11

Alcohols, Phenols *and* Ethers

Topic 1

Alcohols and Phenols

Previous Years' Examination Questions

Practice the **Real Questions**

1 Mark Questions

1. Write the equations involved in the following reaction:
Reimer-Tiemann reaction
[All India 2012]

2. Draw the structure of hex-1-en-3-ol compound. **[Delhi 2012]**

3. Draw the structural formula of 2-methylpropan-2-ol molecule. **[Delhi 2012]**

4. Write the IUPAC name of the following compound :

$$CH_3-CH=CH-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_3$$

[Foreign 2012]

5. How could you convert ethanol to ethene? **[All India 2011]**

6. Draw the structure of 2, 6-dimethyl phenol. **[All India 2011]**

7. Write the chemical equation for the preparation of phenol from benzene using oleum and sodium hydroxide. **[Delhi 2011]**

8. Write Reimer-Tiemann reaction giving an example. **[All India 2011]**

9. Write the structure of the molecule of compound whose IUPAC name is 1-phenyl propan-2-ol. **[All India 2010]**

10. Give IUPAC name of the following compound.

$$H_2C=CH-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2-CH_2-CH_3$$

[All India 2009]

11. Write the IUPAC name of

$$H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2OH$$

[Delhi 2008]

2 Marks Questions

12. Explain the mechanism of the following reaction?

$$CH_3-CH_2-OH \xrightarrow[443\ K]{H^+} CH_2=CH_2 + H_2O$$

[All India 2013]

13. How will you convert the following?
(i) Propan-2- ol to propanone
(ii) Phenol to 2, 4, 6-tribromophenol
[Delhi 2013]

14. How will you convert:
(i) Propene to propan-1-ol?
(ii) Ethanal to propan-2-ol? **[Delhi 2013]**

15. How will you convert:
(i) Propene to propan-2-ol?
(ii) Phenol to 2, 4, 6- trinitrophenol?
[Delhi 2013]

16. Explain the following behaviours.
(i) Alcohols are more soluble in water than the hydrocarbons of comparable molecular masses.
(ii) *Ortho*-nitrophenol is more acidic than *ortho*-methoxyphenol. **[All India 2012]**

17. Explain the mechanism of acid catalysed hydration of an alkene to form corresponding alcohol. **[All India 2012]**

18. How would you obtain **[Delhi 2011]**
(i) picric acid from phenol?
(ii) 2-methyl propanol from 2-methyl propene?

19. Account for the following **[Delhi 2011C, 2008C]**
(i) Propanol has higher boling point than butane.
(ii) *Ortho*-nitrophenol is more acidic than *ortho*-methoxy phenol.

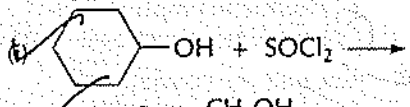
20. How are the following conversions carried out? **[Delhi 2010]**
(i) Benzyl chloride to benzyl alcohol
(ii) Methyl magnesium bromide to 2-methyl propane-2-ol

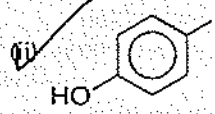
21. How are the following conversions carried out? **[Delhi 2010; 2006C]**
(i) Propene to prapan-2-ol
(ii) Ethyl magnesium chloride to propan-1-ol

22. Write the mechanism of hydration of ethene to ethanol. **[Foreign 2010, 2009]**

23. Give one chemical test to distinguish between the following pairs of compounds.
(i) Phenol and benzoic acid
(ii) 1-propanol and 2-propanol
[Delhi 2010C, 2009C]

24. Complete the following reaction equations. **[Delhi 2009]**

(i)  + $SOCl_2$ ⟶

(ii)  + HCl ⟶

25. Give reason for the following.
(i) m-amino phenol is a stronger acid than o-amino phenol.
(ii) Alcohols act as weak bases.
[Delhi 2008C]

26. Describe the mechanism of alcohols reacting both as nucleophiles and as electrophiles in their reactions. **[Foreign 2008]**

27. Write the reactions and conditions involved in the conversion of
(i) propene to propane-1-ol
(ii) phenol to salicylic acid **[Delhi 2006]**

3 Marks **Questions**

28. Draw the structure and name the product formed if the following alcohols are oxidized. Assume that an excess of oxidizing agent is used.
(i) $CH_3CH_2CH_2CH_2OH$
(ii) 2-butanol
(iii) 2-methyl-1-propanol **[Delhi 2012]**

29. How would you obtain the following?
(i) Benzoquinone from phenol.
(ii) 2-methylpropan-2-ol from methyl magnesium bromide
(iii) Propan-2-ol from propene
[All India 2011; Foreign 2011]

30. Account for the following.
(i) The boiling point of ethanol is higher than that of methanol.
(ii) Phenol is a stronger acid than an alcohol.
(iii) The boiling point of ethers are lower than isomeric alcohols.
[Delhi 2011C; All India 2009]

31. Account for the following.
(i) Propanol has higher boiling point than butane
(ii) *Ortho*-nitrophenol is more acidic than *ortho*-methoxy phenol.
(iii) Preparation of ethers by acid dehydration of secondary or tertiary alcohols is not a suitable method.
[Delhi 2011C]

