

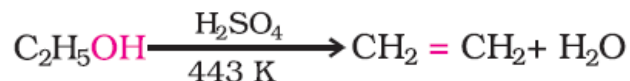
**Previous HSE questions and answers for the chapter "Alcohols, Phenols and Ethers"**

- The bond angle in C-O-H in alcohols is slightly less than tetrahedral angle.
  - Give the reason for the difference in the bond angle observed in alcohol. (1)
  - What is the bond angle in C-O-H in phenol? Give the reason for the variation. (2)
  - Alcohols undergo dehydration. How is ethanol converted to ethene? (1) [March 2008]

*Ans: a) It is due to the repulsion between the 2 unshared electron pairs of oxygen.*

*b) The C-O-H bond angle in phenol is  $109^\circ$ . It is due to the repulsion between unshared electron pair on oxygen atom and due to the presence of bulky phenyl group.*

*c) Ethanol on heating with concentrated  $\text{H}_2\text{SO}_4$  at 443 K, undergoes dehydration to form ethene.*



- Williamson's synthesis is an important method of ether synthesis.
  - To synthesis tertiary butyl ether, which of the following reagent sets are better? Justify.
    - $(\text{CH}_3)_3\text{C-Br} + \text{CH}_3\text{ONa}$
    - $(\text{CH}_3)_3\text{C-ONa} + \text{CH}_3\text{-Br}$ . (2)

*b) Explain the cleavage of C-O in  $\text{CH}_3\text{-CH}_2\text{-O-CH}_3$  when treated with HI. (1) [March 2009]*

*Ans: a) The set of reagents  $(\text{CH}_3)_3\text{C-ONa}$  &  $\text{CH}_3\text{-Br}$  are suitable for the preparation of tert-butyl ether. If the alkoxide used is primary, dehydrohalogenation occurs and the product formed is an alkene. This is because of the strong basic character of  $1^\circ$  alkoxide.*

*b) In the case of ethers containing two different alkyl groups, the lower alkyl group forms the alkyl halide.*



- Phenols are more acidic than alcohols.
  - Name the product obtained when phenol is treated with chloroform in the presence of NaOH. ( $\frac{1}{2}$ )
  - Name the above reaction. ( $\frac{1}{2}$ )
  - What is the product obtained when phenol is treated with Conc.  $\text{HNO}_3$ ? ( $\frac{1}{2}$ )
  - Write the structure and IUPAC name of the above product. (1)
  - Ethanol and propane have comparable molecular masses, but their boiling points differ widely. Which of them have higher boiling points? Substantiate your answer. ( $1\frac{1}{2}$ ) [March 2010]

*Ans: a) Salicylaldehyde (o-hydroxybenzaldehyde)*

*b) Reimer-Tiemann reaction*

*c) Picric acid*

*d) 2,4,6-trinitrophenol*



*e) Ethanol has higher boiling point than propane. This is due to inter molecular hydrogen bonding in ethanol.*

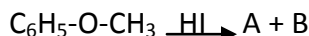
- Ethanol can be prepared by treating HCHO and  $\text{CH}_3\text{CH}_2\text{MgBr}$ .
  - Is the above statement true? (1)
  - Justify your answer. (2) [March 2010]

*Ans: a) This is not true.*

b) For the preparation of ethanol, treat formaldehyde (HCHO) with methyl magnesium bromide ( $\text{CH}_3\text{MgBr}$ ).



5. Ethers are generally non-reactive compounds. One of the important reactions of ethers is the action of HI.



Identify A and B. explain the reaction. (4) [March 2011]

Ans: A is phenol ( $\text{C}_6\text{H}_5\text{-OH}$ ) and B is iodomethane ( $\text{CH}_3\text{-I}$ )



Here the O-CH<sub>3</sub> bond is weaker than the O-C<sub>6</sub>H<sub>5</sub> bond. This is because the carbon of phenyl group is  $\text{sp}^2$  hybridised and there is a partial double bond character.

6. Mixture of Conc. HCl and anhydrous  $\text{ZnCl}_2$  is an important reagent which helps to distinguish between  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols.

