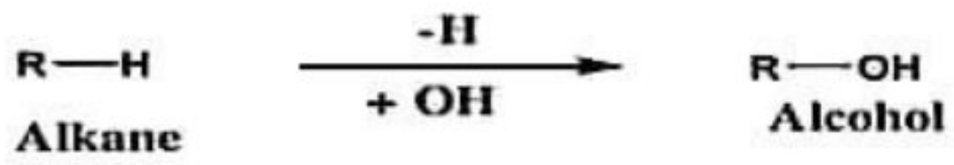
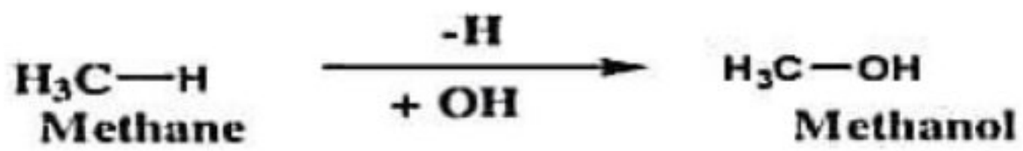
Alcohols and Phenols

Alcohols

When hydrogen atom of any alkane is replaced by –OH functional group, alcohol is formed. Alcohol can generally be represented by (R-OH) where R- is any alkyl group



eg. 

Classification of Alcohols (Monohydric alcohol)

Alcohols are classified as:

1. Primary alcohol (1^{o} Alcohols)
2. Secondary alcohols (2^{o} Alcohols)
3. Tertiary alcohols (3^{o} Alcohols)

1. Primary alcohol(1^{o} Alcohols)

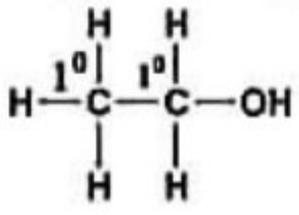
If –OH group is attached to 1^{0} carbon, that alcohol is called 1^{0} alcohol or when primary hydrogen from primary carbon is replaced by –OH group, primary alcohol is formed.

2. Secondary alcohols (2^{o} Alcohols)

If –OH group is attached to 2^{0} carbon, that alcohol is called 2^{0} alcohol or when secondary hydrogen from secondary carbon is replaced by –OH group, secondary alcohol is formed.

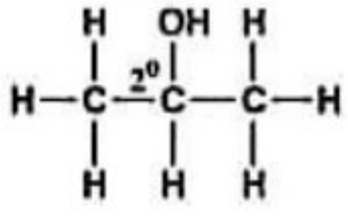
3. Tertiary alcohols (3^{o} Alcohols)

If –OH group is attached to 3^{0} carbon, that alcohol is called 3^{0} alcohol or when tertiary hydrogen from tertiary carbon is replaced by –OH group, tertiary alcohol is formed.



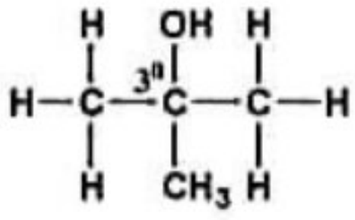
1^{0} Alcohol

(Ethanol)



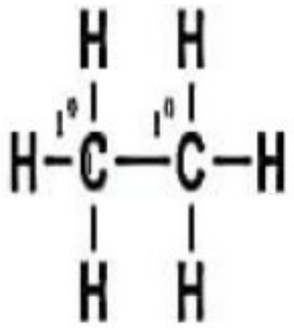
2^{0} Alcohol

(Propan-2-ol)

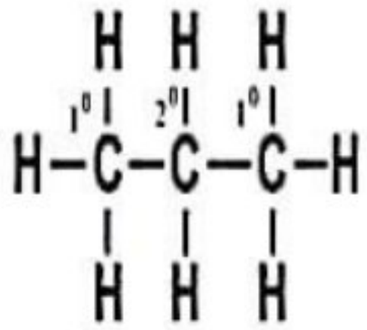


3^{0} Alcohol

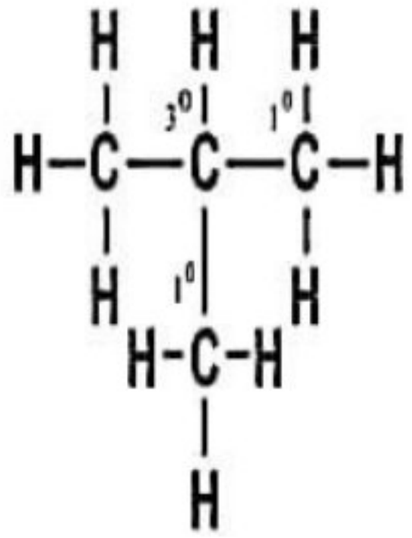
(2-methylpropan-2-ol)



2 carbons are 1^0carbons



1carbon is 2^0carbon



1carbon is 3^0carbon

Hydrocarbons showing Primary, Secondary and tertiary carbons and hydrogens attached with primary, secondary and tertiary carbons are called primary, secondary and tertiary hydrogens.

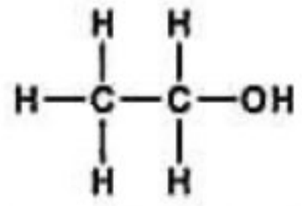
Alcohols may be also classified as:

(i) Monohydric alcohols (containing one – OH group)

(ii) Dihydric alcohols (containing two – OH groups)

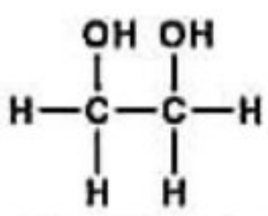
(iii) Trihydric alcohols (containing three -OH groups)

(iv) Polyhydric alcohols (containing more than two or three –OH groups)



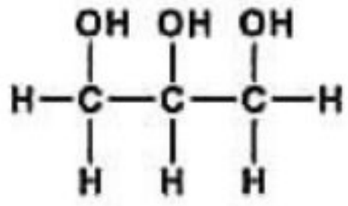
Monohydric alcohol

(Ethanol)



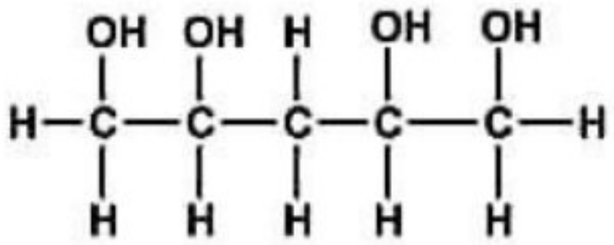
Dihydric alcohol

(Ethan-1,2-diol)



Trihydric alcohol

(Propan-1,2,3-triol)



Polyhydric alcohol

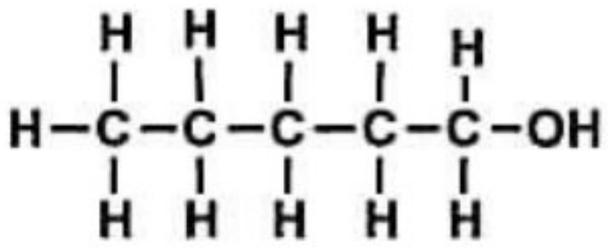
(Pentan 1,2,4,5-tetraol)

Isomerism in alcohols:

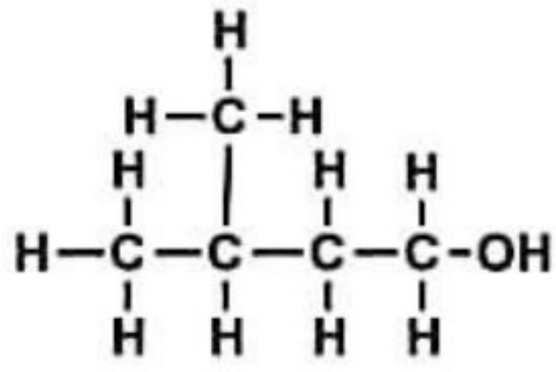
Compounds having the same molecular formula but different structural formula and chemical properties are called isomers (Structural isomers) and the phenomenon is known as isomerism. Alcohols exhibit only following three types of structural isomerism.

1. Chain isomerism

Alcohols having same molecular formula but differ only in the length of the carbon chain and properties are called chain isomers and phenomenon is known as chain isomerism



Pentan-1-ol

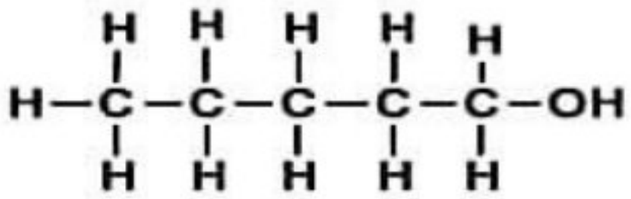


3-methylbutane-1-ol

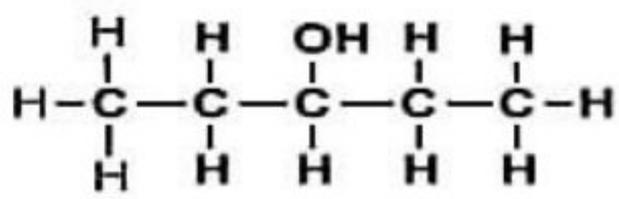
Both are chain isomers to each other

2. Positional isomerism

Alcohol having the same molecular formula, same carbon chain length but differ only in the position of the –OH group in the carbon chain are called positional isomers and phenomenon is known as positional isomerism.



Pentan-1-ol

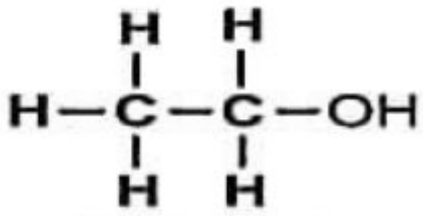


Pentan-3-ol

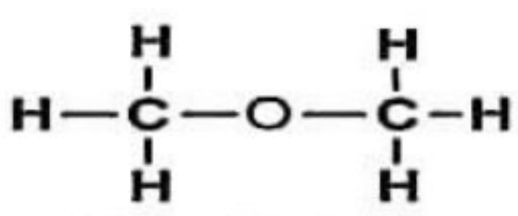
Both are positional isomers to each other

3. Functional isomerism

Alcohols are isomeric with ether. So alcohols can be functional isomers to each other.



Ethanol



Dimethyl ether

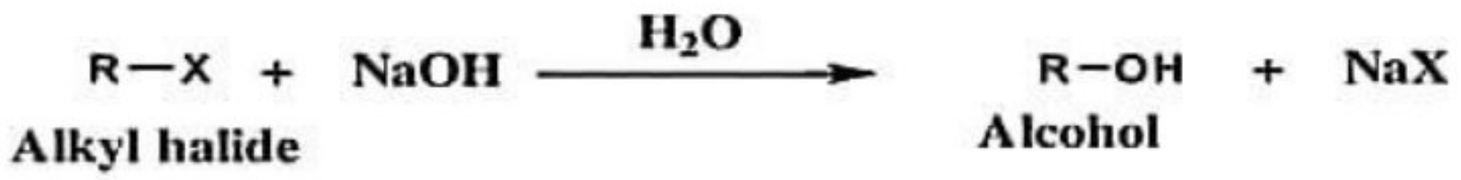
Both are chain isomers to each other

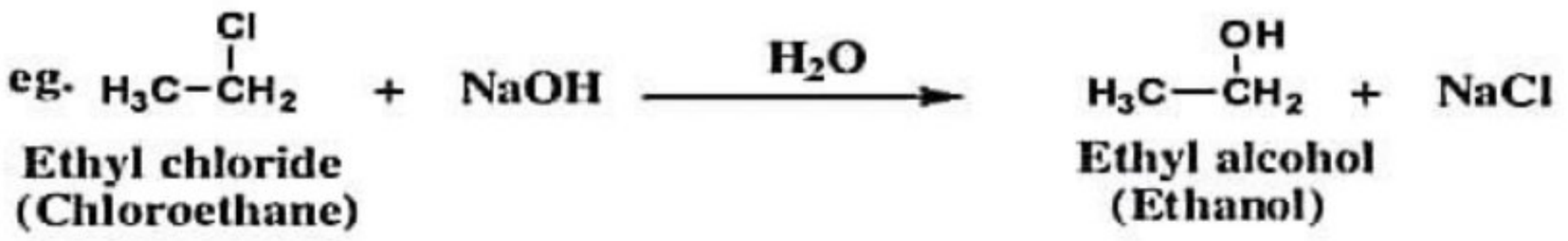
General methods for the preparation of Monohydric alcohols

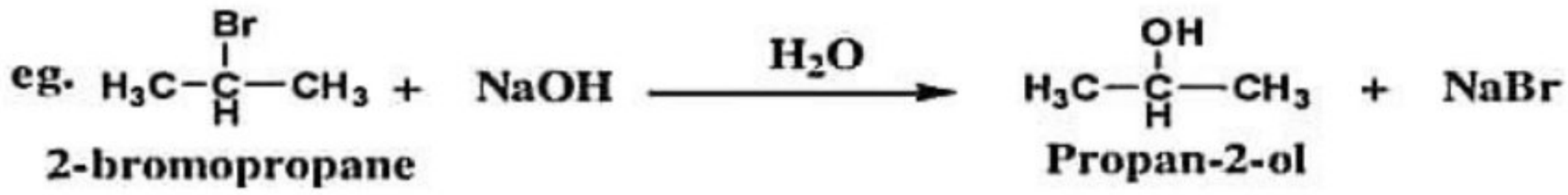
Alcohols can generally be prepared by the following methods

1.Byhydrolysis of alkyl halides

When the alkyl halides are hydrolyzed in the presence of aqueous NaOH or KOH, alcohols are prepared.

