

## I. Multiple Choice Questions (Type-I)

**1. Monochlorination of toluene in sunlight followed by hydrolysis with aq. NaOH yields.**

- (i) o-Cresol
- (ii) m-Cresol
- (iii) 2, 4-Dihydroxytoluene
- (iv) Benzyl alcohol

**Solution:**

Option (iv) is the answer.

**2. How many alcohols with molecular formula  $C_4H_{10}O$  are chiral?**

- (i) 1
- (ii) 2
- (iii) 3
- (iv) 4

**Solution:**

Option (i) is the answer.

**3. What is the correct order of reactivity of alcohols in the following reaction?**



- (i)  $1^\circ > 2^\circ > 3^\circ$
- (ii)  $1^\circ < 2^\circ > 3^\circ$
- (iii)  $3^\circ > 2^\circ > 1^\circ$
- (iv)  $3^\circ > 1^\circ > 2^\circ$

**Solution:**

Option (iii) is the answer.

**4.  $CH_3CH_2OH$  can be converted into  $CH_3CHO$  by \_\_\_\_\_.**

- (i) catalytic hydrogenation
- (ii) treatment with  $LiAlH_4$
- (iii) treatment with pyridinium chlorochromate
- (iv) treatment with  $KMnO_4$

**Solution:**

Option (iii) is the answer.

**5. The process of converting alkyl halides into alcohols involves \_\_\_\_\_.**

- (i) addition reaction
- (ii) substitution reaction
- (iii) dehydrohalogenation reaction
- (iv) rearrangement reaction

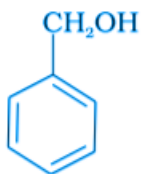
**Solution:**

Option (ii) is the answer.

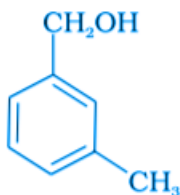
**6. Which of the following compounds is aromatic alcohol?**



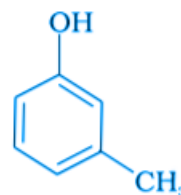
(A)



(B)



(C)



(D)

(i) A, B, C, D

(ii) A, D

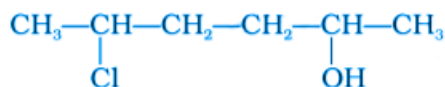
(iii) B, C

(iv) A

**Solution:**

Option (iii) is the answer.

**7. Give IUPAC name of the compound given below.**



(i) 2-Chloro-5-hydroxyhexane

(ii) 2-Hydroxy-5-chlorohexane

(iii) 5-Chlorohexan-2-ol

(iv) 2-Chlorohexan-5-ol

**Solution:**

Option (iii) is the answer.

**8. IUPAC name of m-cresol is \_\_\_\_\_.**

(i) 3-methylphenol

(ii) 3-chlorophenol

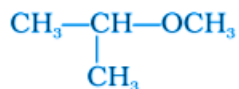
(iii) 3-methoxyphenol

(iv) benzene-1,3-diol

**Solution:**

Option (i) is the answer.

**9. IUPAC name of the compound is \_\_\_\_\_.**



- (i) 1-methoxy-1-methylethane
- (ii) 2-methoxy-2-methylethane
- (iii) 2-methoxypropane
- (iv) isopropylmethyl ether

**Solution:**

Option (iii) is the answer.

**10. Which of the following species can act as the strongest base?**

- (i)  $^-\text{OH}$
- (ii)  $^-\text{OR}$
- (iii)  $^-\text{O C}_6\text{H}_5$
- (iv)  $^-\text{O}-\text{C}_6\text{H}_4-\text{NO}_2$

**Solution:**

Option (ii) is the answer.

**11. Which of the following compounds will react with sodium hydroxide solution in water?**

- (i)  $\text{C}_6\text{H}_5\text{OH}$
- (ii)  $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$
- (iii)  $(\text{CH}_3)_3\text{COH}$
- (iv)  $\text{C}_2\text{H}_5\text{OH}$

**Solution:**

Option (i) is the answer

**12. Phenol is less acidic than \_\_\_\_\_.**

- (i) ethanol
- (ii) o-nitrophenol
- (iii) o-methyl phenol
- (iv) o-methoxy phenol

**Solution:**

Option (ii) is the answer.