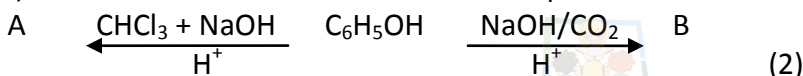
- Give the name of the above reagent. ( $\frac{1}{2}$ )
- Give one example each for  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols. ( $1\frac{1}{2}$ )
- Explain how the above reagent helps to distinguish above three types of alcohols. (2) [SAY 2011]

Ans: a) Lucas Reagent

b)  $1^\circ$  alcohol – methanol ( $\text{CH}_3\text{-OH}$ ),  $2^\circ$  alcohol – isopropylalcohol [ $(\text{CH}_3)_2\text{CHOH}$ ] and  $3^\circ$  alcohol – tert-butyl alcohol [ $(\text{CH}_3)_3\text{C-OH}$ ]

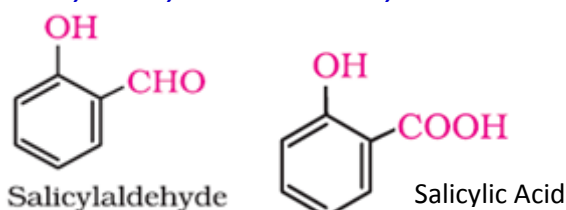
c) Lucas Test: Tertiary alcohols react with Lucas reagent and form immediate turbidity; secondary alcohols form a turbidity within 5 minutes while primary alcohols do not produce turbidity at room temperature. But they give turbidity on heating.

7. a) Write the name or structure of the compounds A and B in the following reactions:

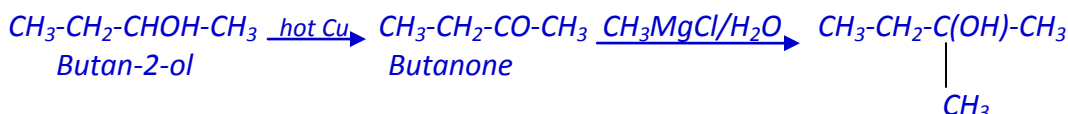


b) Vapours of an alcohol 'C' on passing over heated copper produce compound 'D'. 'D' on reaction with  $\text{CH}_3\text{MgCl}$  followed by hydrolysis produces 2-methylbutan-2-ol. Write the name or structure of compounds 'C' and 'D'. (2) [March 2012]

Ans: a) A is salicylaldehyde and B is salicylic acid



b) C is butan-2-ol and D is butanone.



8. Methanol and ethanol are two commercially important alcohols.

- Write one method of preparation of methanol and ethanol. (2)
- Name the products obtained when ethanol is treated with  $\text{CrO}_3$  in anhydrous medium. (1)
- The boiling point of ethanol is higher than that of methoxy methane. Give reason. (1) [SAY 2012]

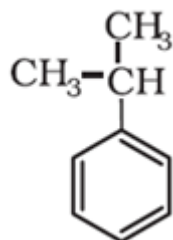
Ans: i) Formaldehyde on reduction using  $\text{LiAlH}_4$ , gives methanol, while acetaldehyde gives ethanol.



ii) Ethanal or acetaldehyde  $[\text{CH}_3\text{-CH}_2\text{-OH} \xrightarrow{\text{CrO}_3} \text{CH}_3\text{-CHO}]$

iii) This is due to the presence of inter molecular hydrogen bonding in ethanol.

9. a) Write the IUPAC names of all the possible isomers with molecular formula  $C_3H_8O$  (1½)  
 b) Phenol is usually manufactured from cumene. Write the structure of cumene. (½)  
 c) Primary, secondary and tertiary alcohols can be distinguished by Lucas test.  
 i) What is Lucas reagent? (½)  
 ii) Write the observations, for primary, secondary and tertiary alcohols in Lucas test. (1½) [March 2013]  
*Ans: a)  $CH_3-CH_2-CH_2OH$  – Propan-1-ol,  $CH_3-CHOH-CH_3$  – Propan-2-ol and  $CH_3-O-CH_2-CH_3$  – Methoxyethane  
 b) Cumene is isopropylbenzene (2-phenyl propane). Its structure is:*

