

Chapter 11: Alcohols, Phenols and Ethers

NCERT Exemplar · Class 12 · Chemistry

Questions

Question 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.

Question 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.

Question 3

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



A.



B.



C.



D.



Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 4

CH₃CH₂OH can be converted into CH₃CHO by _____.

(i) catalytic hydrogenation

(ii) treatment with LiAlH₄

(iii) treatment with pyridinium chlorochromate

(iv) treatment with KMnO₄

Solution

Option (iii) is the answer.

Question 5

The process of converting alkyl halides into alcohols involves_____.

(i) addition reaction

(ii) substitution reaction

(iii) dehydrohalogenation reaction

(iv) rearrangement reaction

Solution

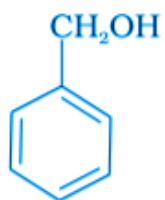
Option (ii) is the answer.

Question 6

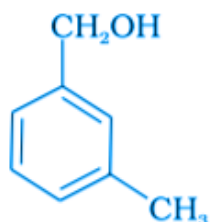
Which of the following compounds is aromatic alcohol?



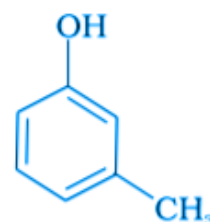
(A)



(B)



(C)



(D)

A.

A, B, C, D

B.

A, D

C.

B, C

D.

A

Answer

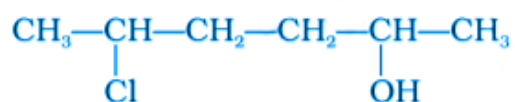
Correct option: C

Solution

Option (iii) is the answer.

Question 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.

Question 8

IUPAC name of m-cresol is _____.

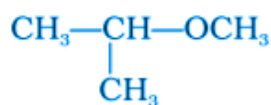
- (i) 3-methylphenol
- (ii) 3-chlorophenol
- (iii) 3-methoxyphenol
- (iv) benzene-1,3-diol

Solution

Option (i) is the answer.

Question 9

IUPAC name of the compound is _____.



(i) 1-methoxy-1-methylethane

(ii) 2-methoxy-2-methylethane

(iii) 2-methoxypropane

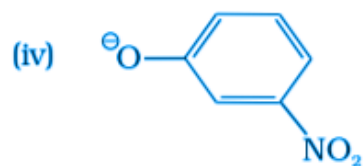
(iv) isopropylmethyl ether

Solution

Option (iii) is the answer.

Question 10

Which of the following species can act as the strongest base?



Solution

Option (ii) is the answer.

Question 11

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

A.



B.



C.



D.



Answer

Correct option: A

Solution

Option (i) is the answer

Question 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.

Question 13

Which of the following is most acidic?

A.

Benzyl alcohol

B.

Cyclohexanol

C.

Phenol

D.

m-Chlorophenol

Answer

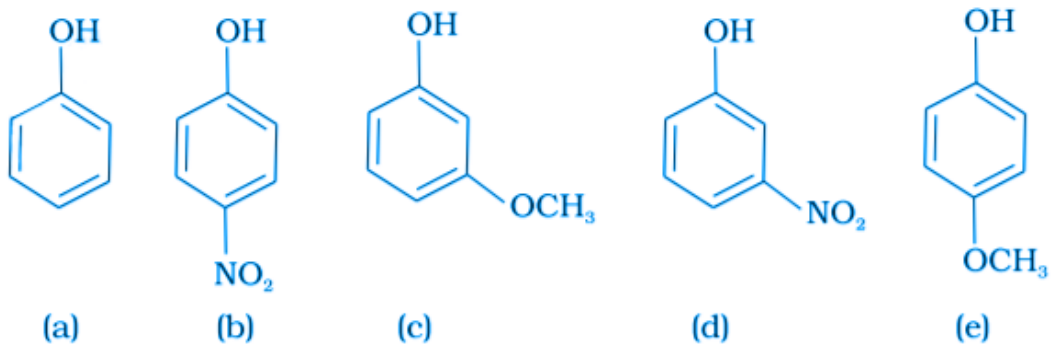
Correct option: D

Solution

Option (iv) is the answer.

Question 14

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



A.

$e > d > b > a > c$

B.

$b > d > a > c > e$

C.

$d > e > c > b > a$

D.

$e > d > c > b > a$

Answer

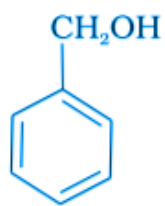
Correct option: B

Solution

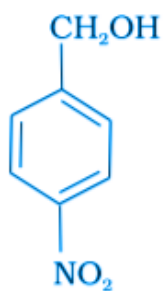
Option (ii) is the answer.

Question 15

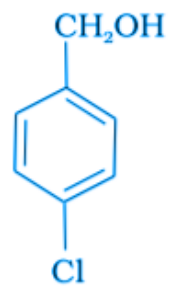
Mark the correct increasing order of reactivity of the following compounds with HBr/HCl.



(a)



(b)



(c)

A.

$a < b < c$

B.

$b < a < c$

C.

$b < c < a$

D.

