise a three-stage synthetic route to convert benzene into benzenediazonium Chloride.

Benzene $\longrightarrow$ Benzenediazonium Chloride



(ii) How would you convert the benzenediazonium chloride into an orange dye.



⑦

Test Used for the Identification of Functional Groups.

Following tests are used for the identification of functional groups.

Test: 1

Bromine Water test

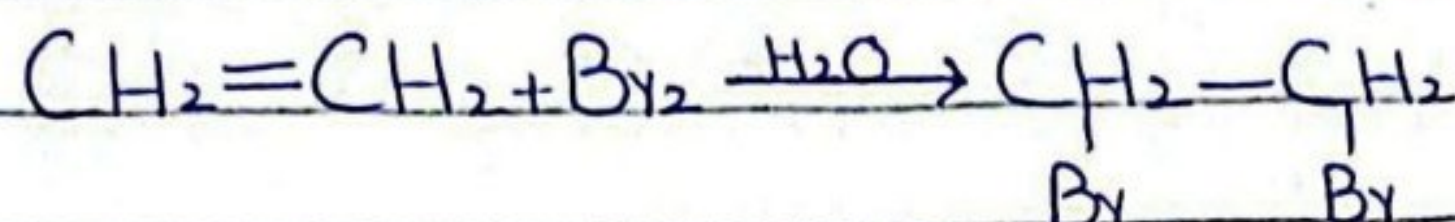
This test is used for the identification of unsaturation ($C=C$ / $C\equiv C$) in an organic compound.

Reagent:

Aqueous Bromine.

Observation with alkene or alkyne:

Redish brown colour of bromine fades away.



Test: 2

Silver Nitrate Test:

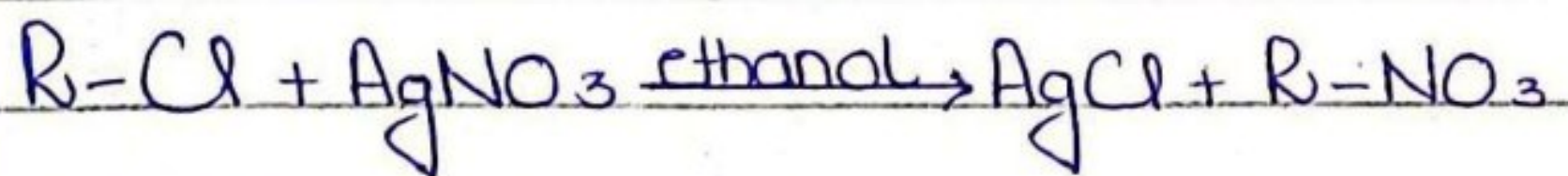
This test is used for identifying the halogen present in the given organic compound.

Reagent:

Aqueous Silver nitrate in ethanol.

Observation with chloro alkane:

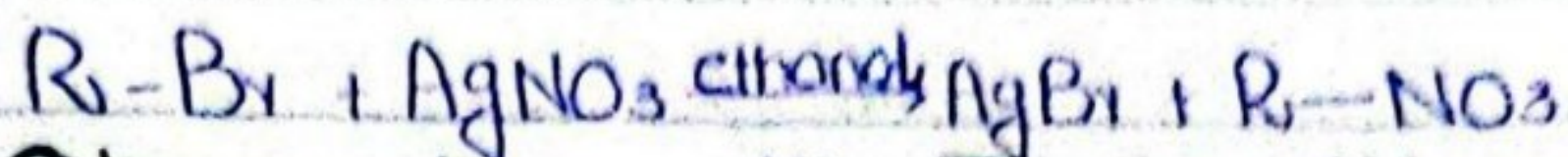
White ppt of $AgCl$ is formed.



(8)

Observation with Bromo alkane.

Cream ppt of AgBr is formed



Observation with Iodo alkane.

Yellow ppt of AgI is formed

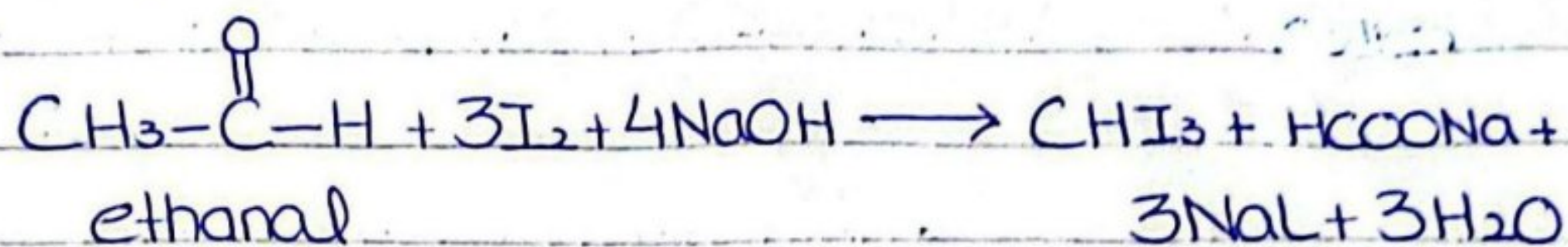


Test: 3

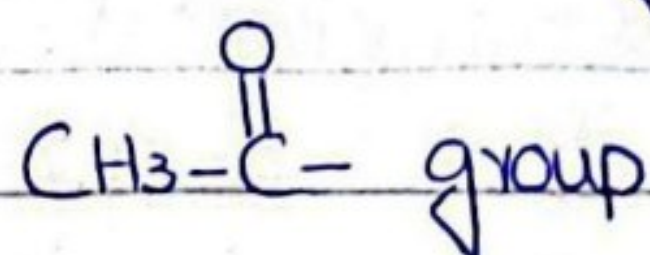
Iodoform Test

This test is given by alcohols, aldehydes and Ketones.

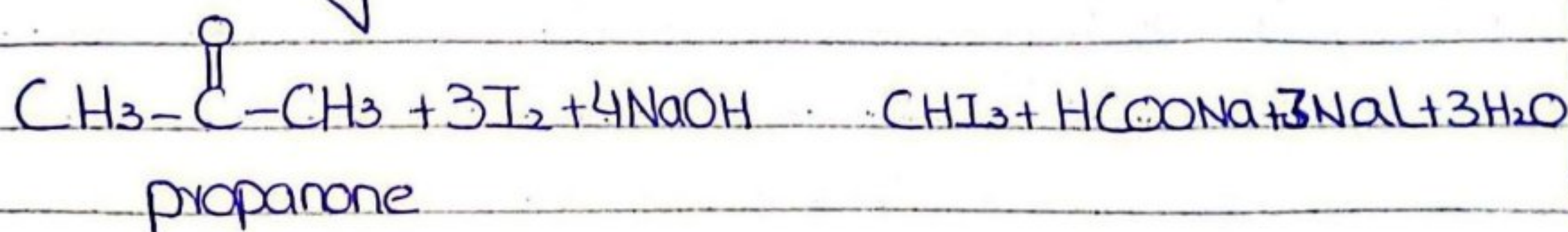
1. In primary alcohols, only ethanol will give this test positive
2. In Secondary alcohols, only those alcohol will give this test which contain $\text{CH}_3-\underset{\text{OH}}{\text{CH}}$
3. This test is not given by tertiary alcohols
4. In aldehyde, only ethanal will give this test positive



5. In Ketones only those Ketones will give this test which contain



i.e Methyl Ketone



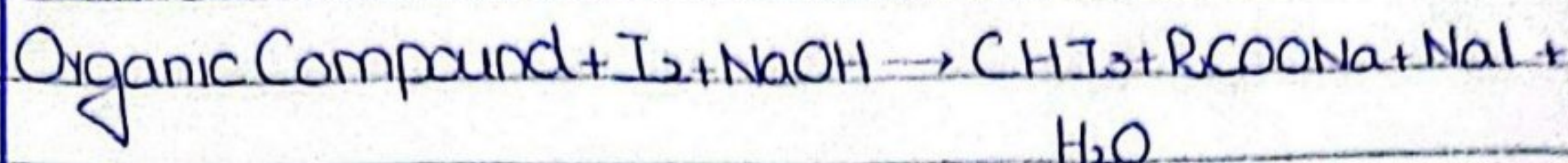
(9)

Reagent:

Iodine and aqueous sodium hydroxide

Observation:

Yellow ppt of triiodomethane (CHI_3) is formed



Test: 4

2,4-Dinitrophenyl hydrazine Test.

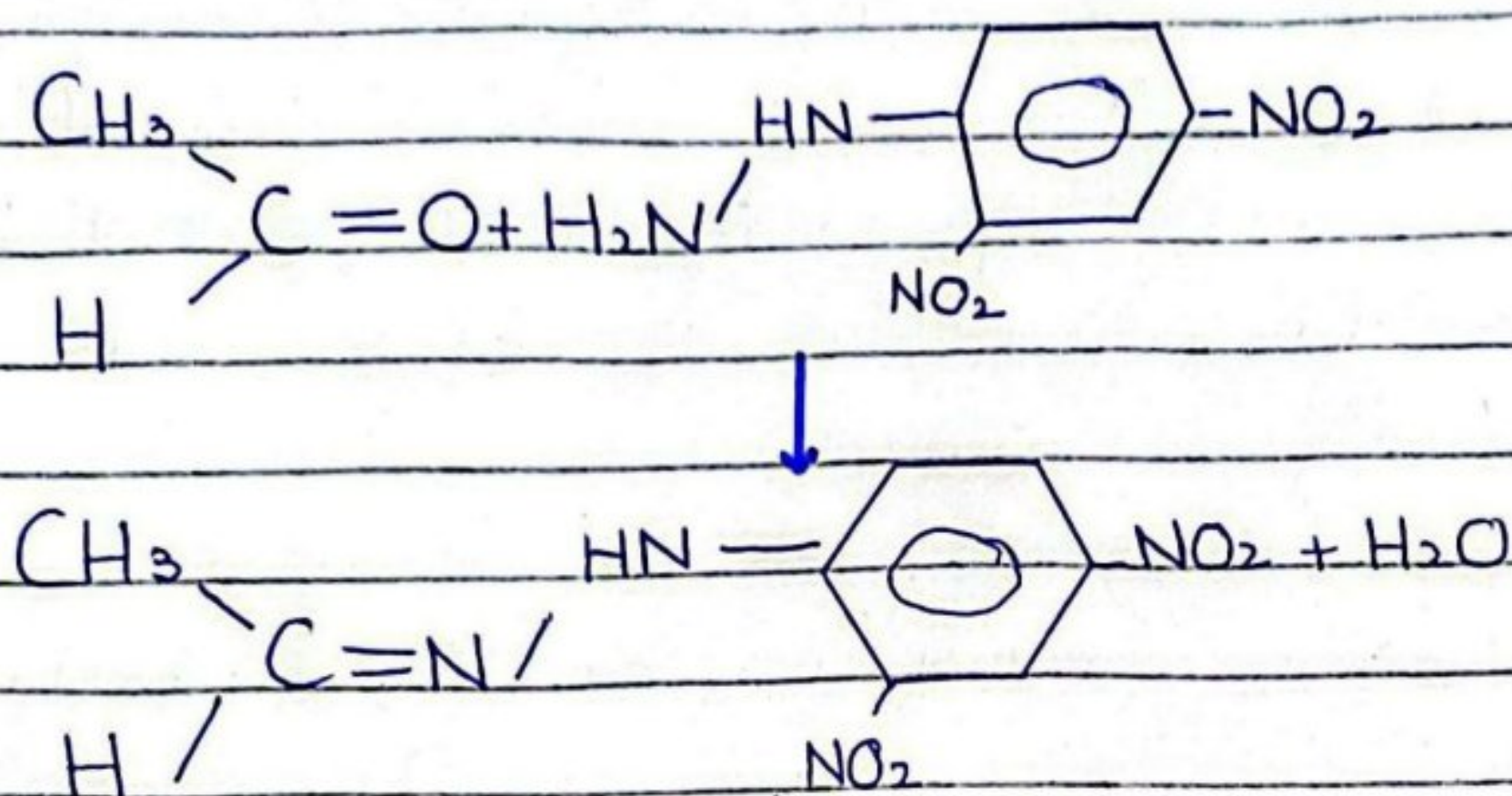
This test is used for identifying Carbonyl Compound i.e Aldehyde and Ketones.