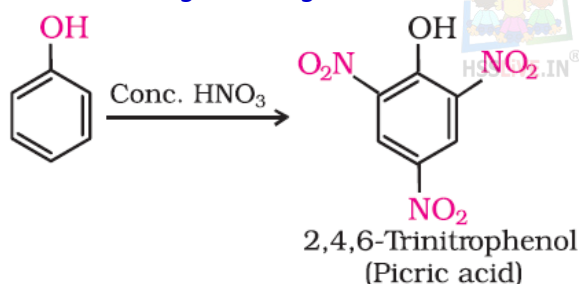


- c) i) Lucas reagent is a mixture of Conc. HCl and anhydrous  $ZnCl_2$   
 ii) Tertiary alcohols react with Lucas reagent and form immediate turbidity; secondary alcohols form turbidity within 5 minutes while primary alcohols do not produce turbidity at room temperature.*
10. How are the following conversions carried out? Represent the chemical reactions.  
 a) Ethanol to ethanal (1)  
 b) Phenol to picric acid (1)  
 c) Phenol to benzene (1)  
 d) Phenol to tribromophenol (1) [June 2013]

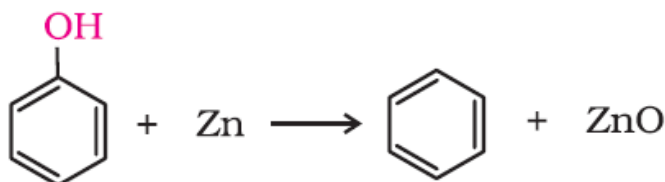
*Ans: a) By oxidation using  $CrO_3$ .*



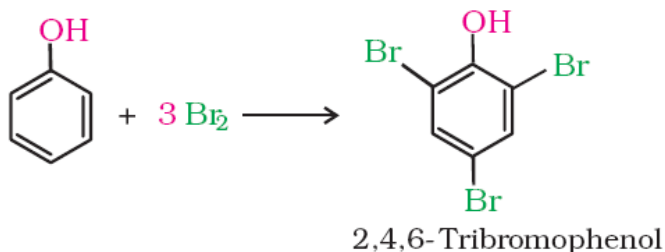
*b) By nitration using nitrating mixture.*



*c) By heating with zinc dust.*



*d) Bromination using bromine water.*



11. a) How will you prepare the following compounds using a Grignard reagent?

- i) Primary alcohol  
 ii) Secondary alcohol (2)  
 b) How will you distinguish primary and secondary alcohols using Luca's test? (1)  
 c) Write the correct pair of reactants for the preparation of t-butyl ether by Williamson synthesis. (1)  
 [March 2014]

*Ans: a) Formaldehyde (methanal) reacts with Grignard reagent followed by hydrolysis gives primary alcohols.*



*Aldehydes other than formaldehyde, reacts with Grignard reagent followed by hydrolysis gives secondary alcohols.*



- b) Refer the answer of question no. 6 (c).  
 c) Refer the answer of question no. 2 (a).

12. a) Write the name or formula of the following:

- i) A simple ether  
 ii) A mixed ether  
 iii) A dihydric alcohol  
 iv) A trihydric alcohol (2)  
 b) Phenol on treatment with Br<sub>2</sub> in CS<sub>2</sub> at low temperature gives two isomeric monobromophenols 'X' and 'Y'. But phenol on treatment with bromine water gives a white precipitate 'Z'. Identify the products 'X', 'Y' and 'Z'. (2) [SAY 2014]

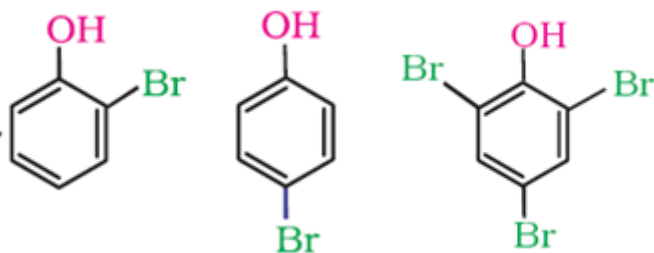
*Ans: a) i) CH<sub>3</sub> - O - CH<sub>3</sub> (Methoxymethane)*

