

ALCOHOLS, PHENOLS AND ETHERS.

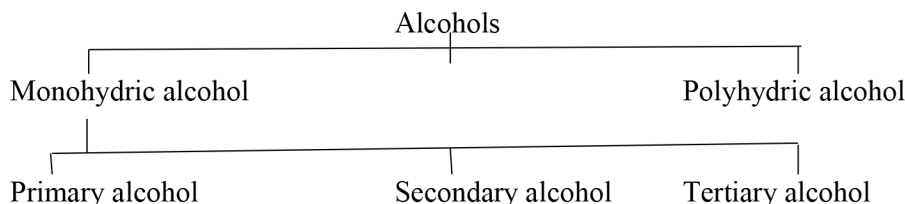
1. What are alcohols? How are they classified?

GRW-2008, LHR -2012

Ans: **Define:-** "The compounds in which one or more hydrogen atoms of alkanes are replaced by -OH groups are called alcohols."

Classification of Alcohol:-

Alcohols are classified as follows.



2. Define Monohydric Alcohol. With examples.

DGK – 2015

Ans: **Monohydric Alcohol:**

Define:- "The alcohol in which one hydrogen atom of alkane is replaced by one -OH group is called monohydric alcohol."

Example: CH_3OH $\text{C}_2\text{H}_5\text{OH}$ $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}$
 Methyl Alcohol Ethyl Alcohol n-Propyl alcohol

Monohydric alcohols are further classified into primary, secondary and tertiary alcohols.

3. Define Primary Alcohols. With examples.

LHR – 2013

Ans: **Primary Alcohols:**

Define:- "The alcohols in which hydroxyl group is attached with primary carbon atom, are called primary alcohols."

Example:

CH_3OH $\text{C}_2\text{H}_5\text{OH}$ $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}$
 Methylanol Ethanol 1-Proanol

4. Define Secondary alcohols. With examples

LHR – 2013

Ans: **Secondary Alcohol:**

Define:- "The alcohols in which hydroxyl group is attached with secondary carbon atom, are called secondary alcohols."

Example:



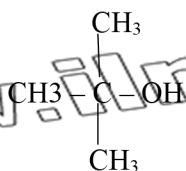
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5. Define Tertiary Alcohols.

Ans: **Tertiary Alcohols:**

Define:- "The alcohols in which hydroxyl group is attached with tertiary carbon atom, are known as tertiary alcohol."

Example:



2-Methyl -2- Propanol (Ter-butyl alcohol)

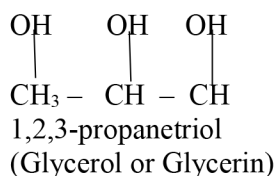
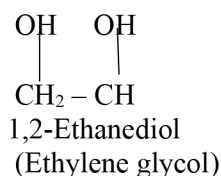
6. Define polyhydric alcohols. With example.

DGK – 2015

Ans: **Polyhydric Alcohols:**

Define:- "If more than one hydroxyl group -OH are present in a compound, it is called polyhydric alcohol. If number of -OH groups are two, it is called dihydric if it is three it is called trihydric etc, some examples of polyhydric alcohols are given below.

Example:



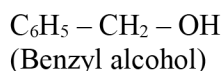
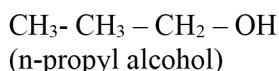
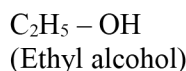
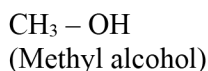
LHR -2013

7. Write two methods for naming alcohols.

Ans: a) **Common or trivial Names:**

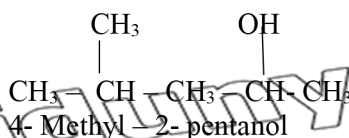
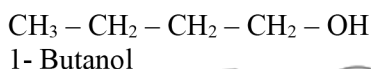
In common method of naming word "alcohol" is added after the name of alkyl radical. Lower alcohols or simpler alcohols are usually named by this method.

Examples:



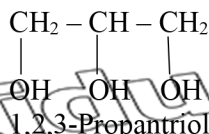
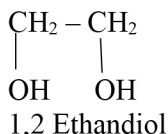
b) **IUPAC System:**

1. Following rules are obeyed for the nomenclature of alcohol.
2. Select longest possible chain of carbon atoms containing the hydroxyl group in it.
3. Start numbering from that end which is near to -OH group.
4. The position of -OH group is indicated by a number placed before the name.
5. If substituents of different nature are present, they are named in alphabetical order.



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6. If more than one hydroxyl group are present on a molecule, they are indicated by an appropriate suffix diol, triol, etc. for example.

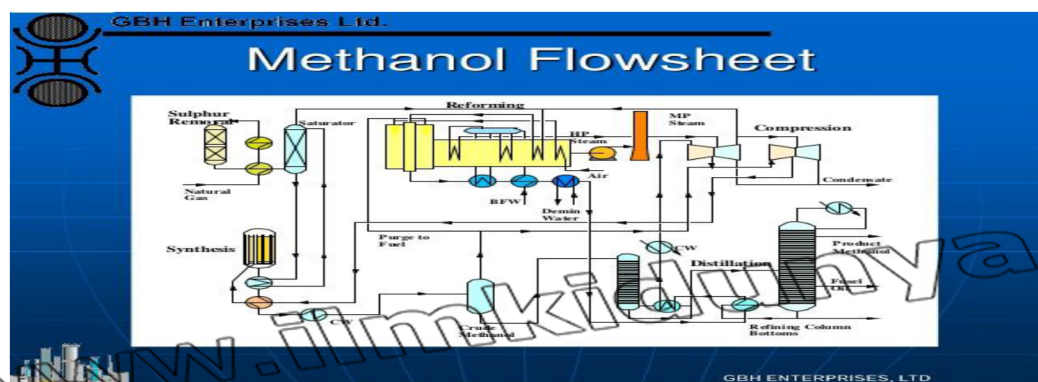


8. How methyl alcohol obtained on large scale? How it may be distinguished from ethyl alcohol?

Ans: **Industrial Preparation of Methanol or Methyl Alcohol:**

- Formerly methyl alcohol was obtained by the destructive distillation of wood logs and also called "wood spirit".
- Now a days, methanol is prepared from carbon monoxide and hydrogen or water gas.

CO reacts with H_2 at high temperature (450°C), 200 atmospheric pressure and in the presence of $\text{ZnO} + \text{Cr}_2\text{O}_3$ catalyst, following reaction take place.