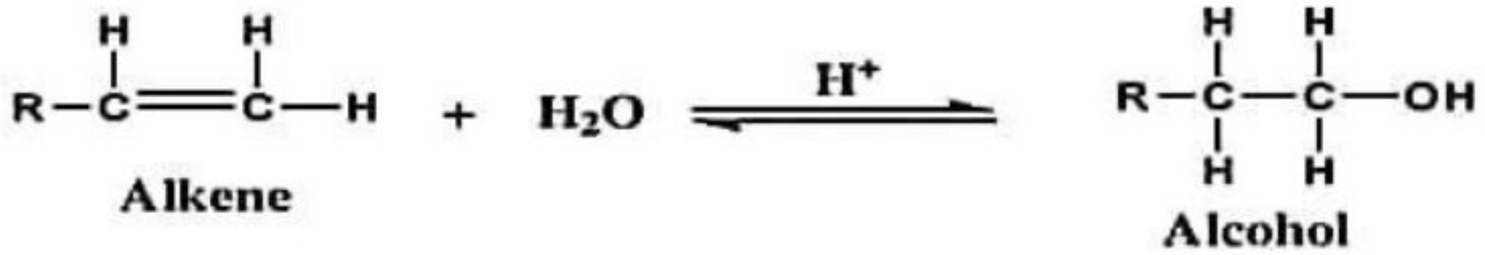


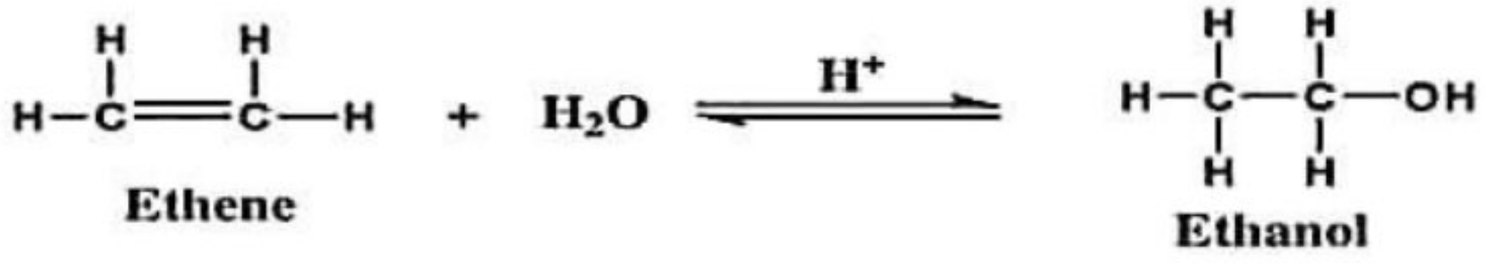


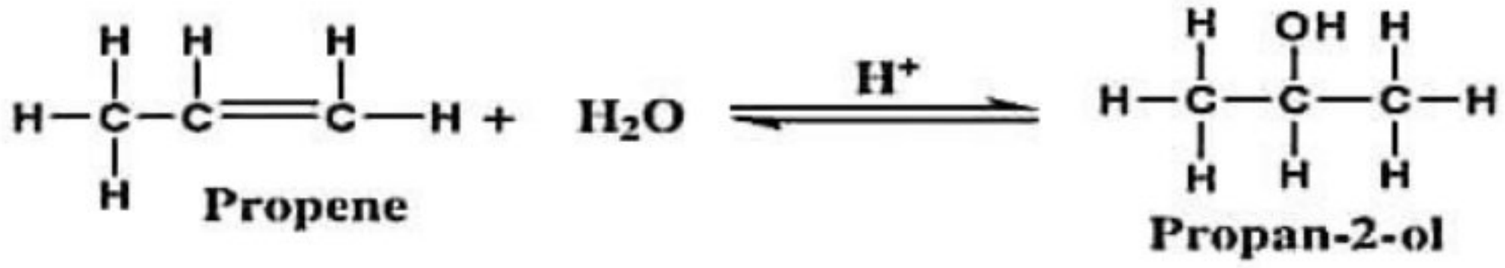


By acid catalyzed hydration:

Alkenes react with water in the presence of acid as catalyst to form alcohols. In case of unsymmetrical alkenes, the addition reaction takes place in accordance with Markovnikov's rule





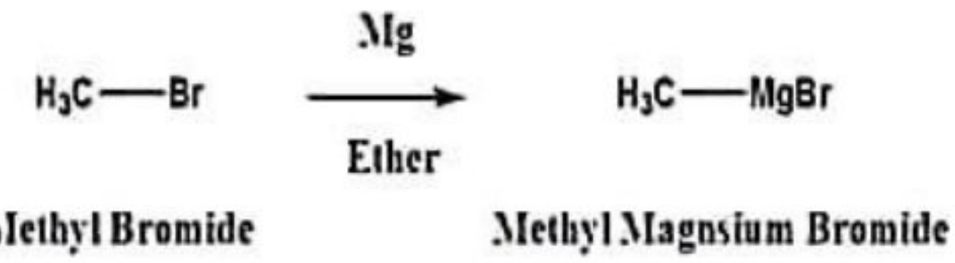


3.From Grignard reagents

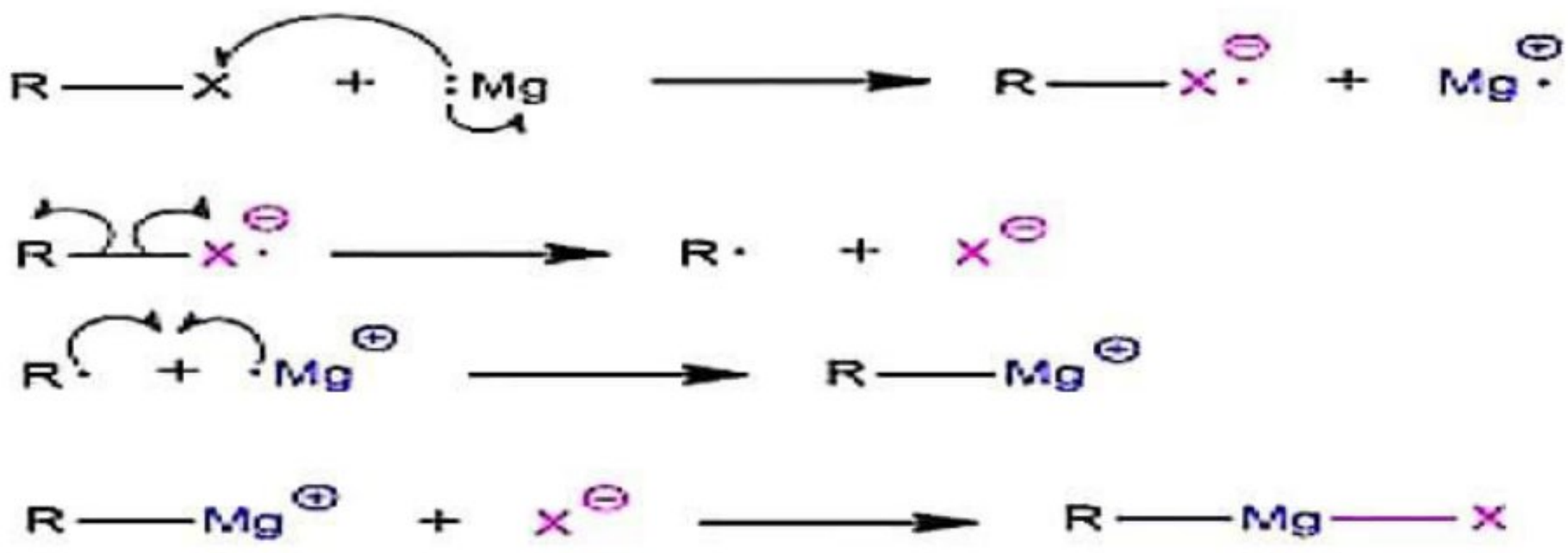
Alkyl magnesium chloride is known as Grignard reagent.