*ii) CH<sub>3</sub>-CH<sub>2</sub>-O-CH<sub>3</sub> (Methoxyethane)*

*iii) HO-CH<sub>2</sub>-CH<sub>2</sub>-OH (Ethane-1,2-diol)*

*iv) HO-CH<sub>2</sub>-CHOH-CH<sub>2</sub>OH (Propane-1,2,3-triol)*

*b) X is 2-Bromophenol, Y is 4-Bromophenol and Z is 2,4,6-tribromophenol.*



*o-bromophenol      p-bromophenol      2,4,6-tribromophenol*

13. Alcohols are compounds with general formula R-OH.

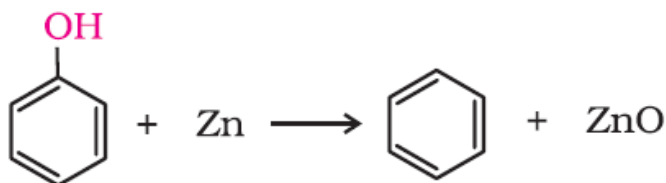
- a) Alcohols are soluble in water. Give reason? (1)  
 b) i) Explain a method for the manufacture of ethanol. (2)  
 ii) How will you convert phenol to benzene? (1) [March 2015]

*Ans: a) This is because alcohols can form inter molecular hydrogen bonding with water.*

*b) i) Ethanol can also be manufactured by hydration of ethene in acidic medium.*



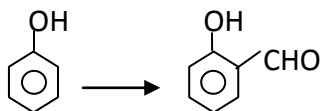
*ii) By heating with zinc dust.*



Phenol

Benzene

14. a) Write a test to distinguish between phenol and alcohol. (1)  
 b) Write suitable reagent(s) used for the following conversions:  
 i)  $\text{CH}_3\text{-CH}_2\text{-Cl} \longrightarrow \text{CH}_3\text{-CH}_2\text{-OH}$   
 ii)  $\text{CH}_3\text{-CH}_2\text{-OH} \longrightarrow \text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3$   
 iii)



(3) [SAY 2015]

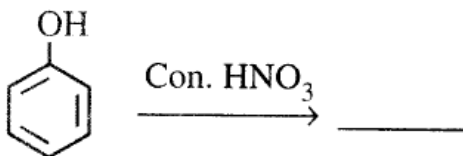
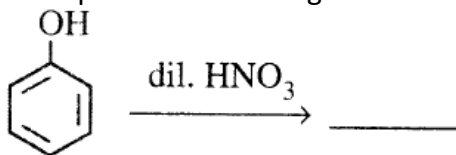
Ans: a) Phenol gives brisk effervescence with metallic sodium, but alcohol does not.

i) Aq. KOH or NaOH

ii) Conc.  $\text{H}_2\text{SO}_4/413\text{ K}$

iii) Chloroform ( $\text{CHCl}_3$ ) + aq. NaOH followed by acidification

15. a) Complete the following:



(2)

- b) Explain the following:

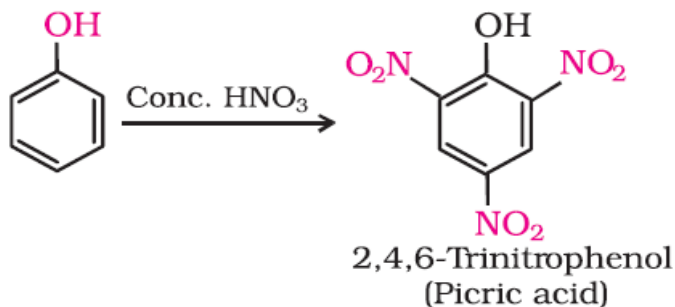
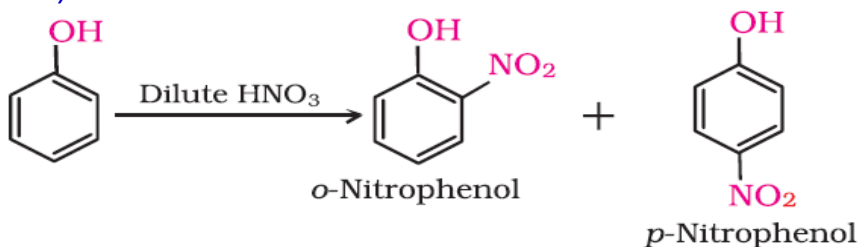
i) Esterification

ii) Williamson Synthesis

(2)

[March 2016]

Ans: a)



- c) i) Esterification: Alcohols and phenols react with carboxylic acids, acid chlorides and acid anhydrides to form esters.

ii) **Williamson Synthesis:** Alkyl halide reacts with sodium alkoxide to form ether. This reaction is called **Williamson's ether synthesis**.