Reagents:

2,4-dinitrophenyl hydrazine.

Observation:

Yellow/orange precipitate of dinitrohydrazone is formed.



Test: 5

Fehling's Solution test:

This test is given by aldehydes only. This test is used to differentiate aldehydes from ketones.

10

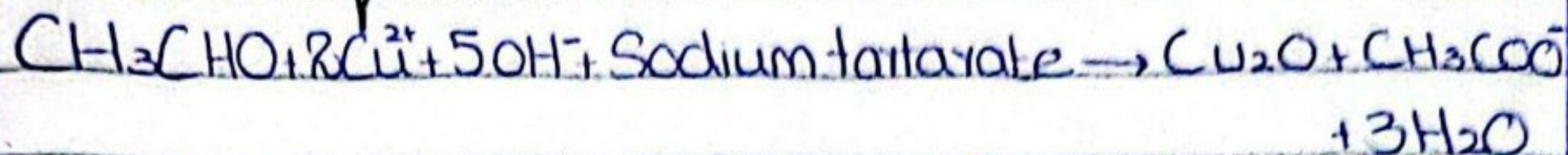
Reagent

Fehling Solution (Mild oxidizing agent) is an alkaline solution of Cu^{2+} ion and sodium, potassium tartrate.

Observation

Brick red ppt of Cu_2O is formed with aldehyde
not with ketones

Ionic equation:



Test: 6

Silver Mirror Test / Tollen's Test.

This test is given by aldehydes only. This test is used to differentiate aldehydes from ketones.

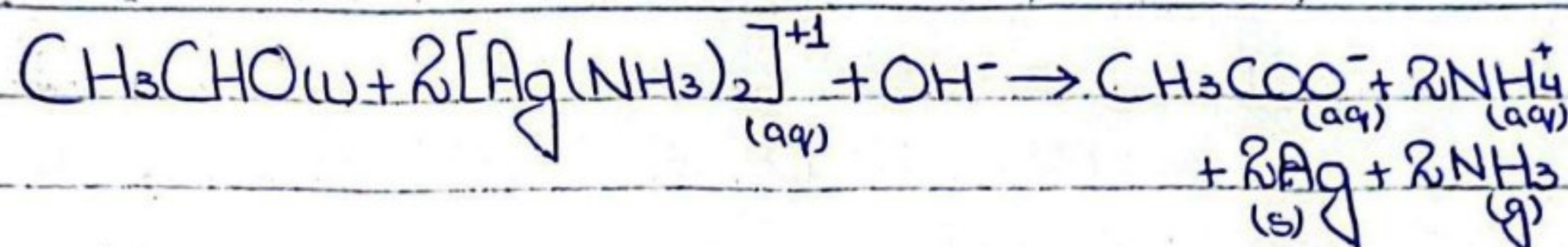
Reagent.

Ammonical Silver nitrate (Tollen's Reagent)

Observation:

Silver mirror of Ag is formed with aldehyde not with Ketones.

Ionic equation:



V.V.V imp

Silver Mirror

Test: 7

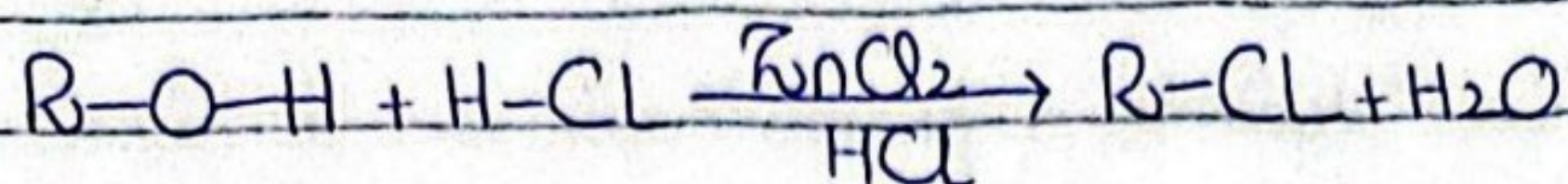
(Test used to distinguish primary, secondary, and tertiary alcohols)

OR

Lucas Test

(11)

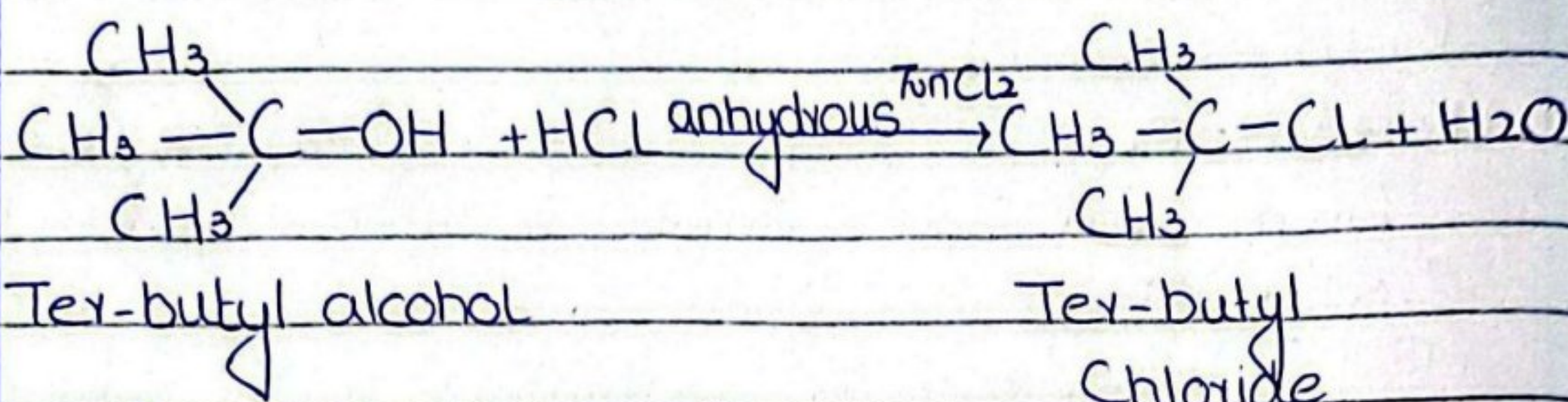
Alcohols on reaction with Lucas reagent (anhydrous Zinc chloride and concentrated hydrochloric acid (ZnCl_2/HCl)) gives an oily layer of haloalkanes.



Different alcohols react with Lucas reagent with different rates.

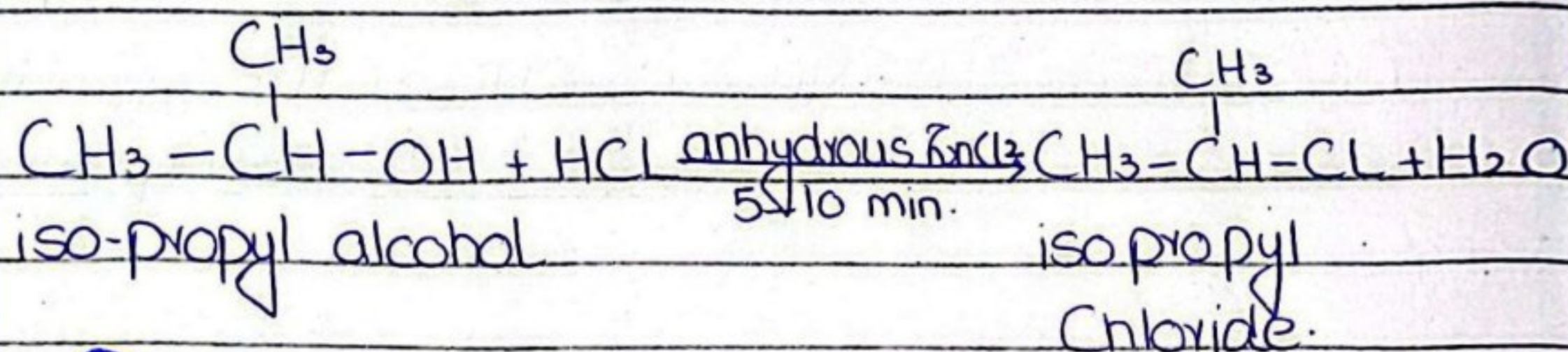
(a) Tertiary alcohols:

form an oily layer immediately



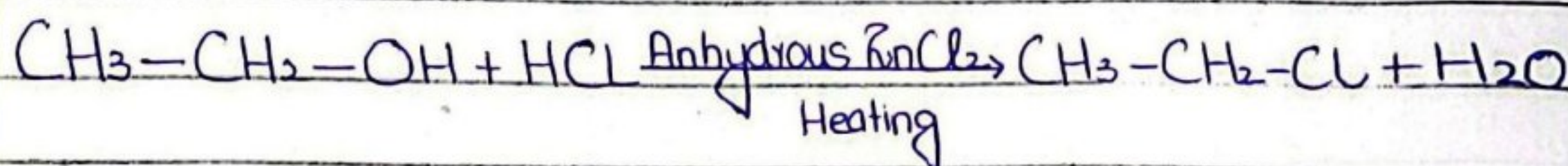
(b) Secondary alcohols:

form an oily layer within 5 to 10 minutes



(c) Primary alcohols:

form an oily layer on heating



Test: 8

Test of Carboxylic Acid.

This test is used to identify Carboxylic acid

Reagent:

Sodium Carbonate (Na_2CO_3)

Observation:

Effervescence



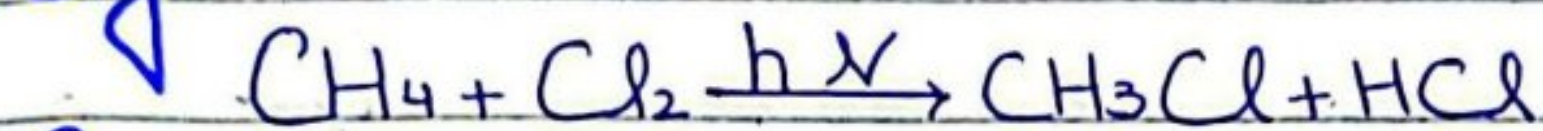
Types of Reaction Given by Functional Group.

1. Reaction of Alkane

Free Radical Substitution

Alkanes undergo free radical Substitution reaction. In this type of reaction, hydrogen of alkane is displaced by free radical

e.g



Condition:

diffused Sunlight.

2. Reaction of Unsaturated Hydrocarbon (Alkene and Alkyne)

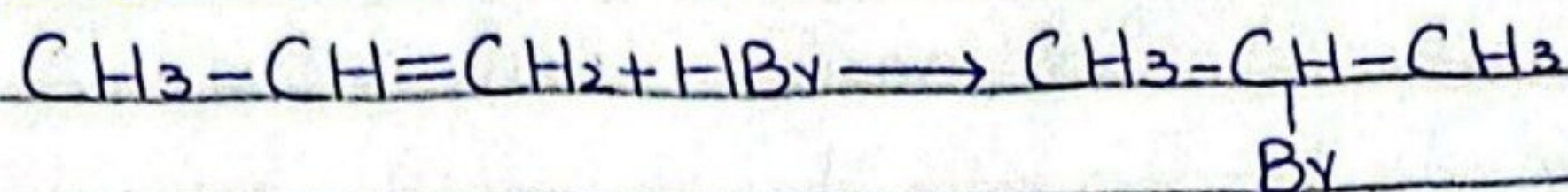
Alkene and Alkyne undergo two type of reaction.