32. (i) Describe the mechanism of hydration of ethene to yield ethanol.
(ii) Write Kolbe's reaction with an example. **[All India 2011C]**

33. A compound *A* (C_2H_6O) on oxidation by PCC gave *B*, which on treatment with aqueous alkali and subsequent heating furnished *C*. *B* on oxidation by $KMnO_4$, forms a monobasic carboxylic acid with molar mass 60 g mol^{-1}. Deduce the structure of *A*, *B* and *C*. **[All India 2011C]**

34. Account for the following.
(i) The boiling points of alcohols decrease with increase in branching of the alkyl chain. **[Delhi 2011C]**
(ii) Phenol does not give protonation reaction readily. **[All India 2008]**

(iii) Phenyl methyl ether reacts with HI to give phenol and methyl iodide and not iodobenzene and methyl alcohol. **[NCERT]**

35. How would you convert
(i) phenol to benzoquinone
(ii) propanone to 2-methylpropan-2-ol
(iii) propene to propan-2-ol? **[All India 2010]**

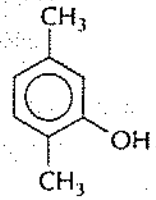
36. (i) Describe the mechanism of acid catalyzed dehydration of ethanol to yield ethene.
(ii) Describe the chemical test to distinguish between ethanol and phenol. **[Delhi 2008C; All India 2010C, 2009]**

37. Explain the mechanism of the following reactions.
(i) Addition of Grignard's reagent to the carbonyl group of compound forming an adduct followed by hydrolysis. **[Delhi 2009]**
(ii) Acid catalyzed dehydration of an alcohol forming an alkene. **[All India 2010C, Foreign 2010]**
(iii) Acid catalysed hydration of an alkene forming an alcohol. **[All India 2012]**

38. Explain the following observations:
(i) The boiling point of ethanol is higher than of methoxy methane
(ii) Phenol is more acidic than ethanol.
(iii) o-and p-nitro phenols are more acidic than phenol. **[All India 2009]**

39. Name the reagents which are used in the following conversions.
(i) A primary alcohol to an aldehyde
(ii) Butan-2-one to butan-2-ol
(iii) Phenol to 2, 4, 6 - tribromophenol. **[Delhi 2008]**

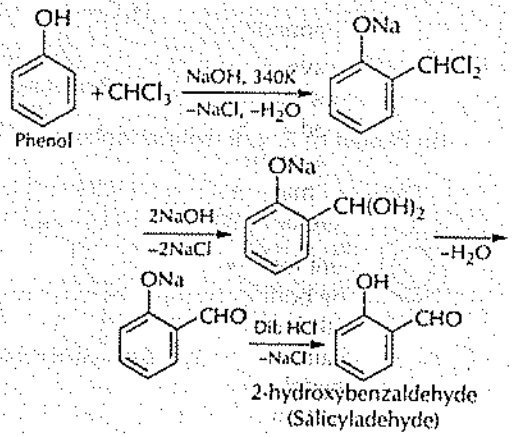
40. (i) Write the IUPAC name of the following.



(ii) Give reason for
(a) Phenol is a stronger acid than alcohol.
(b) Alcohols are comparatively more soluble in water than the corresponding hydrocarbons. **[All India 2008C]**

Step-by-Step Solutions

1. (i) Reimer -Tiemann reaction



2-hydroxybenzaldehyde
(Salicyladehyde)

A small amount of p-hydroxy benzaldehyde is also formed.

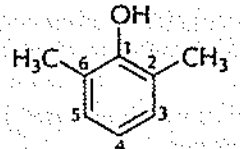
It CCl_4 is used instead of chloroform salicylic acid is formed. (1)

2. $CH_3-CH_2-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH=CH_2$ (1)

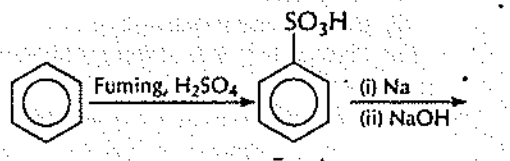
3. $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{\overset{|}{\underset{|}{C}}}}-CH_3$ (1)

4. Hex-4- en-3-ol (1)

5. $CH_3CH_2OH \xrightarrow[443K]{\text{Conc. } H_2SO_4} CH_2=CH_2$ (1)
Ethanol — Ethene

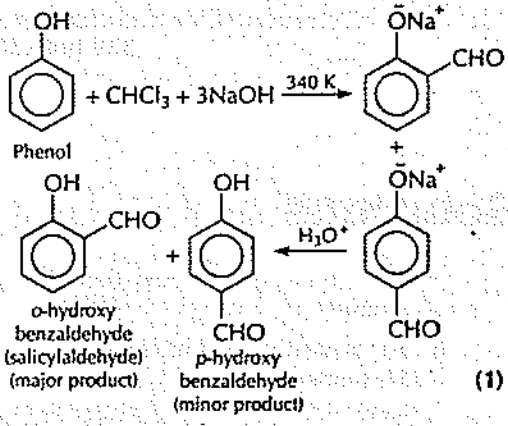
6.

(1)

2, 6-dimethyl phenol

7.