16. a) Phenol when treated with Conc.  $HNO_3$  gives,

- (i) o-Nitrophenol      (ii) p-Nitrophenol      (iii) 2,4,6-Trinitrophenol      (iv) a mixture of o-nitrophenol and p-nitrophenol      (1)

b) Methanol and ethanol are two commercially important alcohols. Write one method each for the preparation of methanol and ethanol.      (3)      [SAY 2016]

**Ans: a) 2,4,6-Trinitrophenol**

**b) Refer the answer of question no. 8 (i)**

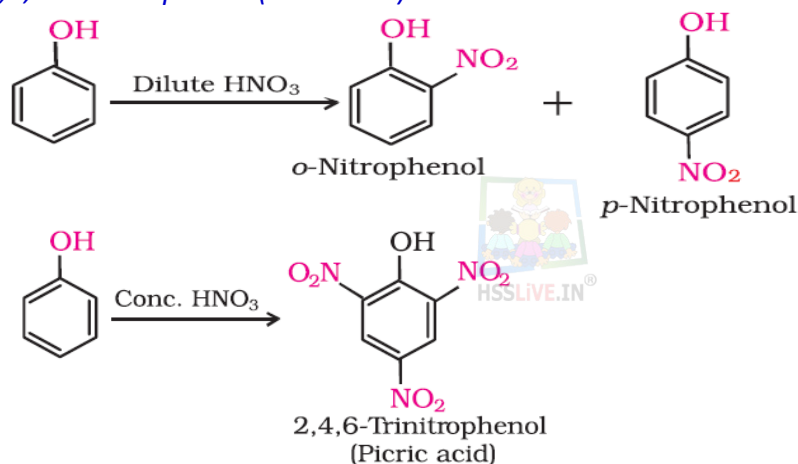
17. a) Arrange the following compounds in the order of increasing boiling points:

Ethanol, Propan-1-ol, Butan-1-ol, Butan-2-ol      (1)

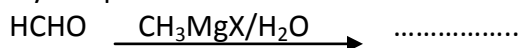
b) In the lab, students were asked to carry out the reaction between phenol and conc.  $HNO_3$ . But one student, 'A' carry out the reaction between phenol and dil.  $HNO_3$ . Do you think the student 'A' got the same result as others. Substantiate with suitable explanations. [also write the chemical equations wherever necessary].      (3)      [March 2017]

**Ans: a) Ethanol < Propan-1-ol < Butan-2-ol < Butan-1-ol**

**b) With dil.  $HNO_3$ , phenol gives a mixture of ortho and para nitrophenols, but with conc.  $HNO_3$ , it gives 2,4,6-trinitrophenol (Picric acid)**

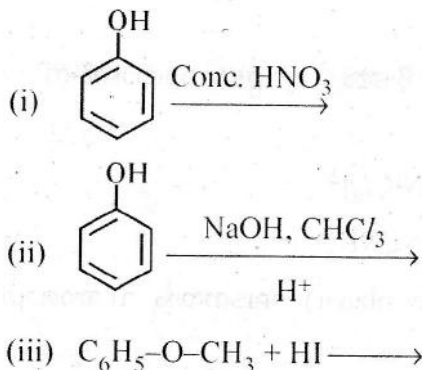


18. a) Identify the product:



- i)  $CH_3OH$       ii)  $CH_3CH_2OH$       iii)  $CH_3-\underset{\text{OH}}{\text{CH}}-CH_3$       iv)  $CH_3-\underset{\text{OH}}{\text{CH}}-CH_2-CH_3$       (1)