Electrophillic Addition Reaction

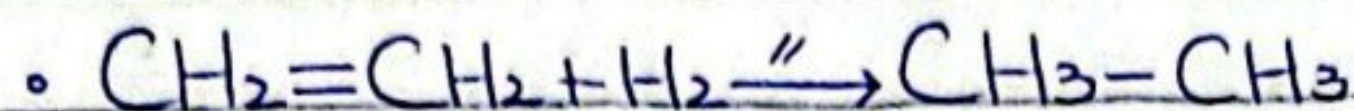
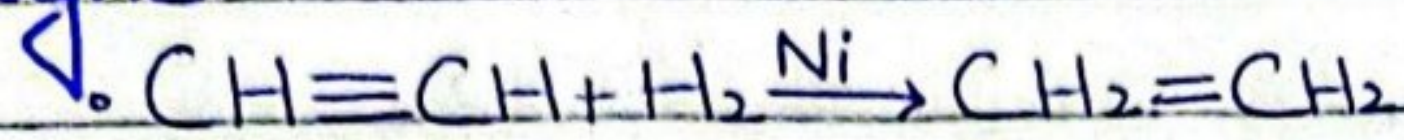
In these reaction one of the two bonds in Carbon-Carbon double bond is broken and a new single bond is formed from each of the two Carbon atoms.

(13)

Alkene

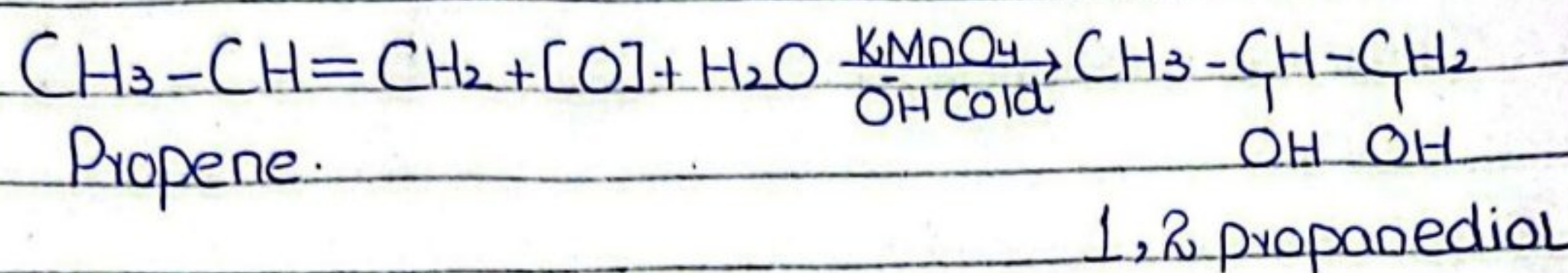


Alkyne:

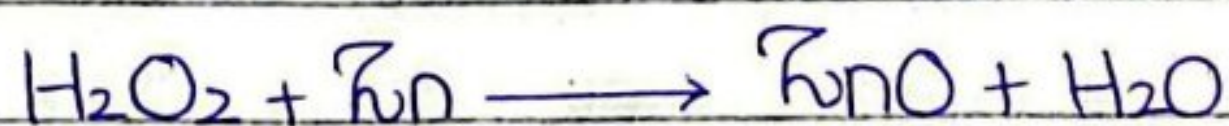
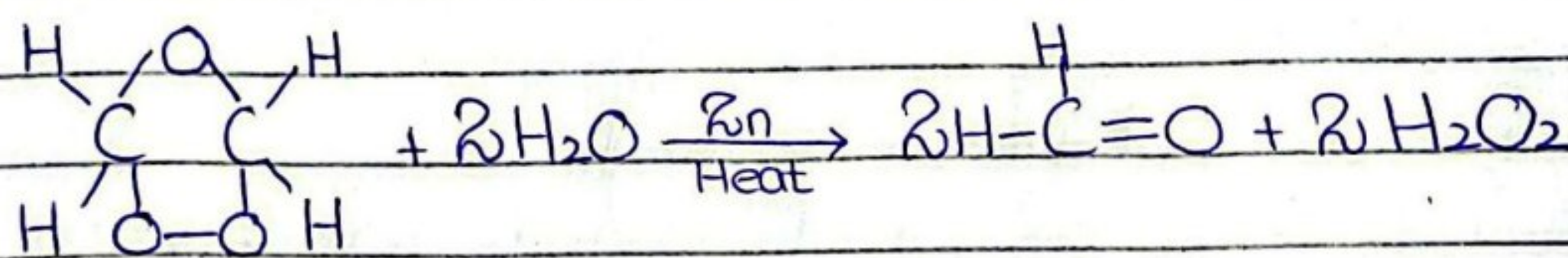
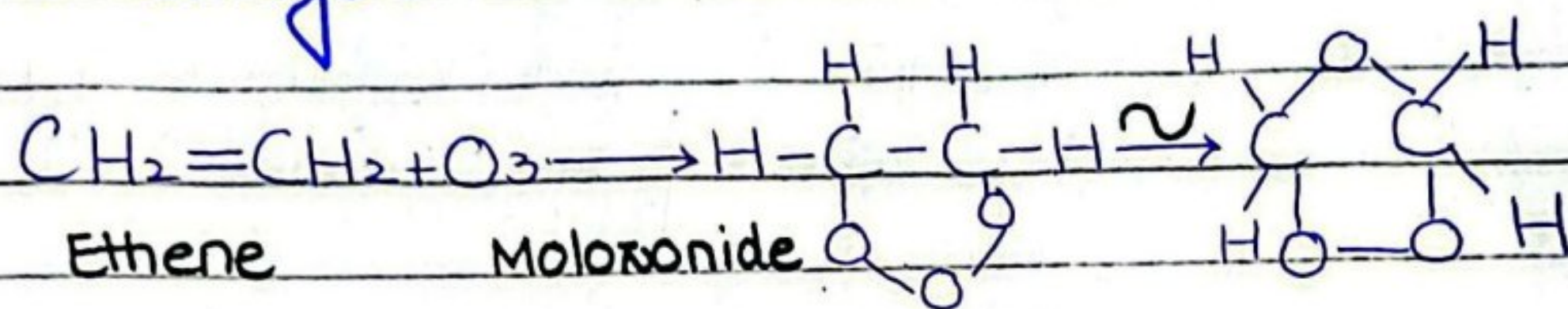


Oxidation Reaction:

Alkene can be oxidized to produce diols in the presence of cold dilute alkaline solution of KMnO_4 (Bayer's Test)



Ozonolysis of Alkene.



Note:

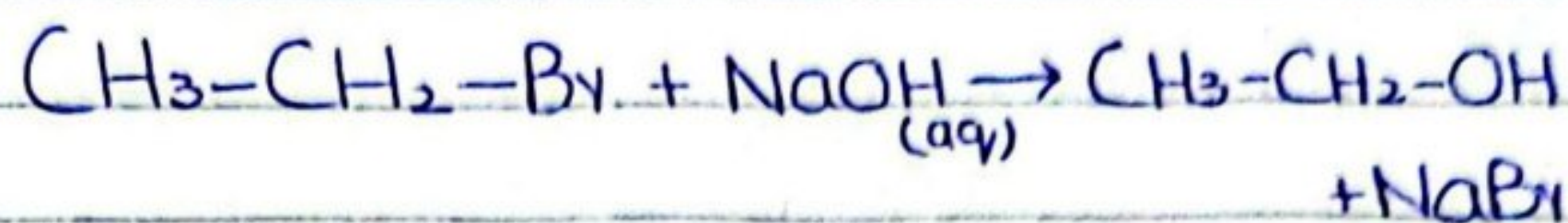
This reaction is used to determine the position of double bond in alkenes by reasoning back from structure of products.

3. Reactions of Alkyl Halides.

Alkyl halides undergo two types of reactions.

1. Nucleophilic Substitution Reaction.

In this type of reaction halogen group in alkyl halide ($R-X$) is displaced by attacking nucleophiles e.g. OH^- , NH_3 and CN^- .
Example:

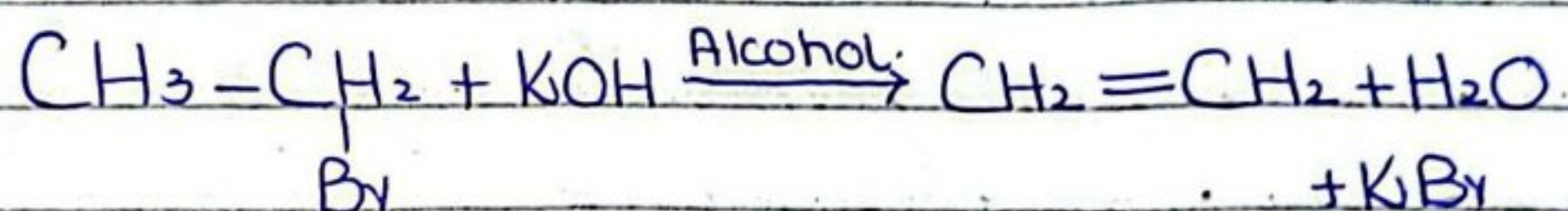


2. Elimination Reaction:

In this type of reaction hydrogen and halogen are eliminated from alkyl halides, leaving an alkene as the organic product.

Reagent: ethanolic $NaOH/KOH$.

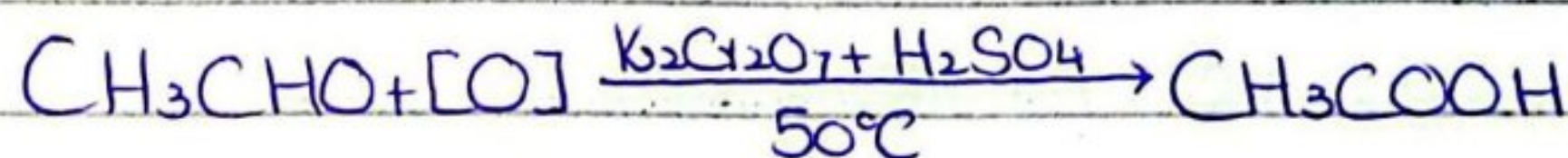
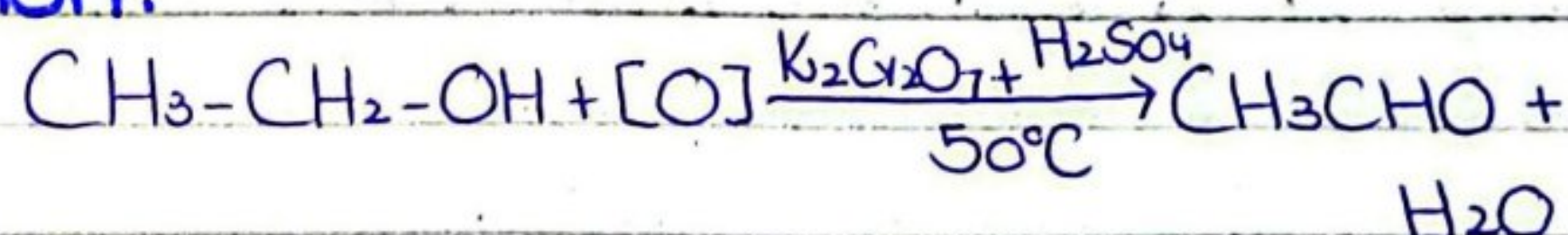
Example:



4. Reactions of Alcohol.

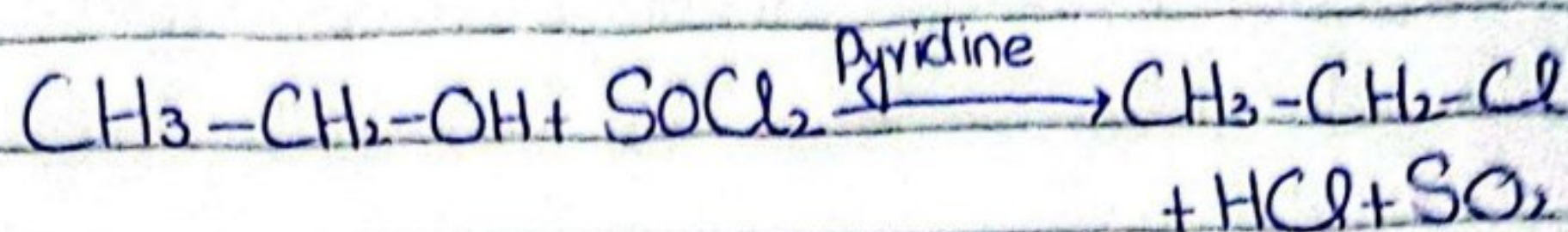
Alcohol undergoes different type of reactions.