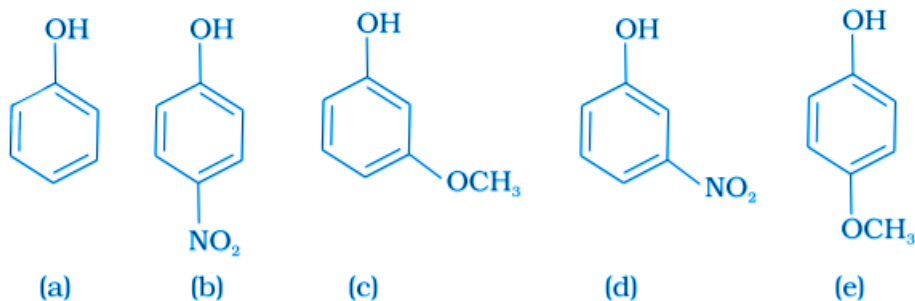
**13. Which of the following is most acidic?**

- (i) Benzyl alcohol
- (ii) Cyclohexanol
- (iii) Phenol
- (iv) m-Chlorophenol

**Solution:**

Option (iv) is the answer.

**14. Mark the correct order of decreasing acid strength of the following compounds.**

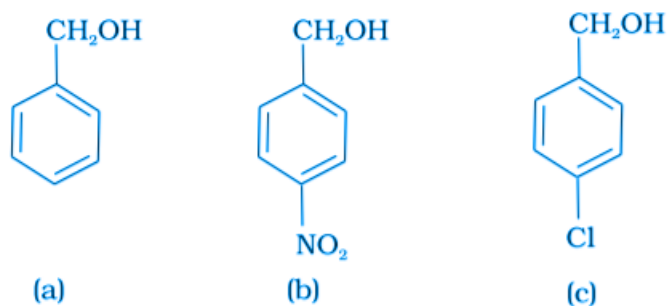


- (i)  $e > d > b > a > c$
- (ii)  $b > d > a > c > e$
- (iii)  $d > e > c > b > a$
- (iv)  $e > d > c > b > a$

**Solution:**

Option (ii) is the answer.

**15. Mark the correct increasing order of reactivity of the following compounds with HBr/HCl.**



- (i)  $a < b < c$
- (ii)  $b < a < c$
- (iii)  $b < c < a$
- (iv)  $c < b < a$

**Solution:**

Option (iii) is the answer.

**16. Arrange the following compounds in increasing order of boiling point.**

Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(i) Propan-1-ol, butan-2-ol, butan-1-ol, pentan-1-ol

(ii) Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(iii) Pentan-1-ol, butan-2-ol, butan-1-ol, propan-1-ol

(iv) Pentan-1-ol, butan-1-ol, butan-2-ol, propan-1-ol

**Solution:**

Option (i) is the answer

## II. Multiple Choice Questions (Type-II)

**Note:** In the following questions two or more options may be correct.

**17. Which of the following are used to convert  $\text{RCHO}$  into  $\text{RCH}_2\text{OH}$ ?**

(i)  $\text{H}_2/\text{Pd}$

(ii)  $\text{LiAlH}_4$

(iii)  $\text{NaBH}_4$

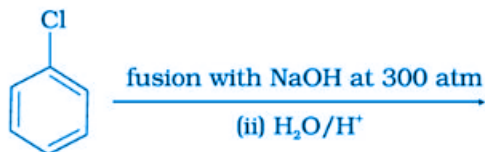
(iv) Reaction with  $\text{RMgX}$  followed by hydrolysis

**Solution:**

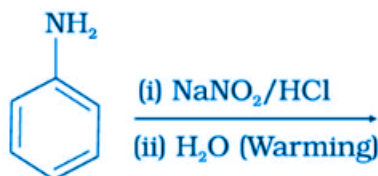
Option (i), (ii) and (iii) are the answers.