Phenol
(1)

8. The reaction of phenol with chloroform in the presence of alkali to give *o*-and *p*-hydroxy aldehyde is known as Reimer-Tiemann reaction. e.g.,

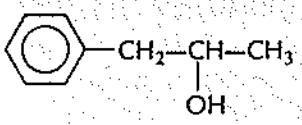


Phenol

o-hydroxy benzaldehyde (salicylaldehyde) (major product)

p-hydroxy benzaldehyde (minor product)

(1)

9.


1-phenylpropan-2-ol (1)

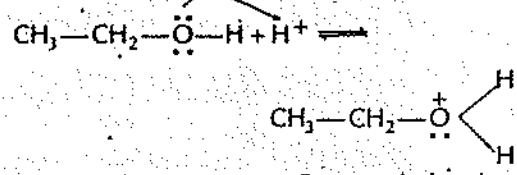
10. Hex-1-en-3-ol (1)

11. 2,5-dimethylhexan-1, 3-diol (1)

12. $CH_3-CH_2-OH \xrightarrow[443K]{H^+} CH_2=CH_2 + H_2O$

Mechanism This reaction involves the following steps :

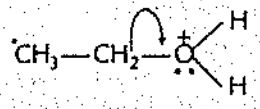
Step I Formation of protonated alcohol



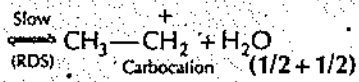
Protonated ethanol (Oxonium salt)

(1/2)

Step II Formation of carbocation



Protonated ethanol

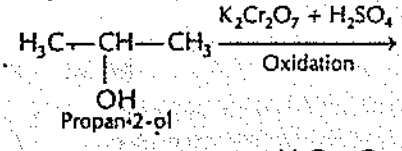


Carbocation (1/2 + 1/2)

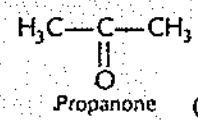
Step III Loss of proton to give alkene

$CH_3CH_2^+ \xrightarrow[-H^+]{} CH_2 = CH_2$ (1/2)

13. (i) Propan-2-ol to propanone

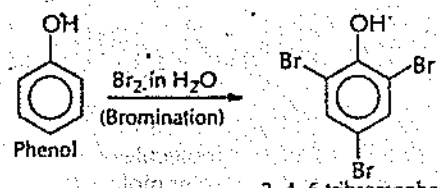


Propan-2-ol



Propanone (1)

(ii) Phenol to 2, 4, 6 -tribromophenol



Phenol

2, 4, 6-tribromophenol (1)

14. (i) Propene to propan-1-ol

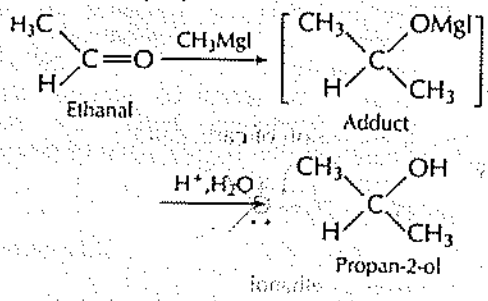
$$CH_3CH=CH_2 + HBr \xrightarrow{\text{Peroxide}} \underset{\text{Propene}}{} \quad CH_3CH_2CH_2Br$$

Propylbromide

$$\xrightarrow{\text{aq. KOH}} \overset{3}{CH_3}-\overset{2}{CH_2}-\overset{1}{CH_2}-OH \quad (1)$$

Propan - 1 - ol

(ii) Ethanal to propan-2-ol



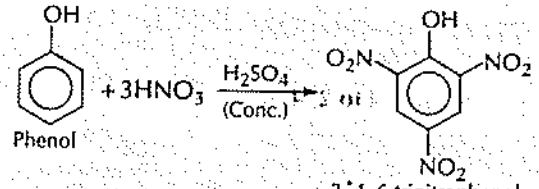
Ethanal — Adduct — Propan-2-ol (1)

15. (i) Propene to propan-2-ol Addition of H_2SO_4 takes place (in accordance with Markownikoff's rule) while converting propene to propan-2-ol.

$$CH_3CH=CH_2 + H_2SO_4 \xrightarrow[\text{Boil}]{H_2O} CH_3-\underset{OH}{\underset{|}{CH}}-CH_3$$

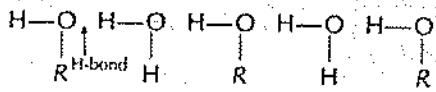
Propene — Propan-2-ol (1)

(ii) Phenol to 2, 4, 6 trinitrophenol Nitration of phenol in the presence of conc. H_2SO_4 and conc. HNO_3 yields 2, 4, 6 - trinitrophenol.



Phenol — 2, 4, 6-trinitrophenol (1)

16. (i) Because of the presence of polar — OH bond, alcohol molecules can form H-bonds with the water molecules and the water-alcohol interaction becomes stronger than the water-water or alcohol-alcohol interactions. That's why alcohols are soluble in water.