Oxidation:

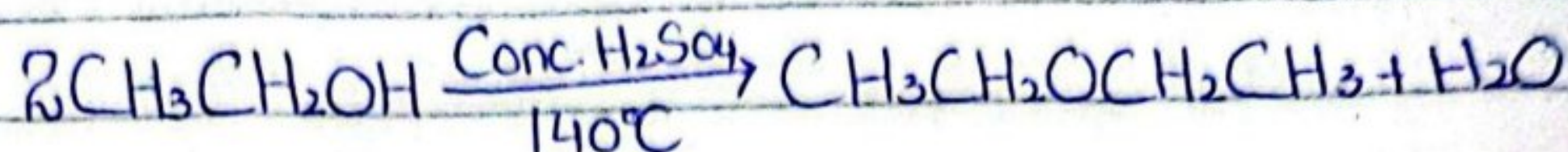
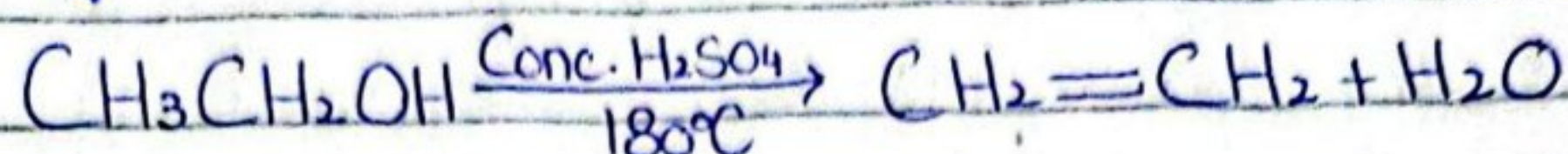


(15)

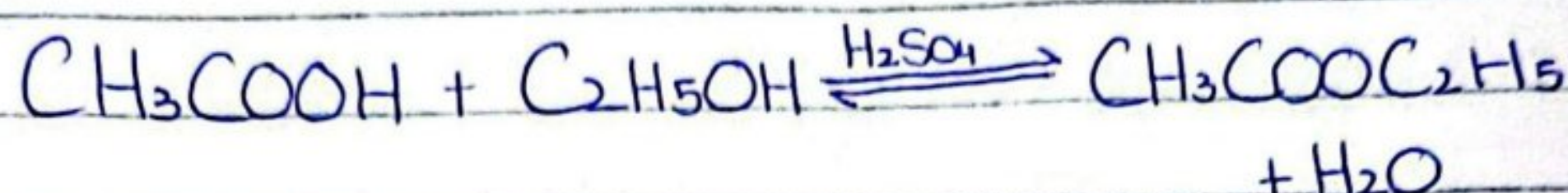
Substitution:



Dehydration:



Esterification.

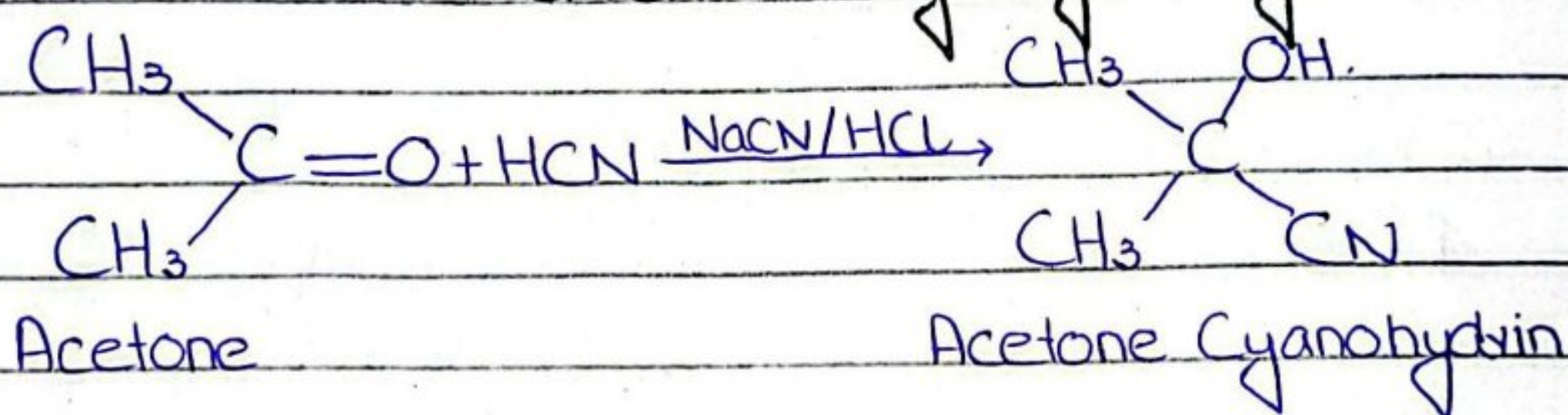


5. Reaction of Carbonyl Compounds.

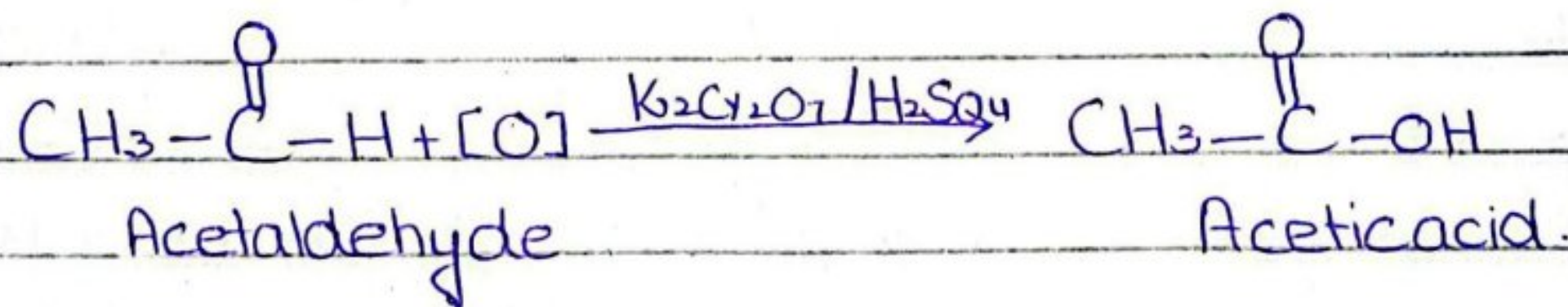
Carbonyl Compounds undergo different type of reactions.

Nucleophilic Addition Reaction.

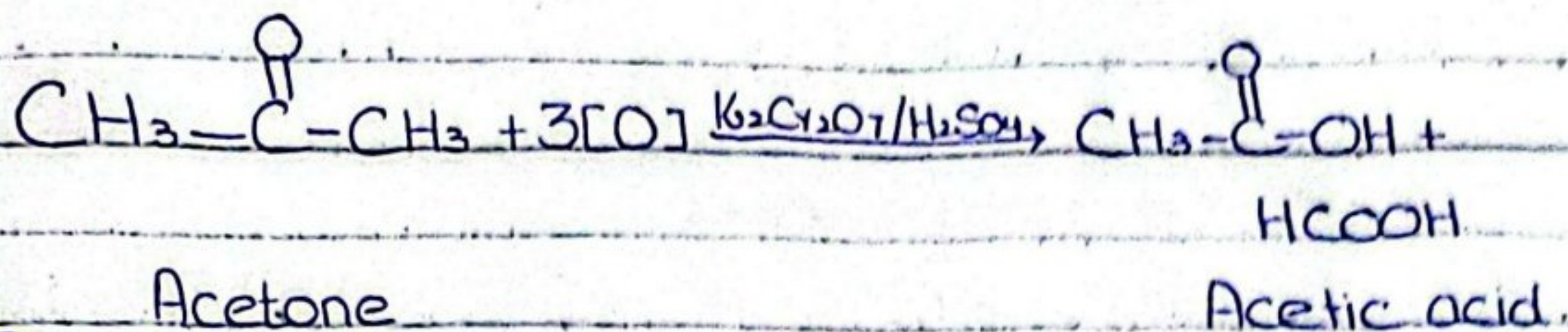
Addition of Hydrogen Cyanide



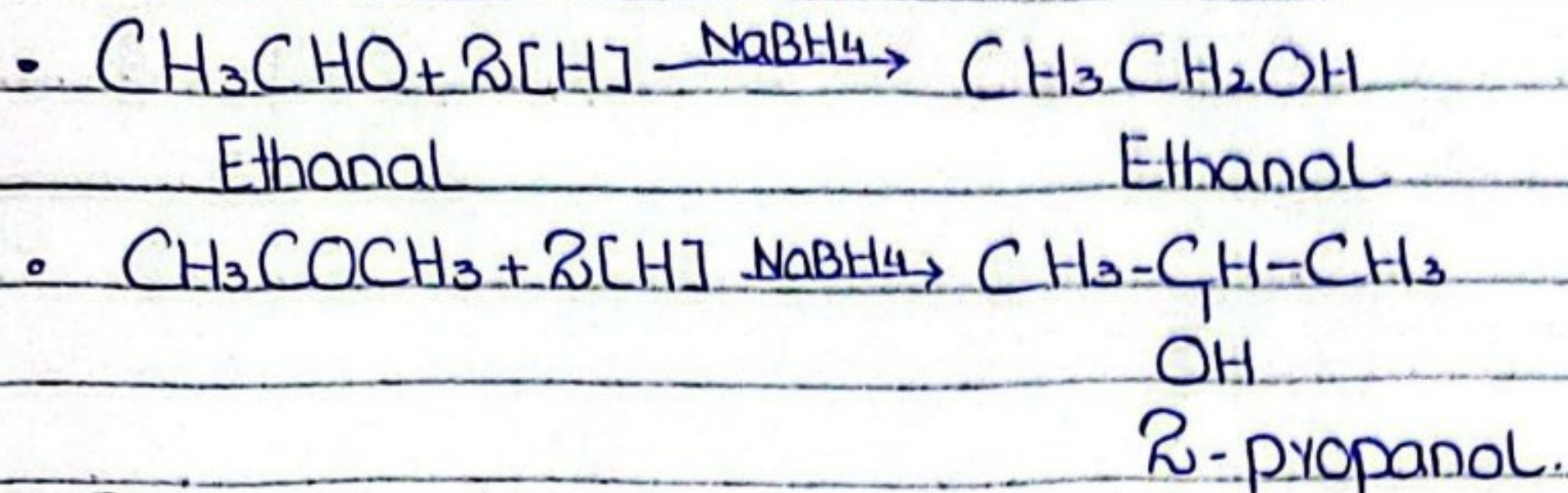
Oxidation:



(16)



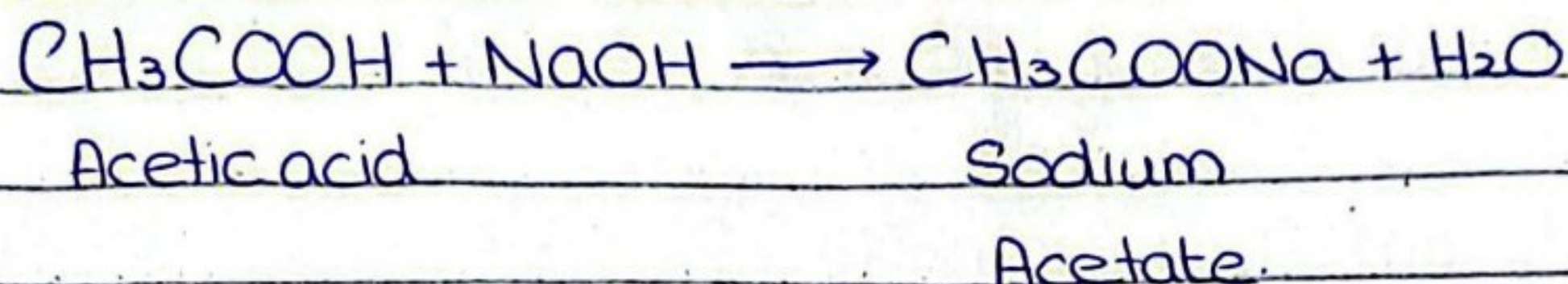
Reduction:



