

HALOALKANES AND ARENES: NCERT SOLUTION

HALO ALKANES AND ARENES

Question 10.1:

Write structures of the following compounds:

(i) 2-Chloro-3-methylpentane

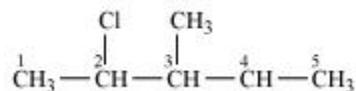
(ii) 1-Chloro-4-ethylcyclohexane

(iii) 4-tert. Butyl-3-iodoheptane

(iv) 1,4-Dibromobut-2-ene

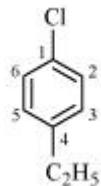
(v) 1-Bromo-4-sec. butyl-2-methylbenzene

(i)



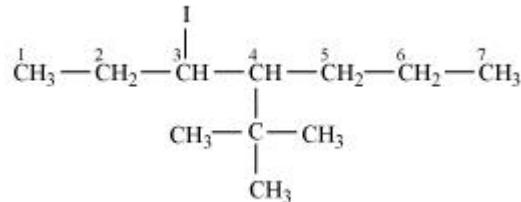
2-Chloro-3-methyl pentane

(ii)



1-Chloro-4-ethylcyclohexane

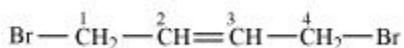
(iii)



4- tert-Butyl-3-iodoheptane

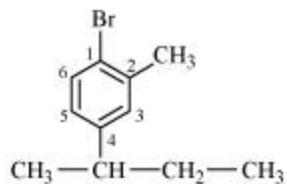
(iv)

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1, 4-Dibromobut-2-ene

(v)



1-Bromo-4-sec-butyl-2-methylbenzene

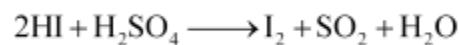
Question 10.2:

Why is sulphuric acid not used during the reaction of alcohols with KI?

In the presence of sulphuric acid (H₂SO₄), KI produces HI



Since H₂SO₄ is an oxidizing agent, it oxidizes HI (produced in the reaction to I₂).



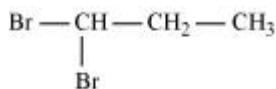
As a result, the reaction between alcohol and HI to produce alkyl iodide cannot occur. Therefore, sulphuric acid is not used during the reaction of alcohols with KI. Instead, a non-oxidizing acid such as H₃PO₄ is used.

Question 10.3:

Write structures of different dihalogen derivatives of propane.

There are four different dihalogen derivatives of propane. The structures of these derivatives are shown below.

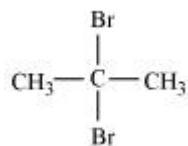
(i)



1, 1-Dibromopropane

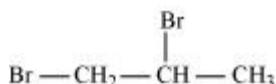
(ii)

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2, 2-Dibromopropane

(iii)



1, 2-Dibromopropane

(iv)



1, 3-Dibromopropane

Question 10.4:

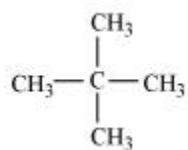
Among the isomeric alkanes of molecular formula C_5H_{12} , identify the one that on photochemical chlorination yields

(i) A single monochloride.

(ii) Three isomeric monochlorides.

(iii) Four isomeric monochlorides.

(i) To have a single monochloride, there should be only one type of H-atom in the isomer of the alkane of the molecular formula C_5H_{12} . This is because, replacement of any H-atom leads to the formation of the same product. The isomer is neopentane.

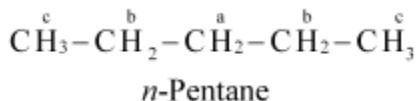


Neopentane

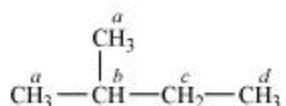
(ii) To have three isomeric monochlorides, the isomer of the alkane of the molecular formula C_5H_{12} should contain three different types of H-atoms.

Therefore, the isomer is *n*-pentane. It can be observed that there are three types of H atoms labelled as *a*, *b* and *c* in *n*-pentane.

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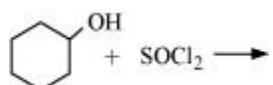
(iii) To have four isomeric monochlorides, the isomer of the alkane of the molecular formula C_5H_{12} should contain four different types of H-atoms. Therefore, the isomer is 2-methylbutane. It can be observed that there are four types of H-atoms labelled as *a*, *b*, *c*, and *d* in 2-methylbutane.



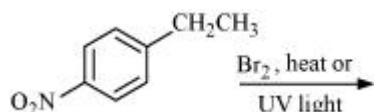
Question 10.5:

Draw the structures of major monohalo products in each of the following reactions:

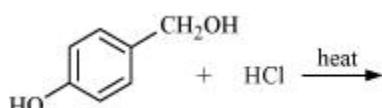
(i)



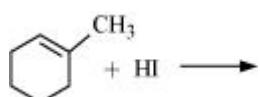
(ii)



(iii)



(iv)



(v)

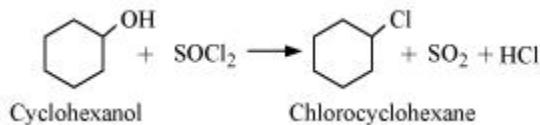


(vi)

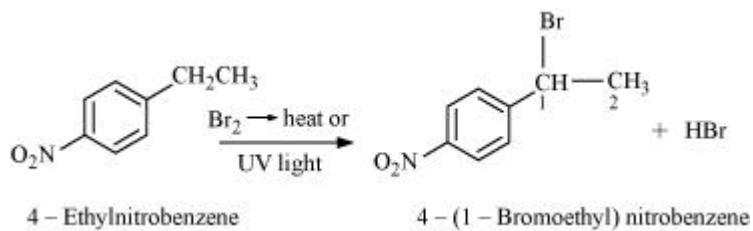
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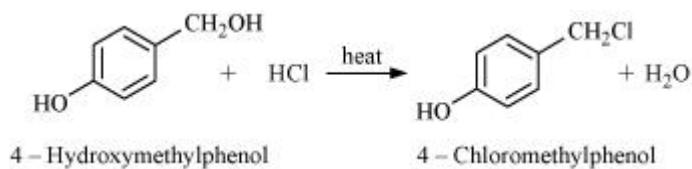
(i)



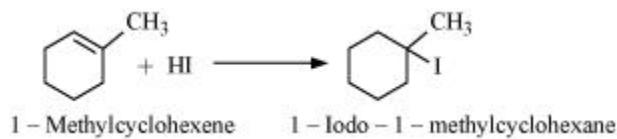
(ii)



(iii)



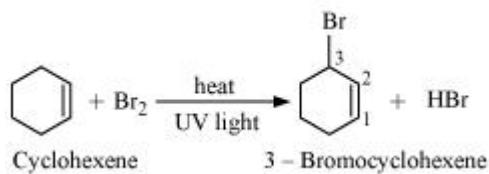
(iv)



(v)



(vi)



Question 10.6:

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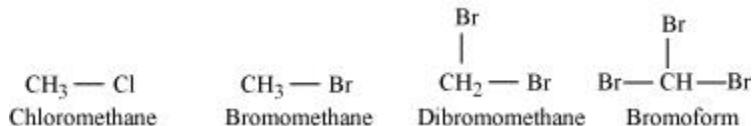
Arrange each set of compounds in order of increasing boiling points.

(i) Bromomethane, Bromoform, Chloromethane, Dibromomethane.

(ii) 1-Chloropropane, Isopropyl chloride, 1-Chlorobutane.

Answer

(i)



For alkyl halides containing the same alkyl group, the boiling point increases with an increase in the atomic mass of the halogen atom.

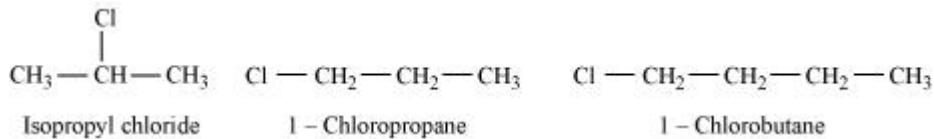
Since the atomic mass of Br is greater than that of Cl, the boiling point of bromomethane is higher than that of chloromethane.

Further, for alkyl halides containing the same alkyl group, the boiling point increases with an increase in the number of halides. Therefore, the boiling point of Dibromomethane is higher than that of chloromethane and bromomethane, but lower than that of bromoform.

Hence, the given set of compounds can be arranged in the order of their increasing boiling points as:

Chloromethane < Bromomethane < Dibromomethane < Bromoform.

(ii)



For alkyl halides containing the same halide, the boiling point increases with an increase in the size of the alkyl group. Thus, the boiling point of 1-chlorobutane is higher than that of isopropyl chloride and 1-chloropropane.

Further, the boiling point decreases with an increase in branching in the chain. Thus, the boiling point of isopropyl alcohol is lower than that of 1-chloropropane.

Hence, the given set of compounds can be arranged in the increasing order of their boiling points as:

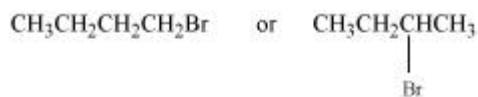
Isopropyl chloride < 1-Chloropropane < 1-Chlorobutane

Question 10.7:

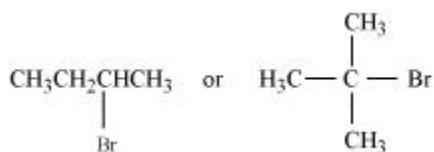
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Which alkyl halide from the following pairs would you expect to react more rapidly by an S_N2 mechanism? Explain your answer.

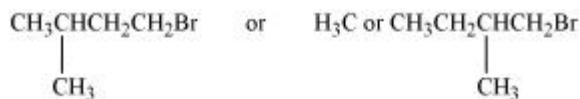
(i)



(ii)

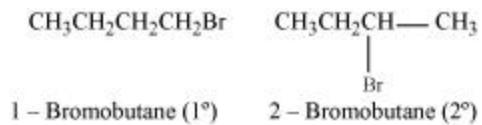


(iii)



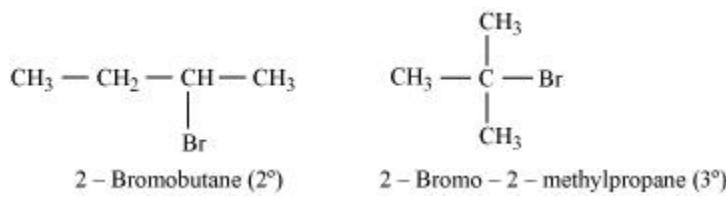
Answer

(i)



2-bromobutane is a 2° alkylhalide whereas 1-bromobutane is a 1° alkyl halide. The approaching of nucleophile is more hindered in 2-bromobutane than in 1-bromobutane. Therefore, 1-bromobutane reacts more rapidly than 2-bromobutane by an S_N2 mechanism.

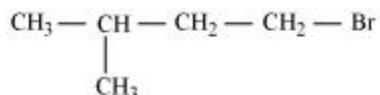
(ii)



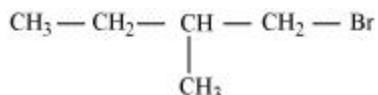
2-Bromobutane is 2° alkylhalide whereas 2-bromo-2-methylpropane is 3° alkyl halide. Therefore, greater numbers of substituents are present in 3° alkyl halide than in 2° alkyl halide to hinder the approaching nucleophile. Hence, 2-bromobutane reacts more rapidly than 2-bromo-2-methylpropane by an S_N2 mechanism.

(iii)

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1 – Bromo – 3 – methylbutane (1°)



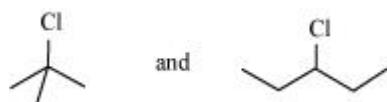
1 – Bromo – 2 – methylbutane (1°)

Both the alkyl halides are primary. However, the substituent $-CH_3$ is at a greater distance to the carbon atom linked to Br in 1-bromo-3-methylbutane than in 1-bromo-2-methylbutane. Therefore, the approaching nucleophile is less hindered in case of the former than in case of the latter. Hence, the former reacts faster than the latter by S_N2 mechanism.

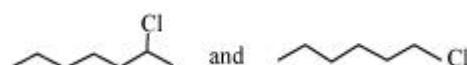
Question 10.8:

In the following pairs of halogen compounds, which compound undergoes faster S_N1 reaction?

(i)



(ii)

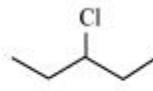


Answer

(i)



2 - Chloro - 2 - methylpropane (3°) (I)



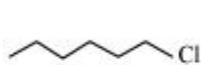
3 - chloropentane (2°) (II)

S_N1 reaction proceeds via the formation of carbocation. The alkyl halide (I) is 3° while (II) is 2° . Therefore, (I) forms 3° carbocation while (II) forms 2° carbocation. Greater the stability of the carbocation, faster is the rate of S_N1 reaction. Since 3° carbocation is more stable than 2° carbocation. (I), i.e. 2-chloro-2-methylpropane, undergoes faster S_N1 reaction than (II) i.e., 3-chloropentane.

(ii)



2 - chloroheptane (2°) (I)



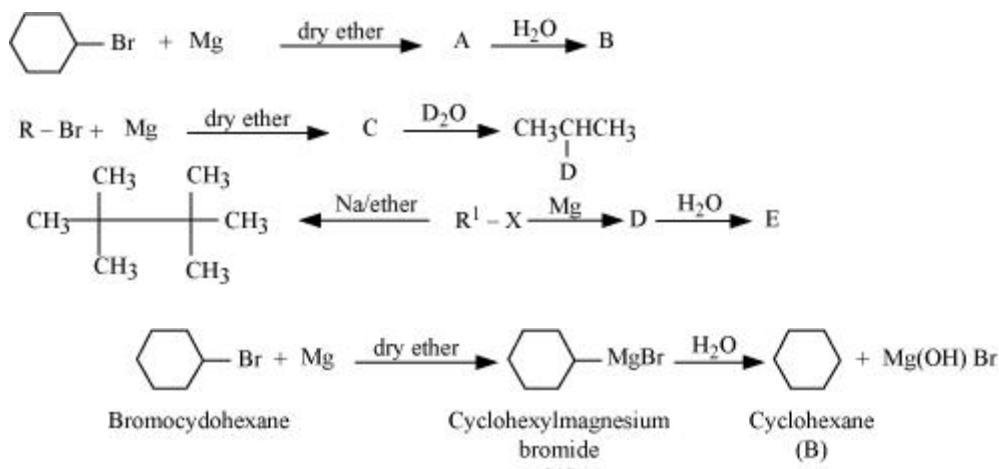
1 - chlorohexane (1°) (II)

The alkyl halide (I) is 2° while (II) is 1° . 2° carbocation is more stable than 1° carbocation. Therefore, (I), 2-chloroheptane, undergoes faster S_N1 reaction than (II), 1-chlorohexane.