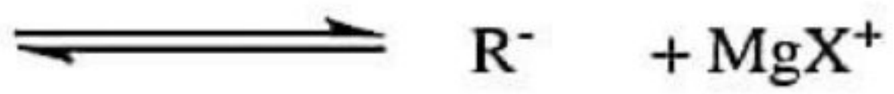
RMgX

Grignard ragent

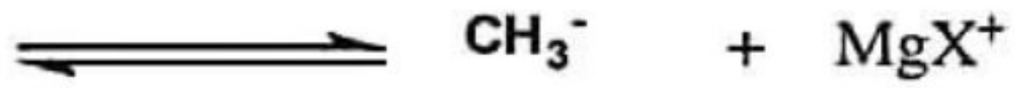


Methyl Bromide Methyl Magnsium Bromide





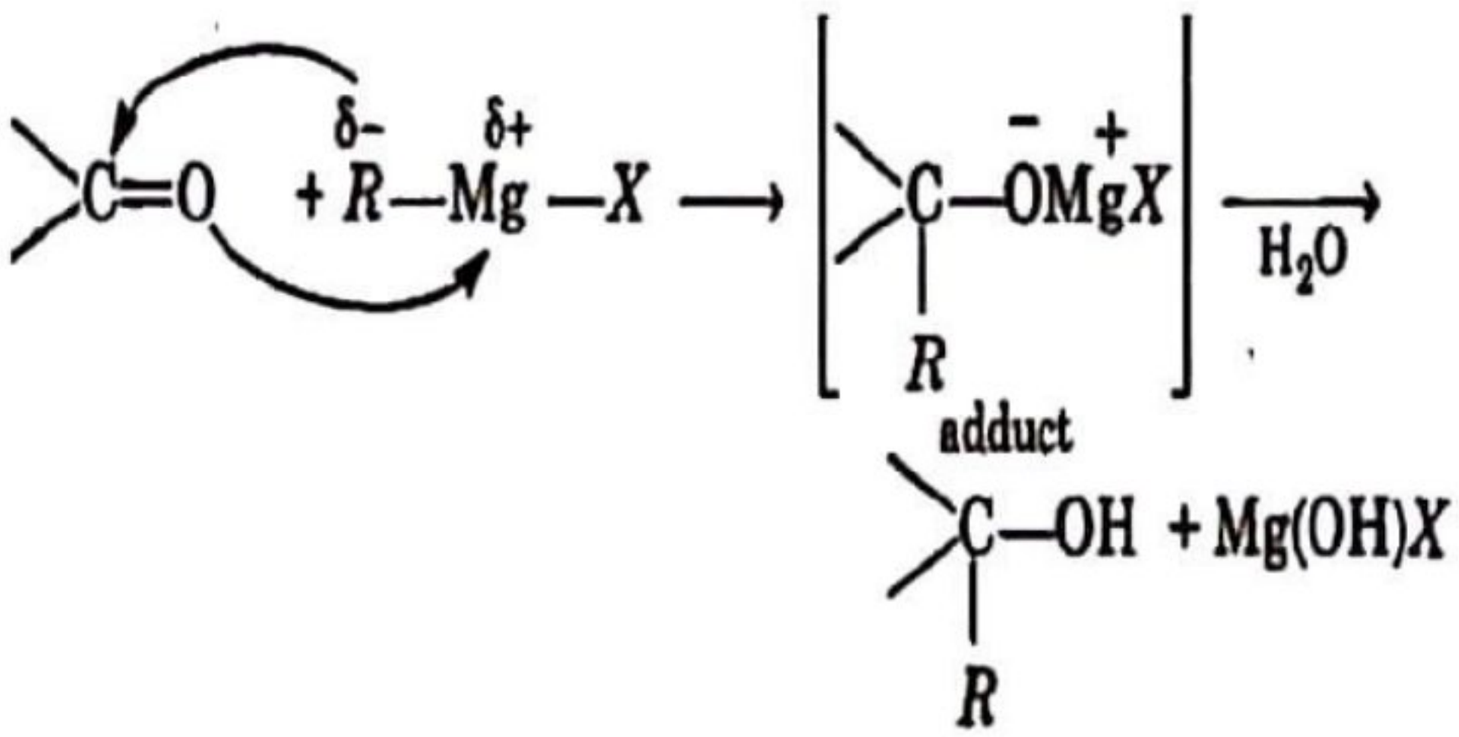
Grignard ragent



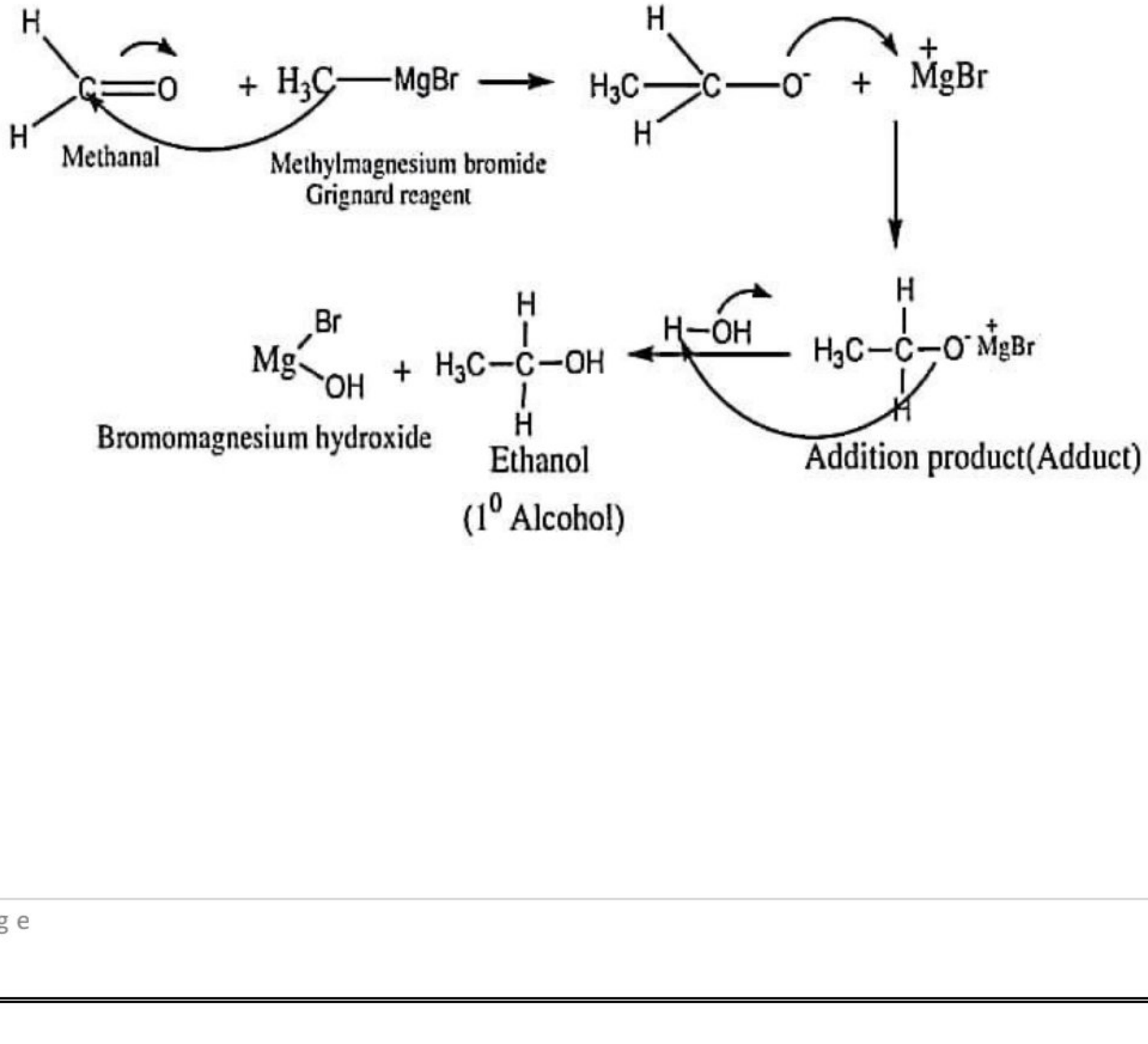
Methyl magnesium bromide
(Grignard reagent)

Aldehydes and ketones (Carbonyl compounds) react with Grignard reagent in the presence of dry ether followed by hydrolysis give primary (1^0), secondary (2^0) and tertiary (3^0) alcohols depending upon the type of aldehydes and ketones used.

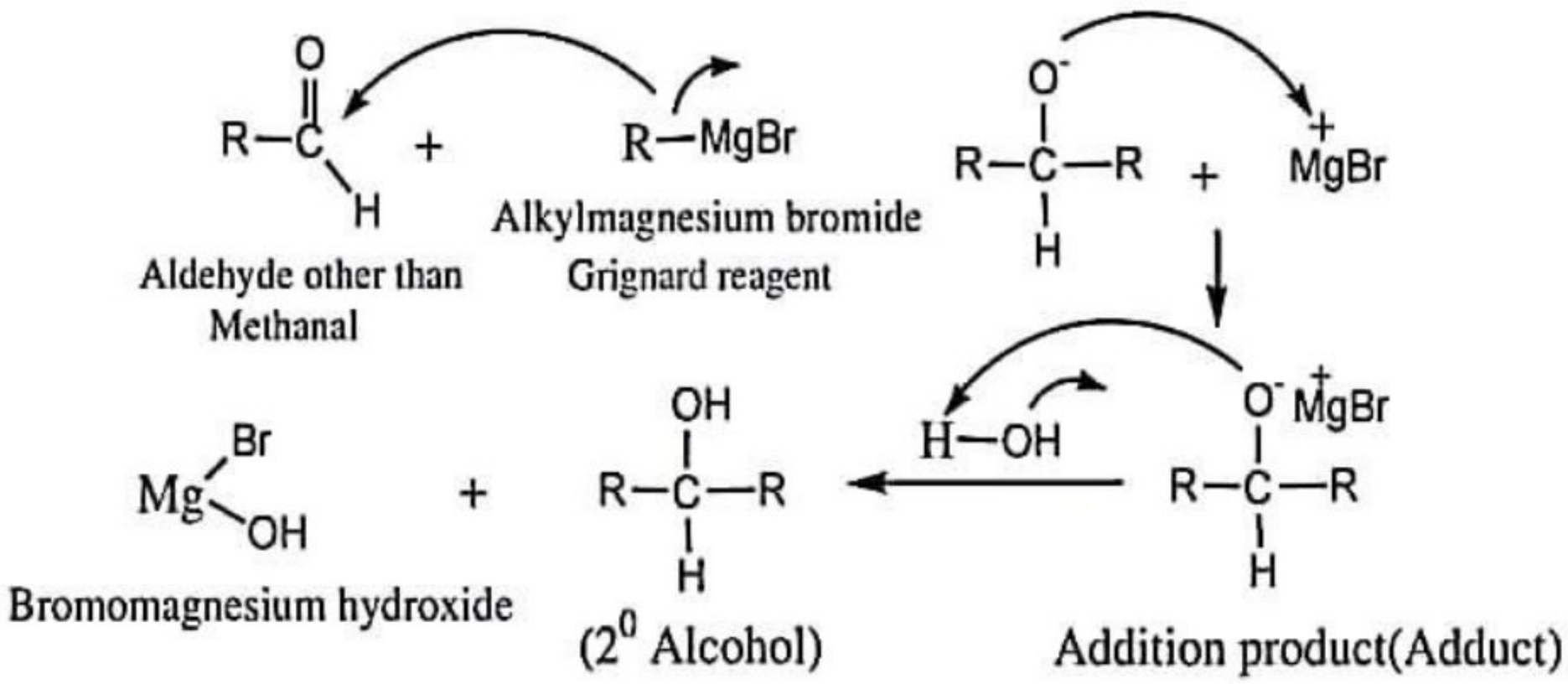
The first step of the reaction is the nucleophilic addition of Grignard reagent to the carbonyl group to form an adduct. Hydrolysis of the adduct yields an alcohol.



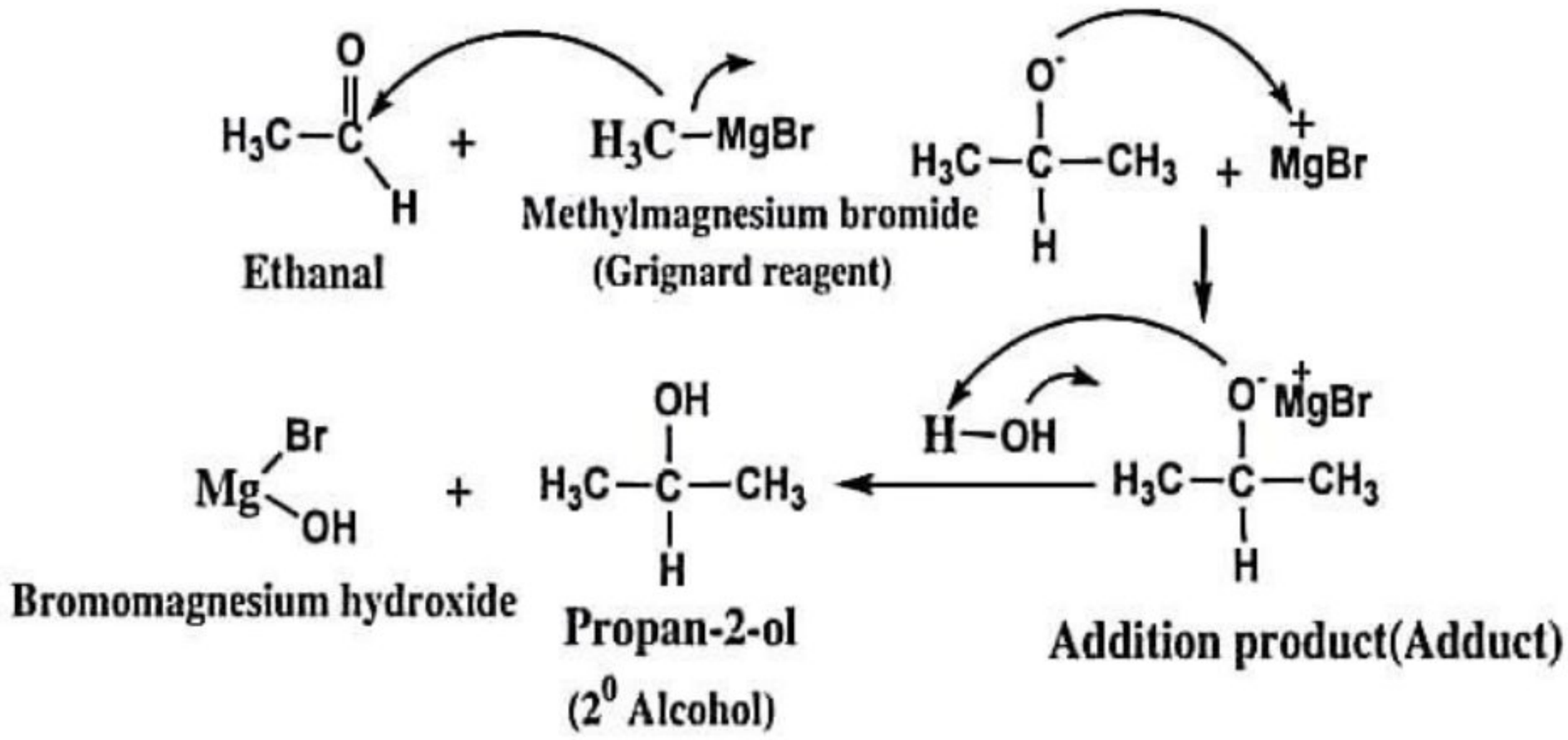
1. Formaldehyde or methanal react with any Grignard reagent, always give primary (1^0)alcohols