- First of all, a mixture of carbon monoxide and hydrogen is purified, compressed under a pressure of 200 atmospheres and taken into a reaction chamber by means of coiled pipe. Here the catalyst is heated upto $450 - 500^\circ\text{C}$.
- Gases react to form methanol vapours. These vapours are passed through a condenser to get methanol.
- Un-reacted gases are re-cycled through compressor into reaction chamber.

9. What is fermentation? What compounds may be obtained on industrial scale by fermentation?

Ans: **Ethanol or Ethyl Alcohol or Grain Alcohol.**

Ethanol is prepared on industrial scale by the process of fermentation.

"Fermentation is a chemical change in which larger molecules are broken down to smaller molecules in the presence of enzymes present in the bacteria or yeast."

Optimum Conditions for Fermentation:

- The optimum conditions of temperature is $25 - 35^\circ\text{C}$, which is an optimum temperature for the growth of enzymes.
- Moreover, proper aeration, dilution of solution and the absence of any preservative are essential conditions for fermentation.

In Pakistan, ethanol is prepared by the fermentation of molasses, starch grains of fruit juices.

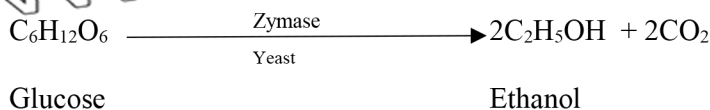
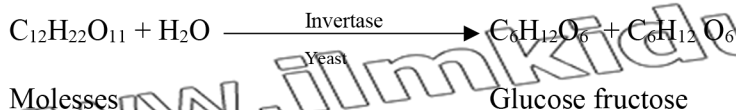
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RWP-2010, LHR-2008, SGD-2014, BWP-2015

From Molasses:

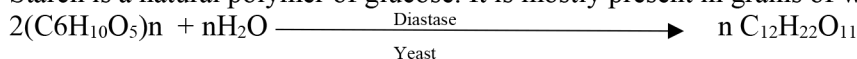
$$\text{C}_{12}\text{H}_{22}\text{O}_{11} + \text{H}_2\text{O} \xrightarrow[\text{Yeast}]{\text{Invertase}} \text{C}_6\text{H}_{12}\text{O}_6 + \text{C}_6\text{H}_{12}\text{O}_6$$

Molasses Glucose fructose

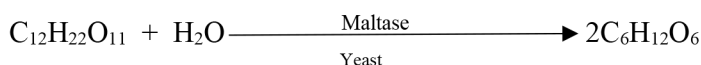


OR

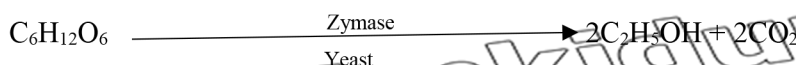
GRW – 2014

$$2(\text{C}_6\text{H}_{10}\text{O}_5)_n + n\text{H}_2\text{O} \xrightarrow[\text{Yeast}]{\text{Diastase}} n\text{C}_{12}\text{H}_{22}\text{O}_{11}$$


Maltose



Glucose



Other methods of preparation of alcohols:

Alcohols can be obtained by the hydration of alkenes and by the reaction of Grignard reagents with aldehydes and ketones. These methods have been discussed in previous chapter.

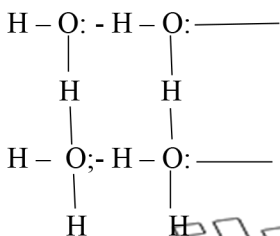
Ans: During fermentation process, upto 14% alcohol can be prepared. If the concentration of alcohol increases above 14%, enzymes become inactive and concentration of alcohol does not increase further.

Ans: Ethyl alcohol is liquid due to hydrogen bonding between the molecules while ethyl chloride has no such hydrogen bonding. Greater will be the intermolecular forces, greater will be the attraction.

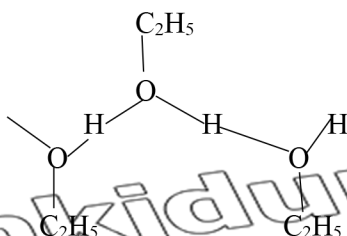
LHR – 2016

Ans: Ethanol has higher boiling point than ether due to hydrogen bonding in ethanol. In diethyl ether weak intermolecular forces are present.

Ans: Water has higher boiling point than ethanol due to strong hydrogen bonding in water. In hydrogen bonding of water, two lone pairs are utilized while in case of C_2H_5OH , only one lone pair is utilized for hydrogen bonding. In other words, water has greater hydrogen bonding than ethyl alcohol boiling point of water is $100^\circ C$ while ethyl alcohol is $78^\circ C$.



Hydrogen bonding in water



Hydrogen bonding in alcohol

16. Explain the following terms:

Absolute alcohol, Methylated Spirit, Rectified spirit, Denaturing of alcohols.

Ans: **Absolute Alcohol:**

“Ethyl alcohol which is 100 % pure is called absolute alcohol.”

Absolute alcohol is obtained by re distillation of rectified spirit in the presence of quick lime (CaO) which absorb moisture's.

Methylated spirit:

GRW-2012,LHR-2014,FBD-2014,MTN-2014

When 10% methanol is added to ethanol for its denaturing then resulting alcohols is called **methylated spirit**. Small quantity of pyridine or acetone may also be used for denaturing of ethanol.

17. Only 12-14% ethanol can be prepared by fermentation process. Justify.

Ans: **Rectified spirit:**

Alcohol obtained by fermentation is only upto 12% never exceeds 14% because beyond this limit, enzymes become inactive. This alcohol is distilled again and again to obtain 95% alcohol which is called **rectified spirit**.

18. What is denaturing of alcohol?

GRW-2012, LHR-2014,FBD-2014,MTN-2014

Ans: **Denaturing of Alcohol:**

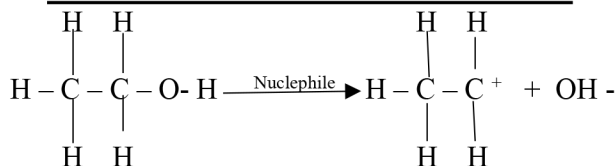
- Sometimes, ethanol is denatured by the addition of 10% methanol to avoid its use for drinking purposes. Such alcohol is called “Methylated spirit”.
- Methanol is toxic to humans, causing blindness in low does (15mL) and death in larger amount (100-250 mL).
- Small quantity of pyridine or acetone may also be added for denaturing of alcohol.