**18. Which of the following reactions will yield phenol?**

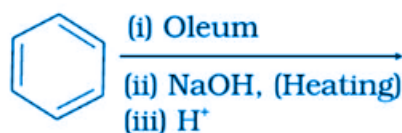
A.



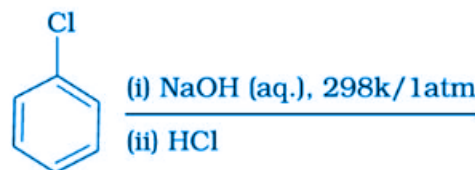
B.



C.



D.



**Solution:**

Option (A), (B) and (C)

**19. Which of the following reagents can be used to oxidise primary alcohols to aldehydes?**

(i)  $\text{CrO}_3$

in an anhydrous medium.

- (ii)  $\text{KMnO}_4$  in acidic medium.  
 (iii) Pyridinium chlorochromate.  
 (iv) Heat in the presence of Cu at 573K

**Solution:**

Option (i), (iii) and (iv) are the answers.

**20. Phenol can be distinguished from ethanol by the reactions with \_\_\_\_\_.**

- (i)  $\text{Br}_2/\text{water}$   
 (ii) Na  
 (iii) Neutral  $\text{FeCl}_3$   
 (iv) All the above

**Solution:**

Option (i) and (iii) are the answers.

**21. Which of the following are benzylic alcohols?**

- (i)  $\text{C}_6\text{H}_5\text{—CH}_2\text{—CH}_2\text{OH}$   
 (ii)  $\text{C}_6\text{H}_5\text{—CH}_2\text{OH}$   
 (iii)  $\text{C}_6\text{H}_5\text{—}\underset{\text{CH}_3}{\text{CH}}\text{—OH}$   
 (iv)  $\text{C}_6\text{H}_5\text{—CH}_2\text{—}\underset{\text{CH}_3}{\text{CH}}\text{—OH}$

**Solution:**

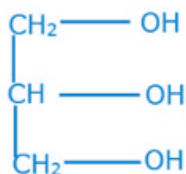
Option (ii) and (iii) are the answers.

### III. Short Answer Type

**22. What is the structure and IUPAC name of glycerol?**

**Solution:**

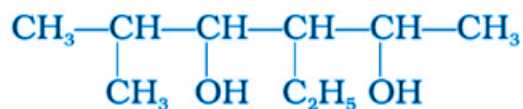
Structure of Glycerol



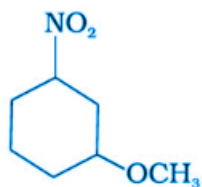
IUPAC name: Propane-1,2,3-triol

**23. Write the IUPAC name of the following compounds.**

(A)



(B)

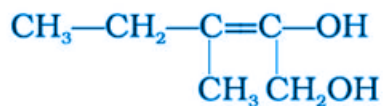


**Solution:**

(A) IUPAC name of the compound is 3-Ethyl-5-methyl hexane-2,4-diol.

(B) IUPAC name of the compound is 1-Methoxy-3-nitrocyclohexane.

**24. Write the IUPAC name of the compound given below.**



**Solution:**

IUPAC name of the compound is 3-Methylpent-2-ene-1,2-diol.

**25. Name the factors responsible for the solubility of alcohols in water.**

**Solution:**

The factors responsible for the solubility of alcohols in water are:

- I) Hydrogen bonds
- II) Size of the alkyl or aryl groups
- III) The molecular mass of the Alcohols.

**26. What is denatured alcohol?**

**Solution:**

Alcohols that are used for drinking are made unfit for human consumption by mixing alcohol with some copper sulfate and pyridine, which gives the colour and a foul smell to the liquid respectively. This is called denatured alcohol.

**27. Suggest a reagent for the following conversion.**



**Solution:**

The chemical reaction above shows the oxidation of secondary alcohol into a ketone. This can be easily achieved by using oxidizing agents like chromic anhydride ( $\text{CrO}_3$ ), Pyridinium chlorochromate (PCC), etc.