2. Aldehydes other than methanal of formaldehyde react with any Grignard reagent, always give secondary (2^0)alcohols

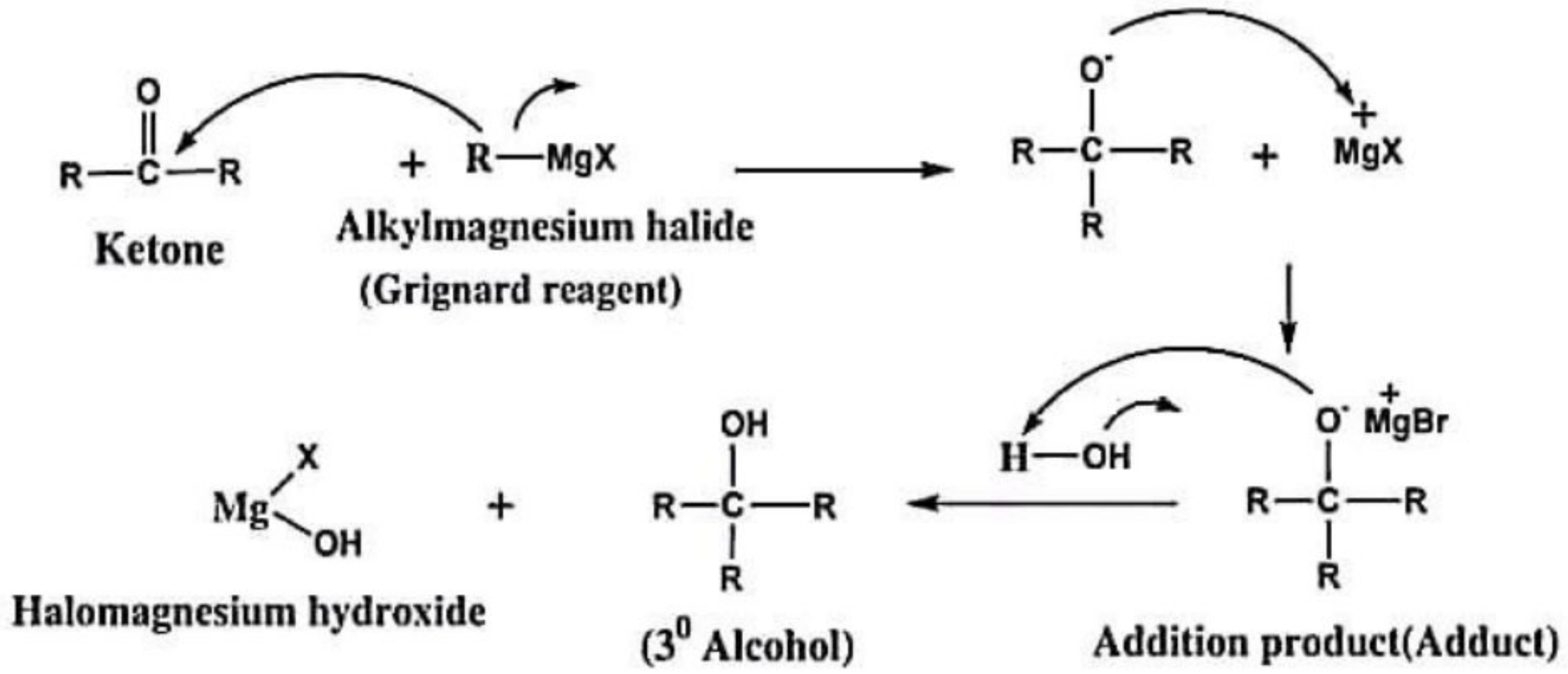


Mechanism

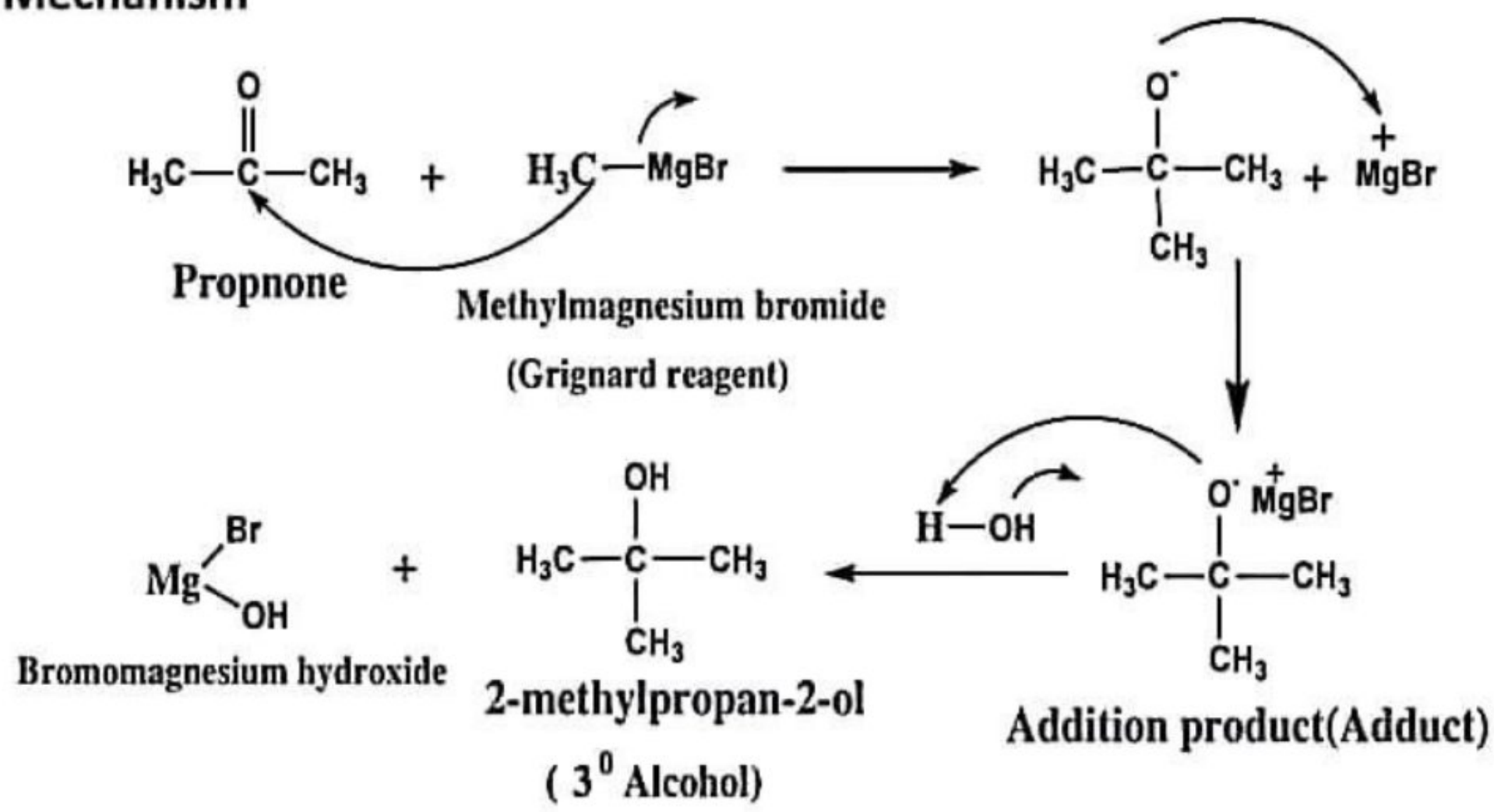


3. Any ketones when react with any Grignard reagent , always give tertiary (3^0) alcohols

Mechanism

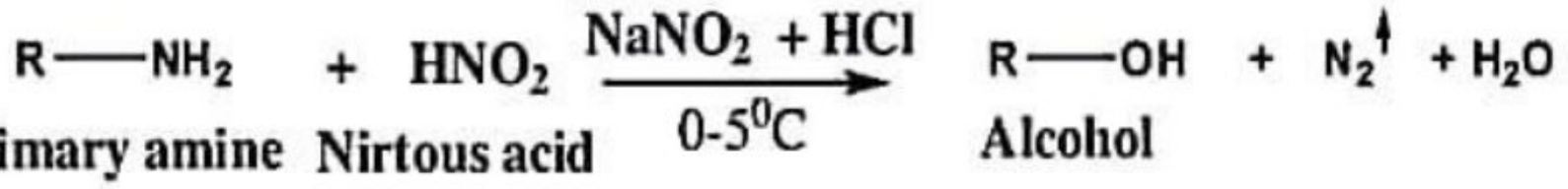


Mechanism

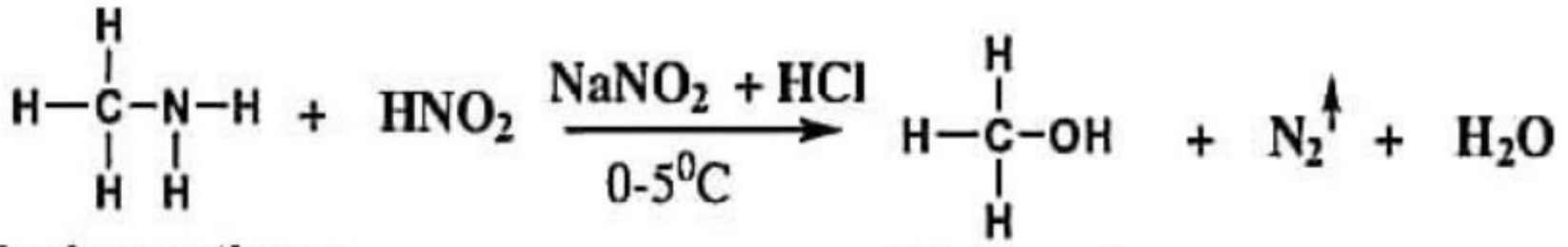


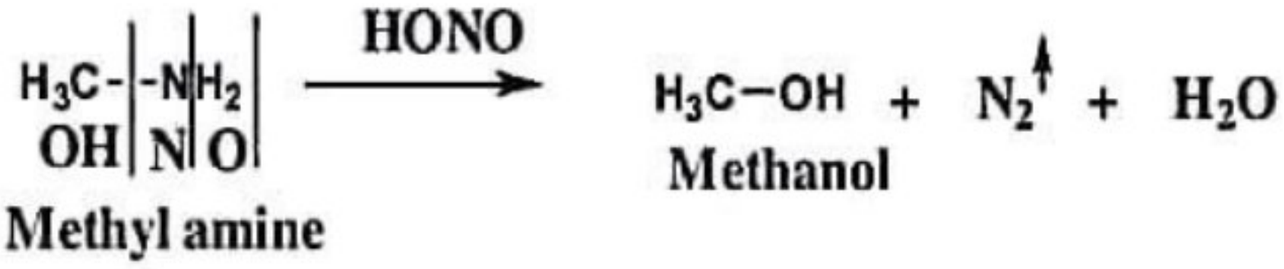
From primary amines

When primary amines are treated with nitrous acid. Alcohols are formed. Nitrous acid is formed by the reaction of $NaNO_2$ and HCl. In this reaction nitrogen gas is also liberated.



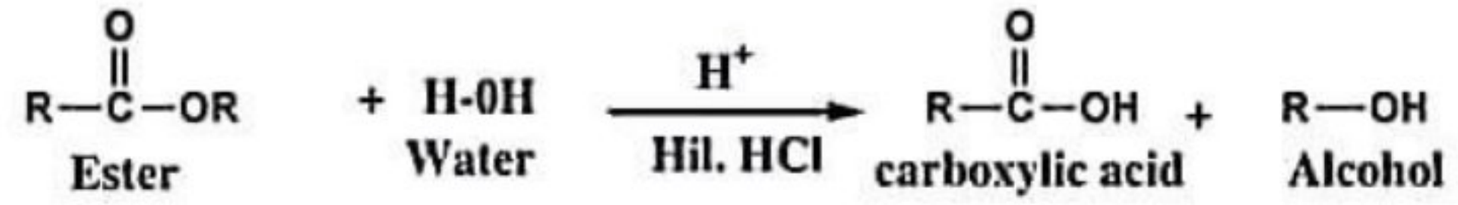
Eg.

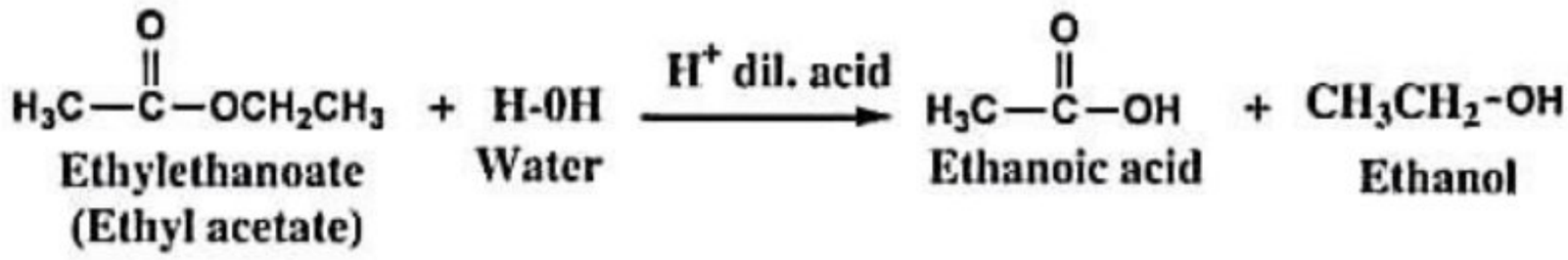


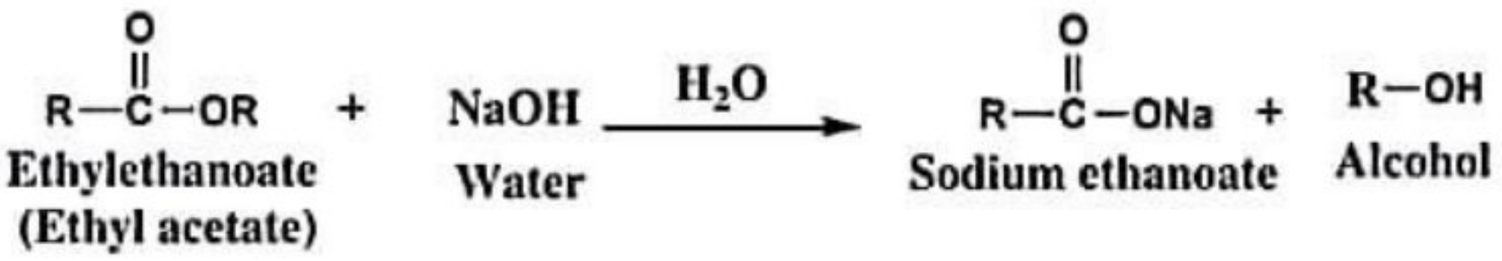


From Hydrolysis of Ester

Alcohols can also be prepared by the hydrolysis of ester in the presence of aq. Acidic or basic medium







Industrial preparation of Alcohol

1. Fermentation of carbohydrates(sugar)

Fermentation is the slow decomposition of complex or higher organic compound into simpler compounds by the action of enzymes. The carbohydrates used for the fermentation are sucrose, glucose ,fructose, molasses and sugar containing fruits and starchy materials like wheat, rice, maize, barley, potato etc.

Fermentation is the old traditional method for the commercial manufacture of ethyl alcohol.

enzyme used is the unicellular plant material which contains enzymes like invertase, diastase, maltase, zymase etc.

1. **From fermentation of sugar**

   Molasses is the big source of sucrose, glucose, fructose. Etc. Molasses is the dark brown colored mother liquor obtained after the crystallization of cane sugar in the sugar industries.

Sucrose obtained from molasses when hydrolyzed in the presence of enzyme 'invertase' give glucose or fructose. Glucose or fructose then comes in contact with enzyme 'zymase' convert into ethyl alcohol along with the evolution of CO_2 gas.

Reaction:

$$\underset{\text{Sucrose (from molasses)}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Invertase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Froctose}}{C_6H_{12}O_6}$$

$$\underset{\text{Glucose or Fructose}}{C_6H_{12}O_6} \xrightarrow{\text{Zymase}} \underset{\text{Ethyl alcohol}}{2C_2H_5OH} + 2CO_2\uparrow$$

The fermented liquor from the above process is called 'wash'. This wash contains 12-15% ethyl alcohol which can be obtained in pure form by distillation process.

2. From fermentation of Starch

Starchy raw material used for the fermentation process are rice, wheat, maize, barley, potato etc.

The raw materials are first thoroughly cocked or boiled with water to release starch which is called 'Mesh'. The mesh is then mixed with yeast (Enzyme) and kept for about 7-10 days or more.

$$\text{Starch} + n H_2O \xrightarrow{\text{Diastase}} \underset{\text{Sucrose}}{n C_{12}H_{22}O_{11}}$$

$$\underset{\text{Sucrose (from molasses)}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Invertase or Maltase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Froctose}}{C_6H_{12}O_6}$$

$$\underset{\text{Glucose or Fructose}}{C_6H_{12}O_6} \xrightarrow{\text{Zymase}} \underset{\text{Ethyl alcohol}}{2C_2H_5OH} + 2CO_2 \uparrow$$

This fermented liquor is called 'wash' this wash contains 12-15 % ethyl alcohol is obtained impure form by distillation

Favorable condition for fermentation:

- **Yeast**, a type of single-celled **fungus**, provides the **enzymes** needed for fermentation.
- Little amount of ammonium sulphate or ammonium phosphate is added as nutrient of yeast.
- If the yeast **cells** become too cold, fermentation happens very slowly, or may not happen at all.
- If the yeast cells become too hot, their enzymes become **denatured** and fermentation stops.
- sugars **dissolved** in water, and mixed with yeast
- an air lock to allow carbon dioxide out, while stopping air getting in
- warm **temperature**, 25-35°C
- The yeast dies when the ethanol concentration reaches about 15 %
- If air is present, the oxygen causes the ethanol to oxidize to ethanoic acid, so the drink tastes of vinegar.