19. Give order of reactivity of alcohols when:

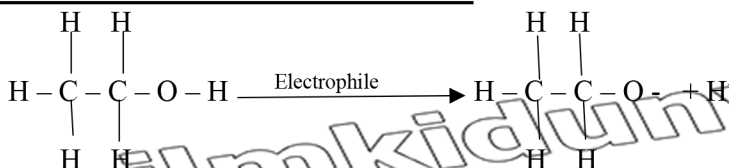
- (i) C – O bond broken (ii) -O – H bond broken

Ans: Alcohol reacts with other reagents in two ways.

i) **Reaction in which C – O Bond breaks:**



ii) **Reaction in which O – H bond breaks:**



When bond will break, depend upon the nature of the attacking reagent. If a nucleophile attacks, it is the C – O bond which breaks. On the other hand, if an electrophile attacks on alcohol, it is the O – H bond which breaks.

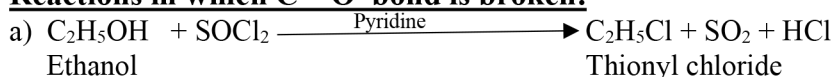
The order of reactivity of alcohols when C – O bond breaks:

Tertiary Alcohol > Secondary Alcohol > Primary Alcohol

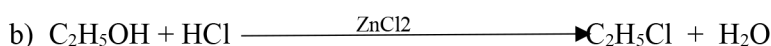
The order of reactivity of alcohols when O – H bond breaks:

$\text{CH}_3\text{OH} > \text{Primary Alcohol} > \text{Secondary Alcohol} > \text{Tertiary Alcohol}$

i. **Reactions in which C – O bond is broken:**



BWP -2015

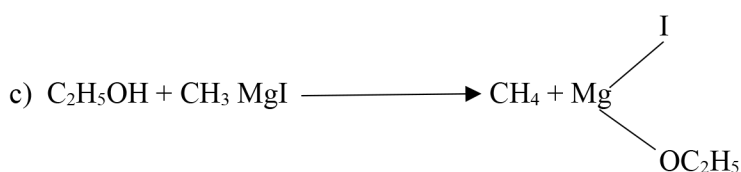
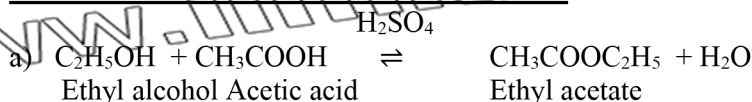


BWP -2015



BWP -2015

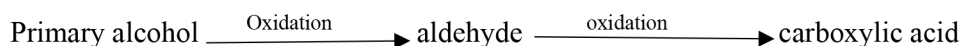
ii. **Reaction in which O – H bond is broken:**



20. Reaction Oxidation of Alcohol.

Ans: **Oxidation of Alcohol:**

Alcohol are oxidized in the presence of concentrated H_2SO_4 and potassium dichromate to aldehyde and then to carboxylic acid.



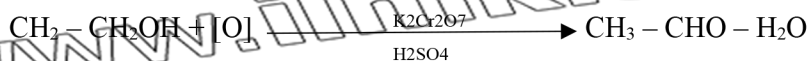
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21. Reaction of Primary alcohol.

RWP – 2007,2008,2010,2014,MTN-2008,GRW-2013,SGD-2010,2014,2015,DGK-2008,GRW-2011,LHR-2012,2015

Ans: **Oxidation of Primary Alcohol**

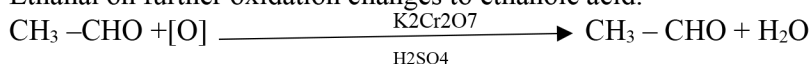
Ethanol on oxidation changes to acetaldehyde or ethanol.



Ethanol (Ethyl alcohol)

Ethanal

Ethanal on further oxidation changes to ethanoic acid.



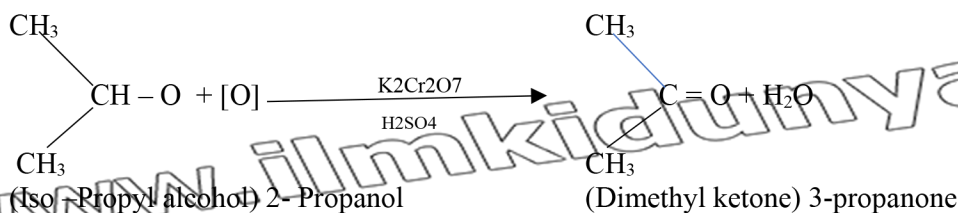
Ethanal (Acetaldehyde)

Ethanoic acid (Acetic acid)

22. Reaction of Secondary alcohol.

RWP – 2007,2008,2010,2014,MTN-2008,GRW-2013,SGD-2010,2014,2015,DGK-2008,GRW-2011,LHR-2012,2015

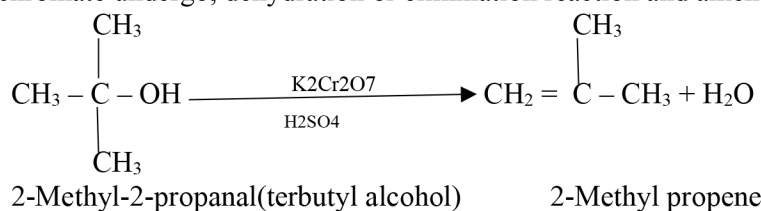
Ans: Secondary alcohols on oxidation change to ketones.



23. Reaction of Tertiary Alcohol.

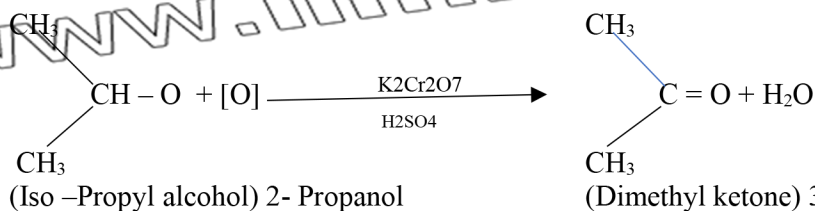
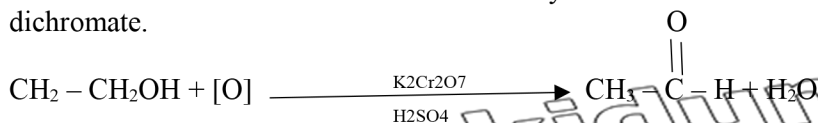
RWP – 2007,2008,2010,2014,MTN-2008,GRW-2013,SGD-2010,2014,2015,DGK-2008,GRW-2011,LHR-2012,2015

Ans: Tertiary alcohols are not oxidized. Tertiary alcohols, in the presence of mixture of H_2SO_4 and potassium dichromate undergo, dehydration or elimination reaction and alkenes are produced.