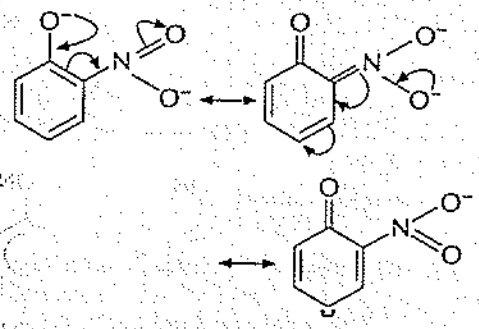


Intermolecular H-bonding between alcohol and water

Hydrocarbons, on the other hand, have no polar bond and hence, the water-hydrocarbon interaction remains weaker as compared to water-water or hydrocarbon-hydrocarbon interactions, *i.e.*, hydrocarbons do not form H-bond with water. Thus, they remain insoluble in water. (1)

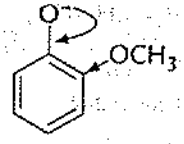
(ii) Acidity is the tendency to give a proton. It depends upon the stability of phenoxide ion formed (in case of phenols). Higher the stability of phenoxide ion, more will be the acidic character.

NO_2 group, being electron withdrawing, stabilises the phenoxide ion by dispersing negative charge.



and so on.

Methoxy group (— OCH_3) on the other hand destabilises the phenoxide ion by intensifying the negative charge.

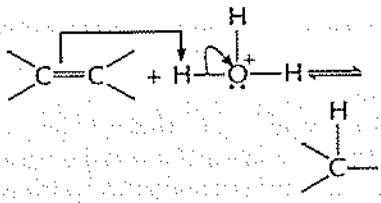


Thus, o-nitrophenol is more acidic than *ortho*-methoxyphenol. (1)

17. Following steps are involved in the acid catalysed hydration of ethene.

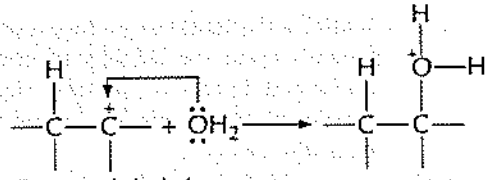
Step I Protonation of alkene to give carbocation by electrophilic attack of H_3O^+ as shown below

$$H_2O + H^+ \longrightarrow H_3O^+$$



(1/2)

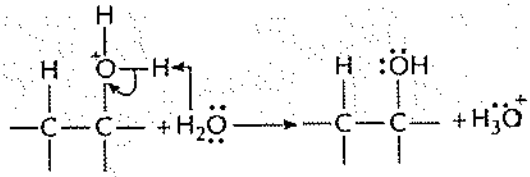
Step II Attack of nucleophile water on carbocation formed



Protonated alcohol

(1)

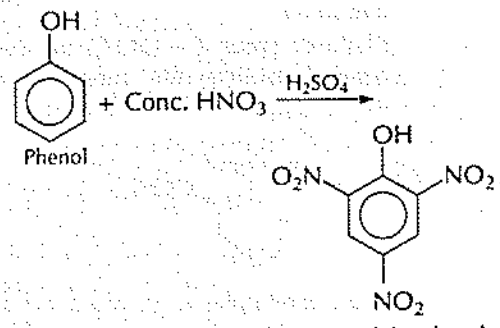
Step III Deprotonation to give an alcohol



Protonated alcohol

(1/2)

18. (i) Phenol when treated with concentrated nitric acid is converted into 2,4,6-trinitrophenol (picric acid). (1)



Phenol

2, 4, 6 - trinitrophenol (picric acid)

(1)

(ii) $3CH_3-\underset{CH_3}{\underset{|}{C}}=CH_2 + BH_3 \xrightarrow[\text{hydroboration}]{}$

$$B[(CH_3)_2CHCH_2]_3 \xrightarrow[OH^-]{H_2O_2} 3(CH_3)_2CHCH_2OH$$
$$-H_3BO_3$$

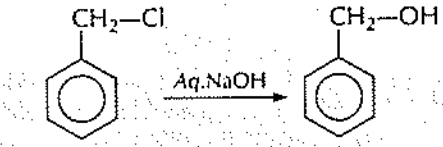
or $H_3C-\underset{CH_3}{\underset{|}{CH}}-CH_2OH$ (1)

2-methyl propanol

19. (i) The molecules of propanol are held together by intermolecular hydrogen bonding while butane has only weak forces of interaction *i.e.*, van der Waals' forces. Hydrogen bonds are much stronger so the boiling point of propanol is much higher. (1)

(ii) Refer ans. 16 (ii). (1)

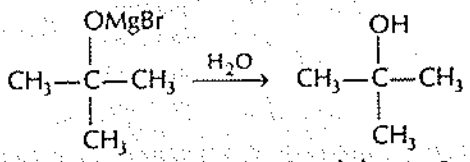
20. (i)



Benzyl chloride — Benzyl alcohol

(1)

(ii) $CH_3MgBr + CH_3-\underset{\underset{O}{\|}}{C}-CH_3 \longrightarrow$



2-methylpropan-2-ol

(1)

21. (i) $CH_2=CH-CH_3 \xrightarrow{H_2O/H^+}$

Propene

$CH_3-\underset{OH}{\underset{|}{CH}}-CH_3$

Propan-2-ol (1)

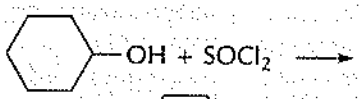
(ii) $CH_3CH_2MgCl \xrightarrow{HCHO} CH_3CH_2CH_2OMgCl \xrightarrow[H_2O]{} CH_3CH_2CH_2OH$ (1)