Oxo process:

This is also the industrial process for manufacturing of alcohol above ethanol. In this process alkenes are treated with ($CO+H_2$) the presence of cobalt carbonyl catalyst (octacarbonyl dicobalt) to get aldehyde. This aldehyde on reduction in the presence of Ni/H_2 or Pt/H_2 catalyst Catalytic hydrohenation) gives alcohol.

$$\underset{\text{Ethene}}{H_2C{=}CH_2} + CO + H_2 \xrightarrow[\Delta]{[Co(CO_4)_2]} \underset{\text{Propanal}}{CH_3CH_2CHO} \xrightarrow{Ni/H_2} \underset{\text{Propan-1-ol}}{CH_3CH_2CH_2OH}$$

Hydroboration-oxidation of ethene

Alkenes react with diborane (B_2H_6) or $(BH_3)_2$ undergo hydroboration to give alkyl borane which on oxidation in the presence of H_2O_2 gives alcohol

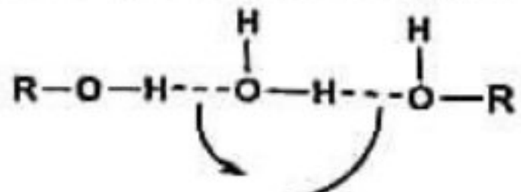
$$\underset{\text{Ethene}}{H_2C{=}CH_2} + \underset{\text{Borane}}{H\text{-}BH_2} \text{ or } {}^1/_2(BH_3)_2 \xrightarrow[\text{Hydroboration}]{\text{Ether}} \underset{\text{Ethylborane}}{CH_3CH_2\text{-}BH_2}$$

$$\underset{\text{Ethylborane}}{CH_3CH_2\text{-}BH_2} \xrightarrow{H_2O_2/OH^-,\ Oxd^n} \underset{\text{Boric acid}}{B(OH)_3} + \underset{\text{Ethanol}}{CH_3CH_2OH}$$

Properties of alcohols (Monohydric alcohols)

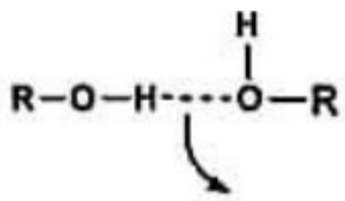
1. Physical properties

- Lower alcohols are colorless liquid with characteristic smell and burning taste while higher alcohols are colorless waxy solids.
- Lower alcohols are soluble in water due to presence of intermolecular hydrogen bonding.
- solubility decreases with increase in the carbon chain or molecular masses. This is due to the difference in the sizes of the alcohol and water molecules.



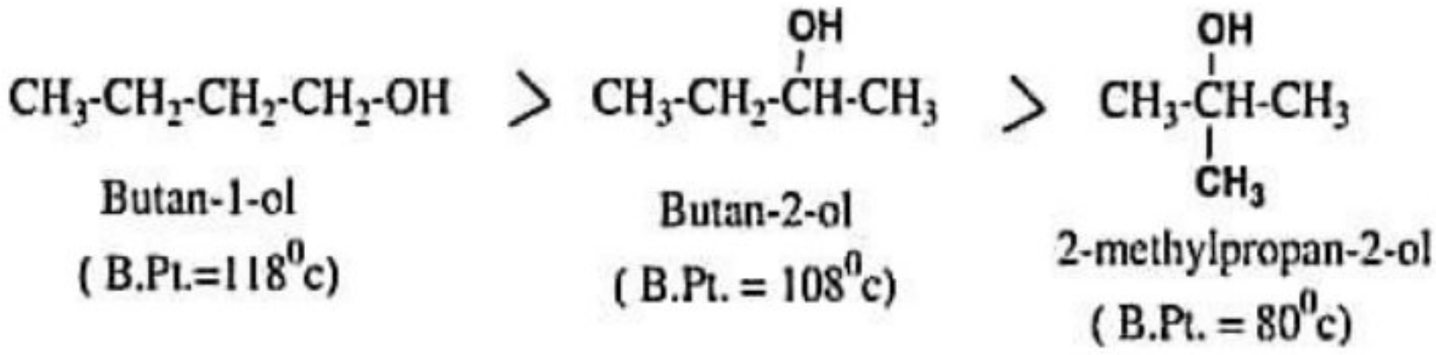
Intermolecular Hydrogen bond

- The boiling points of the alcohols are much higher than those of other hydrocarbons having comparable molecular weight. It is because of intermolecular hydrogen bonding formation.



Intermolecular Hydrogen bonding among alcohol molecules

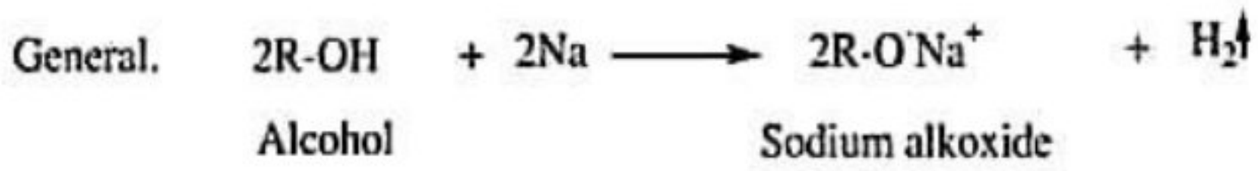
❖ Boiling points of alcohols decreases with increase of branching.



❖ **Chemical Properties of alcohols (Monohydric alcohols)**

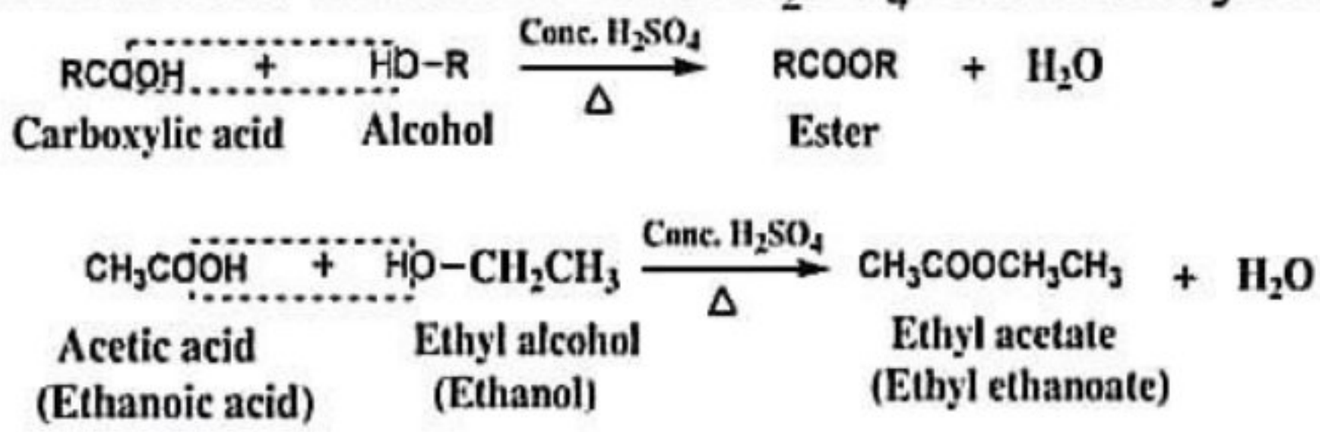
(1) Reaction with metals (Acidic nature of alcohols)

The reaction between highly electropositive metals like Na, K, Li etc. Involves in the presence of ether, breaking of the bond between -O-H takes place and metal alkoxide and H_2 gas released showing the acidic nature of alcohols.



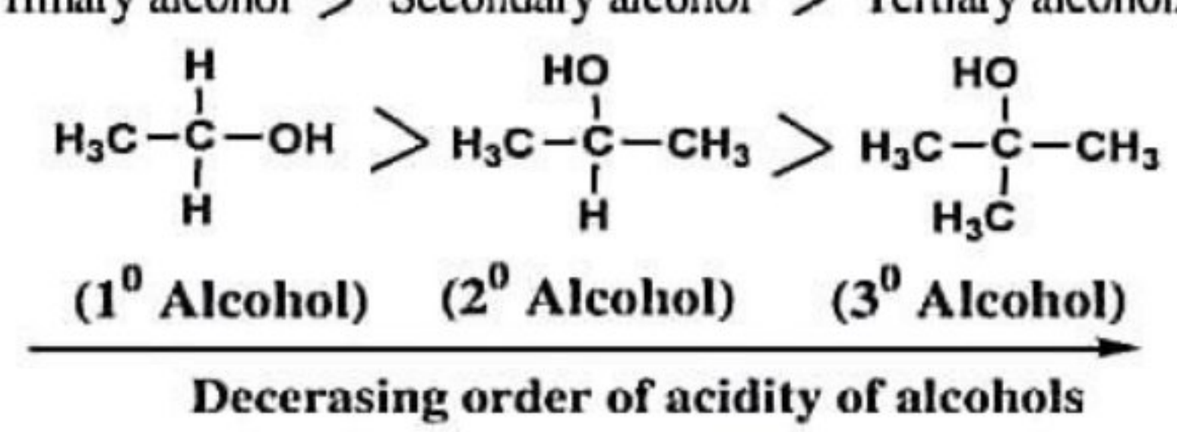
(2)Esterification:

Alcohols react with carboxylic acid in the presence of few drops of conc. H_2SO_4 to give esters. This reaction is called esterification reaction. Conc. H_2SO_4 acts as dehydrating agent.



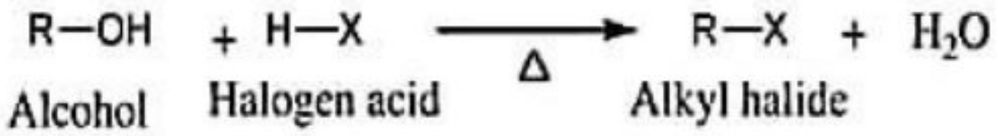
This test is laboratory test for ethyl alcohol.

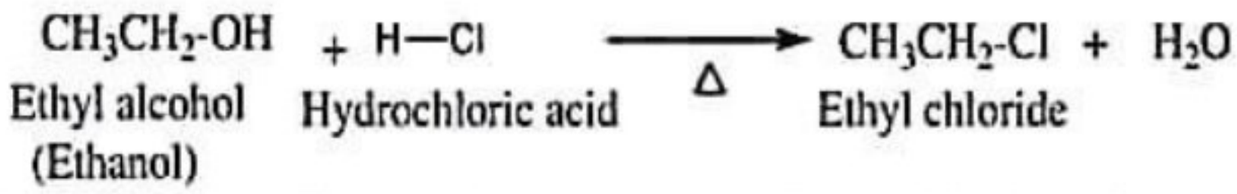
The order of acidic strength of alcohols is given as:



(3) Reaction with halogen acid (Basic nature of alcohol)

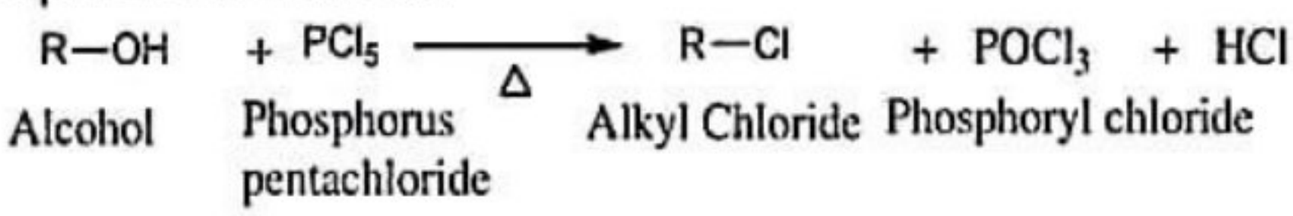
In this reaction –OH group is replaced by halogen atom.