24. How Ethyl Alcohol and Iso-Propyl Alcohols are oxidized?

Ans: Oxidation of alcohols convert them into aldehydes and ketons. The best reagent for these purpose is acid dichromate.



25. Ethanol gives different products with conc. H_2SO_4 under different conditions, explain it.

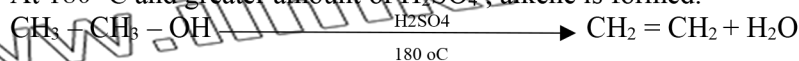
Ans: Ethanol give different products under different conditions with concentrated H_2SO_4

Dehydration:

Alcohols reacts with concentrated H_2SO_4 and different products are formed. Formation of products, depend upon the temperature and the amount of H_2SO_4 taken.

(a) At 180°C and greater amount of H_2SO_4 , alkene is formed.

LHR – 2010

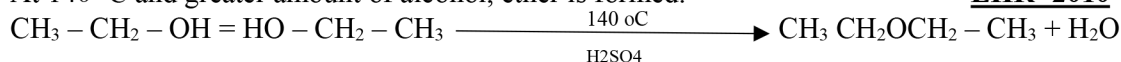


Ethanol

Ethene

(b) At 140°C and greater amount of alcohol, ether is formed.

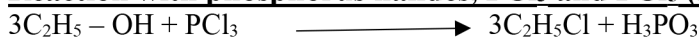
LHR -2010



Ethanol

Ethoxy ethane (diethyl ether)

Reaction with phosphorus halides, PCl_3 and PCl_5 (PX_3 AND PX_5):



RWP -2010

Ethanol

Phosphorus trichloride

Phosphorous acid



DGK-2008,LHR-2009, FBD-2014

Phosphorus pentachloride

Phosphorous oxytrichloride

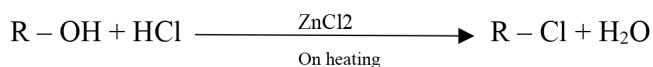
26. How will you distinguish between primary, secondary of tertiary alcohols by Lucas test.

RWP – 2007,2008,2010,2014,MTN-2008,GRW-2013,SGD-2010,2014,2015,DGK-2008,GRW-2011, LHR-2012,2015

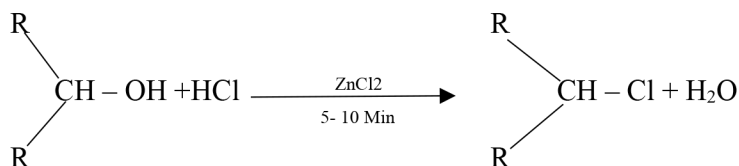
Ans: **Distinction between primary, Secondary and tertiary alcohols by Lucas test:**

Primary, secondary and tertiary alcohols are identified and distinguished by reacting them with conc. HCl in anhydrous ZnCl_2 . An oily layer of alkyl halides separates out in these reactions.

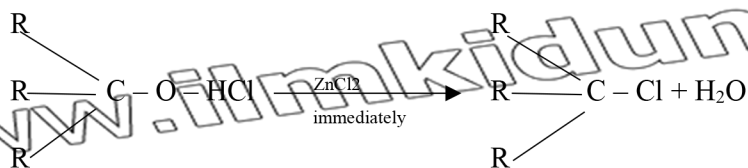
- Tertiary alcohols form an oily layer immediately.
- Secondary alcohols form an oily layer in five to ten minutes.
- Primary alcohols form an oily layer on heating.



Primary alcohol



Secondary alcohol

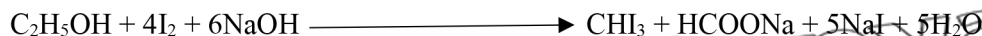


Tertiary alcohol

27. How methanol can be distinguished from ethanol?

LHR-2008, 2011, RWP -2008,2014

Ans: Methanol does not give iodoform test, Ethanol reacts with iodine in the presence of NaOH to form yellow crystalline solid iodoform, CHI_3



Uses of Alcohols:

- A solvent for fats, oils, paints, varnishes.
- It is also used as antifreeze in the radiators of automobiles.
- Denaturing of alcohol.

Ethanol is also used as:

- A solvent, as a drink and as a fuel in some countries.
- Moreover, it is used in pharmaceutical preparation.
- As preservative for biological specimen.

28. Write uses of each methanol and ethanol (Ethyl alcohol)

Ans: **Methanol:**

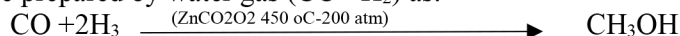
1. It is used as solvent for fats oils, paints, and varnishes.
2. It is also used as antifreeze in the radiators of automobile and for denaturing of alcohol.
3. It is used a volatile liquid in gas chromatography (GC).

Ethanol:

- A solvent, as a drink and as a fuel in some countries.
- Moreover, it is used in pharmaceutical preparation.
- As preservative for biological specimen.

29. Give preparation of methanol by reaction of CO and H_2 ?

Ans: Methanol can be prepared by water gas ($\text{CO} + \text{H}_2$) as:



First of all mixture of carbon monoxide and hydrogen is purified. It is compressed under a pressure of 200 atmosphere and take into a reaction chamber by means of coiled pipes. Here the catalyst is heated upto 450 – 500 °C . Gases react to form methanol vapours. These vapours are passed through a condenser to get methanol. Unreacted gases are recycled though compressor to reaction chamber.

Phenols:

The aromatic compounds which contain one or more – OH groups attached directly to benzene ring are called phenols. E.g. carboic acid or phenol. $\text{C}_6\text{H}_5 - \text{OH}$ is the simplest example of phenols.

Carboic acid or phenol was discovered by **Range** in 1834 from coal tar.

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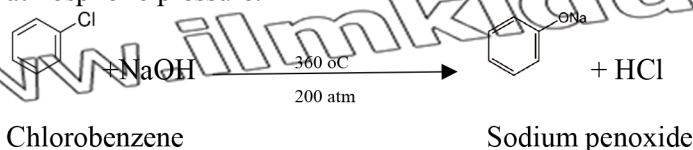
30. Write down two methods for preparing phenol.