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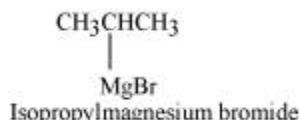
Question 10.9:

Identify A, B, C, D, E, R and R^1 in the following:

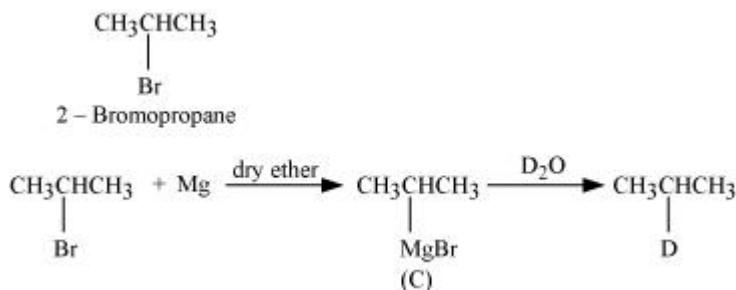


Answer

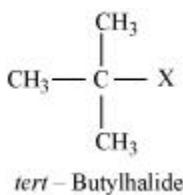
Since D of D_2O gets attached to the carbon atom to which $MgBr$ is attached, C is



Therefore, the compound R – Br is

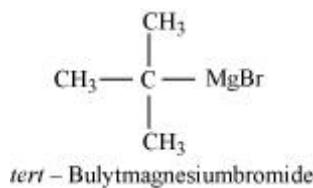


When an alkyl halide is treated with Na in the presence of ether, a hydrocarbon containing double the number of carbon atoms as present in the original halide is obtained as product. This is known as Wurtz reaction. Therefore, the halide, R^1-X , is

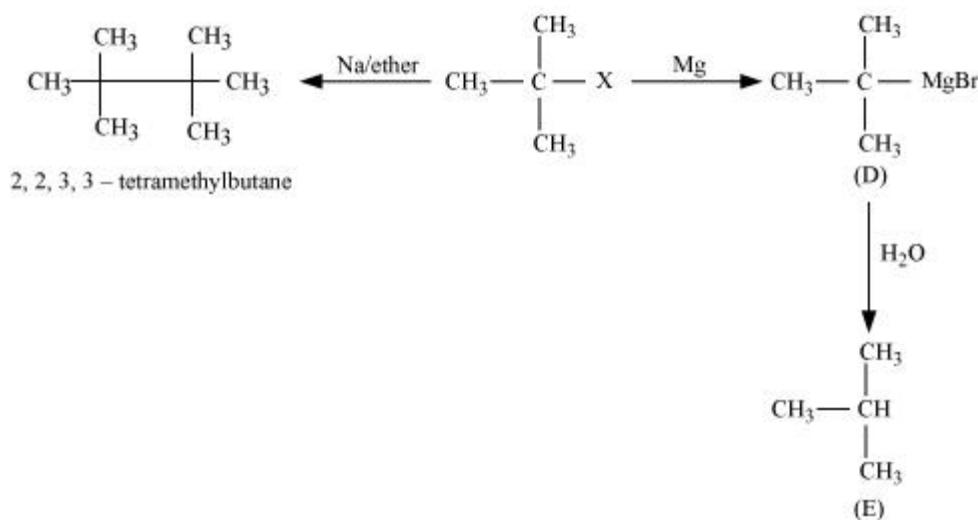
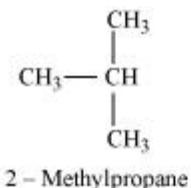


Therefore, compound D is

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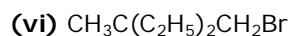
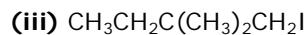


And, compound E is

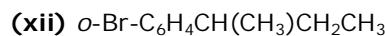
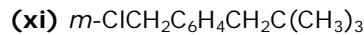
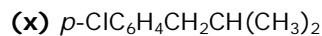
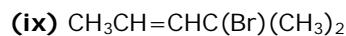
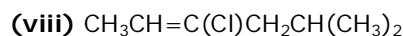
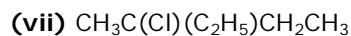


Question 10.1:

Name the following halides according to IUPAC system and classify them as alkyl, allyl, benzyl (primary, secondary, tertiary), vinyl or aryl halides:

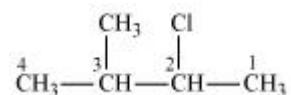


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Answer

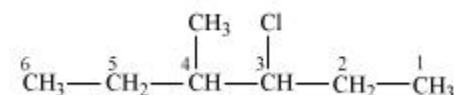
(i)



2-Chloro-3-methylbutane

(Secondary alkyl halide)

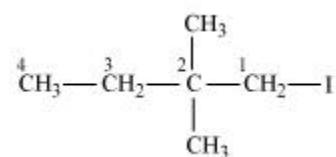
(ii)



3-Chloro-4-methyhexane

(Secondary alkyl halide)

(iii)

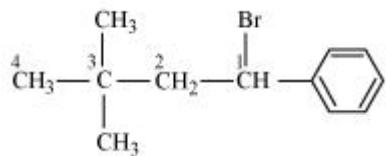


1-Iodo-2, 2-dimethylbutane

(Primary alkyl halide)

(iv)

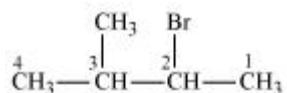
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1-Bromo-3, 3-dimethyl-1-phenylbutane

(Secondary benzyl halide)

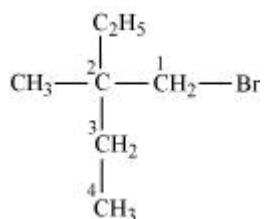
(v)



2-Bromo-3-methylbutane

(Secondary alkyl halide)

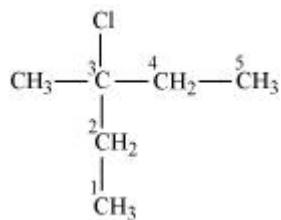
(vi)



1-Bromo-2-ethyl-2-methylbutane

(Primary alkyl halide)

(vii)

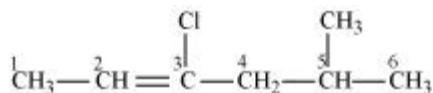


3-Chloro-3-methylpentane

(Tertiary alkyl halide)

(viii)

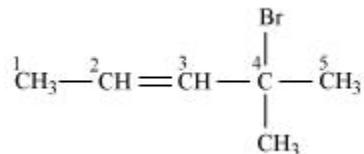
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3-Chloro-5-methylhex-2-ene

(Vinyl halide)

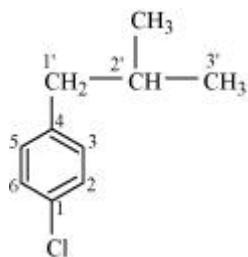
(ix)



4-Bromo-4-methylpent-2-ene

(Allyl halide)

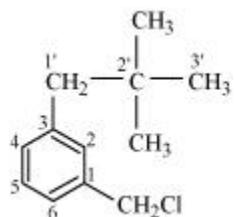
(x)



1-Chloro-4-(2-methylpropyl) benzene

(Aryl halide)

(xi)

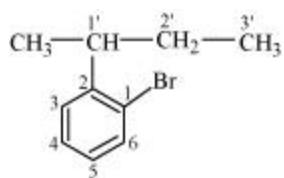


1-Chloromethyl-3-(2, 2-dimethylpropyl) benzene

(Primary benzyl halide)

(xii)

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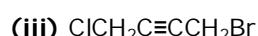
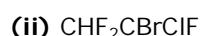
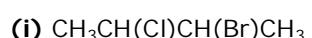


1-Bromo-2-(1-methylpropyl) benzene

(Aryl halide)

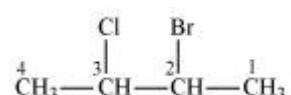
Question 10.2:

Give the IUPAC names of the following compounds:



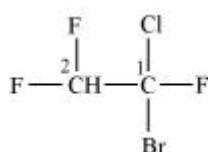
Answer

(i)



2-Bromo-3-chlorobutane

(ii)



1-Bromo-1-chloro-1, 2, 2-trifluoroethane

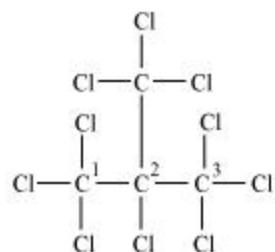
(iii)

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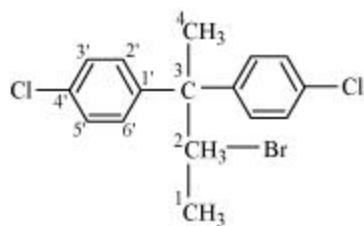
1–Bromo–4–chlorobut–2–yne

(iv)



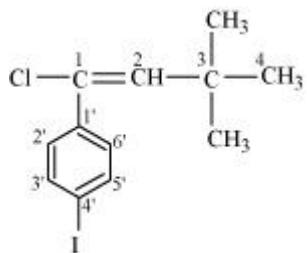
2–(Trichloromethyl)–1,1,1,2,3,3,3–heptachloropropane

(v)



2–Bromo–3, 3–bis(4–chlorophenyl) butane

(vi)



1–chloro–1–(4–iodophenyl)–3, 3–dimethylbut–1–ene

Question 10.3:

Write the structures of the following organic halogen compounds.

(i) 2-Chloro-3-methylpentane

(ii) *p*-Bromochlorobenzene

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(iii) 1-Chloro-4-ethylcyclohexane

(iv) 2-(2-Chlorophenyl)-1-iodooctane

(v) Perfluorobenzene

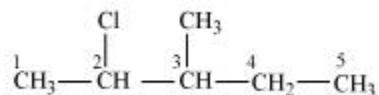
(vi) 4-tert-Butyl-3-iodoheptane

(vii) 1-Bromo-4-sec-butyl-2-methylbenzene

(viii) 1,4-Dibromobut-2-ene

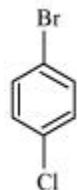
Answer

(i)



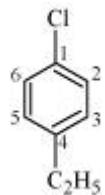
2-Chloro-3-methylpentane

(ii)



p-Bromochlorobenzene

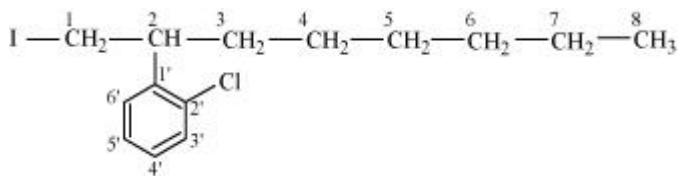
(iii)



1-Chloro-4-ethylcyclohexane

(iv)

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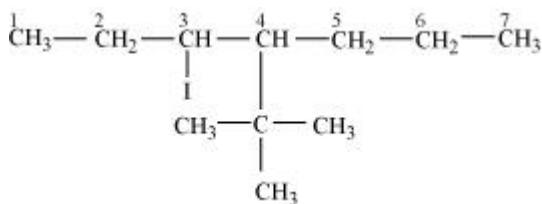
2-(2-Chlorophenyl)-1-iodooctane

(v)



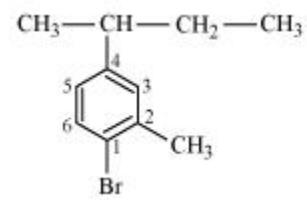
Perfluorobenzene

(vi)



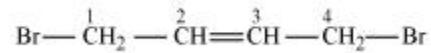
4-Tert-Butyl-3-iodoheptane

(vii)



1-Bromo-4-sec-butyl-2-methylbenzene

(viii)

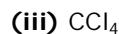
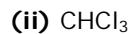


1,4-Dibromobut-2-ene

Question 10.4:

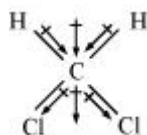
HALOALKANES AND ARENES: NCERT SOLUTION

Which one of the following has the highest dipole moment?



Answer

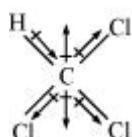
(i)



Dichlormethane (CH_2Cl_2)

$$\mu = 1.60\text{D}$$

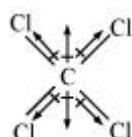
(ii)



Chloroform (CHCl_3)

$$\mu = 1.08\text{D}$$

(iii)



Carbon tetrachloride (CCl_4)

$$\mu = 0\text{D}$$

CCl_4 is a symmetrical molecule. Therefore, the dipole moments of all four C–Cl bonds cancel each other. Hence, its resultant dipole moment is zero.

As shown in the above figure, in CHCl_3 , the resultant of dipole moments of two C–Cl bonds is opposed by the resultant of dipole moments of one C–H bond and one C–Cl bond. Since the resultant of one C–H bond and one C–Cl bond dipole moments is smaller than two C–Cl

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bonds, the opposition is to a small extent. As a result, CHCl_3 has a small dipole moment of 1.08 D.

On the other hand, in case of CH_2Cl_2 , the resultant of the dipole moments of two C–Cl bonds is strengthened by the resultant of the dipole moments of two C–H bonds. As a result, CH_2Cl_2 has a higher dipole moment of 1.60 D than CHCl_3 i.e., CH_2Cl_2 has the highest dipole moment.

Hence, the given compounds can be arranged in the increasing order of their dipole moments as:



Question 10.5:

A hydrocarbon C_5H_{10} does not react with chlorine in dark but gives a single monochloro compound $\text{C}_5\text{H}_9\text{Cl}$ in bright sunlight. Identify the hydrocarbon.

Answer

A hydrocarbon with the molecular formula, C_5H_{10} belongs to the group with a general molecular formula C_nH_{2n} . Therefore, it may either be an alkene or a cycloalkane.

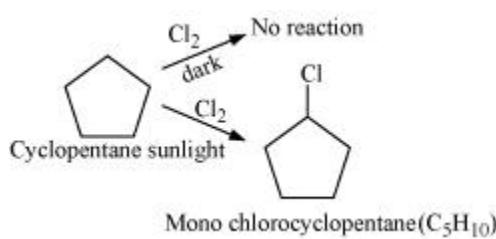
Since hydrocarbon does not react with chlorine in the dark, it cannot be an alkene. Thus, it should be a cycloalkane.

Further, the hydrocarbon gives a single monochloro compound, $\text{C}_5\text{H}_9\text{Cl}$ by reacting with chlorine in bright sunlight. Since a single monochloro compound is formed, the hydrocarbon must contain H-atoms that are all equivalent. Also, as all H-atoms of a cycloalkane are equivalent, the hydrocarbon must be a cycloalkane. Hence, the said compound is cyclopentane.



Cyclopentane (C_5H_{10})

The reactions involved in the question are:



Question 10.6:

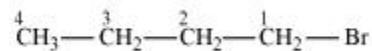
Write the isomers of the compound having formula $\text{C}_4\text{H}_9\text{Br}$.

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Answer

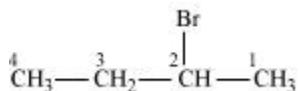
There are four isomers of the compound having the formula C₄H₉Br. These isomers are given below.

(a)



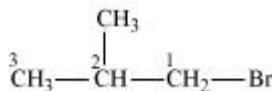
1-Bromobutane

(b)



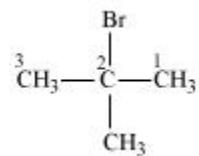
2-Bromobutane

(c)



1-Bromo-2-methylpropane

(d)



2-Bromo-2-methylpropane

Question 10.7:

Write the equations for the preparation of 1-iodobutane from

(i) 1-butanol

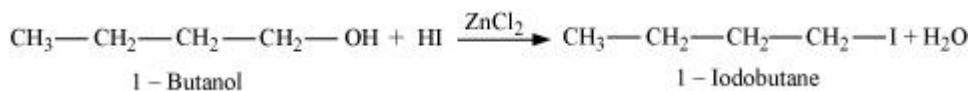
(ii) 1-chlorobutane

(iii) but-1-ene.

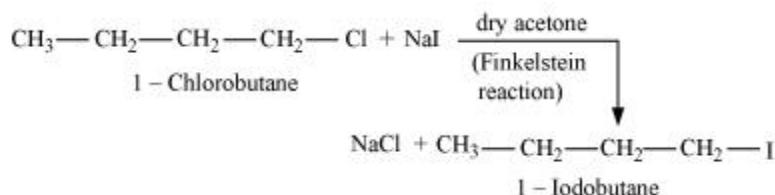
Answer

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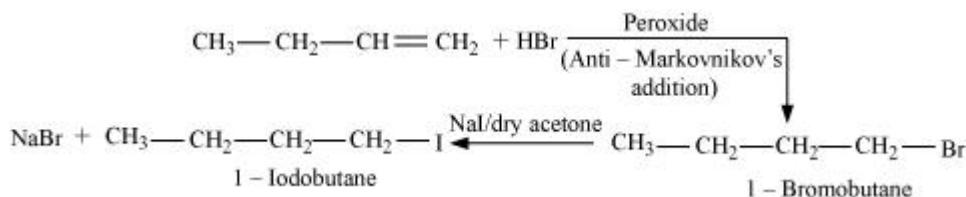
(i)



(ii)



(iii)



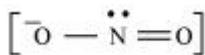
Question 10.8:

What are ambident nucleophiles? Explain with an example.

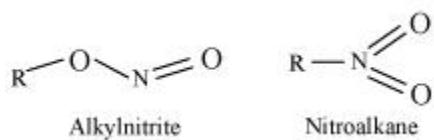
Answer

Ambident nucleophiles are nucleophiles having two nucleophilic sites. Thus, ambident nucleophiles have two sites through which they can attack.