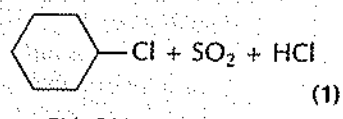
Ethyl magnesium chloride — Propan-1-ol

22. Refer ans. 17. (2)

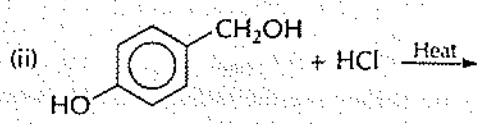
23. (i) Phenol gives a violet colouration with neutral $FeCl_3$ solution while benzoic acid gives buff coloured ppt. (1)

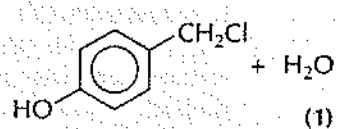
(ii) Propane-2-ol on reaction with sodium hydroxide and I_2 (warm) gives a yellow precipitate of iodoform while propane-1-ol gives no such test. (1)

24. (i) 



(1)

(ii) 



(1)

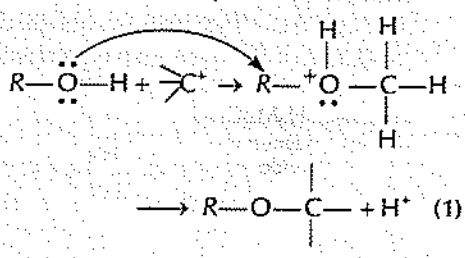
25. (i) Amino group being electron releasing, intensify the charge if present at ortho position and thus makes the phenol less acidic. However, at *m*-position it does not interfere in the dispersal of charge and hence, has no effect over the acidity of phenol. Thus, *m*-aminophenol is more acidic than o-amino phenol. (1)

(ii) Alcohols act as bronsted bases due to the presence of lone pair of electrons on oxygen, which makes them proton acceptors. (1)

26. Alcohols are versatile compounds. They react both as nucleophiles and electrophiles

(i) The bond between 'O' and 'H' (O—H) is broken when alcohols react as nucleophiles.

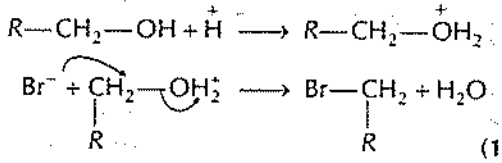
Alcohols as nucleophiles



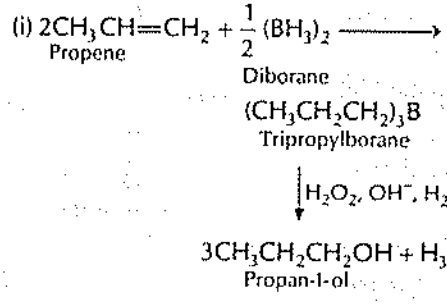
(1)

(ii) The C—O bond between is broken when they react as electrophiles. Protonated alcohols react in this manner.

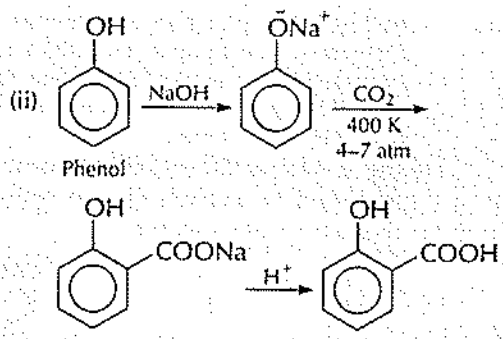
Protonated alcohols as electrophiles



(1)

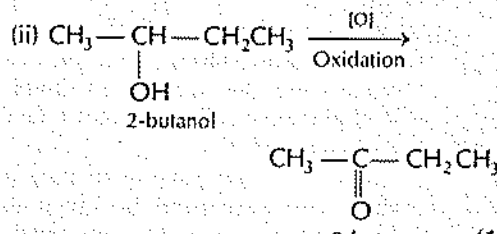
27. (i) 

(1)

(ii) 

(1)

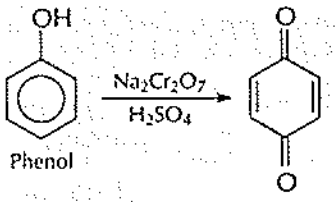
28. (i) $CH_3CH_2CH_2CH_2OH \xrightarrow[\text{Oxidation}]{[O]}$ $CH_3CH_2CH_2COOH$ (1)
Butanoic acid

(ii) 

(1)

(iii) $CH_3-\underset{CH_3}{\overset{H}{\underset{|}{\overset{|}{C}}}}-CH_2OH \xrightarrow[\text{Oxidation}]{[O]} CH_3-\underset{CH_3}{\overset{H}{\underset{|}{\overset{|}{C}}}}-COOH$

2-methylpropanoic acid (1)

29. (i) 

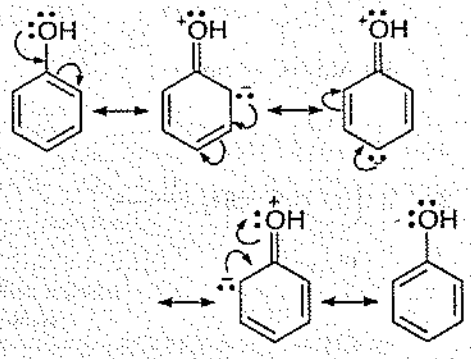
Phenol Benzoquinone (1)

(ii) Refer ans. 20 (ii). (1)

(iii) Refer ans. 21 (i). (1)

30. (i) Boiling point of alcohols increases with increase in the number of carbon atoms (increase in van der Waals' forces). That's why boiling point of ethanol is higher than that of methanol. (1)

(ii) The greater acidic nature of phenols as compared to alcohols can be explained on the basis of resonance.