Ans: **Preparation of Phenols:**

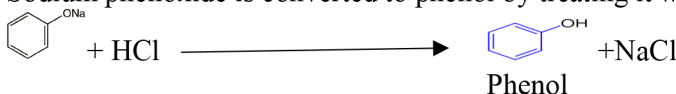
1. **From chlorobenzene (Dow's Process):**

BWP-2008, LHR-2009, 2012, SWL -2015, FBD -2015

In this process, chlorobenzene is heated at 360 °C with dilute solution (10%) of NaOH at 200 atmospheric pressure.



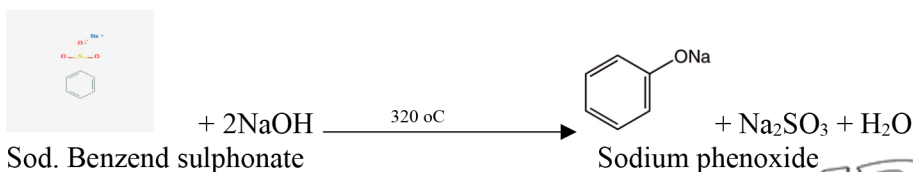
Sodium phenoxide is converted to phenol by treating it with hydrochloric acid.



2. **Fusion of Sodium benzene sulphonate with NaOH:**

BWP -2008

Phenol is obtained by fusing the mixture of sodium benzene sulphonate and solid sodium hydroxide at 320 °C



The resulting sodium phenoxide is treated with an acid stronger than phenol to regenerate the free product.



31. Write Physical properties of Phenol

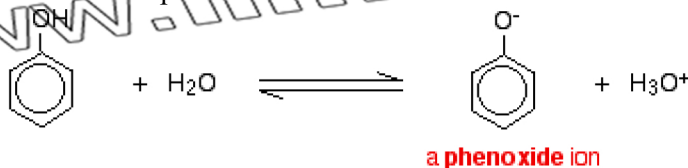
Ans: **Physical Properties of Phenol:**

1. Phenol is colourless, crystalline solid and deliquescent. The deliquescence is the process in which a substance absorb moisture and changes into a liquid form.
2. Its melting point is 41 °C and boiling point is 182 °C.
3. It is sparingly soluble in water forming pink solution at room temperature but completely soluble above 68.5 °C.
4. It is poisonous and used as disinfectant in hospitals and washrooms.

32. Explain acidic behavior of phenol.

GRW-2014, DGK-2014, LHR-2015

- Ans:
1. Phenol is less acid than carboxylic acids and more acidic than alcohols.
 2. It is partially soluble in water but highly soluble in an alkali like NaOH
 3. Phenol does not react with NaHCO_3 and on CO_2 is evolved while carboxylic acids evolve CO_2 due to greater reactivity.
 4. When Phenol is dissolved in water, it dissociates slightly. The dissociation constant of phenol is 1.3×10^{-10} and pH of solution is between 5 to 6. It dissociates a



Reasons for acidity of Phenol:

- Acidity of phenol is due to the resonance stability in phenoxide ion.
- Strength of an acid, depends upon the stability of conjugate base or anion of an acid. Greater will be the stability of anion, stronger will be the acid.
- The reason why phenol is acidic lies in the nature of phenoxide ion. In phenoxide ion, the negative charge on oxygen atom can become involved with the π -electron cloud on the benzene ring. The negative charge is thus delocalized on the ring and the phenoxide ion becomes relatively stable. This type of delocalization is not possible with alcohol.

Acidity order :

Relative acidic strength of alcohol phenol water and carboxylic acid is as follows.

Carboxylic acid > Phenol > Water > Alcohol

Reaction of Phenol:

Phenol shows two types of reactions.

- Reactions due to – OH group.
- Reactions due to benzene ring.

Following structure helps to understand the behavior of phenol.

Phenols are less reactive to nucleophile so nucleophilic attack is less favored i.e. OH is not easy to replace while electrophilic attack of the ring is easy.

33. Why phenol is acidic while alcohol is not?

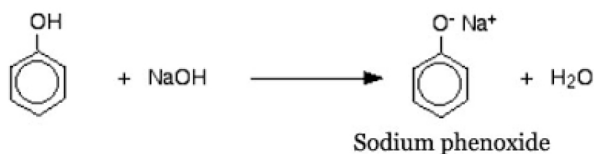
LHR-2008, BWP 2008, SGD -2006, 2007, 2008, FBD -2006, 2009

Ans: Phenol is much more acidic than alcohols but less acidic than carboxylic acids, phenoxide formed by the dissociation of phenol. The negative charge on oxygen atom can become involved with the π -electron cloud on the benzene ring. The negative charge is thus delocalized in the ring and the phenoxide ion becomes relatively stable. This type of delocalization is not possible in alcohols.

Reactions of Phenol Due to OH Group.**1. Salt formation:**

GRW-2012, LHR-2014, MTN-2014

Phenol reacts with alkalis to form salt (Sodium phenoxide and water).

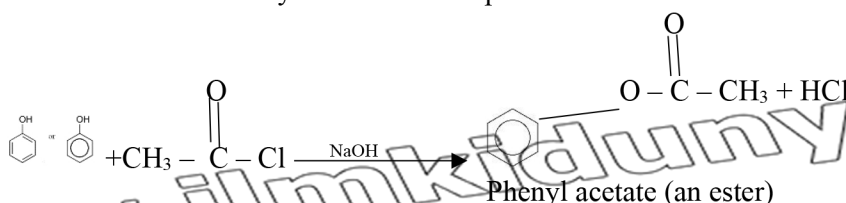


34. Give the reaction of Phenol with conc. H_2SO_4 and acetyl chloride.

GRW – 2011, 2015, MTN-2009

Ans: 1. **Ester formation:**

Phenol reacts with acetyl chloride in the presence of a base to form an ester.



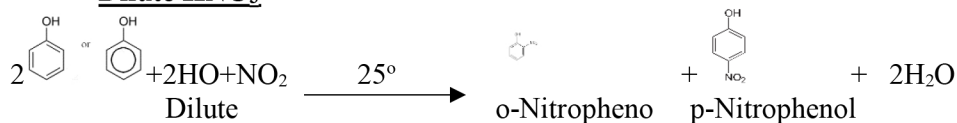
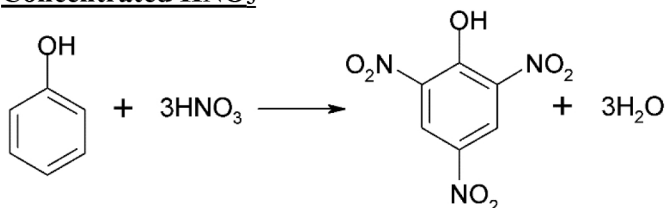
Continue.....p/12.....