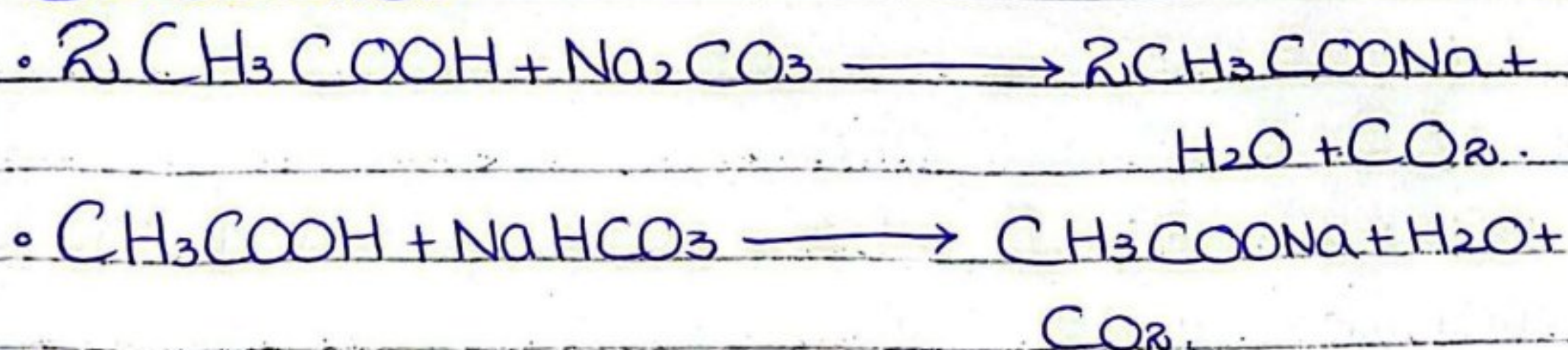
6. Reaction of Carboxylic Acid.

Carboxylic acid undergoes acid base reaction and esterification.

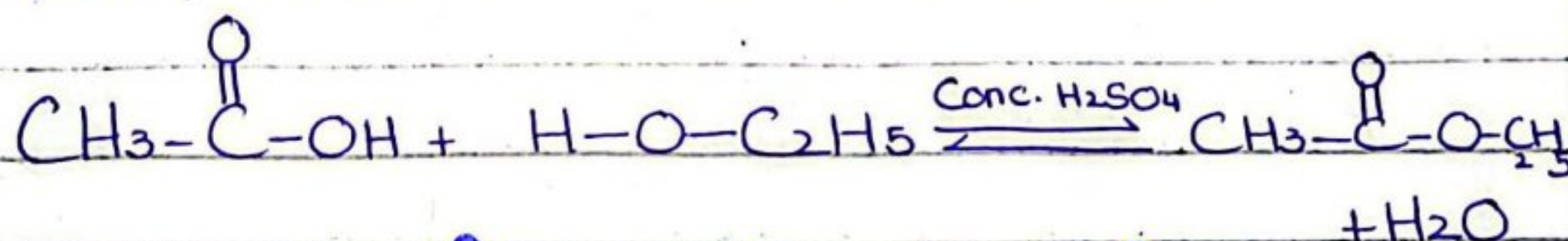
Reactions with base.



Reaction with Carbonates and bi-Carbonates.



Esterification:



Key Reagents Used for
Synthesis.

(17)

Oxidising Agents:

Strong Oxidizing Agent:

(1) $\text{KMnO}_4 + \text{H}_2\text{SO}_4$ (2) $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4$ (3) dilute HNO_3

Mild oxidizing Agent:

(1) Fehling Solution (2) Benedict's solution.
(3) Tollen's reagent.

Reducing Agents:

1 NaBH_4 : Reduce a Carbonyl group to an alcohol

2 LiAlH_4 : Strong reducing agent than NaBH_4 , it reduces Carboxylic acid to alcohol.

3 H_2 and Nickel Catalyst: Reduces a $\text{C}=\text{C}$ double bond.

4 Tin/HCl: Reduces NO_2 to NH_2

Dehydrating Agents:

A dehydrating Agents is one that remove water from a molecule.

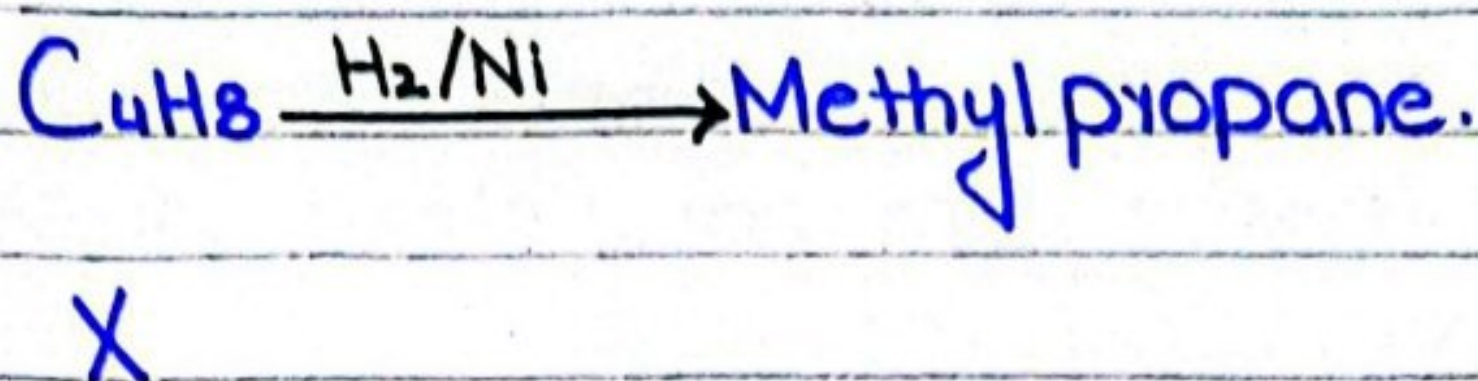
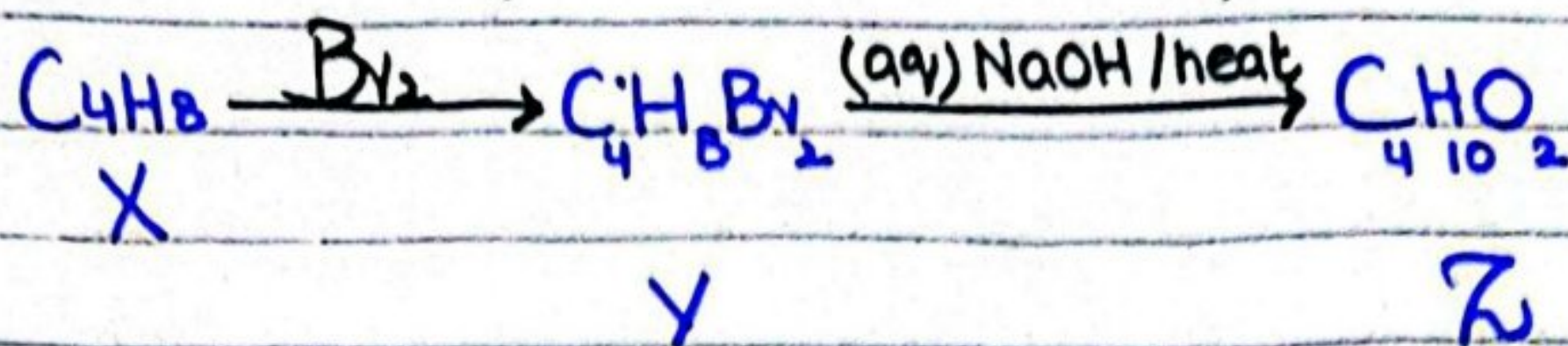
(1) Al_2O_3 (2) Conc. H_2SO_4 (3) H_3PO_4 (4) P_2O_5

Concept Assessment: 21.3

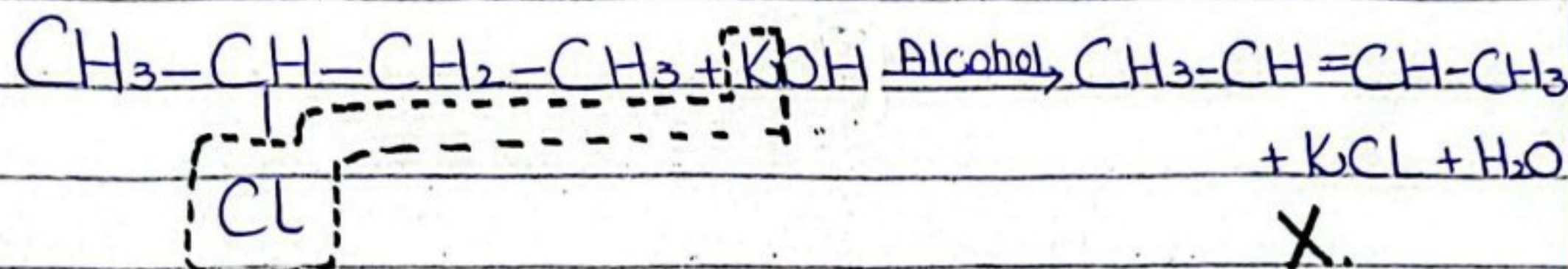
(18)

Question: 1.

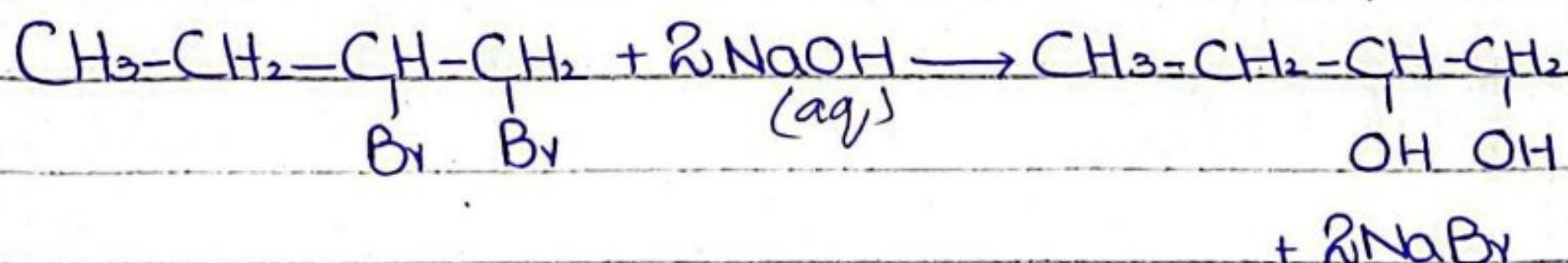
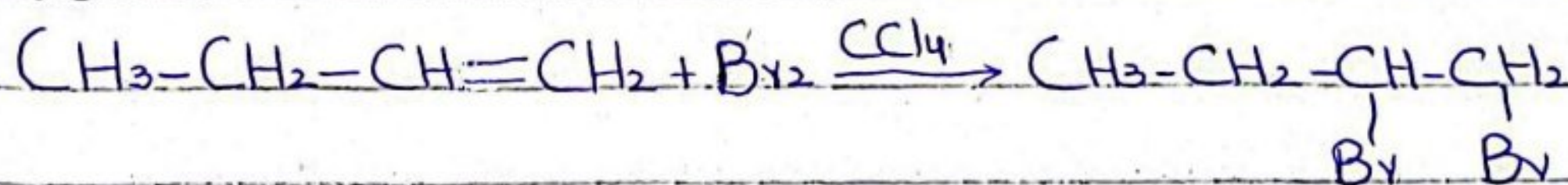
Compound X, Molecular Formula C_4H_8 , Undergoes the following reactions.