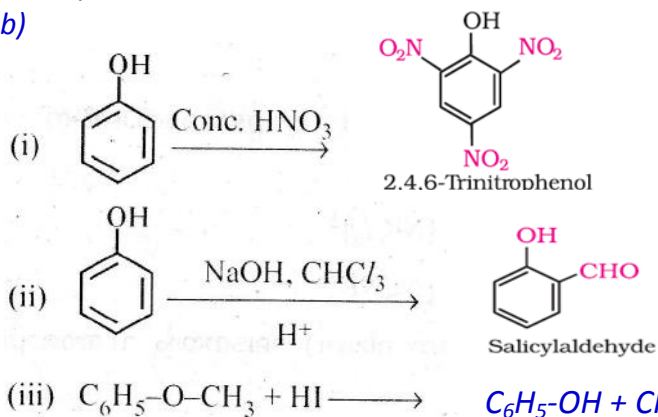
b) Complete the following:



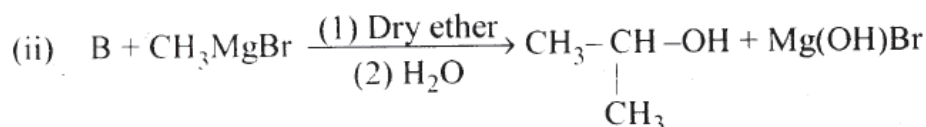
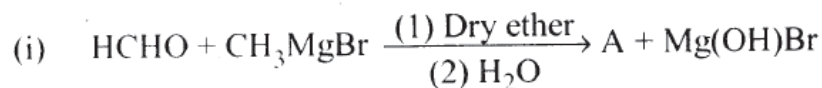
(3)      [SAY 2017]

Ans: a)  $\text{CH}_3\text{-CH}_2\text{-OH}$

b)



19. (a) Grignard reagents are important class of organometallic compounds used to prepare alcohols. Identify the compounds A and B and write the formula.

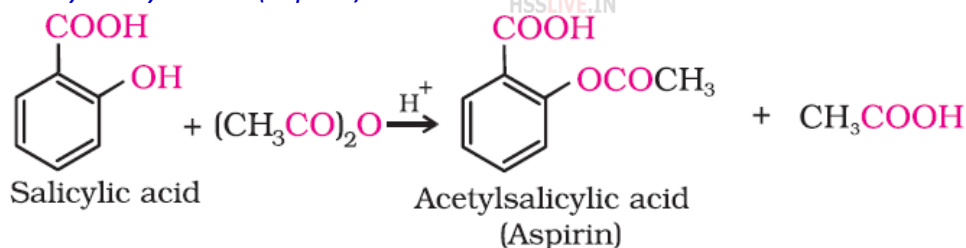


- (b) Write the name of products formed when salicylic acid is treated with acetic anhydride in acid medium. (4) [March 2018]

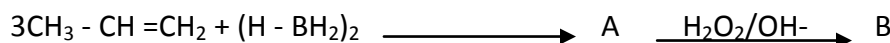
Ans: a) (i) A :  $\text{CH}_3\text{CH}_2\text{OH}$

(ii) B:  $\text{CH}_3\text{-CHO}$

(b) Acetylsalicylic acid (aspirin) and acetic acid



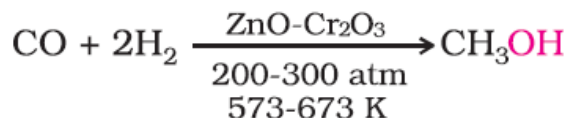
20. (a) Predict the products A and B.



- (b) How methanol is prepared industrially? (4) [SAY 2018]

Ans: a) A is triethylborane  $[(\text{CH}_3\text{-CH}_2\text{-CH}_2)_3\text{B}]$  and B is propan-1-ol  $[\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}]$