**28. Out of 2-chloroethanol and ethanol which is more acidic and why?**

**Solution:**

2-chloroethanol is more acidic because of the presence of chlorine which is an electron-withdrawing

group. This results in a negative inductive effect and thus, the electron density in the  $\text{-O-H}$  bond decreases. It stabilizes the alkoxide ion and therefore, 2-chloroethanol can easily release a proton.

**29. Suggest a reagent for conversion of ethanol to ethanal.**

**Solution:**

PCC or Pyridinium chlorochromate can be used as reagents. The above conversion shows the oxidation of primary alcohol to an aldehyde.

**30. Suggest a reagent for conversion of ethanol to ethanoic acid.**

**Solution:**

Acidified  $\text{KMnO}_4$  can be used as a reagent for the above conversion. The above conversion shows the oxidation of primary alcohol to a carboxylic acid.

**31. Out of o-nitrophenol and p-nitrophenol, which is more volatile? Explain.**

**Solution:**

Due to the presence of intramolecular hydrogen bonding between  $\text{NO}_2$  and  $\text{OH}$  group the o-nitrophenol is more volatile.

**32. Out of o-nitrophenol and o-cresol which is more acidic?**

**Solution:**

There is an electron-withdrawing group  $\text{NO}_2$  that is present in the ortho position in ortho-nitrophenol which enhances the acidic strength and makes more acidic. In o-cresol there is an electron releasing group, they decrease acidic strength.

**33. When phenol is treated with bromine water, a white precipitate is obtained. Give the structure and the name of the compound formed.**

**Solution:**

The name of the compound formed in this reaction is 2,4,6-tribromophenol. The structure of the compound formed is:



**34. Arrange the following compounds in increasing order of acidity and give a suitable explanation. Phenol, o-nitrophenol, o-cresol**

**Solution:**

Increasing order of the acidity of the given compounds: o-cresol < Phenol < o-nitrophenol.  
 Due to the presence of the electron-withdrawing group,  $\text{NO}_2$  o-nitrophenol becomes more acidic.  
 Remaining has an electron releasing group which decreases the acidic strength.

**35. Alcohols react with active metals e.g. Na, K etc. to give corresponding alkoxides.**

**Write down the decreasing order of reactivity of sodium metal towards primary, secondary and tertiary alcohols**

**Solution:**

The decreasing order of reactivity of sodium metal towards alcohols: Primary alcohols > secondary alcohols > tertiary alcohols

The reactivity of sodium metal towards tertiary alcohols is lowest mainly due to two reasons. First, steric hindrance of the alkyl groups. Second, an increase in the electron density on an Oxygen atom in the hydroxyl bond.

**36. What happens when benzene diazonium chloride is heated with water?**

**Solution:**

When benzene diazonium chloride is heated with water, Phenol is formed along with the by-products, Nitrogen gas and Hydrochloric acid.

**37. Arrange the following compounds in decreasing order of acidity.**

**H<sub>2</sub>O, ROH, HC  $\equiv$  CH**

**Solution:**

The decreasing order of the acidity of the given compounds:

H<sub>2</sub>O > ROH > HC  $\equiv$  CH

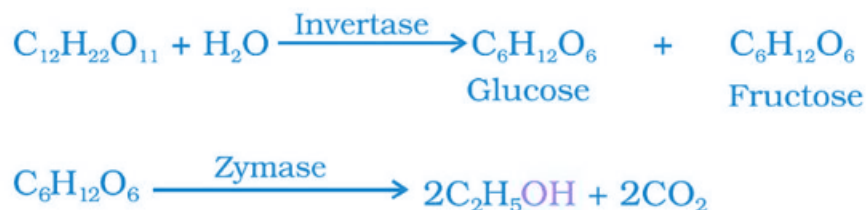
HC  $\equiv$  CH is less acidic because the carbon atoms here is sp hybridized, so the electron density is higher on the carbon atom.

**38. Name the enzymes and write the reactions involved in the preparation of ethanol from sucrose by fermentation.**

**Solution:**

Names of the enzymes involved in the preparation of ethanol from sucrose by fermentation are invertase and zymase.