Due to positive charge on oxygen atom, it attracts the electron pair of O—H bond strongly towards itself and thus, facilitates the release of H^+. (1)

(iii) Ethers have low polarity so they do not show any association by intermolecular hydrogen bonding. On the other hand their isomeric alcohols have strong H-bonding and so their boiling points are high. (1)

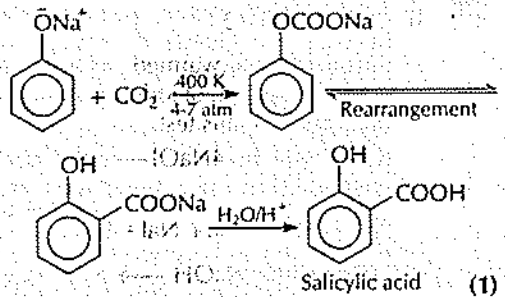
31. (i) Since alcohols can form H-bonds with water molecule, whereas hydrocarbons do not therefore, propanol has higher boiling point than butane. $\left(1\frac{1}{2}\right)$

(ii) It is because, $-NO_2$ group is electron withdrawing group, whereas $-OCH_3$ group is electron releasing group. Therefore, *o*-nitrophenoxide ion is more stable than *o*-methoxyphenoxide ion.

(iii) Secondary and tertiary alcohols on dehydration lead to the formation of alkene but not ethers due to stability of 2° and 3° carbocation. $\left(1\frac{1}{2}\right)$

32. (i) Refer ans. 17. (2)

(ii) Kolbe's reaction When sodium phenoxide is heated with CO_2 at about 400 K and under 4 to 7 atmospheric pressure, sodium salicylate is formed as major product, which on acidification gives salicylic acid, e.g.,



Salicylic acid (1)

33. A monobasic carboxylic acid has the formula *R*COOH.

Given, molar mass of *R*COOH = 60 g mol^{-1}

$$x + 12 + 16 + 16 + 1 = 60$$

$$x = 60 - 45 = 15 \quad (1)$$

Thus, $R = CH_3$ (molar mass 15) and the acid is CH_3COOH. The acid is obtained by the oxidation of aldehyde, so *B* is an aldehyde, *i.e.*, CH_3CHO and *A* is CH_3CH_2OH (an alcohol). The reactions are as

$$\underset{(C_2H_6O)}{\underset{(A)}{CH_3CH_2OH}} \xrightarrow[PCC]{[O]} \underset{(B)}{CH_3CHO}$$

$$CH_3CHO \xrightarrow[\text{(Aldol condensation)}]{\text{Aq. alkali}} CH_3CH(OH)CH_2CHO \xrightarrow{\Delta} CH_3CH{=}CHCHO$$

(B) — (C) — α,β-unsaturated aldehyde (1)

Thus, $A = CH_3CH_2OH$, $B = CH_3CHO$

$C = CH_3CH{=}CHCHO$ (1)

34. (i) Since branched chain alcohol have minimum surface area, therefore, minimum force of attraction, hence lower boiling point. (1)

(ii) It is due to the positive charge on 3 out of 5 resonating structures of phenol. It cannot be protonated easily. (1)

(iii) This is due to the reason that peroxide ion is stabilised by resonance, whereas methoxide ion is not. (1)

35. Refer to ans. 29. (3)

36. (i) Refer to ans 12 (2)

(ii) Ethanol when warmed with NaOH + I_2 gives yellow ppt. of iodoform while phenol does not give this test.

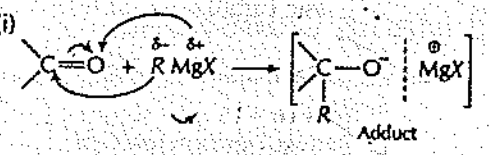
$$CH_3CH_2OH + 4NaOI \longrightarrow \underset{\text{Iodoform (Yellow ppt)}}{CHI_3} + HCOONa + NaI + H_2O + 2NaOH$$

Ethanol

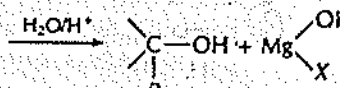
$$C_6H_5OH + NaOH \longrightarrow \text{No yellow ppt}$$

Phenol (1)

37. (i)



Adduct



(1)

(ii) Refer to ans. 17. (1)

(iii) Refer to ans 17. (1)

38. (i) This is due to the reason that ethanol is associated with intermolecular H-bonding, therefore, it has higher boiling point than that of methoxy methane which is not associated with intermolecular H-bonding. (1)

(ii) Refer to ans. 26. (ii). (1)

(iii) $-NO_2$ group is electron withdrawing (*–R* effect) group, so it increases stability of *o*-and *p*-nitrophenoxide ion (phenolate ion) as compared to phenoxide ion. (1)