$c < b < a$

Answer

Correct option: C

Solution

Option (iii) is the answer.

Question 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.

Question 17

Which of the following are used to convert RCHO into RCH_2OH ?

A.

H_2/Pd

B.

LiAlH_4

C.

NaBH_4

D.

Reaction with RMgX followed by hydrolysis

Answer

Correct option: A

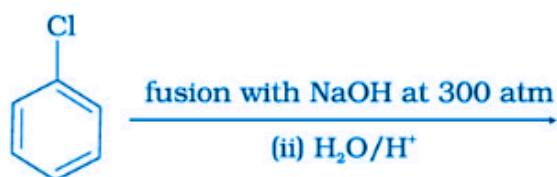
Solution

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

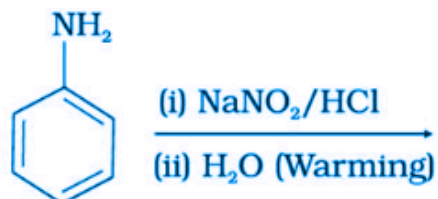
Question 18

Which of the following reactions will yield phenol?

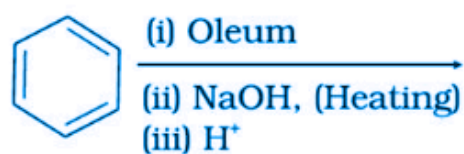
A.



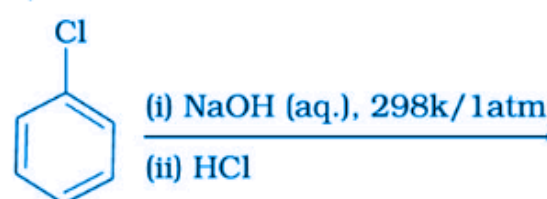
B.



C.



D.



Solution

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

Question 19

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

in an anhydrous medium.

A.

CrO_3

B.

KMnO_4 in acidic medium.

C.

Pyridinium chlorochromate.

D.

Heat in the presence of Cu at 573K

Answer

Correct option: A

Solution

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

Question 20

Phenol can be distinguished from ethanol by the reactions with _____.

(i) Br₂/water

(ii) Na

(iii) Neutral FeCl₃

(iv) All the above

Solution

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

Question 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) $\begin{array}{c} \text{C}_6\text{H}_5\text{—CH—OH} \\ | \\ \text{CH}_3 \end{array}$
(iv) $\begin{array}{c} \text{C}_6\text{H}_5\text{—CH}_2\text{—CH—OH} \\ | \\ \text{CH}_3 \end{array}$

Solution

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

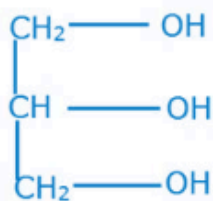
III. Short Answer Type

Question 22

What are the structure and IUPAC name of glycerol?

Solution

Structure of Glycerol

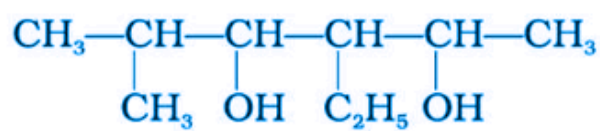


IUPAC name: Propane-1,2,3-triol

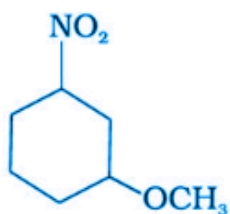
Question 23

Write the IUPAC name of the following compounds.

(A)



(B)



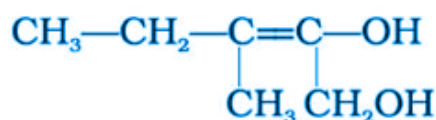
Solution

(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.

Question 24

Write the IUPAC name of the compound given below.



Solution

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

Question 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.
-

Question 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.

Question 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 (CrO_3), Pyridinium chlorochromate (PCC), etc.

Question 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 -O-H bond decreases. It stabilizes the alkoxide ion, and therefore, 2-chloroethanol can easily release a proton.

Question 29

Suggest a reagent for the 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.

Question 30

Suggest a reagent for the conversion of ethanol to ethanoic acid.

Solution

Acidified 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.

Question 31

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

Solution

Due to the presence of intramolecular hydrogen bonding between the NO_2 and OH group, the o-nitrophenol is more volatile.

Question 32

Out of o-nitrophenol and o-cresol, which is more acidic?

Solution

There is an electron-withdrawing group NO_2 that is present in the ortho position in ortho-nitrophenol, which enhances the acidic strength and makes it more acidic. In o-cresol, there is an electron-releasing group that decreases acidic strength.

Question 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:



Question 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, NO₂ o-nitrophenol becomes more acidic. The remaining has an electron-releasing group which decreases the acidic strength.

Question 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 of the Oxygen atom in the

hydroxyl bond.

Question 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.

Question 37

Arrange the following compounds in decreasing order of acidity.

H_2O , ROH , $\text{HC} \equiv \text{CH}$

Solution

The decreasing order of the acidity of the given compounds:

$\text{H}_2\text{O} > \text{ROH} > \text{HC} \equiv \text{CH}$

$\text{HC} \equiv \text{CH}$ is less acidic because the carbon atoms here are sp hybridised, so the electron density is higher on the carbon atom.