Invertase converts sucrose into glucose and fructose. Then, glucose and fructose undergo fermentation in the presence of zymase and ethanol is produced.



**39. How can propane-2-one be converted into tert- butyl alcohol?**

**Solution:**

Propane-2-one is treated with  $\text{CH}_3\text{MgBr}$  in the presence of dry ether (Grignard reagent), followed by the hydrolysis to yield tert- butyl alcohol.

**40. Write the structures of the isomers of alcohols with molecular formula  $\text{C}_4\text{H}_{10}\text{O}$ . Which of these exhibits optical activity?**

**Solution:**

a)



Butan-1-ol

b)



Butan-2-ol

c)



2-Methylpropan-1-ol

d)



2-Methylpropan-2-ol

Here, only Butan-2-ol exhibits optical activity because it has a chiral carbon atom.

**41. Explain why the OH group in phenols is more strongly held as compared to OH group in alcohols.**

**Solution:**

The –OH group in phenol is directly attached to the  $sp^2$  hybridized carbon atom of the benzene ring. The carbon-oxygen bond length in phenol is smaller as compared to the carbon-oxygen bond length in alkyl alcohol and this is due to the partial double bond character or due to the resonance and charge distribution in phenol.

**42. Explain why nucleophilic substitution reactions are not very common in phenols.**

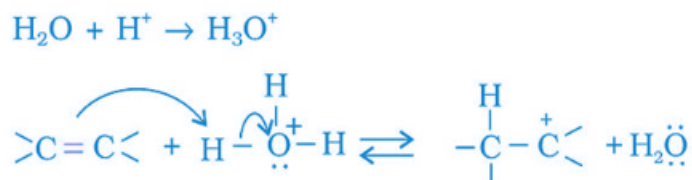
**Solution:**

Due to the resonance, the ortho- and para-positions in the benzene ring becomes electron-rich and therefore, activates it towards electrophilic substitution reaction. Thus, nucleophilic substitution reactions are not very common in phenols

**43. Preparation of alcohols from alkenes involves the electrophilic attack on an alkene carbon atom. Explain its mechanism.**

**Solution:**

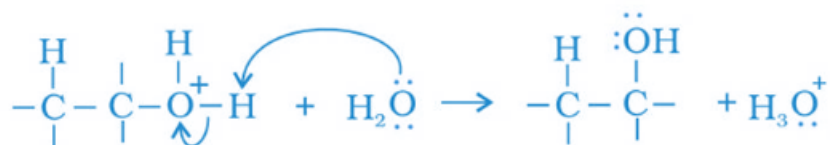
Step (1) Protonation of alkene and formation of a carbocation



Step (2) Nucleophilic attack of water



Step (3) Deprotonation occurs and alcohol is formed.  $\text{H}_3\text{O}^+$  is released.



**44. Explain why is  $\text{O}=\text{C}=\text{O}$  nonpolar while  $\text{R}-\text{O}-\text{R}$  is polar.**

**Solution:**

$\text{O}=\text{C}=\text{O}$  nonpolar because the dipole moment of the two  $\text{C}=\text{O}$  bonds is exactly equal and opposite of each other. Therefore, they cancel each other and so, the net dipole moment of  $\text{O}=\text{C}=\text{O}$  is zero.

**45. Why is the reactivity of all the three classes of alcohols with conc?  $\text{HCl}$  and  $\text{ZnCl}_2$  (Lucas reagent) different?**

**Solution:**

This is because of the steric hindrance of the alkyl group and the stability of carbocation.

Primary alcohol does not show any reaction at room temperature because the  $1^\circ$  carbocation is least stable.

Secondary alcohol does not show any turbidity at room temperature but on heating, turbidity appears.

Tertiary alcohol immediately shows turbidity after addition of Lucas reagent as they can form halides easily due to the higher stability of the carbocation.

**46. Write steps to carry out the conversion of phenol to aspirin.**

**Solution:**

Phenol is treated with  $\text{NaOH}$  to produce phenoxide ion. Phenoxide ion then undergoes electrophilic substitution with  $\text{CO}_2$  to yield salicylic acid as the major product. This is called Kolbe's reaction.