(a) Suggest a Synthesis of the starting material i.e. C_4H_8



(b) What is the formula of Compound "Z"

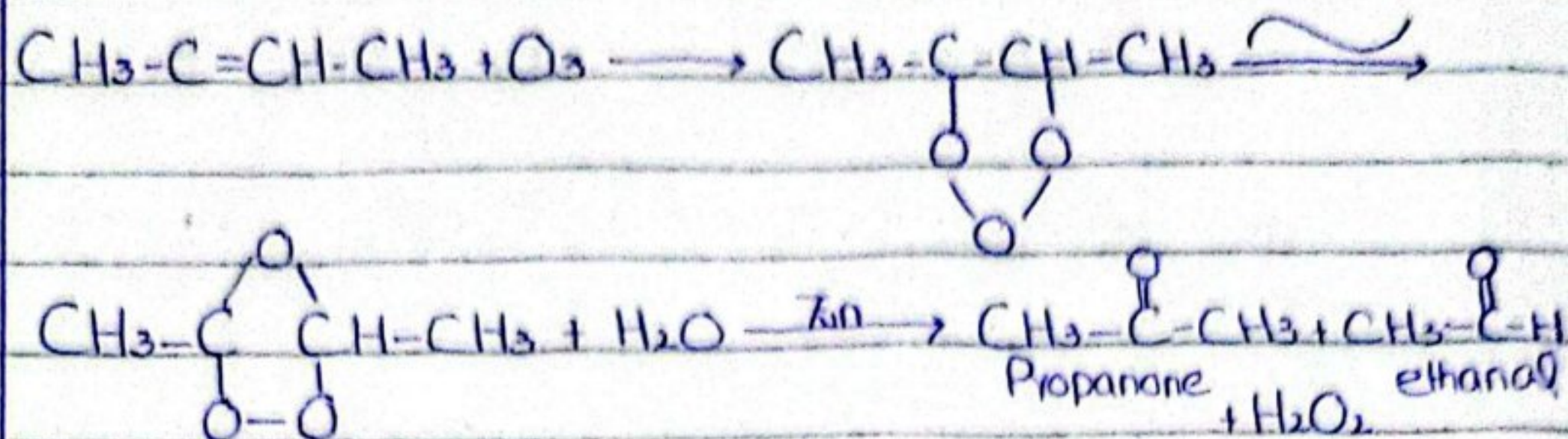


Question: 2

Prepare ethanal and propanoic acid starting from 2-methyl but-2-ene.

(19)

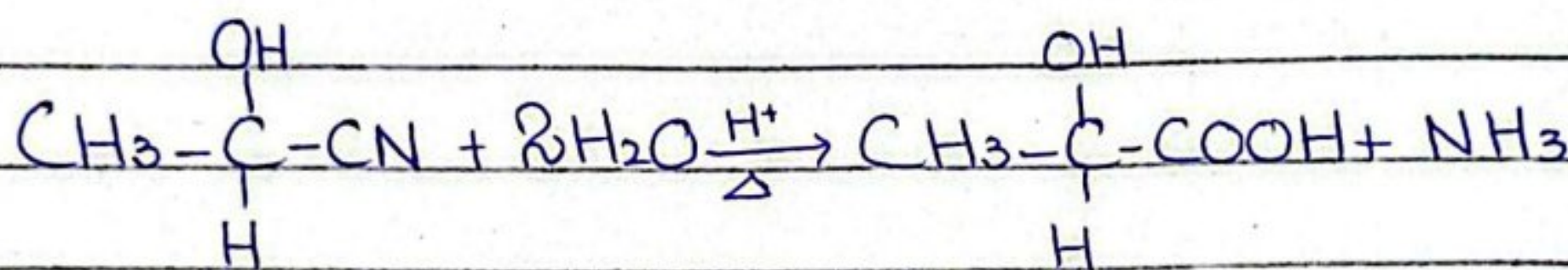
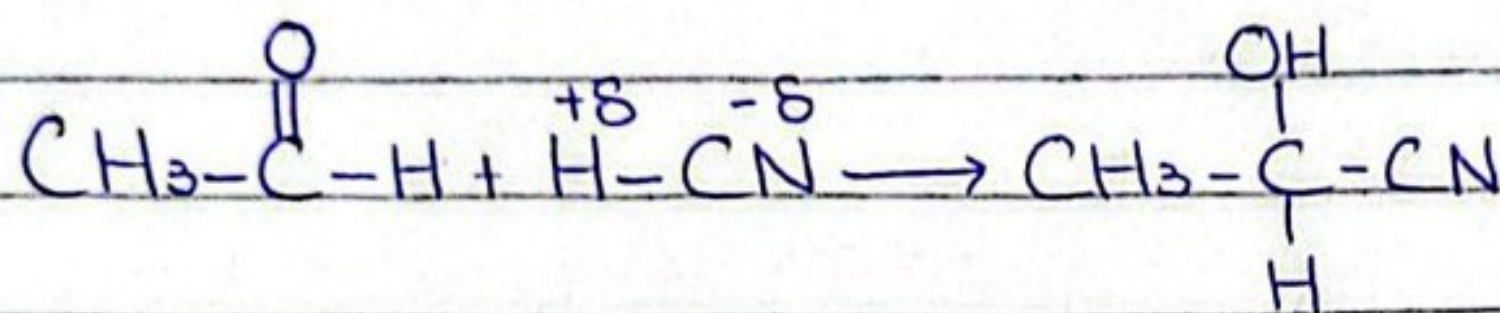
2-methyl-but-2-ene $\longrightarrow$ Ethanal + propanone



Question: 3

Devise the best Synthetic route to prepare 2-hydroxy propandioic acid starting from ethanal.

Ethanal $\longrightarrow$ 2-Hydroxy propandioic acid.



Exercise:

MCQs.

(1) D

(2) B

(3) A

(4) C

(5) D

(6) A

(20)

(7) D

(8) C

(9) D

(10) B

Question: 2.

(A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$.

This Compound is an alcohol. It can be differentiated from other by Lucas Test.

Reagent = Lucas reagent (HCl , ZnCl_2) heat

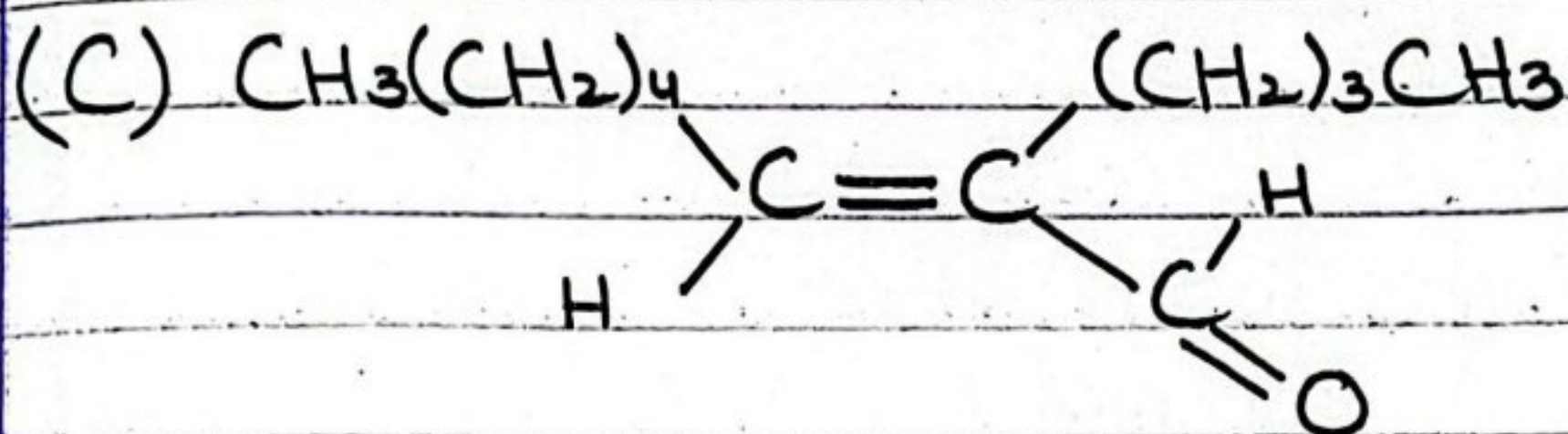
Observation = insoluble oily layer is produced

(B) $\text{CH}_3(\text{CH}_2)_7\overset{\text{O}}{\parallel}\text{CCH}_2\text{CH}_3$

This compound is Ketones it can be differentiated from other by Sodium nitroprusside test.

Reagent = Sodium nitroprusside Solution / NaOH

Observation = redish colouration.

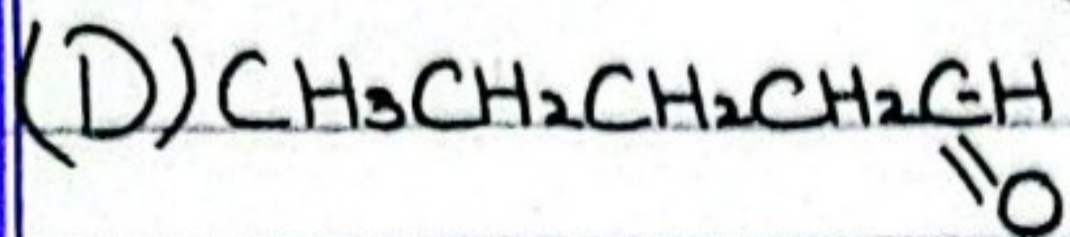


This Compound is aldehyde and it contain double bond. It can be differentiated by Fehling Solution test. Compound D is also an aldehyde so, C and D can be differentiated by bromine water test.

Reagent = Fehling Solution Observation = Red ppt. of Cu_2O

Reagent = Aqueous Bromine Observation = Red colour of Bromine fade away

(21)



This Compound is aldehyde and contain no double bond so it can be differentiate by Fehling Solution.

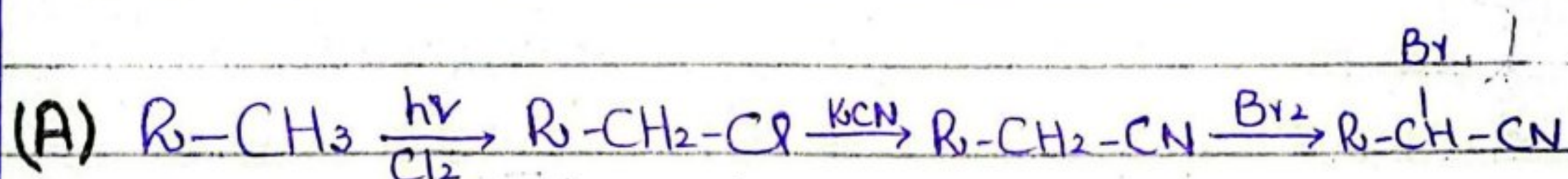
Reagent: Fehling Solution

Observation: Red ppt of Cu_2O formed.

Question: 3.