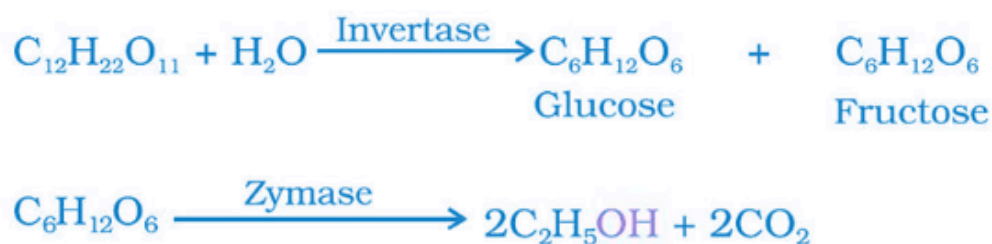
Question 38

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

Solution

The 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.



Question 39

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

Solution

Propane-2-one is treated with CH_3MgBr in the presence of dry ether (Grignard reagent), followed by hydrolysis to yield tert- butyl alcohol.

Question 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?

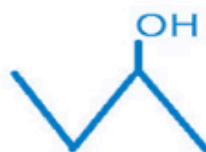
Solution

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.

Question 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.

Question 42

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

Solution

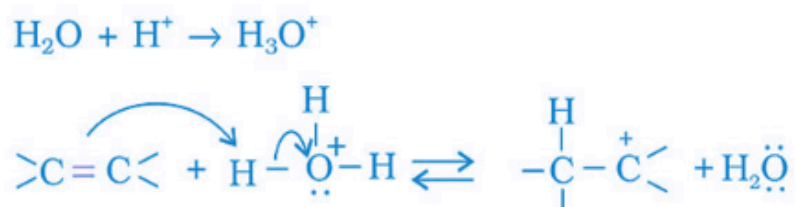
Due to the resonance, the ortho- and para-positions in the benzene ring become electron-rich and, therefore, activates it towards the electrophilic substitution reaction. Thus, nucleophilic substitution reactions are not very common in phenols

Question 43

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

Solution

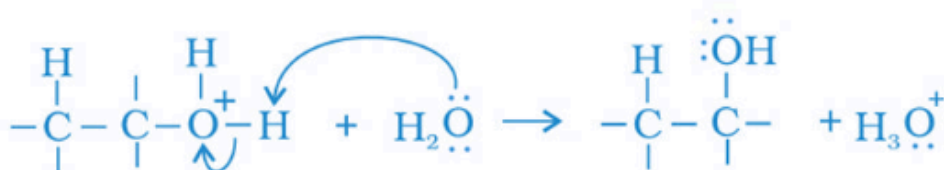
Step (1) Protonation of alkene and formation of a carbocation



Step (2) Nucleophilic attack of water



Step (3) Deprotonation occurs, and alcohol is formed. H_3O^+ is released.



Question 44

Explain why $\text{O}=\text{C}=\text{O}$ is 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.

Question 45

Why is the reactivity of all three classes of alcohols with conc? Are HCl and ZnCl₂ (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° carbocation is the least stable.

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

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

Question 46

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

Solution

Phenol is treated with NaOH to produce phenoxide ions. Phenoxide ion then undergoes electrophilic substitution with CO₂ to yield salicylic acid as the major product. This is called Kolbe's reaction.

Question 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 –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.

Question 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.

Question 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 C-O bond in phenol decreases.

Question 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.

Question 51

Why is the C—O—H bond angle in alcohols slightly less than the tetrahedral angle, whereas the C—O—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.

Question 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.

Question 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, -NO₂ group, which enhances the acidic strength of the compound by stabilizing the phenoxide ion.

Question 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.

Question 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 the 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 sp² hybridized carbon atom, whereas in methanol, Oxygen is directly attached to an sp³ hybridized carbon atom. Thus, the bond formed between oxygen and the sp² hybridized carbon atom is slightly stronger than that in methanol.

Question 56

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

Solution

The increasing order of acidity is: Ethanol < water < phenol

Phenol is more acidic because it forms a 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 of oxygen, and deprotonation gets difficult to occur. Water is a good proton donor than ethanol.

NCERT Exemplar Solutions for Class 12 Chemistry Chapter 11 Alcohols, Phenols and Ethers

In this chapter, students will learn the classification of alcohols, phenols, and ethers. The structure of the functional group is one of the most important parts of this chapter. Every year in the board exam, one question related to the functional group is always asked.

Important Concepts Covered in Class 12 Chemistry Chapter 11 alcohols, Phenols and Ethers

1. Classification- alcohols, phenols, ethers
2. Nomenclature – alcohols, phenols, ethers
3. Structures of Functional groups
4. Methods of Preparation – Alcohols and phenols
5. Chemical Reactions
6. Commercially Important Alcohols

To master the concepts covered in this chapter, students are advised to solve the NCERT Exemplar Solutions for Class 12 Chemistry Chapter 11 Alcohols, Phenols, and Ethers.

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