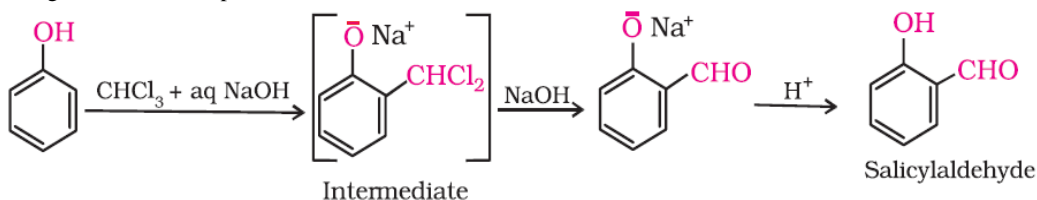
b) Methanol is industrially prepared by the catalytic hydrogenation of carbon monoxide at about 573-673 K temperature and 200-300 atm pressure and in the presence of  $\text{ZnO-Cr}_2\text{O}_3$  catalyst.



21. Write the chemical equation representing Reimer-Tiemann reaction. (2)

Ans: Phenol when treated with chloroform in the presence of sodium hydroxide, followed by acidification, we get salicylaldehyde (o-hydroxybenzaldehyde). This reaction is known as Reimer-Tiemann reaction.





22. Give the structural formula and IUPAC name of the product formed by the reaction of propanone with  $\text{CH}_3\text{MgBr}$  in dry ether, followed by hydrolysis. (2)

*Ans: The product formed is  $(\text{CH}_3)_3\text{C-OH}$ .*

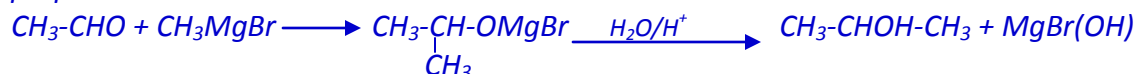
*Its IUPAC name is 2-Methylpropan-2-ol*

23. Predict the products obtained by the reaction of 2-methoxy-2-methylpropane with HI. (2) [March 2019]

*Ans:  $(\text{CH}_3)_3\text{C-I}$  (tert-butyl iodide or 2-Iodo-2-methylpropane) and  $\text{CH}_3\text{-OH}$  (methyl alcohol or methanol)*

24. Write the preparation of propan-2-ol from a Grignard reagent. (2)

*Ans: Acetaldehyde (ethanal) reacts with methyl magnesium bromide followed by acidification, we get propan-2-ol.*

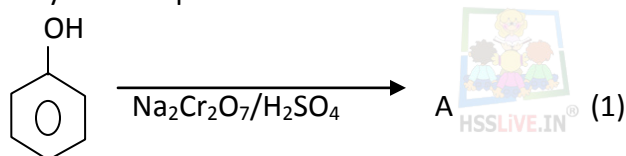


25. Phenols are acidic. Why? (2)

*Ans: In phenols, the  $-\text{OH}$  group is directly bonded to an  $\text{sp}^2$  hybridized carbon atom of the benzene ring. Due to the greater electronegativity of  $\text{sp}^2$  hybridized carbon, the benzene ring acts as an electron withdrawing group. So it is easy to remove the hydrogen atom as  $\text{H}^+$  ion and thus phenol is acidic in nature.*

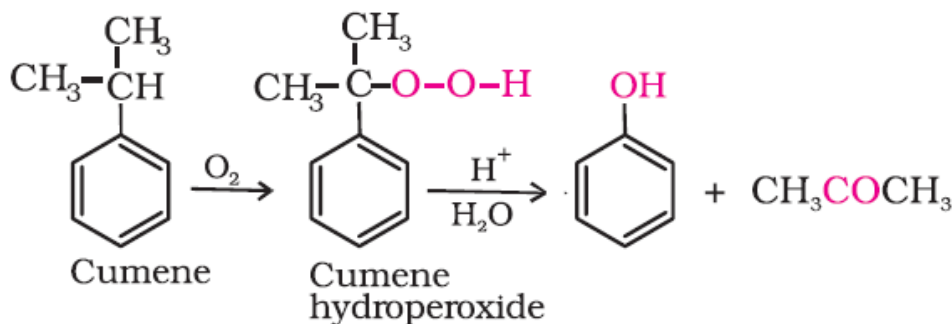
26. (a) What is cumene? Explain the preparation of phenol from cumene. (3)

(b) Identify the compound A.