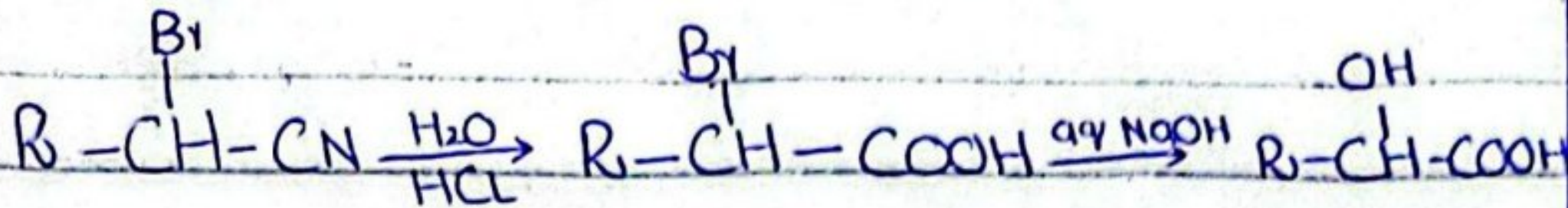
	Reagent	Observation	Letters
1	Acidified Potassium dichromate	Green color on Boiling	A, B, C
2	Acidified potassium manganate	ethanoic acid on Boiling	C, E
3	hydrogen in the Presence of platinum Catalyst	hydrogen absorbed.	C, D, E
4	Fehling's reagent	brown-red ppt on boiling	C
5	2,4-dinitrophenyl hydrazine	orange ppt	C, D
6	Bromine in ^{Solvent} inert	Solution decolourised.	E

Question: 4

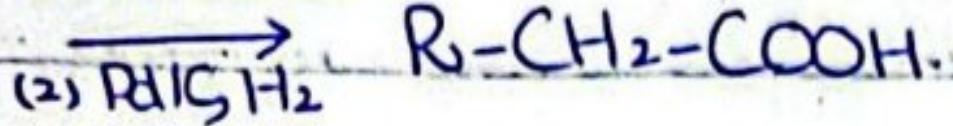


22

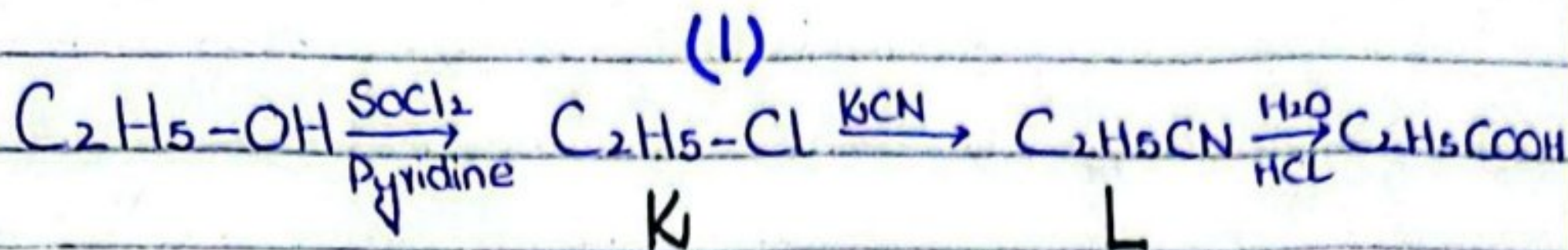
(B)



(1) HCl/ZnCl_2



Question: 5



Step: 1

$\text{SOCl}_2/\text{Pyridine}$

Step: 2

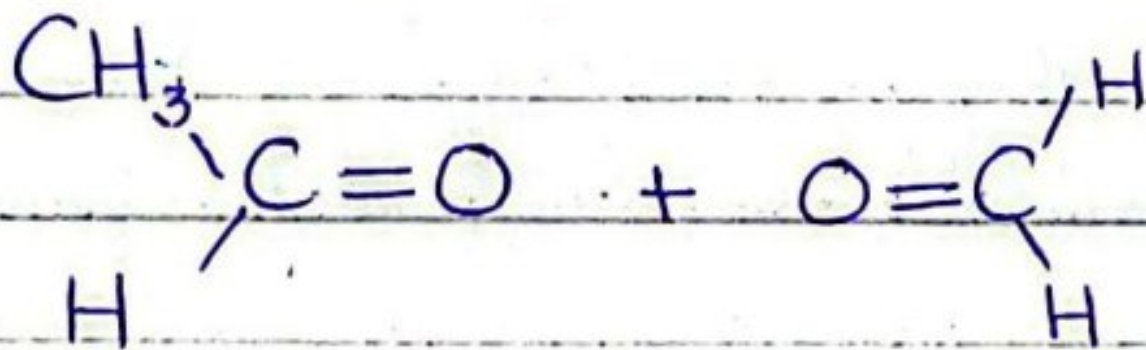
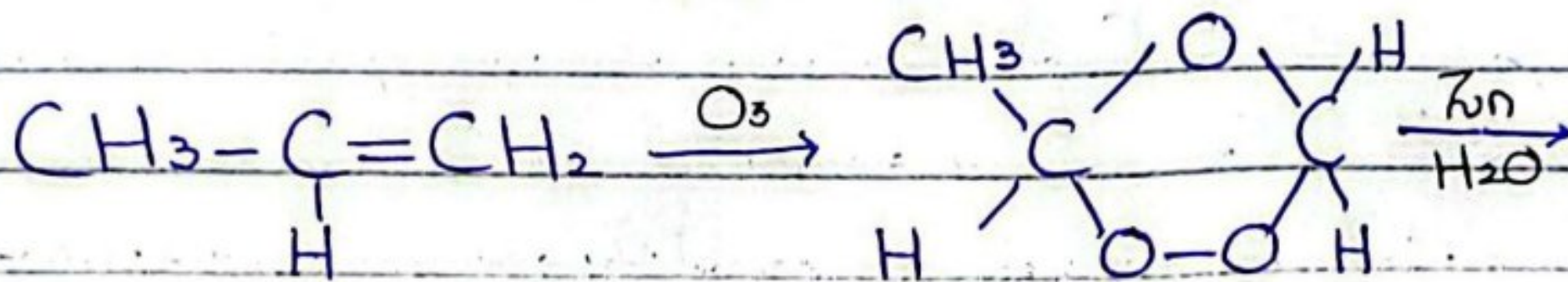
KCN

Step: 3

$\text{H}_2\text{O}/\text{HCl}$

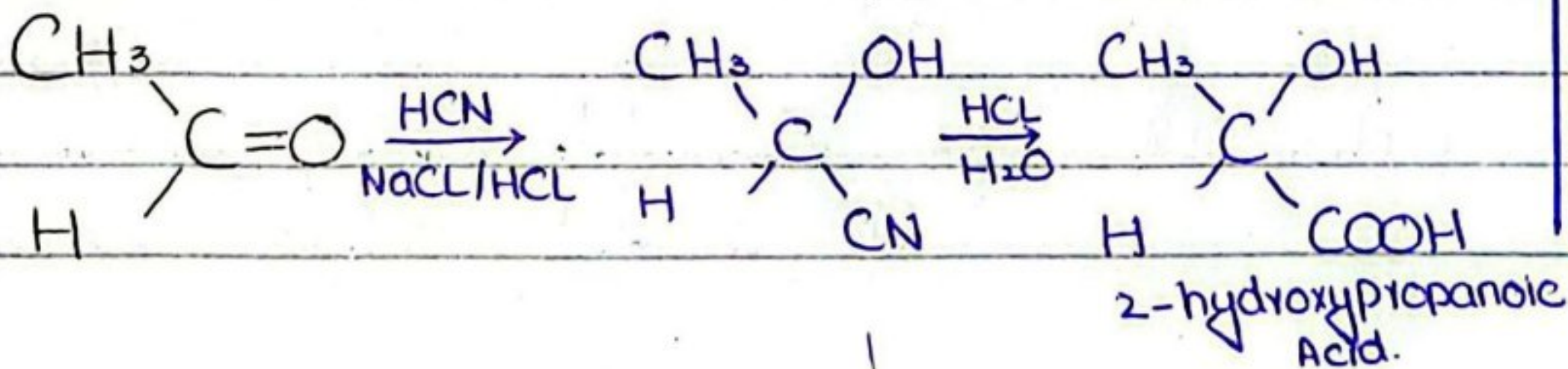
Question: 6.

(a)



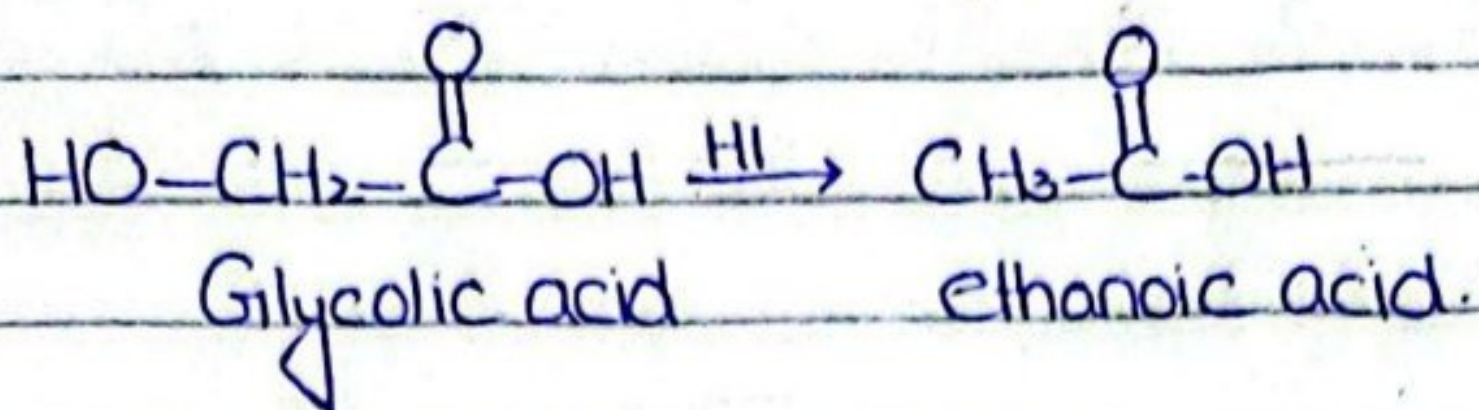
acetaldehyde

Formaldehyde

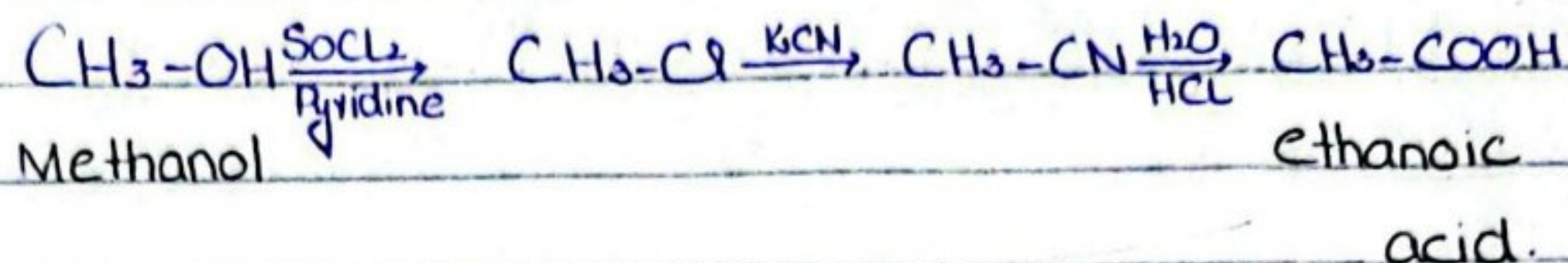


2-hydroxypropanoic Acid.