For example, nitrite ion is an ambident nucleophile.



Nitrite ion can attack through oxygen resulting in the formation of alkyl nitrites. Also, it can attack through nitrogen resulting in the formation of nitroalkanes.



Question 10.9:

Which compound in each of the following pairs will react faster in S_N2 reaction with OH^- ?

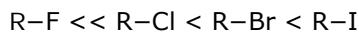
HALOALKANES AND ARENES: NCERT SOLUTION

(i) CH_3Br or CH_3I

(ii) $(\text{CH}_3)_3\text{CCl}$ or CH_3Cl

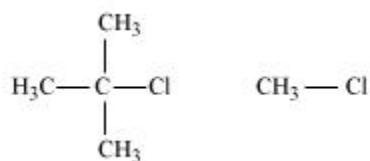
Answer

(i) In the S_N2 mechanism, the reactivity of halides for the same alkyl group increases in the order. This happens because as the size increases, the halide ion becomes a better leaving group.



Therefore, CH_3I will react faster than CH_3Br in S_N2 reactions with OH^- .

(ii)



The S_N2 mechanism involves the attack of the nucleophile at the atom bearing the leaving group. But, in case of $(\text{CH}_3)_3\text{CCl}$, the attack of the nucleophile at the carbon atom is hindered because of the presence of bulky substituents on that carbon atom bearing the leaving group. On the other hand, there are no bulky substituents on the carbon atom bearing the leaving group in CH_3Cl . Hence, CH_3Cl reacts faster than $(\text{CH}_3)_3\text{CCl}$ in S_N2 reaction with OH^- .

Question 10.10:

Predict all the alkenes that would be formed by dehydrohalogenation of the following halides with sodium ethoxide in ethanol and identify the major alkene:

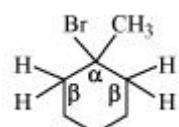
(i) 1-Bromo-1-methylcyclohexane

(ii) 2-Chloro-2-methylbutane

(iii) 2,2,3-Trimethyl-3-bromopentane.

Answer

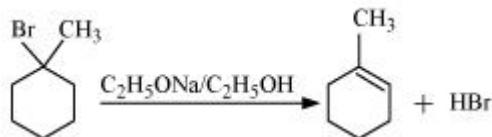
(i)



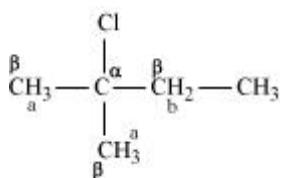
HALOALKANES AND ARENES: NCERT SOLUTION

1-bromo-1-methylcyclohexane

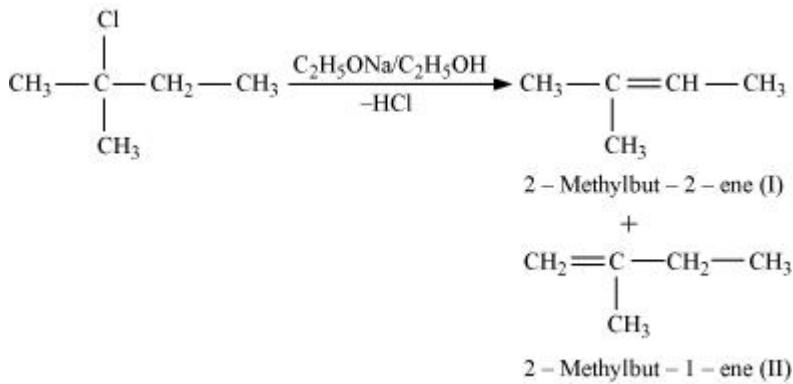
In the given compound, all β -hydrogen atoms are equivalent. Thus, dehydrohalogenation of this compound gives only one alkene.



(ii)



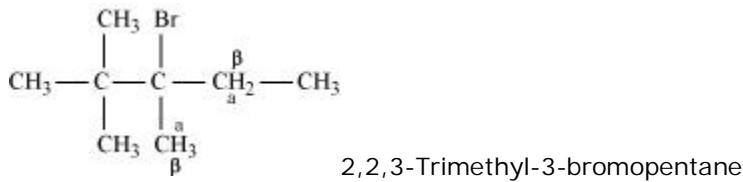
In the given compound, there are two different sets of equivalent β -hydrogen atoms labelled as *a* and *b*. Thus, dehydrohalogenation of the compound yields two alkenes.



Saytzeff's rule implies that in dehydrohalogenation reactions, the alkene having a greater number of alkyl groups attached to a doubly bonded carbon atoms is preferably produced.

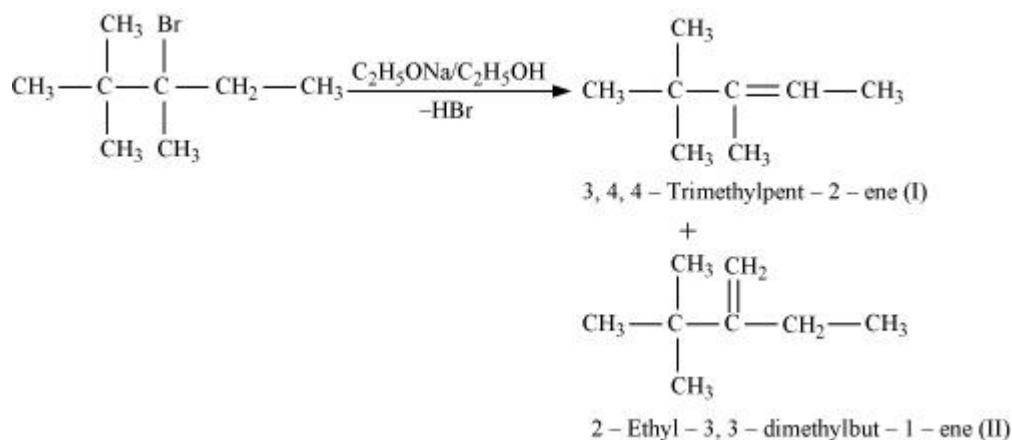
Therefore, alkene (I) i.e., 2-methylbut-2-ene is the major product in this reaction.

(iii)



In the given compound, there are two different sets of equivalent β -hydrogen atoms labelled as *a* and *b*. Thus, dehydrohalogenation of the compound yields two alkenes.

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According to Saytzeff's rule, in dehydrohalogenation reactions, the alkene having a greater number of alkyl groups attached to the doubly bonded carbon atom is preferably formed.

Hence, alkene (I) i.e., 3,4,4-trimethylpent-2-ene is the major product in this reaction

Question 10.11:

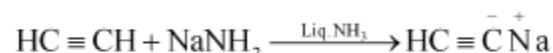
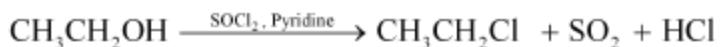
How will you bring about the following conversions?

- (i) Ethanol to but-1-yne
- (ii) Ethane to bromoethene
- (iii) Propene to 1-nitropropane
- (iv) Toluene to benzyl alcohol
- (v) Propene to propyne
- (vi) Ethanol to ethyl fluoride
- (vii) Bromomethane to propanone
- (viii) But-1-ene to but-2-ene
- (ix) 1-Chlorobutane to n-octane
- (x) Benzene to biphenyl.

Answer

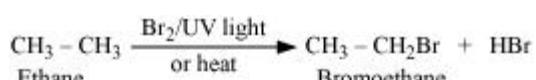
- (i)

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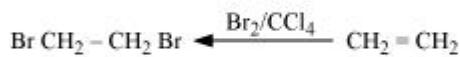


Chloroethane But-1-yne

(ii)



- HBr KOH(alc), Δ



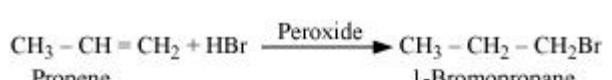
vic-Dibromide

Ethene

Δ | KOH(alc)

1

(iii)



Propene

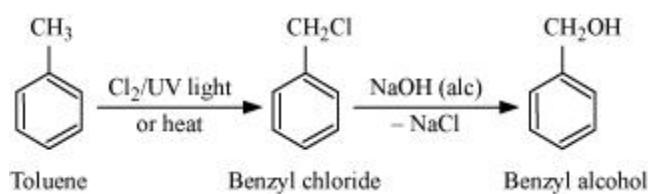
1-Bromopropane

AgNO₃



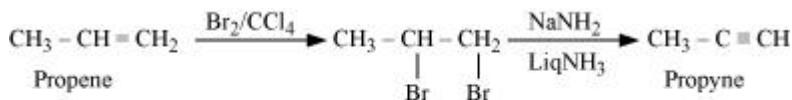
1-Nitronpropane

(iv)



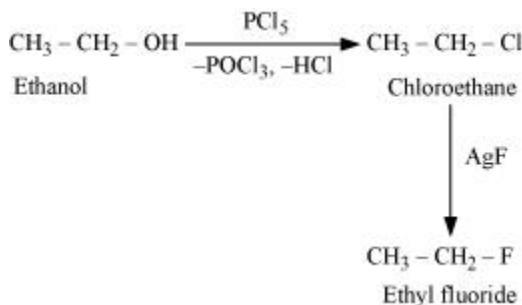
(v)

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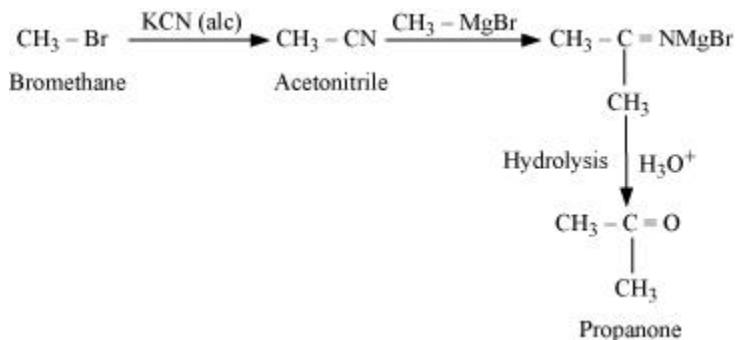


1, 2-Dibromopropane

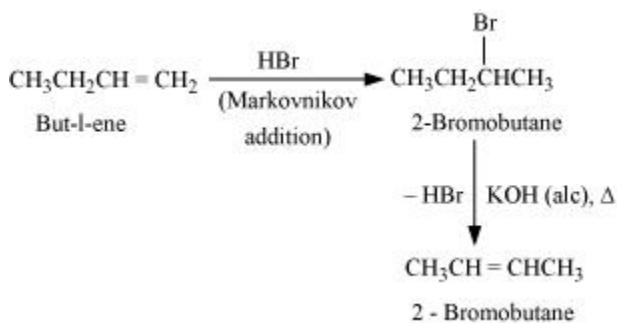
(vi)



(vii)



(viii)

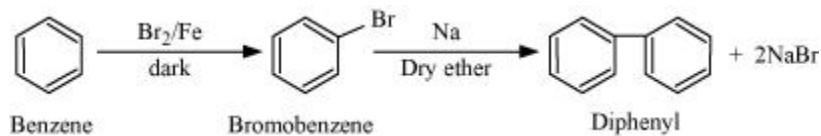


(ix)



(x)

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Question 10.12:

Explain why

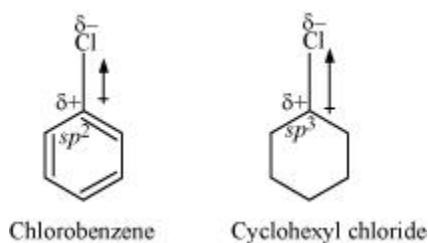
(i) the dipole moment of chlorobenzene is lower than that of cyclohexyl chloride?

(ii) alkyl halides, though polar, are immiscible with water?

(iii) Grignard reagents should be prepared under anhydrous conditions?

Answer

(i)



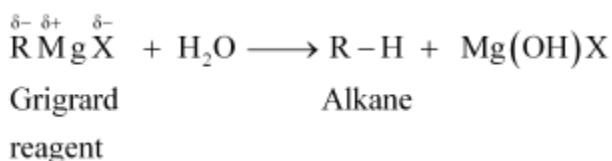
In chlorobenzene, the Cl-atom is linked to a sp^2 hybridized carbon atom. In cyclohexyl chloride, the Cl-atom is linked to a sp^3 hybridized carbon atom. Now, sp^2 hybridized carbon has more s-character than sp^3 hybridized carbon atom. Therefore, the former is more electronegative than the latter. Therefore, the density of electrons of C-Cl bond near the Cl-atom is less in chlorobenzene than in cyclohexyl chloride.

Moreover, the $-R$ effect of the benzene ring of chlorobenzene decreases the electron density of the C-Cl bond near the Cl-atom. As a result, the polarity of the C-Cl bond in chlorobenzene decreases. Hence, the dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.

(ii) To be miscible with water, the solute-water force of attraction must be stronger than the solute-solute and water-water forces of attraction. Alkyl halides are polar molecules and so held together by dipole-dipole interactions. Similarly, strong H-bonds exist between the water molecules. The new force of attraction between the alkyl halide and water molecules is weaker than the alkyl halide-alkyl halide and water-water forces of attraction. Hence, alkyl halides (though polar) are immiscible with water.

(iii) Grignard reagents are very reactive. In the presence of moisture, they react to give alkanes.

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Therefore, Grignard reagents should be prepared under anhydrous conditions

Question 10.13:

Give the uses of freon 12, DDT, carbon tetrachloride and iodoform.

Answer

Uses of Freon – 12

Freon-12 (dichlorodifluoromethane, CF_2Cl_2) is commonly known as CFC. It is used as a refrigerant in refrigerators and air conditioners. It is also used in aerosol spray propellants such as body sprays, hair sprays, etc. However, it damages the ozone layer. Hence, its manufacture was banned in the United States and many other countries in 1994.

Uses of DDT

DDT (*p, p*-dichlorodiphenyltrichloroethane) is one of the best known insecticides. It is very effective against mosquitoes and lice. But due to its harmful effects, it was banned in the United States in 1973.

Uses of carbontetrachloride (CCl_4)

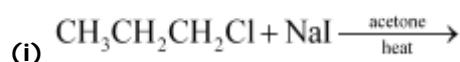
- (i) It is used for manufacturing refrigerants and propellants for aerosol cans.
- (ii) It is used as feedstock in the synthesis of chlorofluorocarbons and other chemicals.
- (iii) It is used as a solvent in the manufacture of pharmaceutical products.
- (iv) Until the mid 1960's, carbon tetrachloride was widely used as a cleaning fluid, a degreasing agent in industries, a spot remover in homes, and a fire extinguisher.