3. **Reaction with Zinc:**

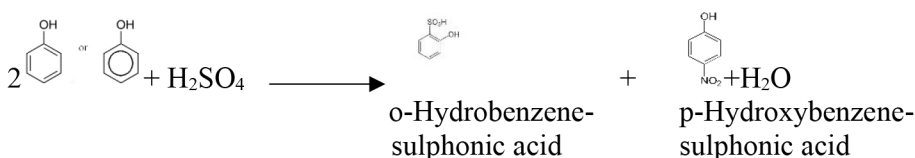
Phenol is reduced to benzene when reacts with zinc dust.

**Reaction due to Benzene Ring**1. **Nitration:**

Phenol reacts with dil. and conc. HNO_3 at different temperatures as follows.

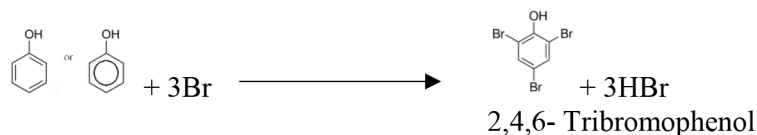
Dilute HNO_3 **Concentrated HNO_3** 2. **Sulphonation:**

Phenol reacts with conc. H_2SO_4 at room temperature giving ortho and para benzenesulphonic acids.

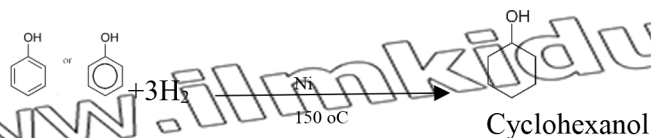
3. **Halogenation:**

BWP – 2015 ,MTN-2009

Aqueous solution of phenol reacts with bromine water to give white ppt. of 2,4,6-tribromophenol.

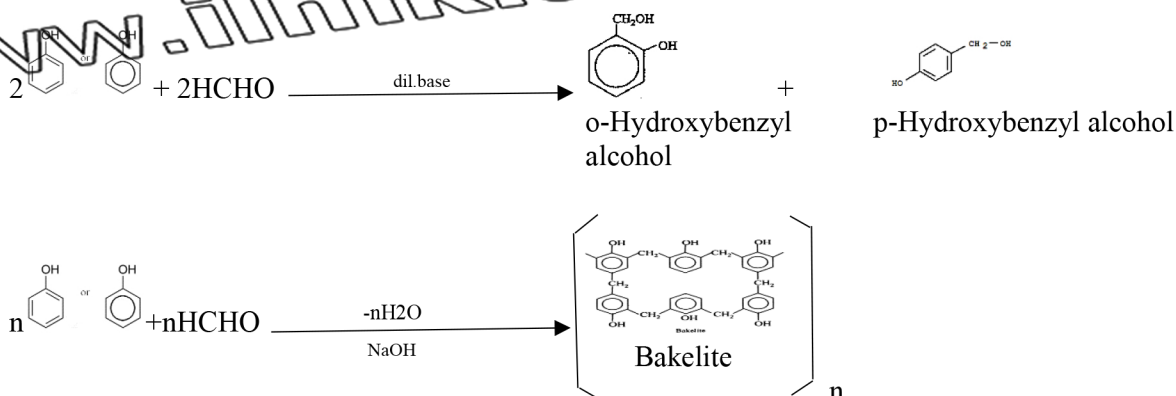
4. **Hydrogenation:**

When hydrogen is passed through phenol at 150°C in the presence of Ni catalyst it gives cyclohexanol.



5. **Reaction with formaldehyde:****DGK-2008, SGD-2008, LHR-2007, 2008, GRW-2013, FBD-2014, BWP -2015**

Phenol reacts with formaldehyde (methanol) in the presence of acid or alkali to give hydroxyl benzyl alcohol which on further reaction with other phenol molecules yields a polymer called Bakelite.



35. Write formula of carboxylic acid and its one use.

Ans: **Formula carboxylic acid:****Use:** It is poisonous and used as disinfectant in hospitals and washroom.

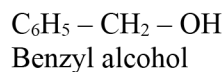
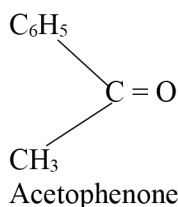
36. How phenol is identified chemically?

FBD – 2015

Ans: An aqueous solution of phenol reacts with bromine water to give white ppt. of 2,4,6-tribromophenol. Thus the colour of bromine is discharged.

37. Write down the formula of Acetophenone and Benzyl Alcohol:

Ans: Formula of Acetophenone and Benzyl alcohol:



38. Picric acid is a phenol which behaves like an acid, Justify.

Ans: Picric acid is 2,4,6-trinitrophenol, it is actually phenol but has three nitro groups attached to the benzene ring of phenol. Nitro groups are electron withdrawing in nature. Nitro groups attract electrons to themselves and makes easy for phenolic part to donate proton easily, so picric acid can donate a proton and behave like an acid. Moreover, after donating a proton the base of picric acid is stable anion.

39. Write uses of Phenol.

LHR- 2008, SGD-2009

Ans: **Uses of Phenol:**

1. Phenol is used for the preparation of Bakelite (Plastic resin)
2. Phenol is used to prepare picric acid. Picric acid and its salts are used as explosives.
3. Phenol is used as antiseptic herbicides and wood and ink preservatives. As antiseptic, it is used in soaps, lotions and ointments.
4. It is poisonous and used as a disinfectant in hospitals and washrooms.
5. Phenol is used as starting material for many pharmaceuticals like salicylic acid, aspirin, phenacetin, salol, etc.
6. It is used to prepare cyclohexanol which is a good organic solvent.

40. Define Ethers

Define:- "The organic compounds in which same or different alkyl or aryl groups are attached on both side of oxygen atom are called ethers."

Ether are classified into two types.

1. Simple or symmetrical ethers:
The ethers in which two similar alkyl or aryl groups are present on both side of oxygen atom e.g. $\text{CH}_3 - \text{OCH}_3$ dimethyl ether, $(\text{C}_2\text{H}_5)_2\text{O}$ diethyl ether, $(\text{C}_6\text{H}_5)_2\text{O}$ diphenyl ether.
2. Mixed or unsymmetrical ethers:
The ethers in which two different groups. (alkyl or aryl) are attached with oxygen atom are called mixed or unsymmetrical ethers. e.g. methyl ethyl ether $\text{CH}_3\text{OCH}_2\text{CH}_3$.