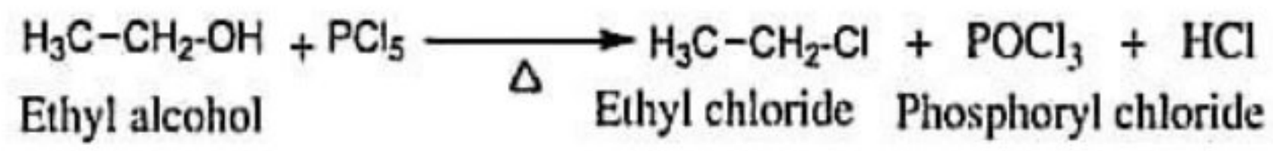




(4) Reaction with Phosphorous halide (PX_3,PX_5)

Alcohols are easily converted to alkyl halide when react with phosphorous halides



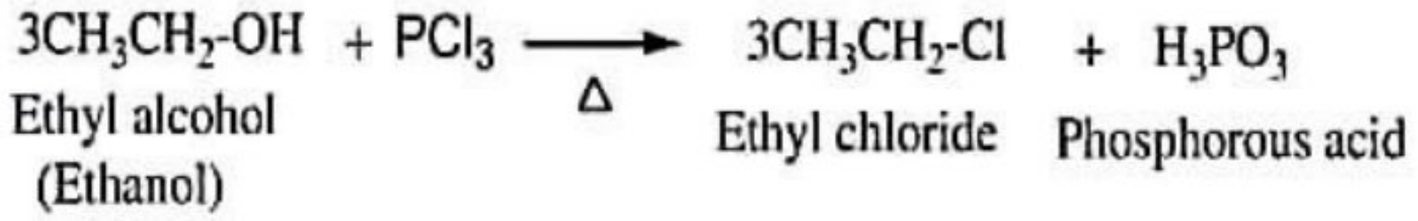


The order of basic strength of alcohols is given as:

Primary alcohol < Secondary alcohol < Tertiary alcohols

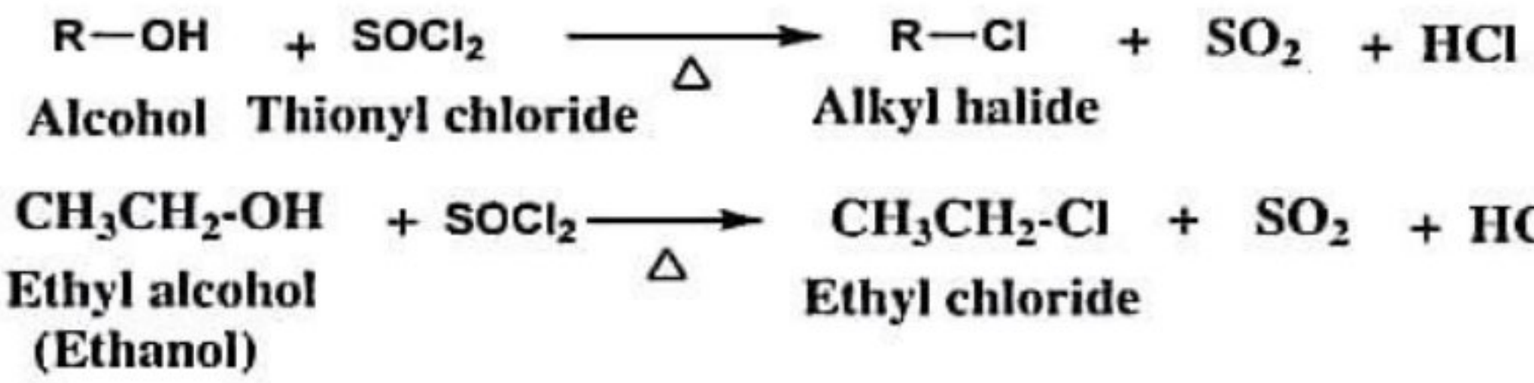
(5) Reaction with PX_3

Alcohols also react with phosphorous trihalide to give alkyl halide.



(6)Reaction with Thionyl chloride ($SOCl_2$)

Alcohols react with thionyl chloride to give alkyl halides.

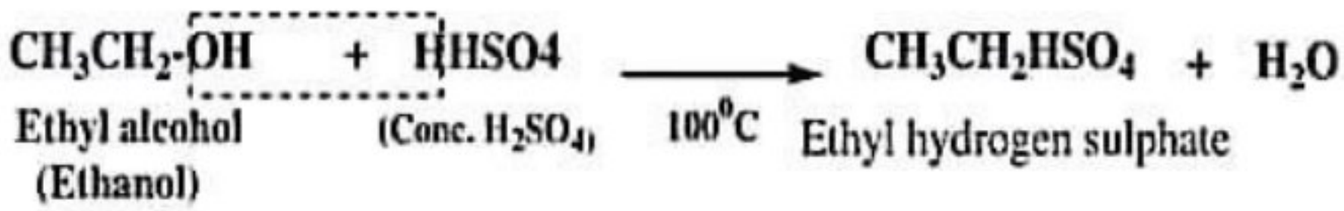


(7) Reaction with H_2SO_4 :

Ethyl alcohol reacts with conc. H_2SO_4 to give different products at different temperatures.

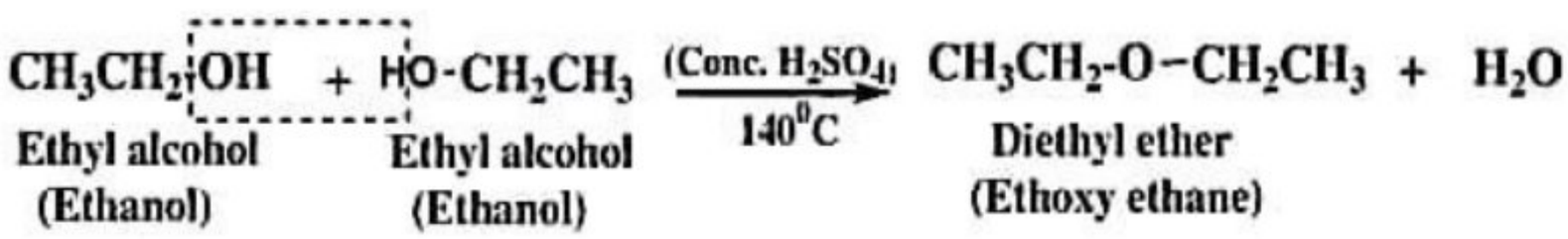
(1)At 100^{0}C:

Ethyl alcohol reacts with conc. H_2SO_4 at 100^{0}C to give ethyl hydrogen sulphate.



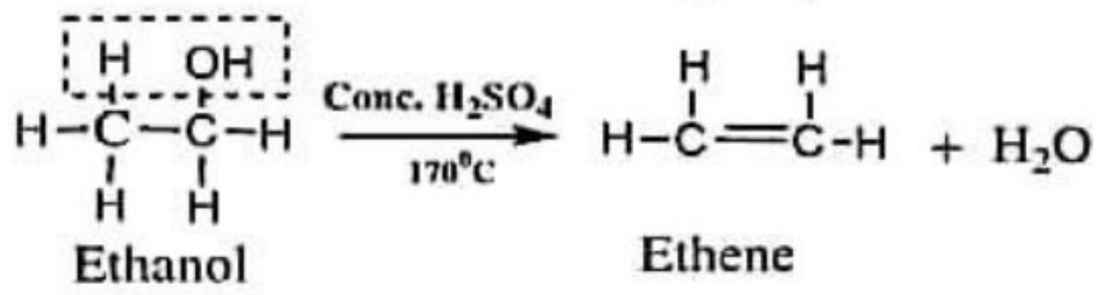
(1)At 140^{0}C:

Ethyl alcohol reacts with conc. H_2SO_4 at 140^{0}C to give ethyl diethyl ether (Ethoxy ethane).



(1)At 170^{0}C:

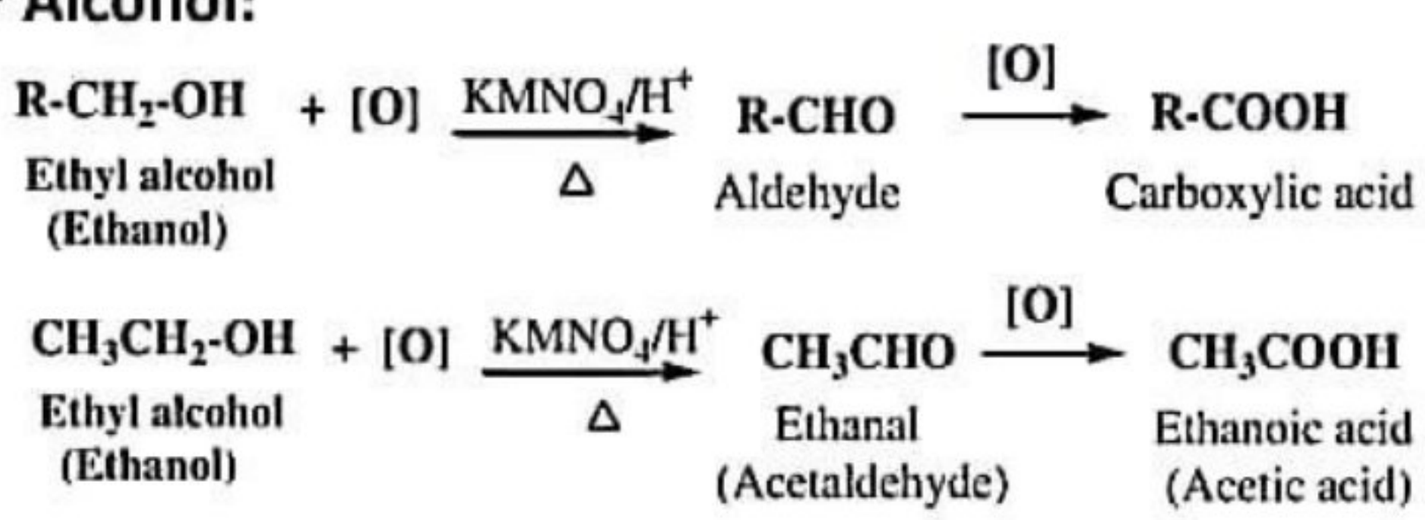
Ethyl alcohol reacts with conc. H_2SO_4 at 170^{0}C to give ethene.



(8) Oxidation of 1^0,2^0 and3^0 alcohols by oxidizing agents:

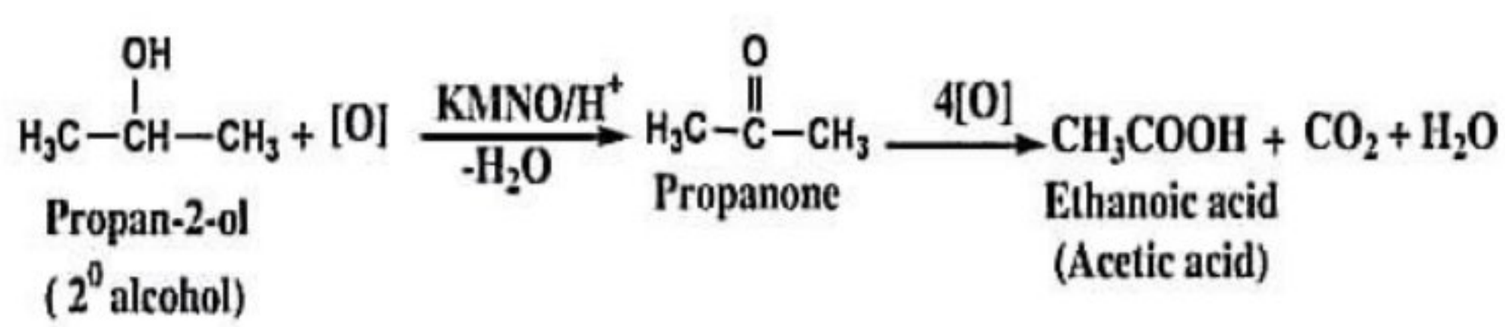
Alcohols can easily be oxidized into aldehydes and ketones in the presence of any oxidizing agents like acidic or alkaline $K_2Cr_2O_7$, $KMNO_4$ etc.

(i) 1^0 Alcohol:



(ii) 2^0 Alcohol:

2^0 alcohols are oxidized into ketone with the same no of carbon atoms. The ketones are further oxidized into carboxylic acid with one carbon less than original ketones.



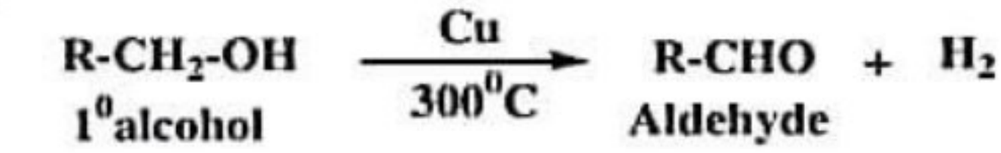
(iii) 3^0 Alcohol:

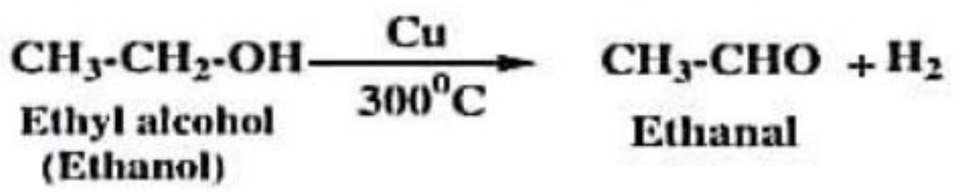
3^0 alcohols are not oxidized in ordinary condition because in 3^0 alcohols carbon containing –OH has no hydrogen atom.

(9) Reduction of alcohols (Catalytic dehydrogenation & dehydration)

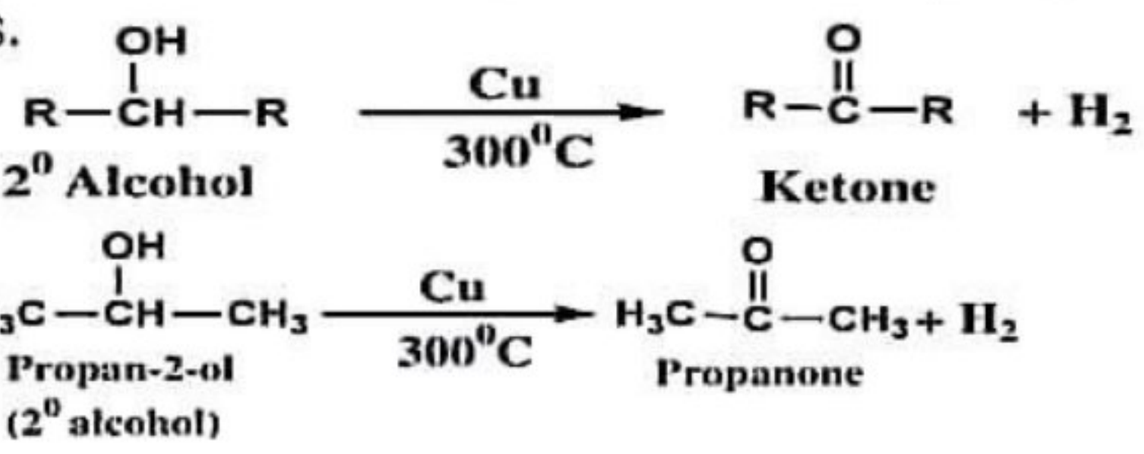
When alcohol vapors are passed through the red hot copper tube at 300^0 C, Different class of alcohols give different products.