Uses of iodoform (CHI_3)

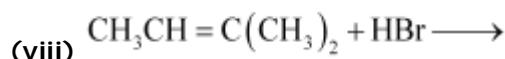
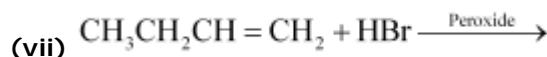
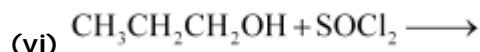
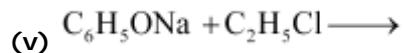
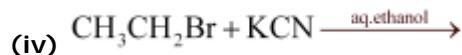
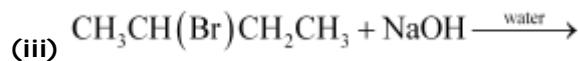
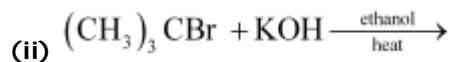
Iodoform was used earlier as an antiseptic, but now it has been replaced by other formulations-containing iodine-due to its objectionable smell. The antiseptic property of iodoform is only due to the liberation of free iodine when it comes in contact with the skin

Question 10.14:

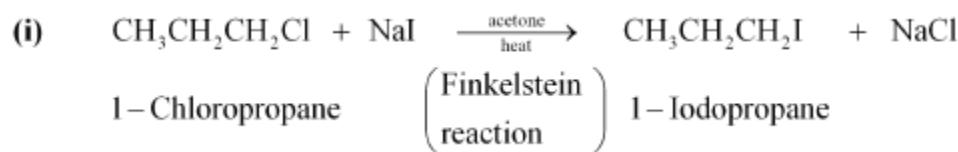
Write the structure of the major organic product in each of the following reactions:



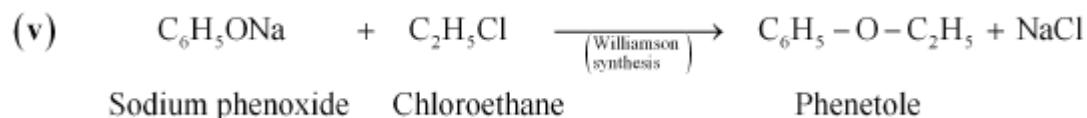
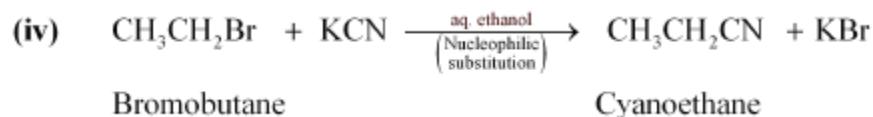
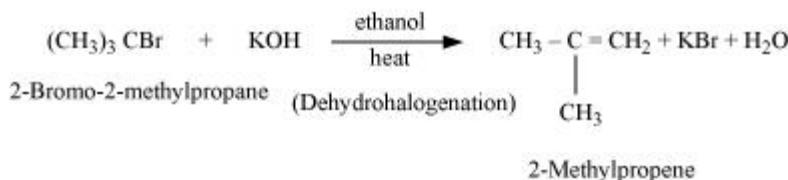
HALOALKANES AND ARENES: NCERT SOLUTION



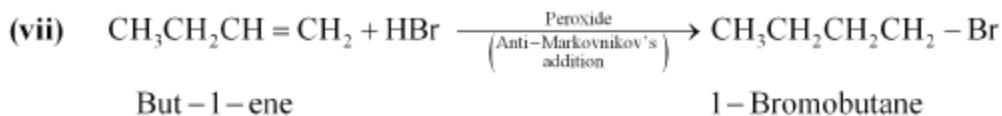
Answer



(ii)



HALOALKANES AND ARENES: NCERT SOLUTION



(viii)



Question 10.15:

Write the mechanism of the following reaction:



Answer

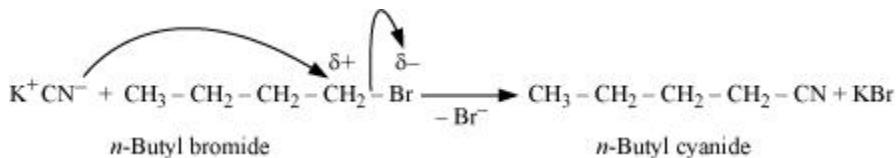
Discussion

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The given reaction is:



The given reaction is an S_N2 reaction. In this reaction, CN^- acts as the nucleophile and attacks the carbon atom to which Br is attached. CN^- ion is an ambident nucleophile and can attack through both C and N. In this case, it attacks through the C-atom.



Question 10.16:

Arrange the compounds of each set in order of reactivity towards S_N2 displacement:

(i) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane

(ii) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 3-Bromo-2-methylbutane

HALOALKANES AND ARENES: NCERT SOLUTION

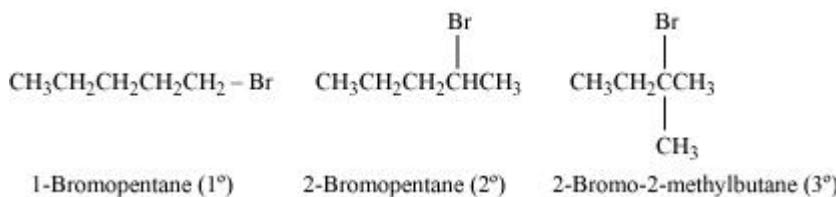
(iii) 1-Bromobutane, 1-Bromo-2,2-dimethylpropane, 1-Bromo-2-methylbutane, 1-Bromo-3-methylbutane.

Answer

Discussion

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(i)



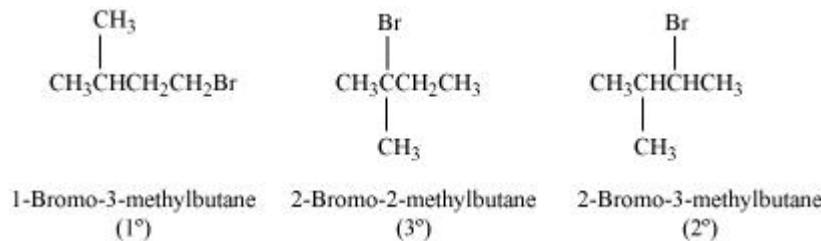
An S_N2 reaction involves the approaching of the nucleophile to the carbon atom to which the leaving group is attached. When the nucleophile is sterically hindered, then the reactivity towards S_N2 displacement decreases. Due to the presence of substituents, hindrance to the approaching nucleophile increases in the following order.

1-Bromopentane < 2-bromopentane < 2-Bromo-2-methylbutane

Hence, the increasing order of reactivity towards S_N2 displacement is:

2-Bromo-2-methylbutane < 2-Bromopentane < 1-Bromopentane

(ii)



Since steric hindrance in alkyl halides increases in the order of $1^\circ < 2^\circ < 3^\circ$, the increasing order of reactivity towards S_N2 displacement is

$3^\circ < 2^\circ < 1^\circ$.

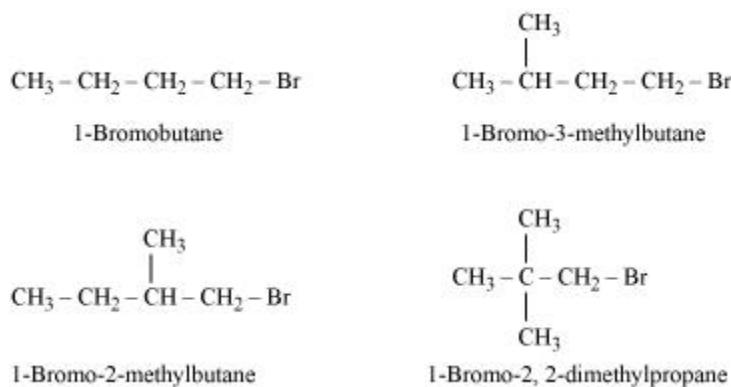
Hence, the given set of compounds can be arranged in the increasing order of their reactivity towards S_N2 displacement as:

2-Bromo-2-methylbutane < 2-Bromo-3-methylbutane < 1-Bromo-3-methylbutane

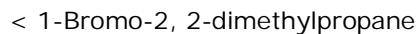
[2-Bromo-3-methylbutane is incorrectly given in NCERT]

(iii)

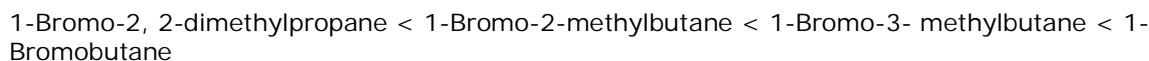
HALOALKANES AND ARENES: NCERT SOLUTION



The steric hindrance to the nucleophile in the S_N2 mechanism increases with a decrease in the distance of the substituents from the atom containing the leaving group. Further, the steric hindrance increases with an increase in the number of substituents. Therefore, the increasing order of steric hindrances in the given compounds is as below:



Hence, the increasing order of reactivity of the given compounds towards S_N2 displacement is:



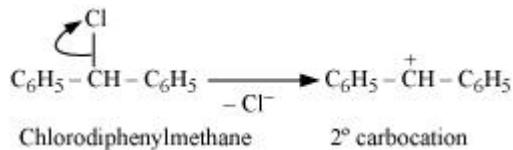
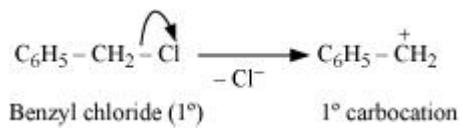
Question 10.17:

Out of $C_6H_5CH_2Cl$ and $C_6H_5CHClC_6H_5$, which is more easily hydrolysed by aqueous KOH?

Answer

Discussion

Share



Hydrolysis by aqueous KOH proceeds through the formation of carbocation. If carbocation is stable, then the compound is easily hydrolyzed by aqueous KOH. Now, $C_6H_5CH_2Cl$ forms 1° -carbocation, while $C_6H_5CHClC_6H_5$ forms 2° -carbocation, which is more stable than 1° -carbocation. Hence, $C_6H_5CHClC_6H_5$ is hydrolyzed more easily than $C_6H_5CH_2Cl$ by aqueous KOH.

HALOALKANES AND ARENES: NCERT SOLUTION

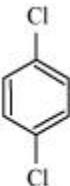
Question 10.18:

p-Dichlorobenzene has higher m.p. and lower solubility than those of *o*- and *m*-isomers. Discuss.

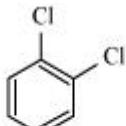
Answer

Discussion

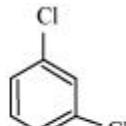
Share



p-Dichlorobenzene



o-Dichlorobenzene



m-Dichlorobenzene

p-Dichlorobenzene is more symmetrical than *o*-and *m*-isomers. For this reason, it fits more closely than *o*-and *m*-isomers in the crystal lattice. Therefore, more energy is required to break the crystal lattice of *p*-dichlorobenzene. As a result, *p*-dichlorobenzene has a higher melting point and lower solubility than *o*-and *m*-isomers

Question 10.19:

How the following conversions can be carried out?

(i) Propene to propan-1-ol

(ii) Ethanol to but-1-yne

(iii) 1-Bromopropane to 2-bromopropane

(iv) Toluene to benzyl alcohol

(v) Benzene to 4-bromonitrobenzene

(vi) Benzyl alcohol to 2-phenylethanoic acid

(vii) Ethanol to propanenitrile

(viii) Aniline to chlorobenzene

(ix) 2-Chlorobutane to 3, 4-dimethylhexane

(x) 2-Methyl-1-propene to 2-chloro-2-methylpropane

HALOALKANES AND ARENES: NCERT SOLUTION

(xi) Ethyl chloride to propanoic acid

(xii) But-1-ene to n-butyliodide

(xiii) 2-Chloropropane to 1-propanol

(xiv) Isopropyl alcohol to iodoform

(xv) Chlorobenzene to *p*-nitrophenol

(xvi) 2-Bromopropane to 1-bromopropane

(xvii) Chloroethane to butane

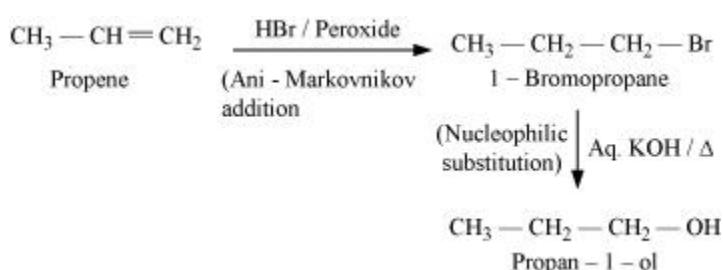
(xviii) Benzene to diphenyl

(xix) *tert*-Butyl bromide to isobutyl bromide

(xx) Aniline to phenylisocyanide

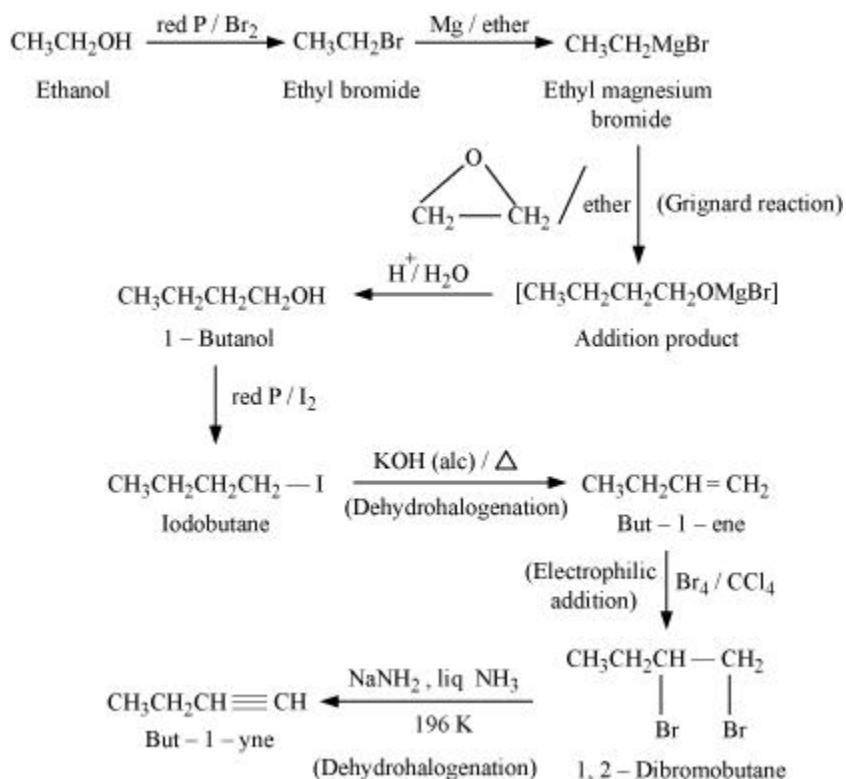
Answer

(i)

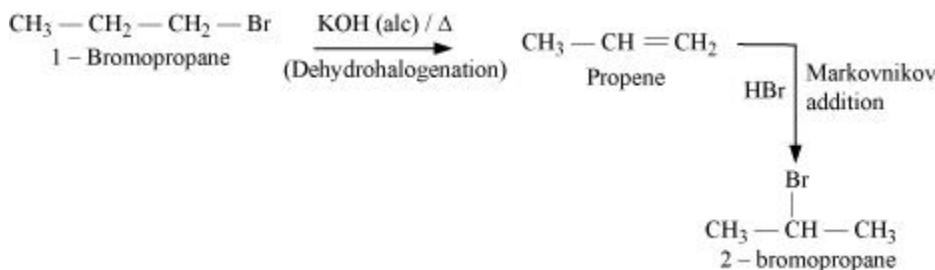


(ii)

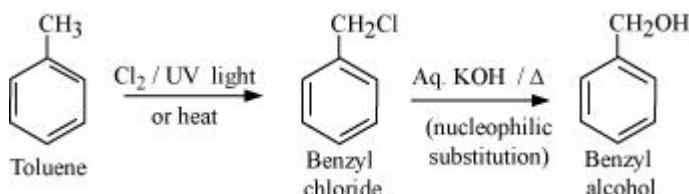
HALOALKANES AND ARENES: NCERT SOLUTION



(iii)

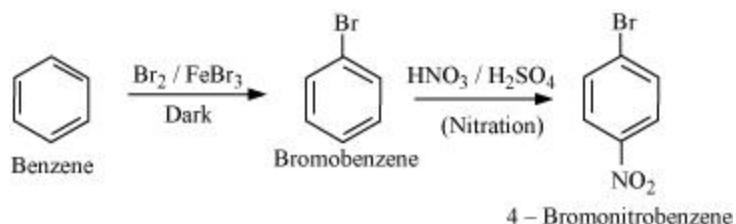


(iv)

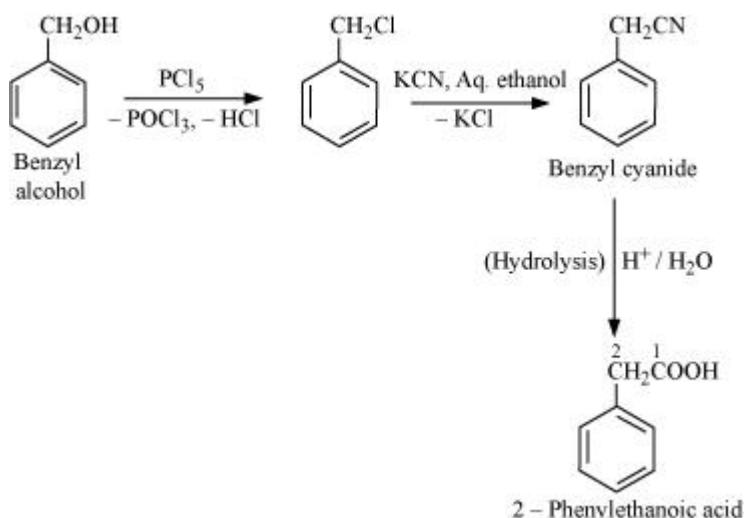


(v)