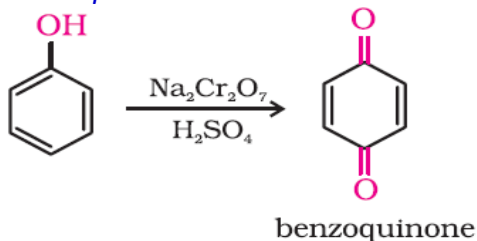


[SAY 2019]

*Ans: (a) Cumene is isopropylbenzene (2-phenyl propane). It is oxidised in presence of air, we get cumene hydroperoxide, which on treating with dilute acid gives phenol and acetone. This method is also used for the manufacture of acetone.*



*(b) A is benzoquinone.*





27. Ethanol and methoxymethane are functional isomers. But ethanol has higher boiling point than methoxymethane. Give reason. (2)

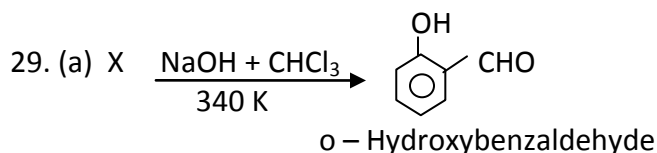
*Ans: This is due to the presence of inter molecular hydrogen bonding in ethanol, which is absent in methoxymethane.*

28. (a) A mixture of anhydrous  $\text{ZnCl}_2$  and conc.  $\text{HCl}$  is an important reagent used to distinguish primary, secondary and tertiary alcohols. How the above reagent is used to distinguish the three types of alcohols? (3)

(b) Predict the product formed in the reaction  $\text{CH}_3\text{-CH}_2\text{-OH} \xrightarrow[443\text{K}]{\text{Conc. H}_2\text{SO}_4} ?$  (1) [March 2020]

*Ans: (a) Refer the answer of question no. 6 (c)*

*(b) Ethene ( $\text{CH}_2=\text{CH}_2$ )*



Identify X and name the reaction. (2)

(b) How can the following conversions be effected:

(i) Phenol  $\longrightarrow$  Benzene (1)

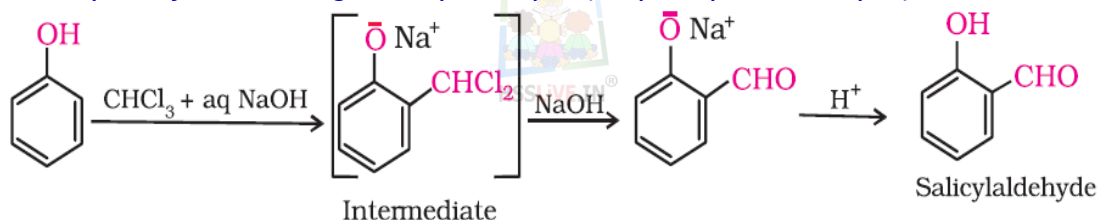
(ii) Phenol  $\longrightarrow$  2, 4, 6-Trinitrophenol (1) [SAY 2020]

*Ans: (a) X is phenol ( $\text{C}_6\text{H}_5\text{-OH}$ ) and the reaction is Reimer-Tiemann reaction.*

*(b) Refer the answer of question no. 10.*

30. Explain the following reactions (i) Reimer-Tiemann reaction (ii) Williamson's synthesis. (3)

*Ans: (i) **Reimer-Tiemann Reaction:** Phenol when treated with chloroform in the presence of NaOH, followed by acidification, we get salicylaldehyde (o-hydroxybenzaldehyde).*



*(ii) **Williamson's synthesis:** Alkyl halide reacts with sodium alkoxide to form ether. This reaction is called Williamson's ether synthesis.*



31. (i) How are the following conversions carried out?

A. Propene to Propan-2-ol.

B. Ethanal to Ethanol. (2)

(ii) Name the enzyme which converts glucose to ethanol. (1) [March 2021]

*Ans: (i) A. Propene reacts with water in the presence of acid as catalyst to form propan-2-ol.*



*B. Ethanal when reduced using lithium aluminium hydride ( $\text{LiAlH}_4$ ) or sodium borohydride ( $\text{NaBH}_4$ ) or on catalytic hydrogenation, we get ethanol.*



*(ii) Zymase*