41. Ethers belong to an inert class of organic compounds, Discuss.

Ans: Ethers are comparatively inert substances, the reagents like ammonia, alkalis, dilute acids and metallic sodium, have no action on ethers on cold state, Moreover, they are not oxidized or reduced easily.

42. Name the following compounds.

- | | |
|---|--|
| i) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{O} - \text{CH}_3$ | ii) $\text{C}_6\text{H}_5 - \text{O} - \text{C}_6\text{H}_5$ |
| iii) $(\text{CH}_3)_2\text{CH} - \text{O} - \text{CH}(\text{CH}_3)_2$ | iv) $\text{CH}_3 - \text{O} - \text{C}_6\text{H}_5$ |
| v) $\text{CH}_3 - \text{CH}_2 - \text{CH}_3 - \text{O} - \text{CH}_2 - \text{CH}_3$ | |

Ans:

- i) Methoxy propane or methyl - n-propyl ether
- ii) Phenyl benzene or diphenyl ether
- iii) 2-Iso-Propoxy propane or di-Isopropyl ether
- iv) Methoxy benzene or methyl phenyl ether
- v) Ethoxy propane or ethyl - n- propyl ethers

43. Write down structure formulas of the following compounds.

Ans:

i) Methoxy ethane	ii) Ethoxy benzene	iii) Sodium ethoxide
iv) Sodium phenoxide	v) Propoxy propane.	

- i) $\text{CH}_3 - \text{O} - \text{CH}_2 - \text{CH}_3$
- ii) $\text{CH}_3\text{CH}_2\text{OC}_6\text{H}_5$
- iii) $\text{C}_2\text{H}_5\text{O}^- \text{Na}^+$
- iv) $\text{C}_6\text{H}_5\text{O}^- \text{Na}^+$
- v) $\text{CH}_3\text{CH}_2\text{CH}_2 - \text{O} - \text{CH}_2\text{CH}_2\text{CH}_3$

LHR - 2013

LHR - 2013

44. How ether is prepared by Williamson synthesis?

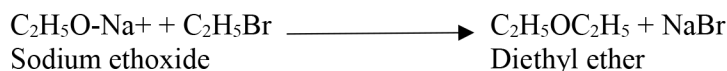
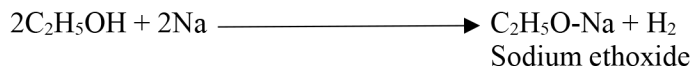
Ans: **Preparation of Ethers.**

Ethers are prepared from alcohols either directly or indirectly. Usually they are obtained by the following methods.

1. **Williamson's Synthesis:**

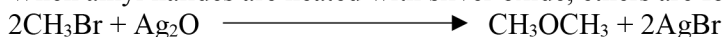
DGK-2008, GRV-2007,2010, FBD-2008, LHR-2009, SGD -2014, BWP -2014, DGK -2014, MTN-2015

Alcohols are reacted with metallic sodium to form alkoxides. This alkoxide is a strong nucleophile and readily reacts with alkyl halide to produce an ether.



2. **From silver oxide and alkyl halides:**

When alkyl halides are heated with silver oxide, ethers are formed.



Physical Properties:

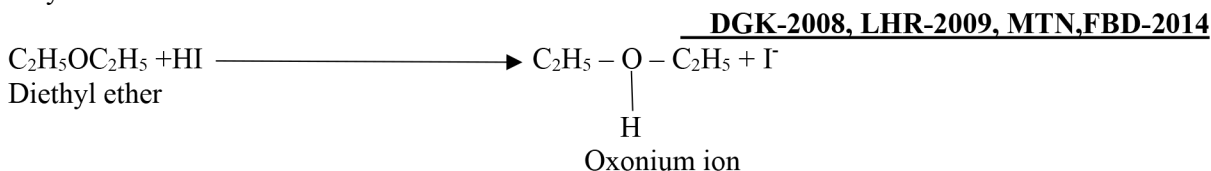
1. Usually ethers are volatile liquid, highly inflammable with low boiling points.
2. they are slightly soluble in water but fairly soluble in organic solvents.
3. Ether molecules do not show hydrogen bonding with one another but they show weak hydrogen bonding with water molecules due to which they are slightly soluble in water.

Chemical Properties:

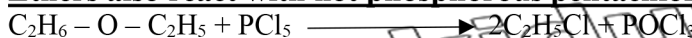
- Ethers are comparatively less reactive than alcohols because no hydrogen atom is attached with oxygen atom directly.
- Ethers do not react with alkalis, NH_3 , sodium metal, dilute acids, oxidizing agents or reducing agents.
- However ethers react with halogen acid HI. Ethers do not react with HF, HCl, or HBr.

i) **Reaction of Ether with HI:**

Ethers react with HI to form alcohol. This alcohol further reacts with halogen acid to form alkyl halide only.



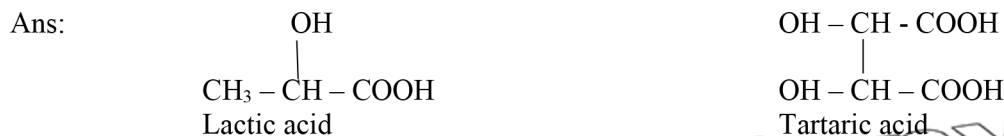
ii) **Ethers also react with hot phosphorous pentachloride to give alkyl chloride:**



45. Ether are less reactive than alcohols. Justify.

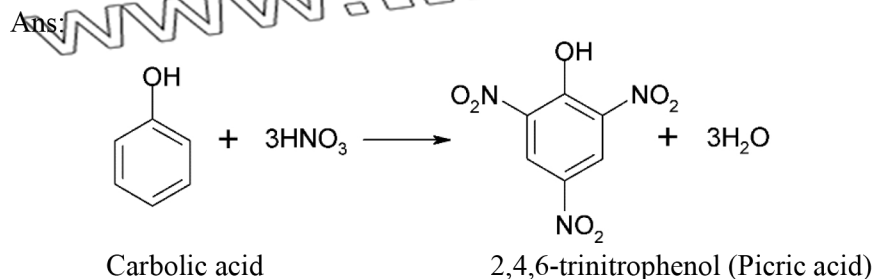
Ans: Ethers are comparatively inert substance. The reagents like ammonia, alkalis, dilute acids and metallic sodium, have no action on ethers on cold state. Moreover, they are not oxidized or reduced easily. On the other hand alcohols can react with reagents due to C – O and O – H bond. These can be oxidize and reduced. Alcohols undergo dehydration reaction.