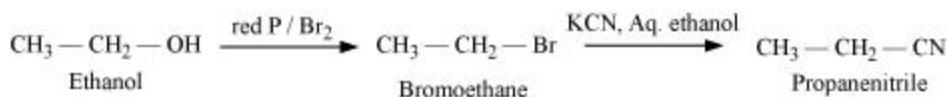
HALOALKANES AND ARENES: NCERT SOLUTION



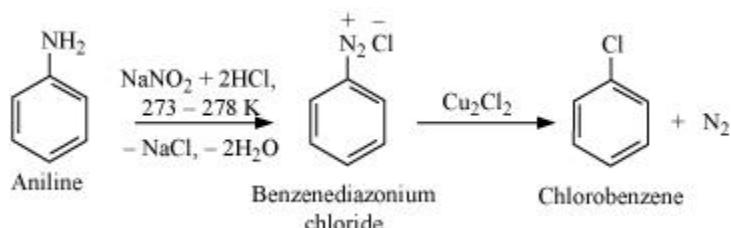
(vi)



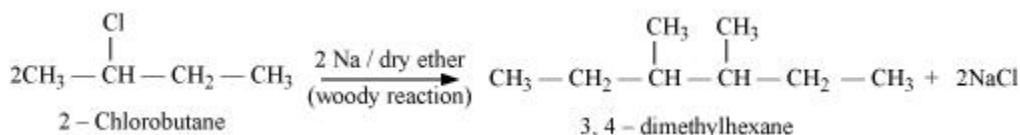
(vii)



(viii)



(ix)

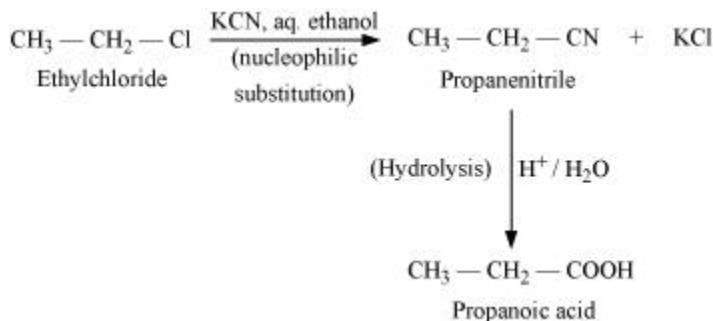


(x)

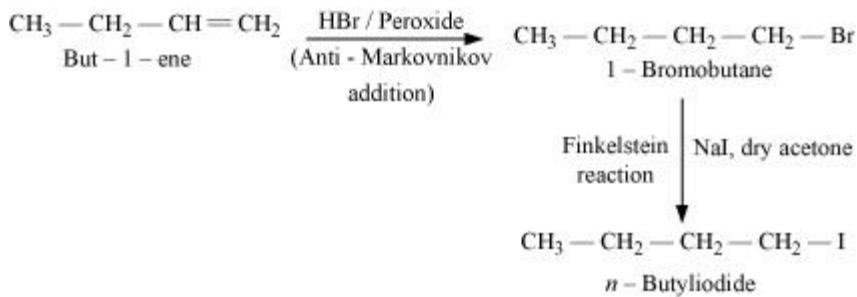
HALOALKANES AND ARENES: NCERT SOLUTION



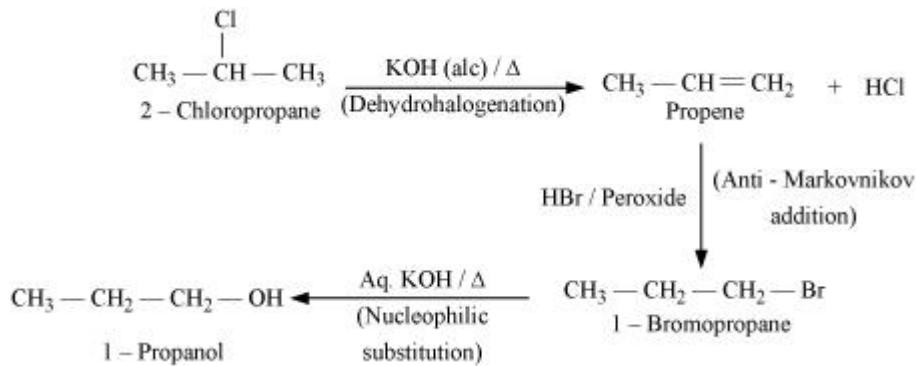
(xi)



(xii)

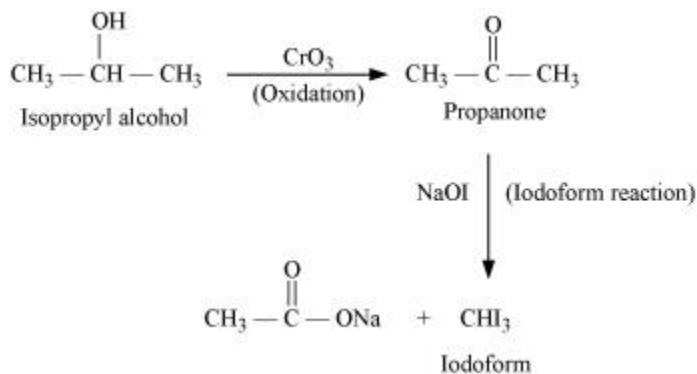


(xiii)

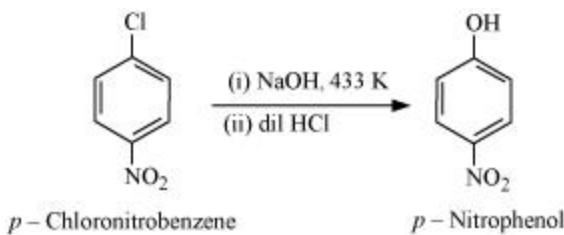
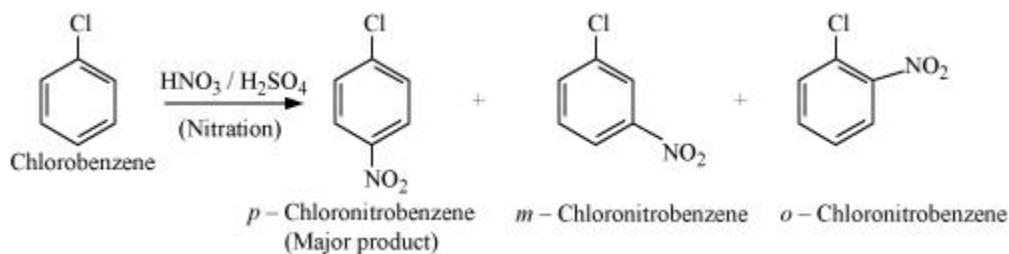


(xiv)

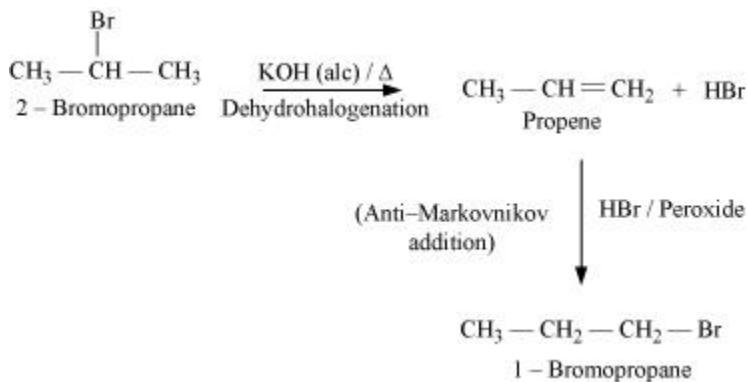
HALOALKANES AND ARENES: NCERT SOLUTION



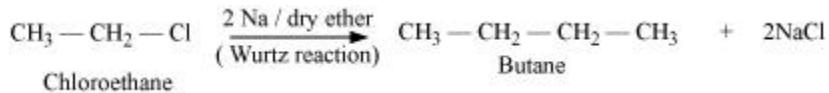
(xv)



(xvi)

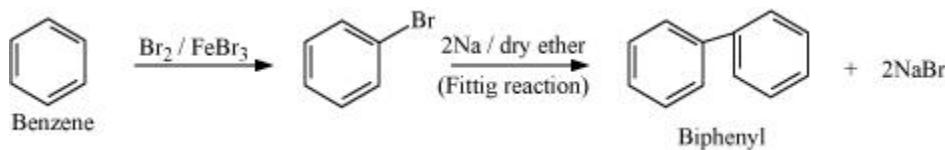


(xvii)

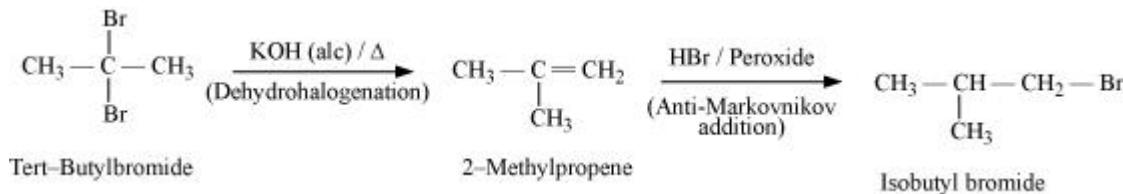


HALOALKANES AND ARENES: NCERT SOLUTION

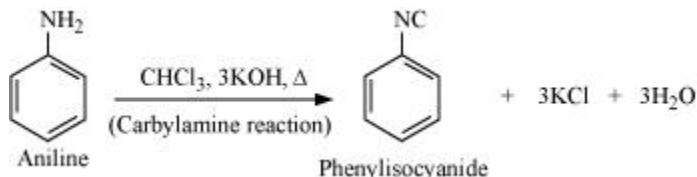
(xviii)



(xix)



(xx)



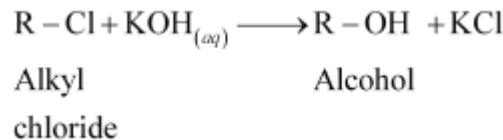
Question 10.20:

The treatment of alkyl chlorides with aqueous KOH leads to the formation of

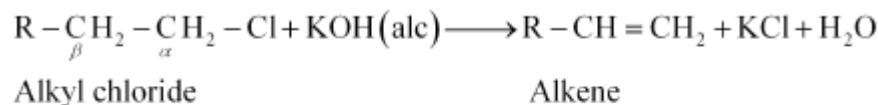
alcohols but in the presence of alcoholic KOH, alkenes are major products. Explain.

Answer

In an aqueous solution, KOH almost completely ionizes to give OH⁻ ions. OH⁻ ion is a strong nucleophile, which leads the alkyl chloride to undergo a substitution reaction to form alcohol.



On the other hand, an alcoholic solution of KOH contains alkoxide (RO⁻) ion, which is a strong base. Thus, it can abstract a hydrogen from the β-carbon of the alkyl chloride and form an alkene by eliminating a molecule of HCl.



HALOALKANES AND ARENES: NCERT SOLUTION

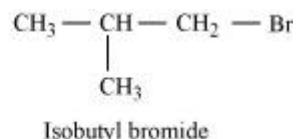
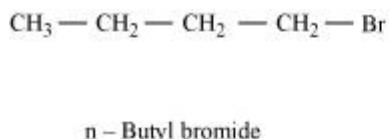
OH^- ion is a much weaker base than RO^- ion. Also, OH^- ion is highly solvated in an aqueous solution and as a result, the basic character of OH^- ion decreases. Therefore, it cannot abstract a hydrogen from the β -carbon.

Question 10.21:

Primary alkyl halide $\text{C}_4\text{H}_9\text{Br}$ (a) reacted with alcoholic KOH to give compound (b). Compound (b) is reacted with HBr to give (c) which is an isomer of (a). When (a) is reacted with sodium metal it gives compound (d), C_8H_{18} which is different from the compound formed when n-butyl bromide is reacted with sodium. Give the structural formula of (a) and write the equations for all the reactions.

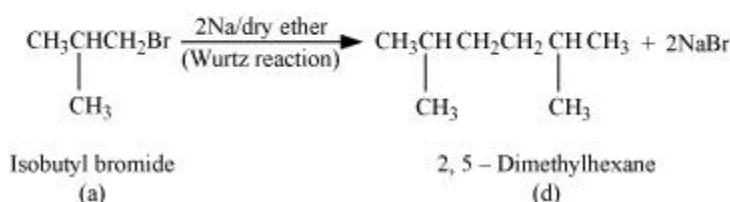
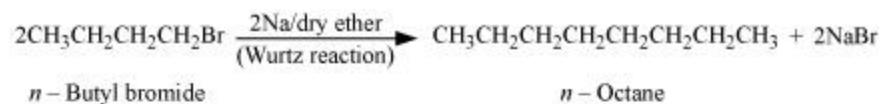
Answer

There are two primary alkyl halides having the formula, $\text{C}_4\text{H}_9\text{Br}$. They are *n* – butyl bromide and isobutyl bromide.



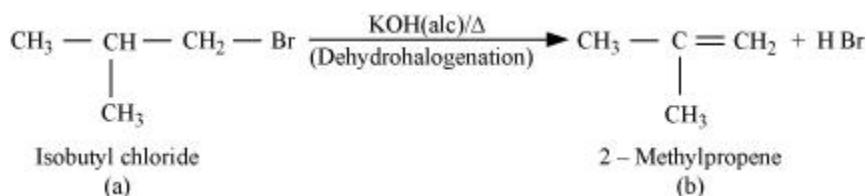
Therefore, compound (a) is either *n*–butyl bromide or isobutyl bromide.

Now, compound (a) reacts with Na metal to give compound (b) of molecular formula, C_8H_{18} , which is different from the compound formed when *n*–butyl bromide reacts with Na metal. Hence, compound (a) must be isobutyl bromide.



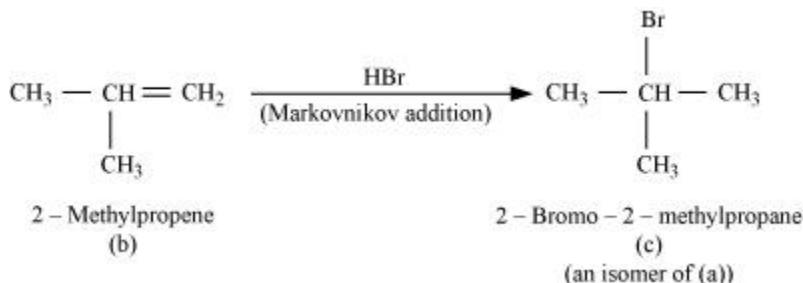
Thus, compound (d) is 2, 5–dimethylhexane.

It is given that compound (a) reacts with alcoholic KOH to give compound (b). Hence, compound (b) is 2–methylpropene.



HALOALKANES AND ARENES: NCERT SOLUTION

Also, compound (b) reacts with HBr to give compound (c) which is an isomer of (a). Hence, compound (c) is 2-bromo-2-methylpropane.



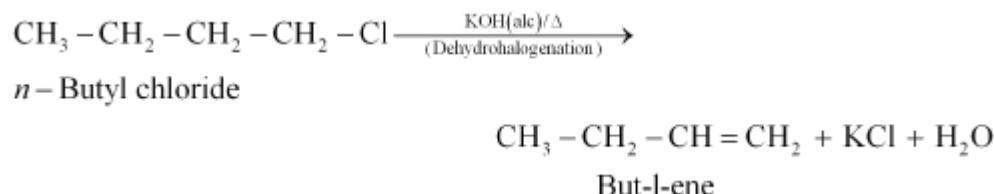
Question 10.22:

What happens when

- (i) n-butyl chloride is treated with alcoholic KOH,
- (ii) bromobenzene is treated with Mg in the presence of dry ether,
- (iii) chlorobenzene is subjected to hydrolysis,
- (iv) ethyl chloride is treated with aqueous KOH,
- (v) methyl bromide is treated with sodium in the presence of dry ether,
- (vi) methyl chloride is treated with KCN.