(i) 1^0 Alcohol: 1^0 or primary alcohols are dehydrogenated into aldehydes.



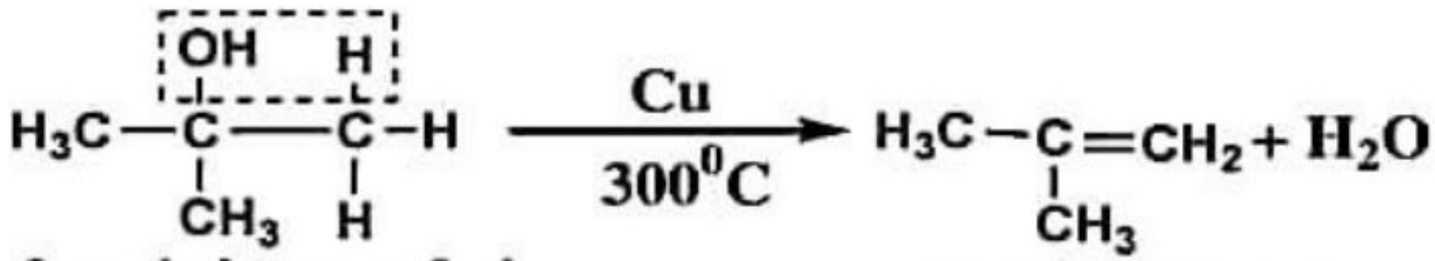


(ii) 2^0 Alcohol: 2^0 or secondary alcohols are dehydrogenated into ketones.



(iii) 3^0 Alcohol:

3^0 or tertiary alcohols are dehydrated into alkenes in the presence of Cu catalyst at 300^0C.



2-methylpropan-2-ol

(3^0 alcohol)

2-methylpropene

Distinction between 1^02^0 and 3^0 alcohols by Victor Meyer's Method

There are several methods for distinguishing 1^02^0 and 3^0 alcohols but most important method is Victor Meyer's Method.

(i) Oxidation method

(ii) Catalytic dehydrogenation

(iii) Victor Meyer's Method etc.

(iv) Lucas Test

Victor Meyer's Method:

Victor Meyer's Method is most important and widely used method for distinguishing 1^0, 2^0 and 3^0 alcohols. In this method the given alcohol is first treated with phosphorous and iodine solution ($P+I_2$) to give iodo alkane which is then treated with silver nitrite($AgNO_2$) to give nitro alkane. The nitro alkane is then treated with nitrous acid (HNO_2) and the resulting solution is finally made alkaline by NaOH or KOH. Following results are obtained.

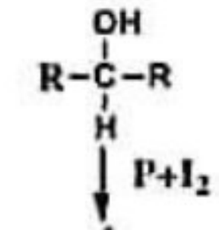
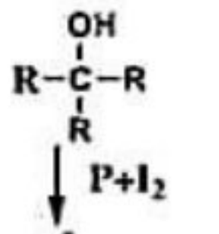
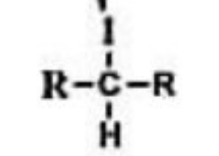
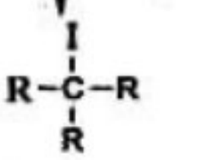
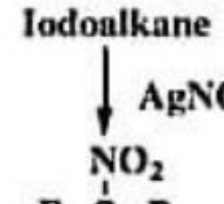
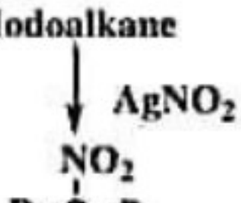
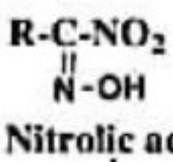
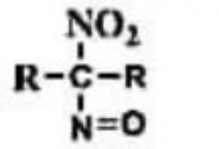
(i) Primary alcohol gives red colour

(ii) Secondary alcohol gives blue colour

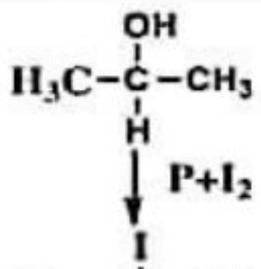
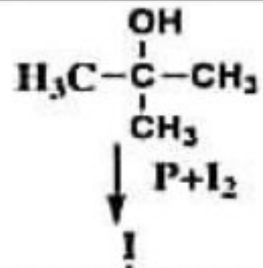
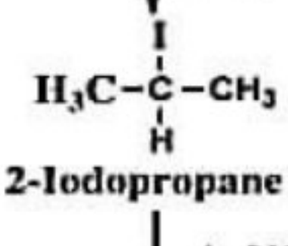
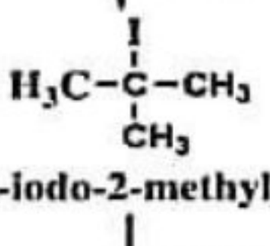
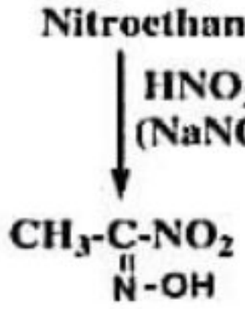
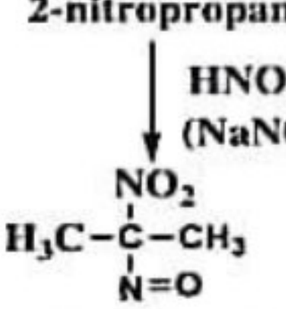
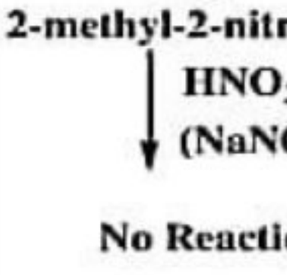
(iii) Tertiary alcohol gives no any colour

Table for distinguishing 1^0, 2^0 and 3^0 alcohols is given in next slide

Table for distinguishing 1^0, 2^0 and 3^0 alcohols

Primary (1^0) Alcohol	Secondary (2^0) Alcohol	Tertiary (3^0) Alcohol
$R\text{-}CH_2\text{-}OH$		
$P+I_2$	$P+I_2$	$P+I_2$
$R\text{-}CH_2\text{-}I$		
Iodoalkane	Iodoalkane	Iodoalkane
$AgNO_2$	$AgNO_2$	$AgNO_2$
		
Nitroalkane	Nitroalkane	Nitroalkane
HNO_2 ($NaNO_2$+ HCl)	HNO_2 ($NaNO_2$+ HCl)	HNO_2 ($NaNO_2$+ HCl)
		No Reaction
Nitrolic acid	Psecudonitrole	Iodoalkane
KOH	KOH	KOH
Red colour	Blue colour	No colour

Example

Ethanol Primary (1^0) Alcohol	Propan-2-ol Secondary (2^0) Alcohol	2-methylpropan-2-ol Tertiary (3^0) Alcohol
$CH_3\text{-}CH_2\text{-}OH$		
$P+I_2$	$P+I_2$	$P+I_2$
$CH_3\text{-}CH_2\text{-}I$		
Iodoethane	2-Iodopropane	2-iodo-2-methylpropane
$AgNO_2$	$AgNO_2$	$AgNO_2$
		
Nitroethane	2-nitropropane	2-methyl-2-nitropropane
HNO_2 ($NaNO_2$+ HCl)	HNO_2 ($NaNO_2$+ HCl)	HNO_2 ($NaNO_2$+ HCl)
		No Reaction
Nitrolic acid	Psecudonitrole	KOH
KOH	KOH	
Red colour	Blue colour	No colour

Lucas Test

In This test the unknown alcohol is treated with the Lucas reagent ($HCl + ZnCl_2$) . This is the reaction of alcohol with HCl in the presence of dilute HCl.

The time taken for the reaction to occur is important to know the class of alcohols. The occurrence of reaction can be observed by the appearance of white turbidity or cloudness.

(i) For 1^0 alcohol, reaction occurs only after heating.

(ii) For 2^0 alcohol, reaction occurs within five minutes.

(iii) For 3^0 alcohol, reaction occurs immediately.

Table:

Primary (1^0) Alcohol	Secondary (2^0) Alcohol	Tertiary (3^0) Alcohol
$R\text{-}CH_2\text{-}OH + HCl \xrightarrow[\Delta]{ZnCl_2} R\text{-}CH_2\text{-}Cl$ Chloroalkane (Reaction occurs only after heating)	$R\text{-}CH(OH)\text{-}R + HCl \xrightarrow{ZnCl_2} R\text{-}CHCl\text{-}R$ Chloroalkane (Reaction occurs within five minutes)	$R\text{-}C(OH)(R)\text{-}R + HCl \xrightarrow{ZnCl_2} R\text{-}CCl(R)\text{-}R$ Chloroalkane (Reaction occurs immediately)

Lucas Test

In This test the unknown alcohol is treated with the Lucas reagent ($HCl + ZnCl_2$) . This is the reaction of alcohol with HCl in the presence of dilute HCl.

The time taken for the reaction to occur is important to know the class of alcohols. The occurrence of reaction can be observed by the appearance of white turbidity or cloudness.

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$R\text{-}CH_2\text{-}OH + HCl \xrightarrow[\Delta]{ZnCl_2} R\text{-}CH_2\text{-}Cl$ Chloroalkane (Reaction occurs only after heating)	$R\text{-}CH(OH)\text{-}R + HCl \xrightarrow{ZnCl_2} R\text{-}CHCl\text{-}R$ Chloroalkane (Reaction occurs within five minutes)	$R\text{-}C(OH)(R)\text{-}R + HCl \xrightarrow{ZnCl_2} R\text{-}CCl(R)\text{-}R$ Chloroalkane (Reaction occurs immediately)

Test for ethyl alcohol:

(i) Esterification Test (Already Studied)

(ii) Iodoform test

(Iodoform Test)

When ethanol is treated with iodine solution in the presence of NaOH or KOH gives iodoform on gentle heating on water bath.

$$\underset{\text{Ethanol}}{CH_3\text{-}CH_2\text{-}OH} + I_2 \xrightarrow[\Delta]{NaOH} \underset{\text{Iodoform}}{CHI_3} + \underset{\text{Sodiumformate (Salt)}}{HCOO^-Na^+}$$

Detail Rxn:

$$\underset{\text{Ethanol}}{CH_3\text{-}CH_2\text{-}OH} \xrightarrow{[O]} \underset{\substack{\text{Ethanal}\\(\text{Acetaldehyde})}}{CH_3CHO} \xrightarrow{3I_2} \underset{\substack{\text{Tri-iodoethanal}\\(\text{Tri-iodoacetaldehyde})}}{CI_3CHO} \xrightarrow[\Delta]{NaOH} \underset{\text{Iodoform}}{CHI_3} + \underset{\substack{\text{Sodiumformate}\\(\text{Salt})}}{HCOO^-Na^+}$$

Procedure: Ethanol solution is taken in a test tube and iodine solution is added till it becomes brown colouration. NaOH solution is added drop wise till the brown color is just disappeared. Now the above mixture is warmed gently on water bath. Pale yellow crystals of iodoform are obtained which indicates the presence of ethanol.

Alcohol Industry(Different types of Ethanol in Industry)

Ethyl alcohol is one of the important industrial raw material and this ethyl alcohol is marketed or sold in the market in different names and grades.

(i) **Rectified spirit:** Ethyl alcohol obtained by the distillation of fermented liquor. Rectified spirit is 95% ethyl alcohol. Or 95% pure ethyl alcohol is called rectified spirit. This percentage of ethanol is made for industrial purposes.

(ii) **Absolute alcohol:** Ethyl alcohol of 100% purity is called absolute alcohol. It can also be prepared by further distillation of rectified spirit.

(iii) **Methylated spirit or denaturated alcohol** : Ethyl alcohol is made available for industrial purposes only after making it unfit for drinking purposes by mixing large quantities of ethyl alcohol with little poisonous substances like methyl alcohol, pyridine, acetone etc, The mixing of other chemicals in very small amount do not effect the industrial purposes.

Alcoholic beverages :

The various liquors used for drinking purposes are made from ethyl alcohol. These liquors are called alcoholic beverages. Alcoholic beverages are of two types.

(i) Undistilled beverages

(ii) Distilled beverages

Undistilled alcoholic beverages:

The undistilled alcoholic beverages are prepared by the fermentation of Juices of the fruits like apple juices, grapes juices, banana juices etc. This undistilled beverage contains low percentage of ethyl alcohol. Beers and various kinds of wines belong to this categories.

Distilled alcoholic beverages:

The distilled beverages are made by the distillation of fermented liquors and contains higher percentage of ethyl alcohol. Such beverages includes Whiskies, Brandies, Rums, Vodkas Gins etc.

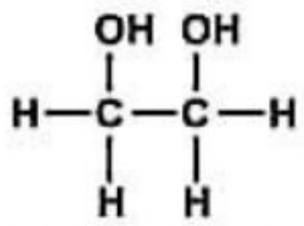
Uses of Alcohols

- Lower members of alcohols are used as solvent for paints and other organic compounds.
- Alcohols are also used as preservative for biological specimens and other decaying materials.
- Ethyl alcohol is used as important industrial raw material.
- Lower members of alcohols are also antiseptics, disinfectants and also germicides.
- Ethyl alcohol is Used as an ingredient in **alcoholic beverages** E.g. whiskies. Rum, brandies, wine, beer etc.
- Used to produce methylated spirit (meth) Methylated spirit is ethanol mixed with small amounts of methanol and other poisonous chemicals for making it unfit for consumption.
- Used as a **fuel**. Ethanol burns cleanly to form carbon dioxide and water.