39. (i) Pyridinium chlorochromate (PCC), a complex of chromium trioxide with pyridine and HCl. (1)

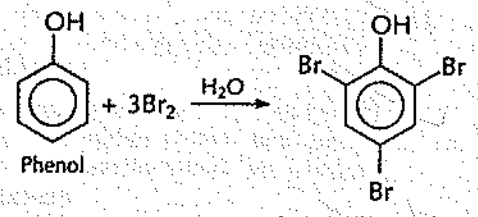
$$CH_3{-}CH{=}CH{-}CH_2OH \xrightarrow{PCC} CH_3{-}CH{=}CH{-}CHO$$

(ii) Ni / H_2 or $LiAlH_4$

$$CH_3CH_2{-}\underset{\underset{O}{\|}}{C}{-}CH_3 \xrightarrow[LiAlH_4]{} CH_3CH_2{-}\underset{\underset{OH}{|}}{CH}{-}CH_3$$

Butan-2-one — Propan-2-ol (1)

(iii) Aqueous bromine or bromine water.



Phenol — 2, 4, 6-tribromophenol (1)

40. (i) 2,5-dimethyl phenol. (1)

(ii) (a) Refer ans. 30 (ii). (1)

(b) Refer ans. 16 (i). (1)

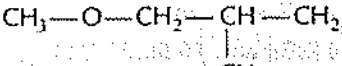
6. Aromatic ethers like anisole can be prepared by the reaction of sodium phenoxide with alkyl halides.
7. Ethers are inert and thus are used as solvents in many reactions.
8. Ethers on cleavage by acids give back alcohols and alkyl halides.
9. Aromatic ethers on cleavage give phenol and alkyl halide.
10. The order of reactivity of alkyl halides for Williamson's synthesis reaction is Primary > Secondary > Tertiary

Previous Years' **Examination Questions**

Practice the **Real Questions**

1 Mark **Questions**

1. Write the equation involved in the reaction Williamson's ether synthesis. **[All India 2013]**
2. Phenyl methyl ether reacts with HI to give phenol and methyl iodide and not iodo benzene and methyl alcohol. Why ? **[Delhi 2010C]**
3. Write the structure of the following compound: 2-methyl-2-ethoxypentane. **[Dehi 2009C]**
4. Write the IUPAC name of



[All Indin 2008]

5. Why is the preparation of ether by acid catalysed dehydration of secondary alcohol not a suitable method? **[All India 2008C]**
6. How can you convert anisole to phenol? **[All India 2007]**

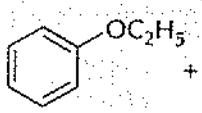
2 Marks **Questions**

7. Explain the following giving one example for each.
   (i) Reimer-Tiemann reaction
   (ii) Friedel-Crafts acetylation of anisole
   [Delhi 2011, 2010; All India 2009C]
8. Illustrate the following reaction by giving a chemical equation for each.
   (i) Kolbe's reaction
   (ii) Williamson's synthesis
   [Delhi 2010; All India 2010; 2009C Foreign 2010, 2009]

3 Marks **Questions**

9. State the products of the following reactions :

(i) $CH_3CH_2CH_2OCH_3 + HBr \longrightarrow$

(ii)  $+ HBr \longrightarrow$

(iii) $(CH_3)_3C-OC_2H_5 \xrightarrow{HI}$

[Foreign 2012]

10. (i) Name the reagents and write the chemical equation for the preparation of the following compounds by Williamson's synthesis.

(a) Ethoxy benzene

(b) 2-methyl-2-methoxy propane

(ii) Why do phenols not give the protonation reaction readily?

[All India 2008]

11. How could you account for

(i) phenols are more acidic than alcohols?

(ii) the boiling points of ethers are much lower than those of the alcohols of comparable molar masses?

[Delhi 2007]

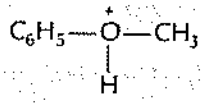
Step-by-Step **Solutions**

1. Williamson's ether synthesis

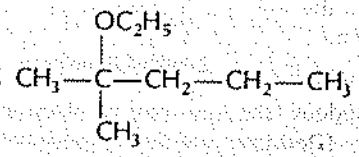
$$\underset{\text{Alkyl halide}}{R-X} + \underset{\text{Sodium alkoxide}}{R'ONa} \longrightarrow \underset{\text{Ether}}{R-O-R'} + NaX \quad \textbf{(1)}$$

e.g., $\underset{\text{Methyl iodide}}{CH_3I} + \underset{\text{Sodium ethoxide}}{C_2H_5ONa} \longrightarrow \underset{\text{Diethyl ether}}{CH_3OC_2H_5} + NaI$

2. Protonation of anisole (Phenyl methyl ether) gives methyl phenyl oxonium ion.

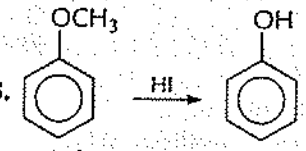


In this ion the stronger bond is $O-C_6H_5$. Therefore, attack by I^- ion exclusively breaks the weaker $O-CH_3$ bond forming methyl iodide and phenol. The phenol formed do not react further to give aryl halides. **(1)**