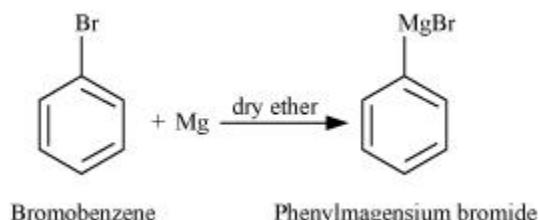
Answer

- (i) When n-butyl chloride is treated with alcoholic KOH, the formation of but-1-ene takes place. This reaction is a dehydrohalogenation reaction.

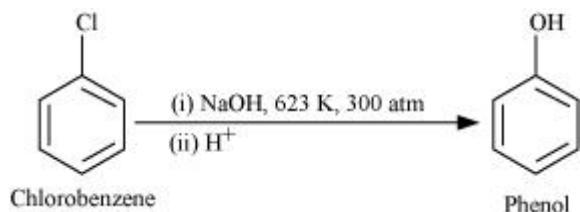


- (ii) When bromobenzene is treated with Mg in the presence of dry ether, phenylmagnesium bromide is formed.

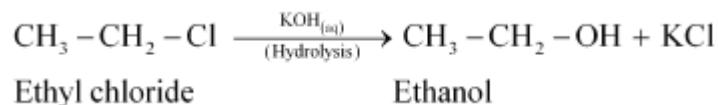
HALOALKANES AND ARENES: NCERT SOLUTION



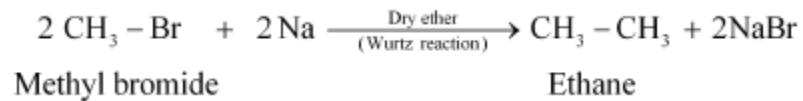
(iii) Chlorobenzene does not undergo hydrolysis under normal conditions. However, it undergoes hydrolysis when heated in an aqueous sodium hydroxide solution at a temperature of 623 K and a pressure of 300 atm to form phenol.



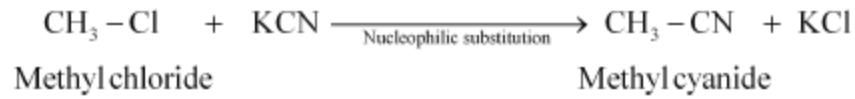
(iv) When ethyl chloride is treated with aqueous KOH, it undergoes hydrolysis to form ethanol.



(v) When methyl bromide is treated with sodium in the presence of dry ether, ethane is formed. This reaction is known as the Wurtz reaction.



(vi) When methyl chloride is treated with KCN, it undergoes a substitution reaction to give methyl cyanide.



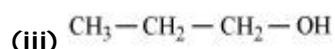
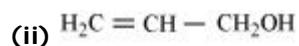
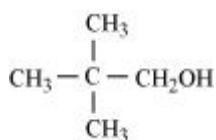
ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

ALCOHOLS AND PHENOLS

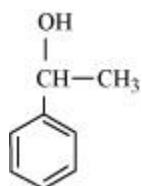
Question 11.1:

Classify the following as primary, secondary and tertiary alcohols:

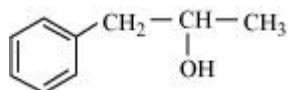
(i)



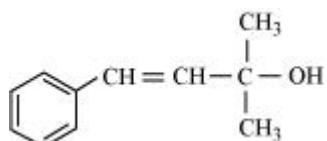
(iv)



(v)



(vi)



Answer

Primary alcohol → (i), (ii), (iii)

Secondary alcohol → (iv), (v)

Tertiary alcohol → (vi)

Question 11.2:

ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

Identify allylic alcohols in the above examples.

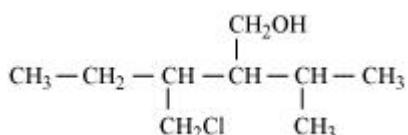
Answer

The alcohols given in (ii) and (vi) are allylic alcohols

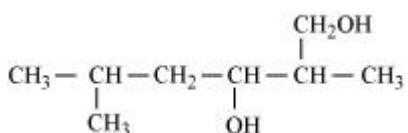
Question 11.3:

Name the following compounds according to IUPAC system.

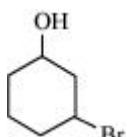
(i)



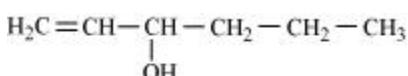
(ii)



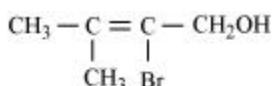
(iii)



(iv)



(v)



Answer

(i) 3-Chloromethyl-2-isopropylpentan-1-ol

(ii) 2, 5-Dimethylhexane-1, 3-diol

ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

(iii) 3-Bromocyclohexanol

(iv) Hex-1-en-3-ol

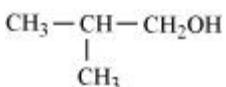
(v) 2-Bromo-3-methylbut-2-en-1-ol

Question 11.4:

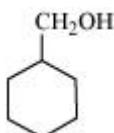
Show how are the following alcohols prepared by the reaction of a suitable

Grignard reagent on methanal?

(i)

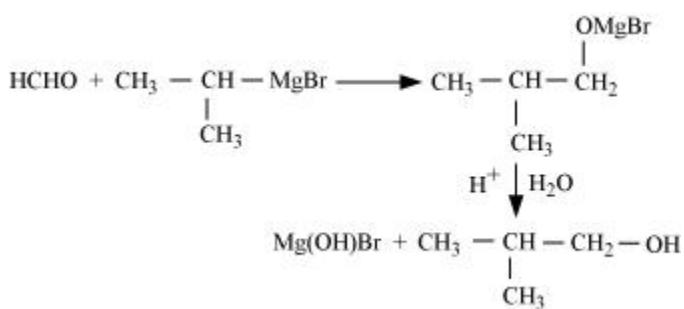


(ii)

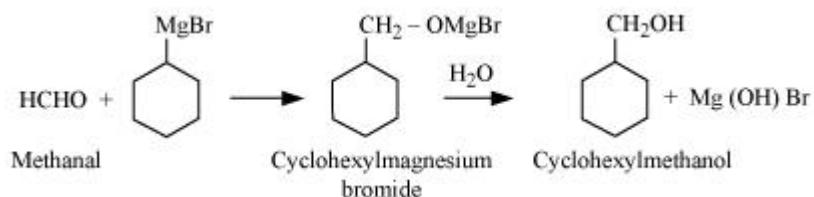


Answer

(i)



(ii)

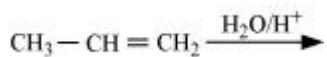


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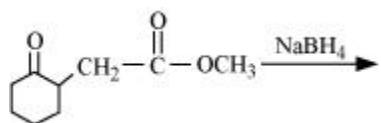
Question 11.5:

Write structures of the products of the following reactions:

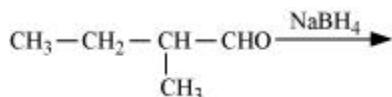
(i)



(ii)

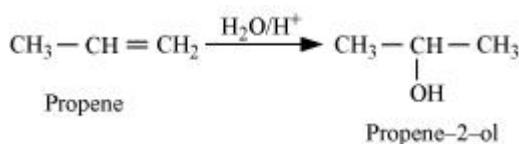


(iii)

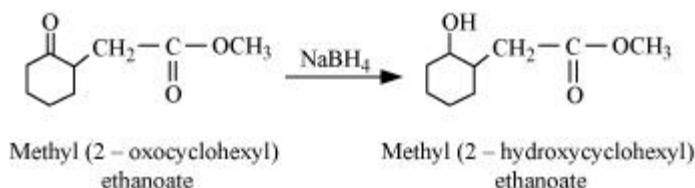


Answer

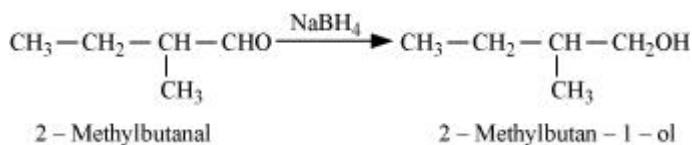
(i)



(ii)



(iii)



Question 11.6:

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Give structures of the products you would expect when each of the following alcohol reacts with (a) HCl-ZnCl₂ (b) HBr and (c) SOCl₂.

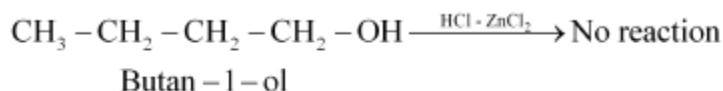
(i) Butan-1-ol

(ii) 2-Methylbutan-2-ol

Answer

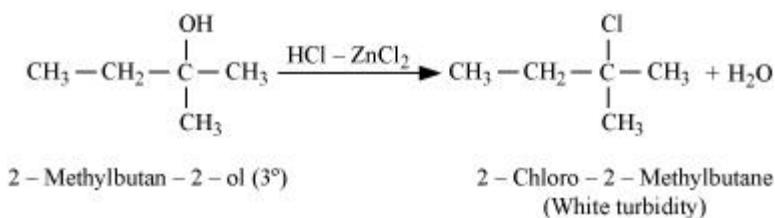
(a)

(i)



Primary alcohols do not react appreciably with Lucas' reagent (HCl-ZnCl₂) at room temperature.

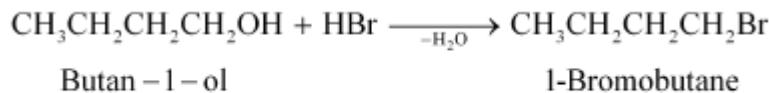
(ii)



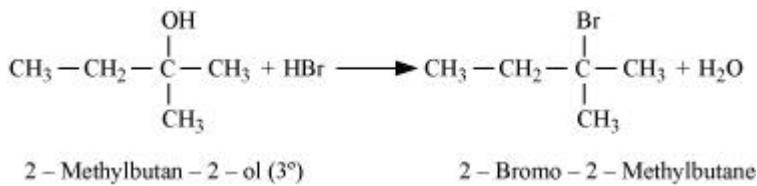
Tertiary alcohols react immediately with Lucas' reagent.

(b)

(i)



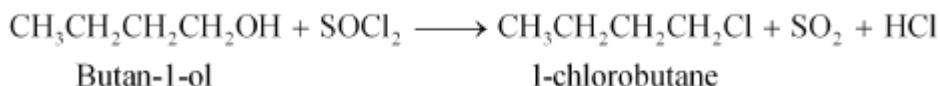
(ii)



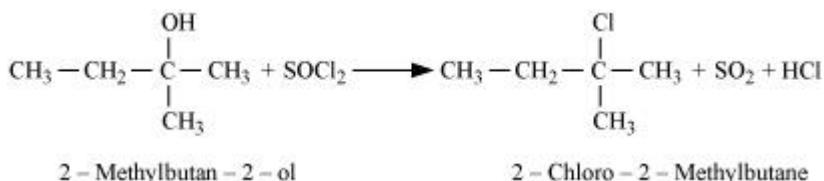
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(c)

(i)



(ii)



Question 11.7:

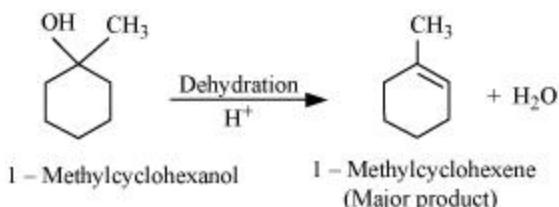
Predict the major product of acid catalysed dehydration of

(i) 1-methylcyclohexanol and

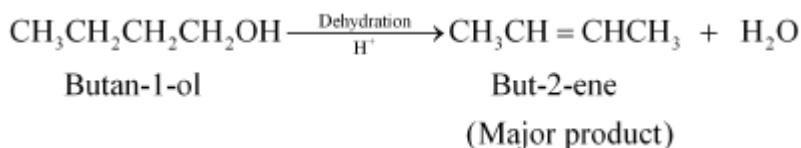
(ii) butan-1-ol

Answer

i.



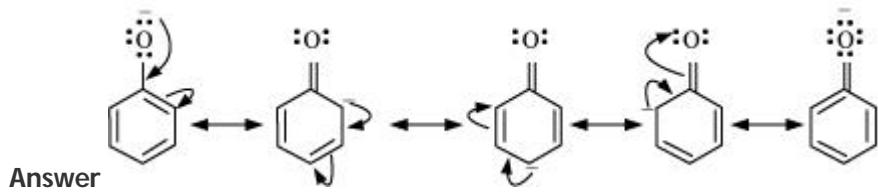
(ii)



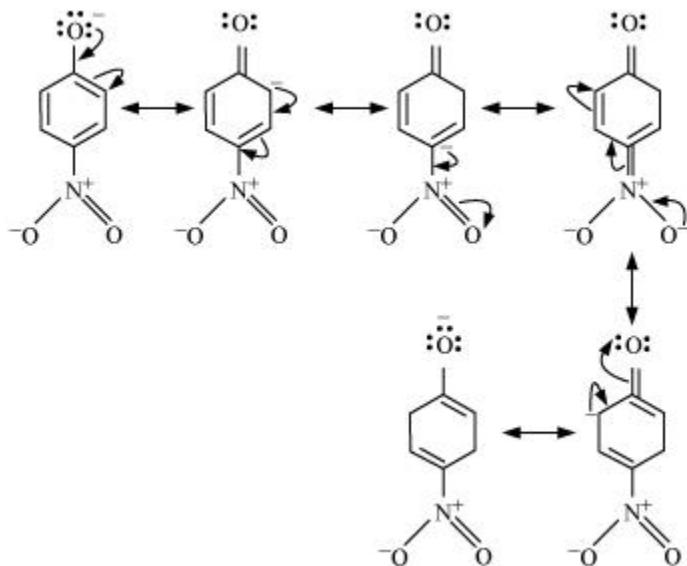
Question 11.8:

Ortho and *para* nitrophenols are more acidic than phenol. Draw the resonance structures of the corresponding phenoxide ions.