.....End (Monohydric alcohols).....

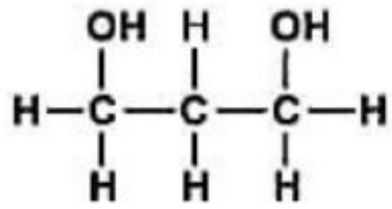
Dihydric Alcohols:

Alcohols containing two –OH functional groups are called dihydric alcohols. They are called diols in IUPAC and glycols in common system.



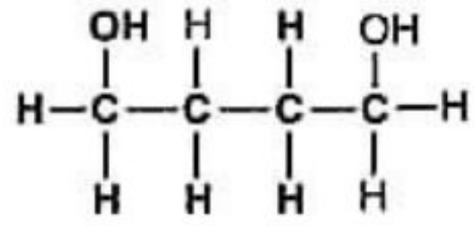
Dihydric alcohol

(Ethan-1,2-diol or ethylene glycol)



Dihydric alcohol

(Propan-1,3-diol)



Dihydric alcohol

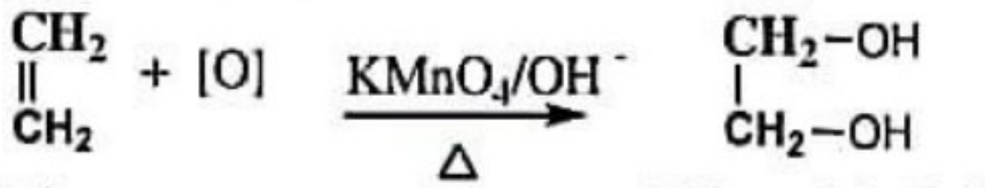
(Butan-1,4-diol)

Ethan-1,2-diol:

Ethan-1,2-diol or ethylene glycol is prepared by following methods

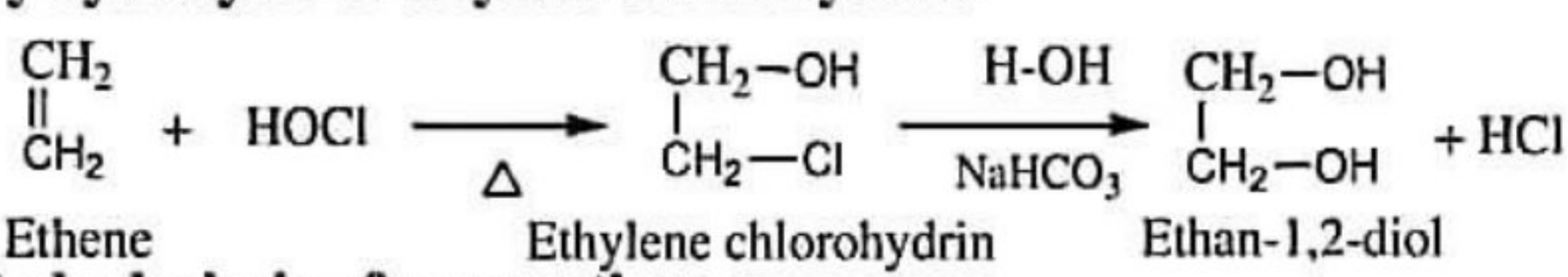
(i) By hydroxylation of ethene:

When ethene is treated with the cold dilute solution of alkaline $KMnO_4$, Ethane-1,2-diol is prepared.



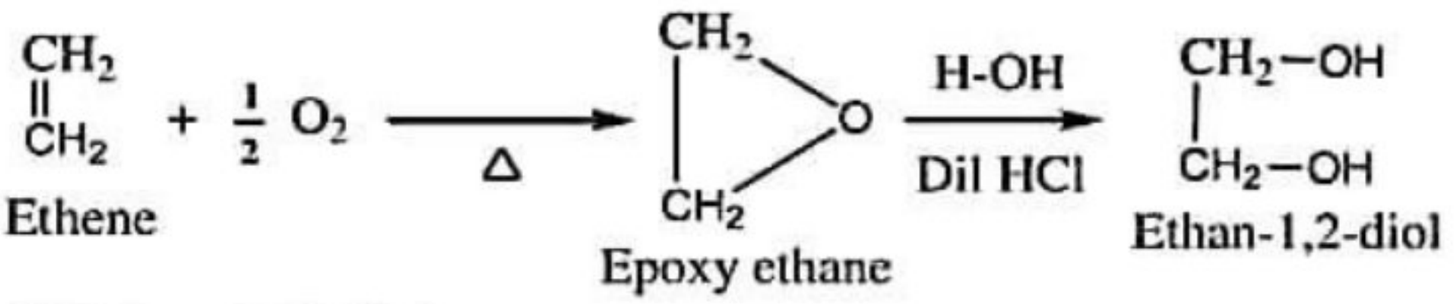
Ethene — Ethane-1,2-diol

By hydrolysis of ethylene chlorohydrin:



Ethene — Ethylene chlorohydrin — Ethan-1,2-diol

By hydrolysis of epoxy ethane:



Ethene — Epoxy ethane — Ethan-1,2-diol

Uses of Ethan-1,2-diol:

(i) Ethan-1,2-diol or ethylene glycol is used as antifreeze for automobile radiator and as coolant in aircraft engine.

(ii) It is used as starting material in the manufacture of nitroglycol which is an explosive.

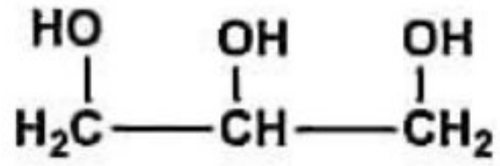
(iii) It is used as an anesthetic and also used as solvent in printing inks and stamp pad inks.

Trihydric alcohols

Alcohols containing three hydroxyl groups in their molecules are called trihydric alcohols. In IUPAC the are called triols

Propan-1,2,3-triol (Glycerol)

Glyceron or propan-1,2,3-triol is an important examples of trihydric alcohols.



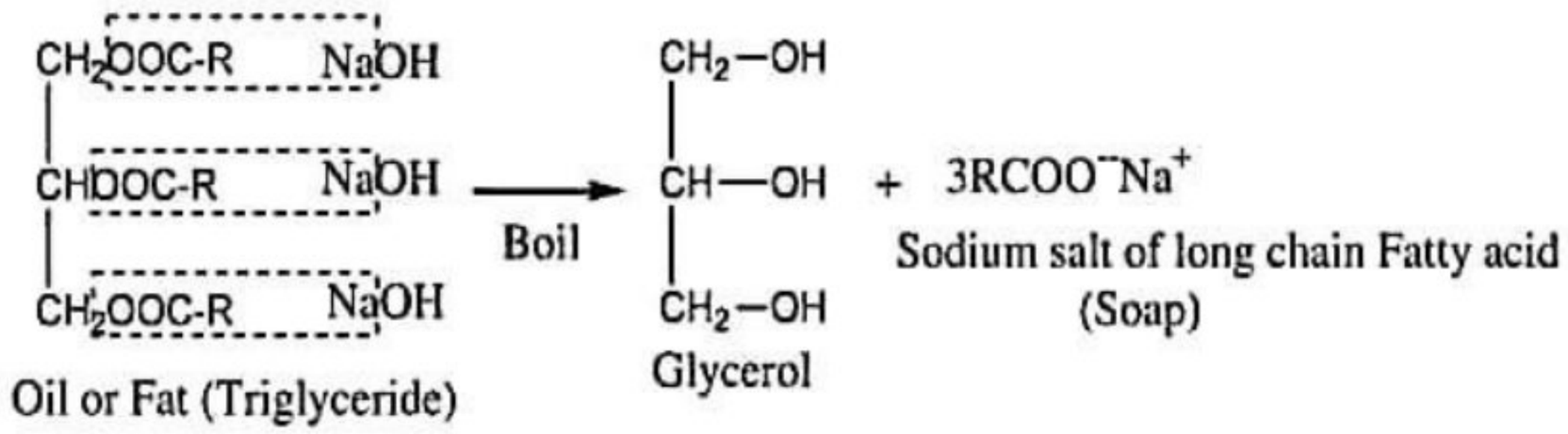
Propan-1,2,3-triol (Glycerol)

Industrial preparation of glycerol

From oils and fat

Oils and fats are the triesters of glycerol with long chain fatty acids mainly palmitic acid($C_{15}H_{31}COOH$), stearic acid($C_{17}H_{35}COOH$), oleic acid ($C_{17}H_{33}COOH$), linoleic acid($C_{17}H_{31}COOH$) etc. These triesters are also called triglycerides.

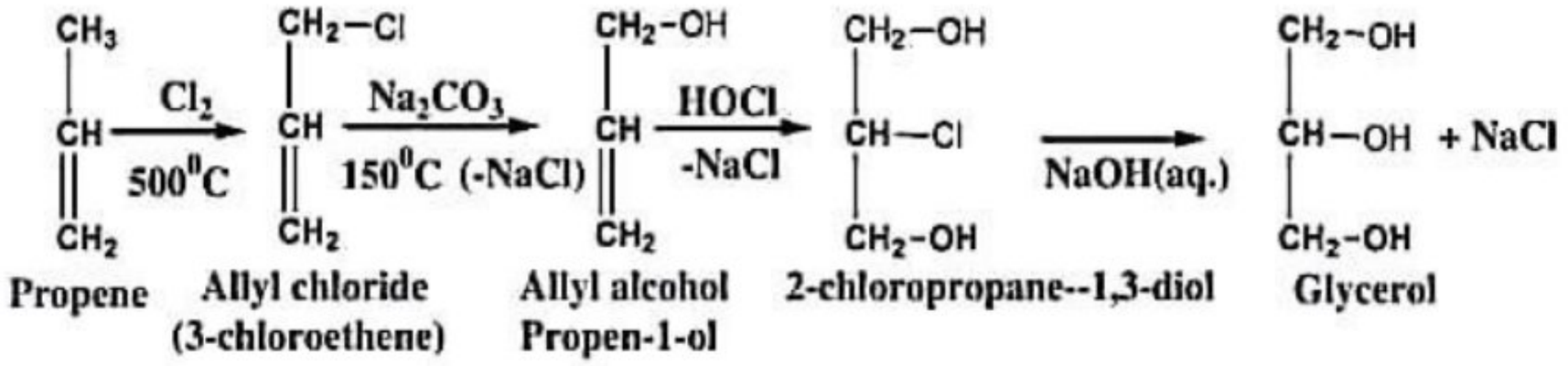
During the manufacture of soaps, oils and fats are heated with strong solution of NaOH or KOH. This is alkaline hydrolysis of triglycerides called **saponification.** After the completion of the saponification process, the triglycerides are converted into glycerol and soap which is the sodium or potassium salts of long chain fatty acids.



The soap is prepared by the adding NaCl solution. The syrupy liquid left after the separation of soap is called **spent lye**. Glycerol is manufactured from **spent lye.**

From Propene or (Propylene)

Glycerol is also prepared synthetically from propene as follows.



Uses of Propan-1,2,3-triol (Glycerol)

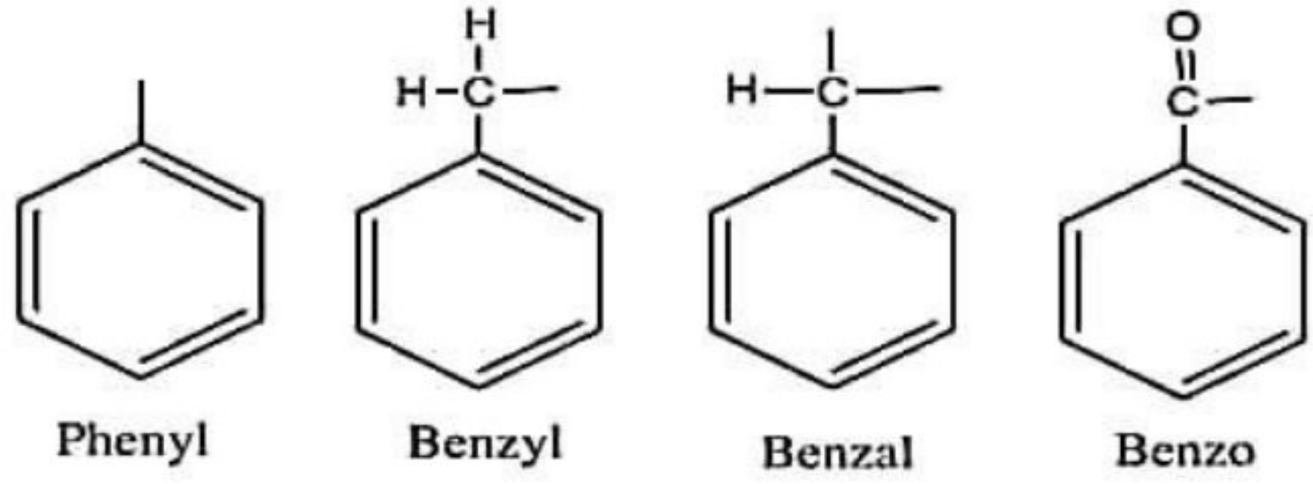
(i) Glycerol is hygroscopic in nature which absorbs moisture so it is used as shaving cream, moistening cream, hand lotion etc.

(ii) It is used in bakery product as sweetening agent.

(iii) It is used in manufacturing explosive like glyceryl trinitrate.

(iv) It is used as lubricant for small machinery parts like watch parts etc.

(v) It is used as solvent for non-drying printing inks, stamp pad inks etc.



Why cresol is less acidic than phenol?