**47. Nitration is an example of aromatic electrophilic substitution and its rate depends upon the group already present in the benzene ring. Out of benzene and phenol, which one is more easily nitrated and why?**

**Solution:**

Phenol is more nitrated because of the presence of the hydroxyl group in phenol. Due to the resonance effect caused by  $-\text{OH}$  group, the ortho- and para-positions in the benzene ring becomes electron-rich and therefore, activates it towards electrophilic substitution reaction. Thus, Nitration, an aromatic electrophilic substitution occurs at a position where the electron density is high.

**48. In Kolbe's reaction, instead of phenol, phenoxide ion is treated with carbon dioxide. Why?**

**Solution:**

In Kolbe's reaction, instead of phenol, phenoxide ion is treated with carbon dioxide (a weak electrophile) because phenoxide ion is more reactive towards electrophilic aromatic substitution.

**49. The dipole moment of phenol is smaller than that of methanol. Why?**

**Solution:**

The dipole moment of phenol is smaller than that of methanol due to the electron-withdrawing effect of the phenyl ring. Due to the resonance, the polarity of the  $\text{C}-\text{O}$  bond in phenol decreases.

**50. Ethers can be prepared by Williamson synthesis in which an alkyl halide is reacted with sodium alkoxide. Di-tert-butyl ether can't be prepared by this method. Explain.**

**Solution:**

Ethers can be prepared by Williamson synthesis in which an alkyl halide is reacted with sodium alkoxide. Di-tert-butyl ether can't be prepared by this method because in this case, elimination is more favoured over substitution.

**51. Why is the  $\text{C}-\text{O}-\text{H}$  bond angle in alcohols slightly less than the tetrahedral angle whereas the  $\text{C}-\text{O}-\text{C}$  bond angle in ether is slightly greater?**

**Solution:**

The C—O—H bond angle in alcohols is slightly less than the tetrahedral angle due to the repulsion between the unshared pair of electrons or the lone pair of electrons on the oxygen atom.

**52. Explain why low molecular mass alcohols are soluble in water.****Solution:**

This is due to the presence of intermolecular hydrogen bonding due to the presence of OH group between alcohol molecules. With an increase in the alkyl group of alcohol or case of high molecular mass alcohols, it suppresses the effect of polar nature of —OH group of alcohol. Thus, the solubility of alcohol decreases with increases in molecular size.

**53. Explain why p-nitrophenol is more acidic than phenol.****Solution:**

Para-nitrophenol is more acidic than phenol due to the presence of an electron-withdrawing group, -NO<sub>2</sub> group, which enhances the acidic strength of the compound by stabilizing the phenoxide ion.

**54. Explain why alcohols and ethers of comparable molecular mass have different boiling points?****Solution:**

Alcohols and ethers of comparable molecular mass have different boiling points because of the presence of intermolecular hydrogen bonding in alcohols.

**55. The carbon-oxygen bond in phenol is slightly stronger than that in methanol. Why?****Solution:**

Reason:

- i) Due to the resonance, it develops a partial double bond character in carbon-oxygen bond. Thus, the decrease in the size of the carbon-oxygen bond in phenol.
- ii) In phenol, Oxygen is directly attached to a sp<sup>2</sup> hybridized carbon atom, whereas in methanol, Oxygen is directly attached to an sp<sup>3</sup> hybridized carbon atom. Thus, the bond formed between oxygen and sp<sup>2</sup> hybridized carbon atom is slightly stronger than that in methanol.

**56. Arrange water, ethanol and phenol in increasing order of acidity and give a reason for your answer.****Solution:**

Increasing order of acidity is: Ethanol < water < phenol

Phenol is more acidic because it forms phenoxide ion after deprotonation and gets stabilized by resonance. Ethanol is less acidic because the ethoxide ion is stabilized by the positive inductive effect. The electron releasing group in ethanol increases the density on oxygen and deprotonation gets difficult to occur. Water is a good proton donor than ethanol.