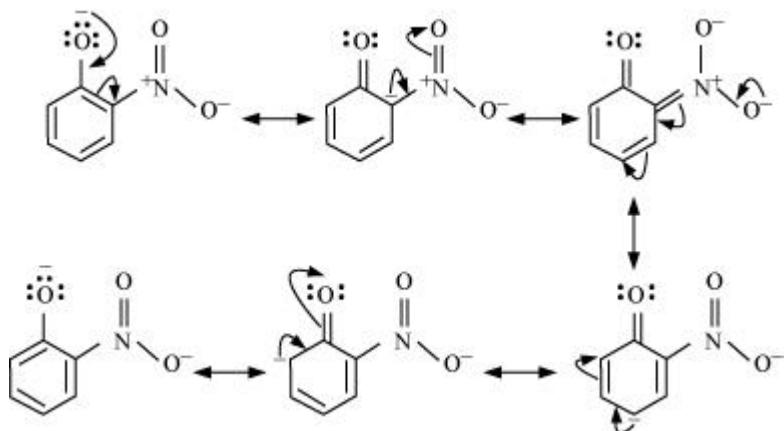
ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION



Resonance structure of the phenoxide ion



Resonance structures of *p*-nitrophenoxide ion



Resonance structures of *m*-nitrophenoxide ion

It can be observed that the presence of nitro groups increases the stability of phenoxide ion

Question 11.9:

Write the equations involved in the following reactions:

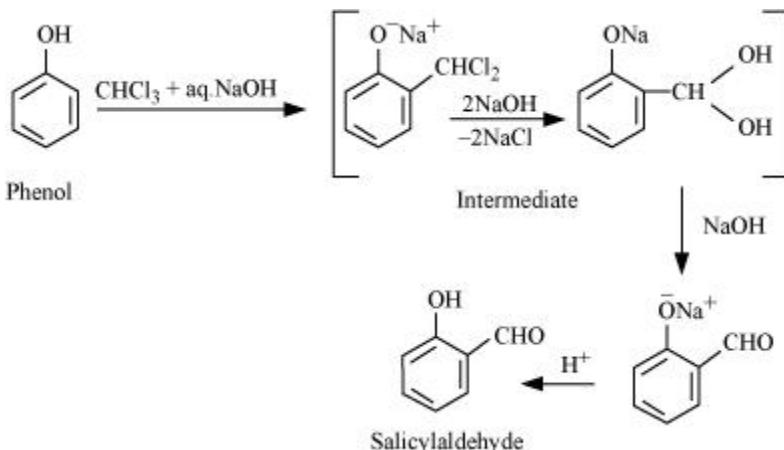
ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

(i) Reimer-Tiemann reaction

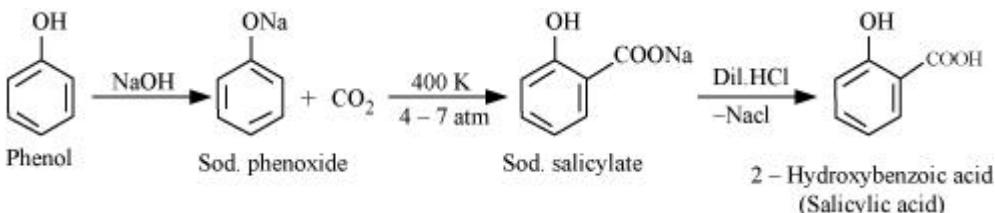
(ii) Kolbe's reaction

Answer

i. **Reimer-Tiemann reaction**



ii. **Kolbe's reaction**

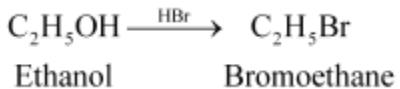


Question 11.10:

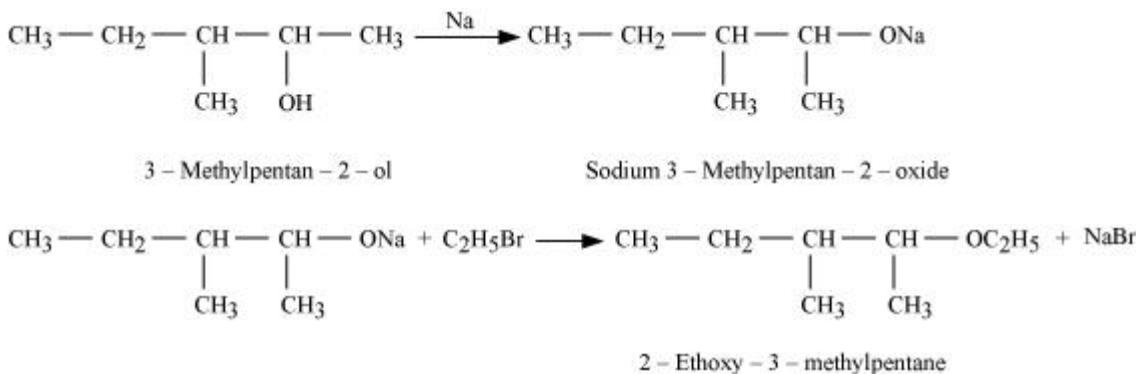
Write the reactions of Williamson synthesis of 2-ethoxy-3-methylpentane starting from ethanol and 3-methylpentan-2-ol.

Answer

In Williamson synthesis, an alkyl halide reacts with an alkoxide ion. Also, it is an S_N2 reaction. In the reaction, alkyl halides should be primary having the least steric hindrance. Hence, an alkyl halide is obtained from ethanol and alkoxide ion from 3-methylpentan-2-ol.



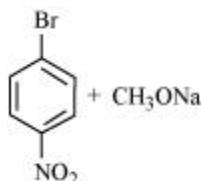
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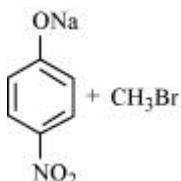
Question 11.11:

Which of the following is an appropriate set of reactants for the preparation of 1-methoxy-4-nitrobenzene and why?

(i)

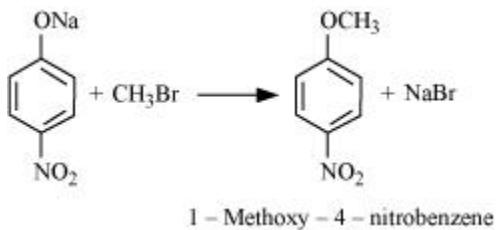


(ii)



Answer

Set (ii) is an appropriate set of reactants for the preparation of 1-methoxy-4-nitrobenzene.

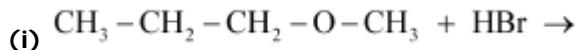


In set (i), sodium methoxide (CH_3ONa) is a strong nucleophile as well as a strong base. Hence, an elimination reaction predominates over a substitution reaction.

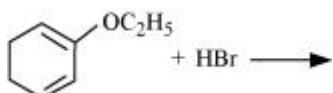
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Question 11.12:

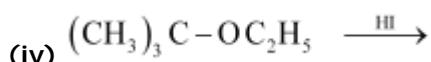
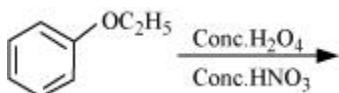
Predict the products of the following reactions:



(ii)

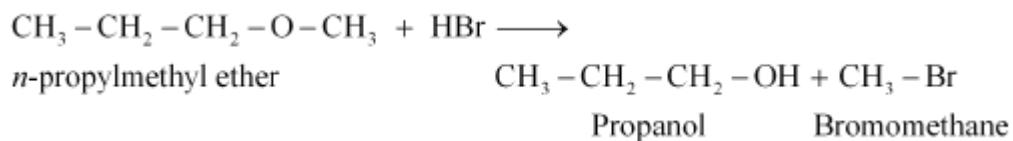


(iii)

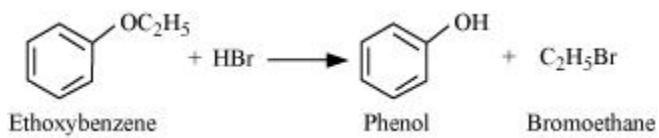


Answer

(i)



(ii)

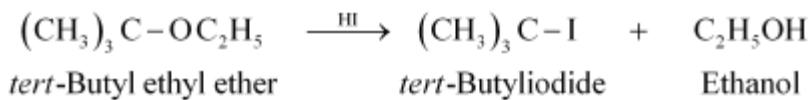


(iii)



(iv)

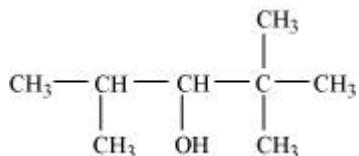
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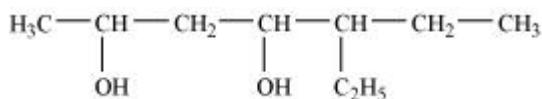
Question 11.1:

Write IUPAC names of the following compounds:

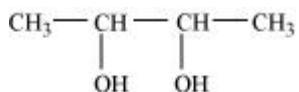
(i)



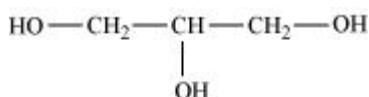
(ii)



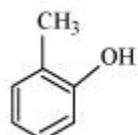
(iii)



(iv)

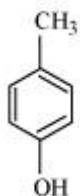


(v)

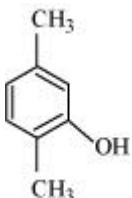


(vi)

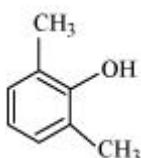
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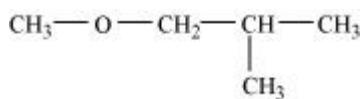
(vii)



(viii)



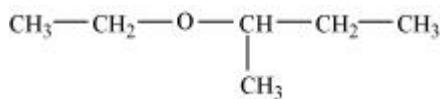
(ix)



(x) $\text{C}_6\text{H}_5 - \text{O} - \text{C}_2\text{H}_5$

(xi) $\text{C}_6\text{H}_5 - \text{O} - \text{C}_7\text{H}_{15}(\text{n}-)$

(xii)



Answer

(i) 2, 2, 4-Trimethylpentan-3-ol

(ii) 5-Ethylheptane-2, 4-diol

(iii) Butane-2, 3-diol

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- (iv)** Propane-1, 2, 3-triol
- (v)** 2-Methylphenol
- (vi)** 4-Methylphenol
- (vii)** 2, 5-Dimethylphenol
- (viii)** 2, 6-Dimethylphenol
- (ix)** 1-Methoxy-2-methylpropane
- (x)** Ethoxybenzene
- (xi)** 1-Phenoxyheptane
- (xii)** 2-Ethoxybutane

Question 11.2:

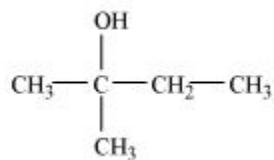
Write structures of the compounds whose IUPAC names are as follows:

- (i)** 2-Methylbutan-2-ol
- (ii)** 1-Phenylpropan-2-ol
- (iii)** 3,5-Dimethylhexane –1, 3, 5-triol
- (iv)** 2,3 – Diethylphenol
- (v)** 1 – Ethoxypropane
- (vi)** 2-Ethoxy-3-methylpentane
- (vii)** Cyclohexylmethanol
- (viii)** 3-Cyclohexylpentan-3-ol
- (ix)** Cyclopent-3-en-1-ol
- (x)** 3-Chloromethylpentan-1-ol.

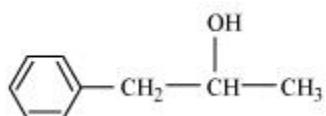
Answer

- (i)**

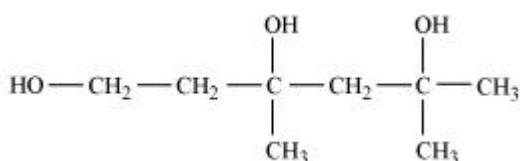
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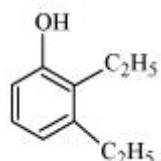
(ii)



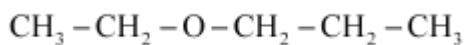
(iii)



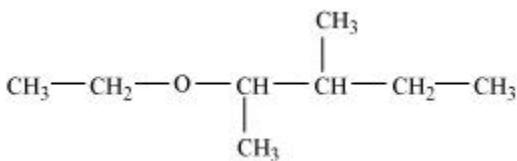
(iv)



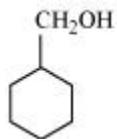
(v)



(vi)

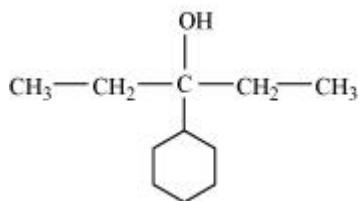


(vii)



(viii)

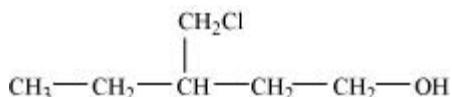
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(ix)



(x)



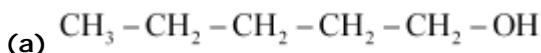
Question 11.3:

(i) Draw the structures of all isomeric alcohols of molecular formula C₅H₁₂O and give their IUPAC names.

(ii) Classify the isomers of alcohols in question 11.3 (i) as primary, secondary and tertiary alcohols.

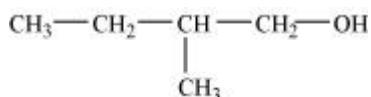
Answer

(i) The structures of all isomeric alcohols of molecular formula, C₅H₁₂O are shown below:



Pentan-1-ol (1°)

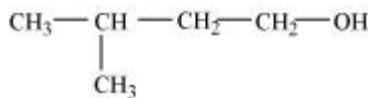
(b)



2-Methylbutan-1-ol (1°)

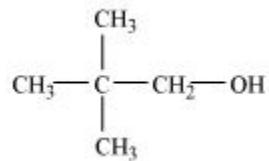
(c)

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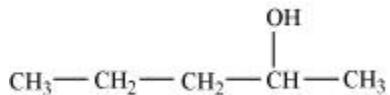
3-Methylbutan-1-ol (1°)

(d)



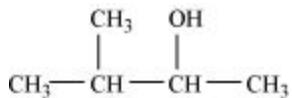
2, 2-Dimethylpropan-1-ol (1°)

(e)



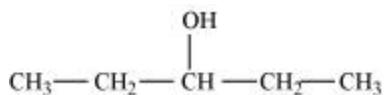
Pentan-2-ol (2°)

(f)



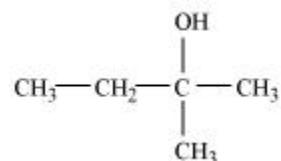
3-Methylbutan-2-ol (2°)

(g)



Pentan-3-ol (2°)

(h)



2-Methylbutan-2-ol (3°)

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(ii) Primary alcohol: Pentan-1-ol; 2-Methylbutan-1-ol;

3-Methylbutan-1-ol; 2, 2-Dimethylpropan-1-ol

Secondary alcohol: Pentan-2-ol; 3-Methylbutan-2-ol;

Pentan-3-ol

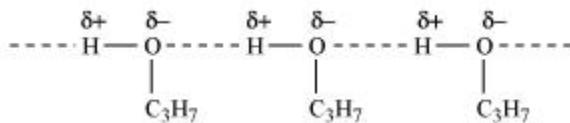
Tertiary alcohol: 2-methylbutan-2-ol

Question 11.4:

Explain why propanol has higher boiling point than that of the hydrocarbon, butane?

Answer

Propanol undergoes intermolecular H-bonding because of the presence of $-\text{OH}$ group. On the other hand, butane does not



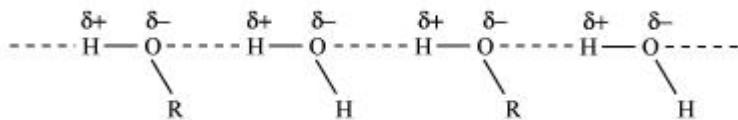
Therefore, extra energy is required to break hydrogen bonds. For this reason, propanol has a higher boiling point than hydrocarbon butane

Question 11.5:

Alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses. Explain this fact.

Answer

Alcohols form H-bonds with water due to the presence of $-\text{OH}$ group. However, hydrocarbons cannot form H-bonds with water.



As a result, alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses.

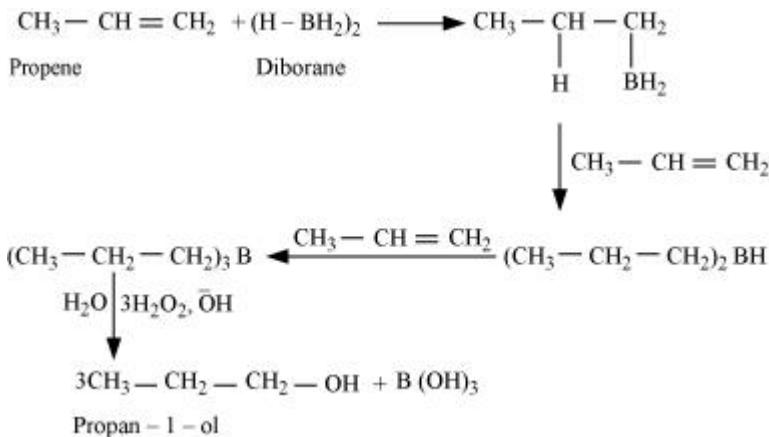
Question 11.6:

What is meant by hydroboration-oxidation reaction? Illustrate it with an example.

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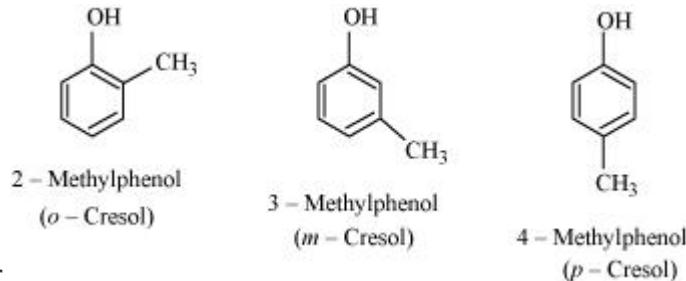
Answer

The addition of borane followed by oxidation is known as the hydroboration-oxidation reaction. For example, propan-1-ol is produced by the hydroboration-oxidation reaction of propene. In this reaction, propene reacts with diborane ($\text{BH}_3\text{}_2$) to form trialkyl borane as an addition product. This addition product is oxidized to alcohol by hydrogen peroxide in the presence of aqueous sodium hydroxide.