3.  **(1)**

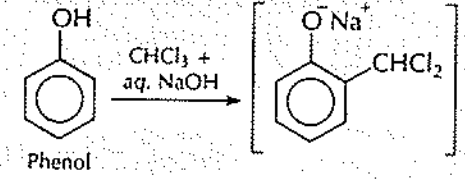
4. 2-methyl-1-methoxy butane. **(1)**

5. 2° and 3° alcohols are sterically hindered and due to steric hindrance, the nucleophilic attack by the alcohol molecule on the protonated alcohol molecule does not occur. The protonated 2° and 3° alcohols readily lose a molecule of water to form stable 2° and 3° carbocations, which after losing a proton give alkane. Thus, acid catalysed dehydration of 2° and 3° alcohols gives alkenes rather than ethers. **(1)**

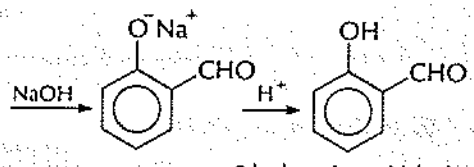
6. 

Anisole Phenol **(1)**

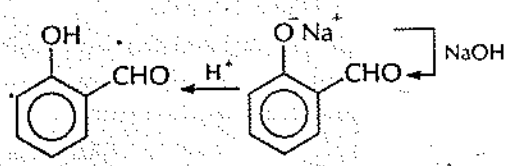
7. (i) **Reimer-Tiemann reaction** Chloroform reacts with phenol in aqueous sodium hydroxide at 340K to give salicylaldehyde.



Phenol

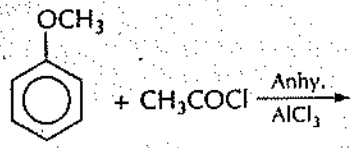


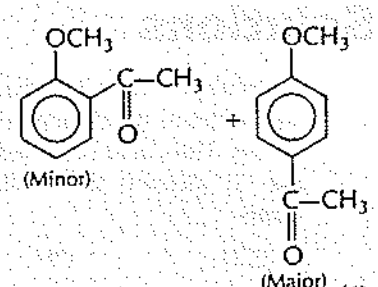
2-hydroxy benzaldehyde (salicylaldehyde)



(1)

(ii) **Friedel-Crafts acetylation of anisole** When anisole reacts with acetyl chloride in the presence of anhydrous $AlCl_3$, the acyl group is introduced at *ortho* and *para*-positions.

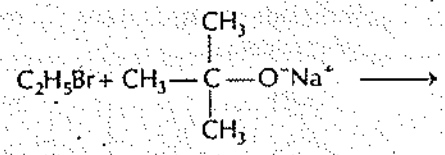


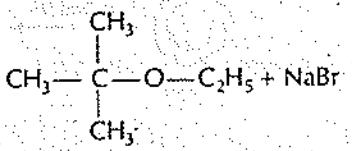


(1)

8. (i) Refer ans. 32 (ii) topic 1. **(1)**

(ii) **Williamson's synthesis** When alkyl halide reacts with sodium alkoxide, ethers are formed. This reaction is known as Willamson's synthesis.



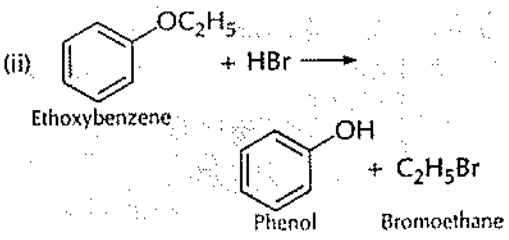


2-ethoxy-2-methylpropane **(1)**

9. (i) $CH_3CH_2CH_2OCH_3 + HBr \longrightarrow CH_3CH_2CH_2OH + CH_3Br$

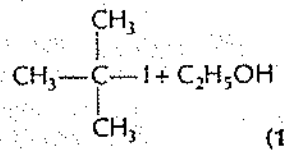
(1)

(ii)



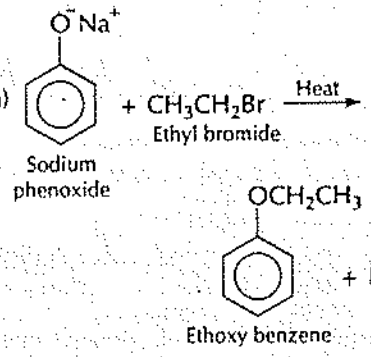
(1)

(iii) $(CH_3)_3C—OC_2H_5 + HI \longrightarrow$



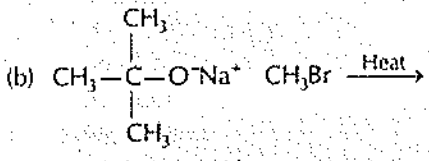
(1)

10. (i) (a)

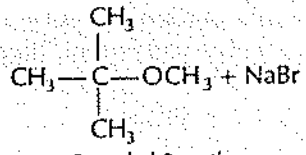


(1)

(b)



2-methyl-2-propoxide



2-methyl-2-methoxy propane **(1)**

(ii) In phenols, the lone pair of electrons on the oxygen atom are delocalised over the benzene ring due to resonance and hence, are not easily available for protonation. **(1)**

11. (i) Refer ans. 30 (ii) of topic 1. $\left(1\frac{1}{2}\right)$

(ii) Refer ans. 30 (iii) of topic 1. $\left(1\frac{1}{2}\right)$