(b)

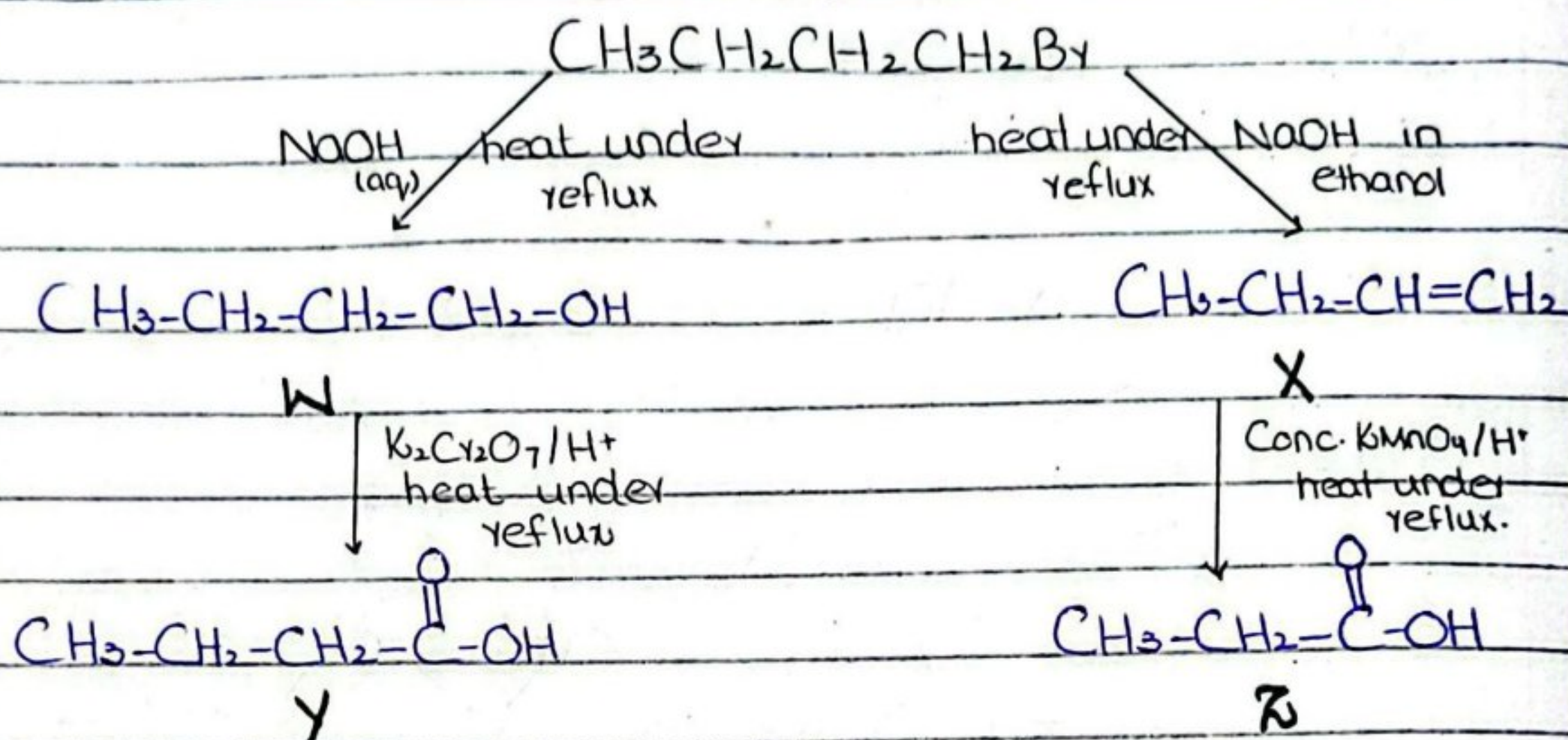


Question: 7



Question: 8

(A)

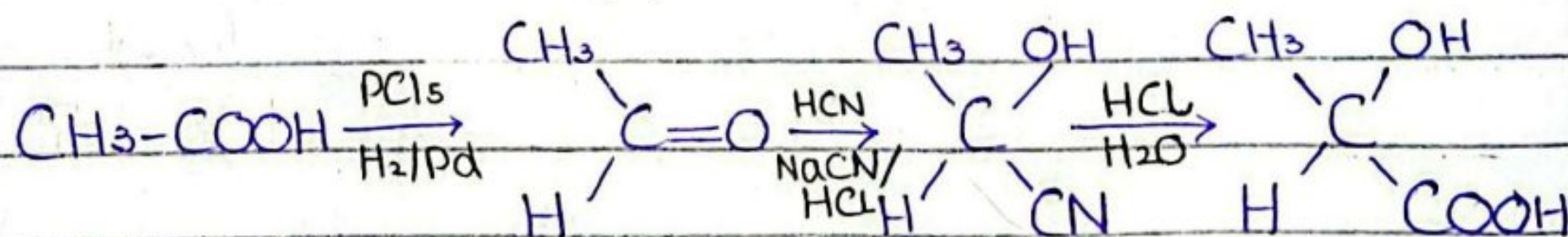


(B)

polymerization of but-1-ene gives a polymer called polybutylene. This polymer is used to make piping for domestic plumbing.

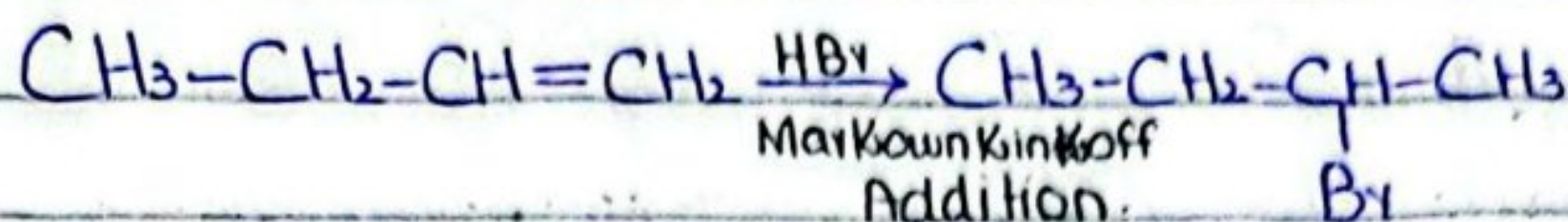
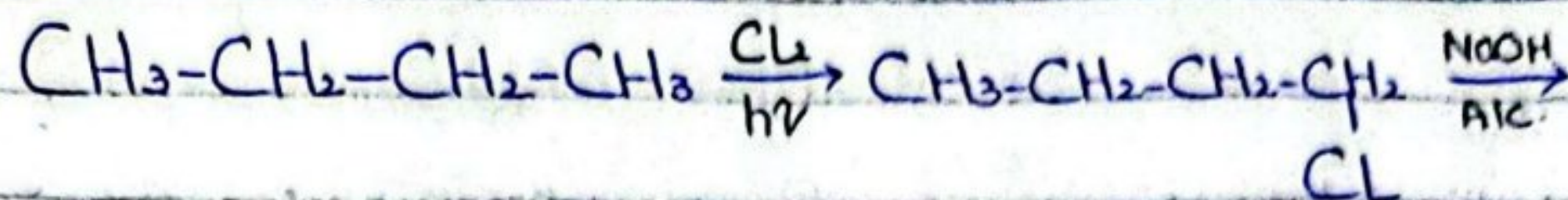
Question: 9.

(A)

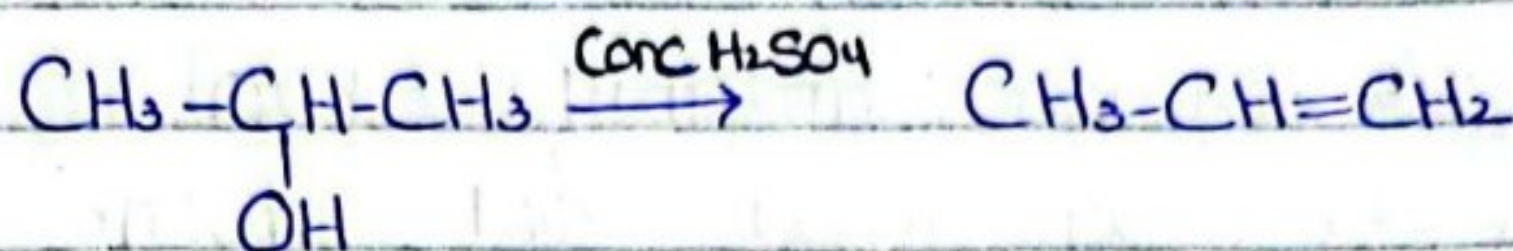


(24)

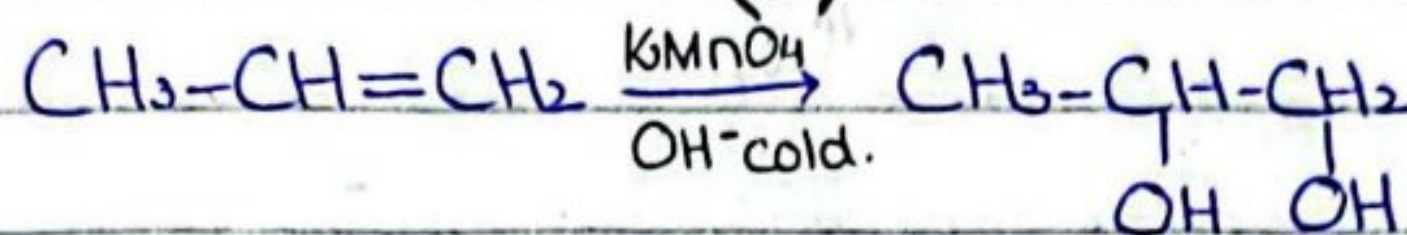
(B)



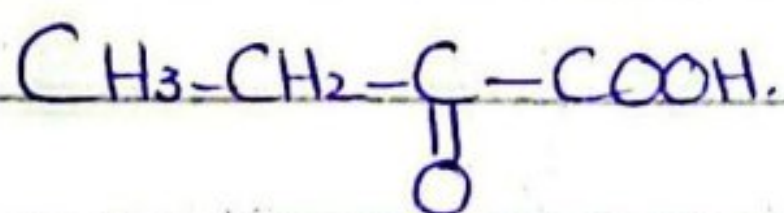
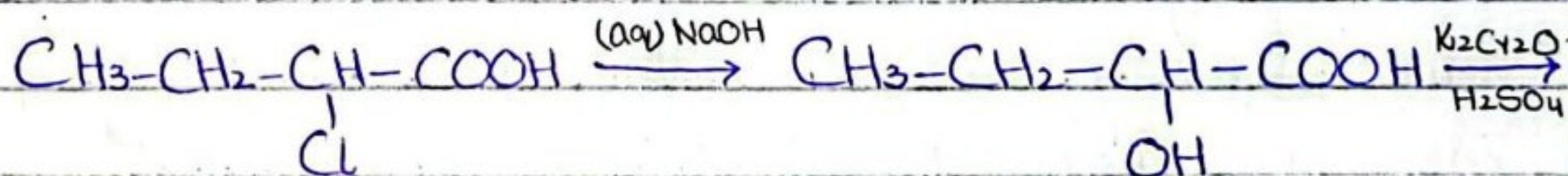
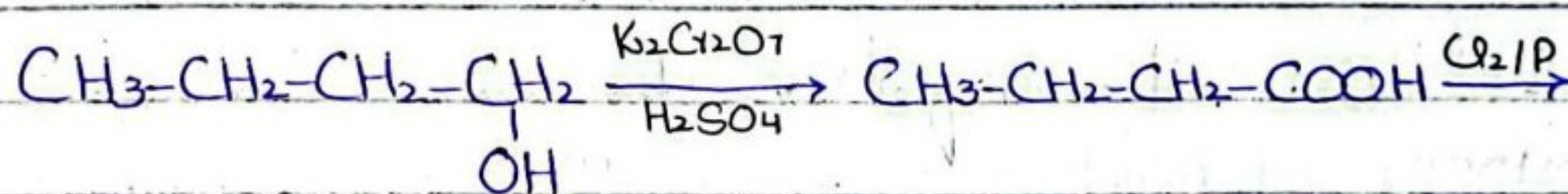
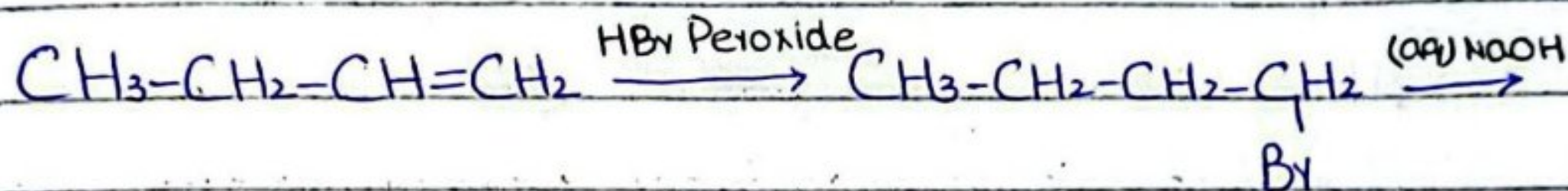
(C)



(D)



Question: 10



2-oxobutanoic acid.