46. Write structural formula of Lactic acid and tartaric acid?



47. Write structural formula of Carboic Acid and Picric Acid

SGD -2010, LHR-2013



TEXT BOOK EXERCISES (SHORT QUESTIONS):

1. How will you distinguish between?
- Alcohol and Phenol
 - Alcohol and an ether
 - Methanol and ethanol
 - 2 tertiary alcohol and a primary alcohol
 - 1-propanol and 2-propanol

Ans: **Alcohol (CH₃CH₂OH)**

- Alcohol is neutral
- Alcohol does not colour
- Alcohol give haloform reaction and deeply yellow ppt. of CHI₃ with I₂ and base.
- Alcohol does not white ppt.

Phenol (C₆H₅-OH):

- Phenol has acidic properties.
- Phenol give deep purple colour with FeCl₃
- Phenol does not
- Phenol gives white ppt. with Br₂

(ii) **Alcohol and an Ether:**

Alcohol (CH₃CH₂OH)

- Alcohol reacts with Na metal to evolve H₂ gas
- Alcohol gives haloform reaction and produce yellow ppt. of CHI₃

Ether (CH₃CH₂)₂O

- Ether does not.
- Ether does not.

(iii) **Methanol and Ethanol**

Methanol (CH₃OH)

- Methanol does not give haloform reaction

Ethanol (CH₃CH₂OH)

Ethanol gives yellow ppt. with I₂ and Na₂CO₃

(iv) **Primary alcohol**

Lucas test can be used to have a distinction
Primary alcohol

Lucas Primary alcohol the reaction happens only heating

Tertiary Alcohol

Lucas test can be used to have a distinction
Tertiary alcohol

Lucas reagent gives oily liquid with tertiary alcohol within five minutes.

- :- 17 :-
- (v) **1-propanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$)** **2-propanol ($\text{CH}_3\text{-CHOH-CH}_3$)** SGD -2015
 1-Propanol is a primary alcohol 2-propanol is a secondary alcohol
 1-propanol does not give iodoform test 2-propanol does

Give reasons for the following:

- (i) **Ethyl alcohol is a liquid while ethyl chloride is a gas.**
 Ethyl alcohol has OH group in it which is responsible for hydrogen bonding among the molecules of alcohols.
 In case of ethyl chloride there is no hydrogen bonding. Hydrogen bonding is responsible to make ethyl alcohol liquid at room temperature, but ethyl chloride remains gas.
- (ii) **Ethanol has higher boiling point than diethyl ether:**
 Ethanol has a hydrogen bonding among the molecules. For this reason it has a higher boiling point than that of ether. Ether is non-polar molecules and there is no hydrogen bonding in it.
- (iii) **Absolute alcohol cannot be prepared by fermentation process;**
 Absolute alcohol cannot be prepared by fermentation process. Actually 14% alcohol is obtained in fermentation process which can be concentrated upto 95% alcohol form azeotropic mixture which cannot be further concentrated by distillation. Anyhow, lime is used to concentrate alcohol further.
- (iv) **Ethanol gives different products with conc. H_2SO_4 under different conditions.**
 Ethanol gives two types of products when treated with concentrated H_2SO_4 .
 a) $2\text{CH}_3\text{CH}_2\text{OH} \xrightarrow[140^\circ\text{C}]{\text{con. H}_2\text{SO}_4} \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3 + \text{H}_2\text{O}$
 In this way diethyl ether is produced when treated with at 140°C from two molecules of alcohol.
 b) $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow[180^\circ\text{C}]{\text{con. H}_2\text{SO}_4} \text{CH}_2=\text{CH}_2 + \text{H}_2\text{O}$
 In this way ethene is produced by the removal of water from single molecule of alcohol.
- (v) **Water has higher boiling point than ethanol:**
 A molecule of H_2O makes three H-bonds with three other water molecules. But $\text{C}_2\text{H}_5\text{OH}$ can make only one H-Bond. C_2H_5 - group is much bigger than H-atom and has no property of H-Bonding.

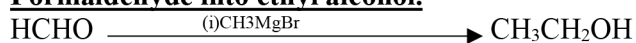
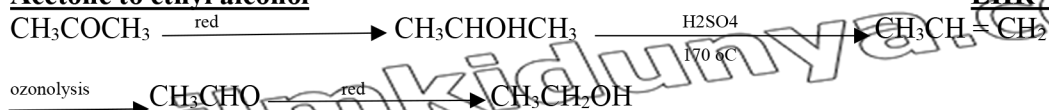
How will you convert?

- Methanol into ethanol
- Ethanol into methanol
- Ethanol into isopropyl alcohol
- Formaldehyde into ethyl alcohol
- Acetone into ethyl alcohol

- (i) **Methanol into ethanol** RWP -2010, LHR-2013
 $\text{CH}_3\text{OH} + \text{SOCl}_2 \longrightarrow \text{CH}_3\text{Cl} + \text{SO}_2 + \text{HCl}$
 $\text{CH}_3\text{Cl} + \text{Na} + \text{CH}_3\text{Cl} \xrightarrow{\text{Wurtz reaction}} \text{CH}_3\text{CH}_3 + \text{NaCl}$
 $\text{CH}_3\text{CH}_3 + \text{Cl}_2 \longrightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{HCl}$
 $\text{CH}_3\text{CH}_2\text{Cl} + \text{KOH} \longrightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{KCl}$

- (ii) **Ethanol into methanol** LHR - 2013
 $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow[\text{NaOH}]{\text{oxidation}} \text{CH}_3\text{CHO} \xrightarrow{[\text{O}]} \text{CH}_3\text{COOH}$
 $\text{CH}_3\text{COOH} \xrightarrow{\text{NaOH}} \text{CH}_3\text{COONa} \xrightarrow{\text{NaOH}} \text{CH}_4 \xrightarrow{\text{Cl}_2} \text{CH}_3\text{Cl} \xrightarrow[\text{KOH}]{\text{aqueous}} \text{CH}_3\text{OH}$

- (iii) **Ethanol into isopropyl alcohol** FBD -2009
 $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{[\text{O}]} \text{CH}_3\text{CHO} \longrightarrow \text{CH}_3 + \text{CH}_3 - \text{OH}$

(iv) Formaldehyde into ethyl alcohol.FBD -2009(v) Acetone to ethyl alcoholLHR-2016

THE END