Question 11.7:

Give the structures and IUPAC names of monohydric phenols of molecular formula, $\text{C}_7\text{H}_8\text{O}$.



Answer

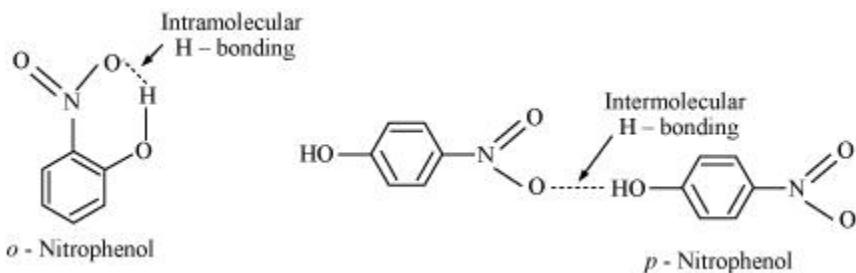
Question 11.8:

While separating a mixture of *ortho* and *para* nitrophenols by steam distillation, name the isomer which will be steam volatile. Give reason.

Answer

Intramolecular H-bonding is present in *o*-nitrophenol. In *p*-nitrophenol, the molecules are strongly associated due to the presence of intermolecular bonding. Hence, *o*-nitrophenol is steam volatile.

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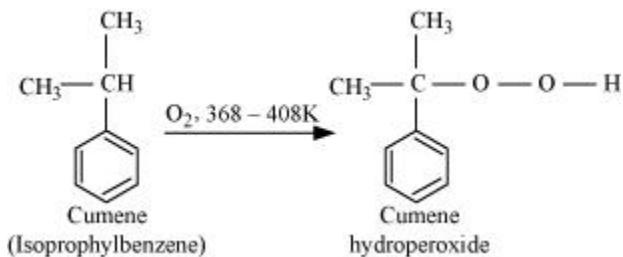


Question 11.9:

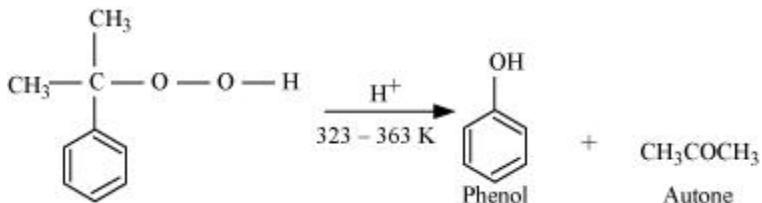
Give the equations of reactions for the preparation of phenol from cumene.

Answer

To prepare phenol, cumene is first oxidized in the presence of air or cumene hydro-peroxide.



Then, cumene hydroperoxide is treated with dilute acid to prepare phenol and acetone as by-products.

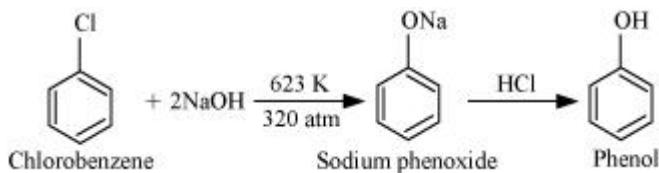


Question 11.10:

Write chemical reaction for the preparation of phenol from chlorobenzene.

Answer

Chlorobenzene is fused with NaOH (at 623 K and 320 atm pressure) to produce sodium phenoxide, which gives phenol on acidification.



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Question 11.11:

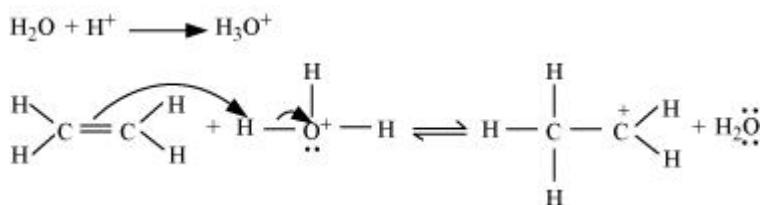
Write the mechanism of hydration of ethene to yield ethanol.

Answer

The mechanism of hydration of ethene to form ethanol involves three steps.

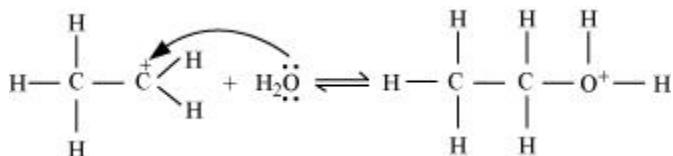
Step 1:

Protonation of ethene to form carbocation by electrophilic attack of H_3O^+ :



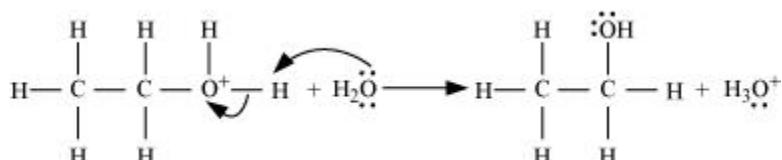
Step 2:

Nucleophilic attack of water on carbocation:



Step 3:

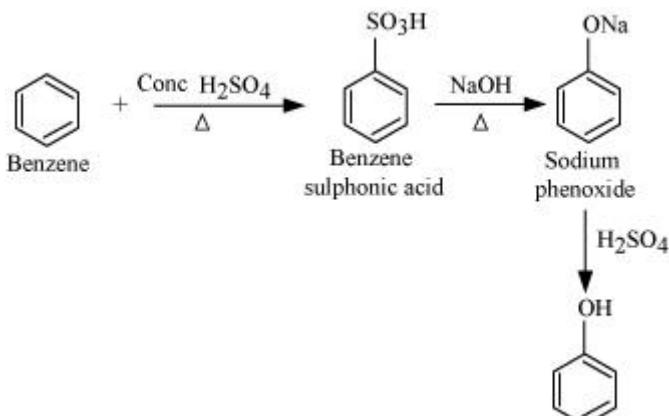
Deprotonation to form ethanol:



Question 11.12:

You are given benzene, conc. H_2SO_4 and NaOH . Write the equations for the preparation of phenol using these reagents.

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Answer

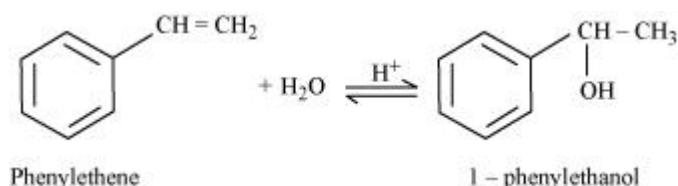
Question 11.13:

Show how will you synthesize:

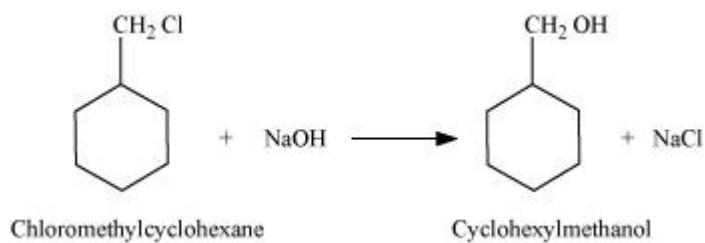
- (i) 1-phenylethanol from a suitable alkene.
 - (ii) cyclohexylmethanol using an alkyl halide by an S_N2 reaction.
 - (iii) pentan-1-ol using a suitable alkyl halide?

Answer

- (i)** By acid-catalyzed hydration of ethylbenzene (styrene), 1-phenylethanol can be synthesized.



- (ii)** When chloromethylcyclohexane is treated with sodium hydroxide, cyclohexylmethanol is obtained.



- (iii) When 1-chloropentane is treated with NaOH, pentan-1-ol is produced.

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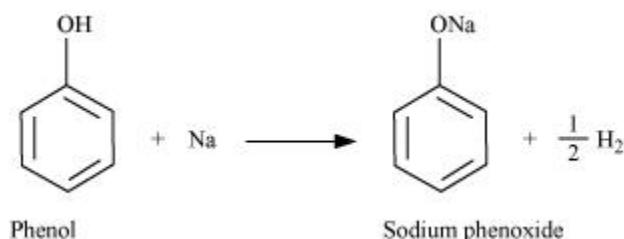
Question 11.14:

Give two reactions that show the acidic nature of phenol. Compare acidity of phenol with that of ethanol.

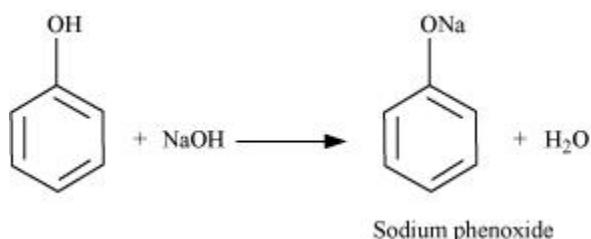
Answer

The acidic nature of phenol can be represented by the following two reactions:

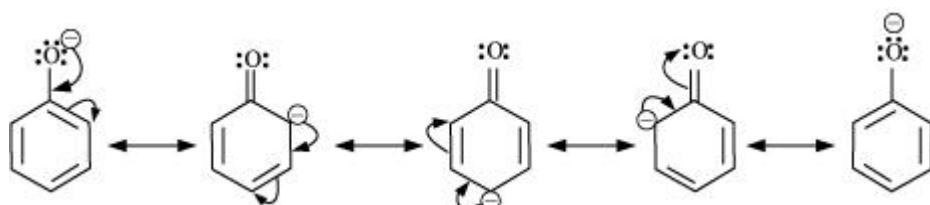
(i) Phenol reacts with sodium to give sodium phenoxide, liberating H₂.



(ii) Phenol reacts with sodium hydroxide to give sodium phenoxide and water as by-products.



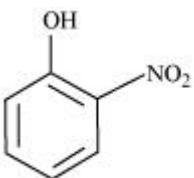
The acidity of phenol is more than that of ethanol. This is because after losing a proton, the phenoxide ion undergoes resonance and gets stabilized whereas ethoxide ion does not.



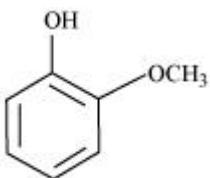
Question 11.15:

Explain why is *ortho* nitrophenol more acidic than *ortho* methoxyphenol?

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Answer o – Nitrophenol



o – Methoxyphenol

The nitro-group is an electron-withdrawing group. The presence of this group in the ortho position decreases the electron density in the O–H bond. As a result, it is easier to lose a proton. Also, the *o*-nitrophenoxide ion formed after the loss of protons is stabilized by resonance. Hence, *ortho* nitrophenol is a stronger acid.

On the other hand, methoxy group is an electron-releasing group. Thus, it increases the electron density in the O–H bond and hence, the proton cannot be given out easily.

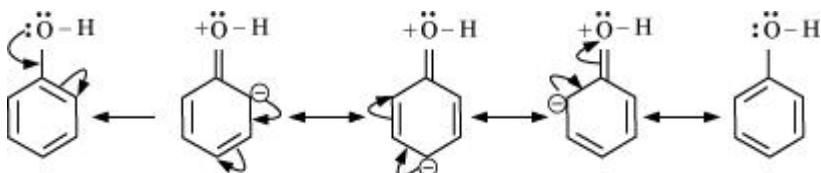
For this reason, *ortho*-nitrophenol is more acidic than *ortho*-methoxyphenol

Question 11.16:

Explain how does the –OH group attached to a carbon of benzene ring activate it towards electrophilic substitution?

Answer

The –OH group is an electron-donating group. Thus, it increases the electron density in the benzene ring as shown in the given resonance structure of phenol.



As a result, the benzene ring is activated towards electrophilic substitution

Question 11.17:

Give equations of the following reactions:

(i) Oxidation of propan-1-ol with alkaline KMnO₄ solution.

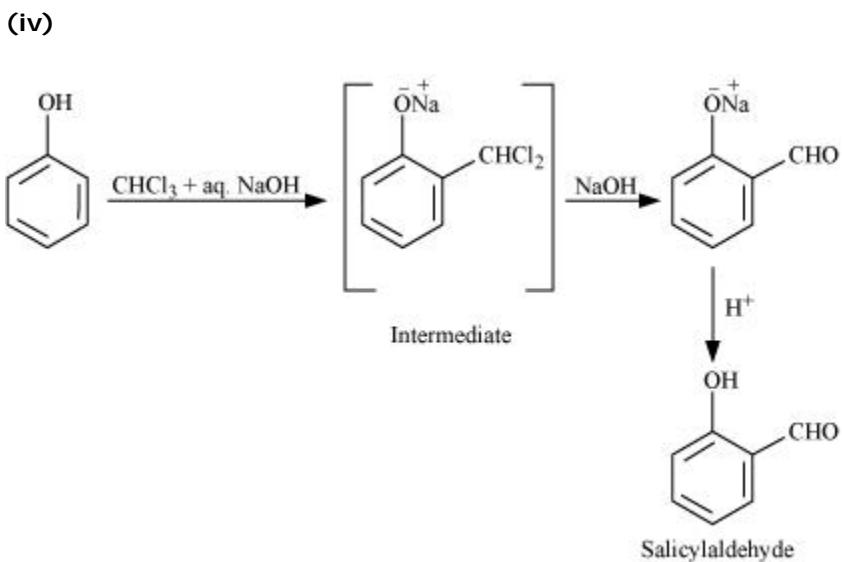
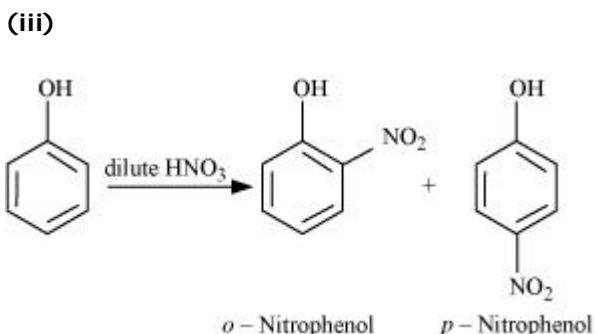
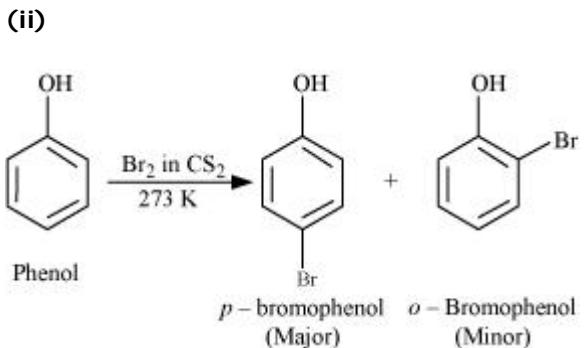
(ii) Bromine in CS₂ with phenol.

(iii) Dilute HNO₃ with phenol.

(iv) Treating phenol with chloroform in presence of aqueous NaOH.

Answer

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Question 11.18:

Explain the following with an example.

(i) Kolbe's reaction.

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(ii) Reimer-Tiemann reaction.

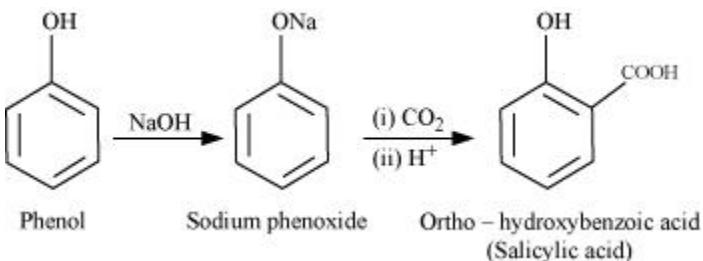
(iii) Williamson ether synthesis.

(iv) Unsymmetrical ether.

Answer

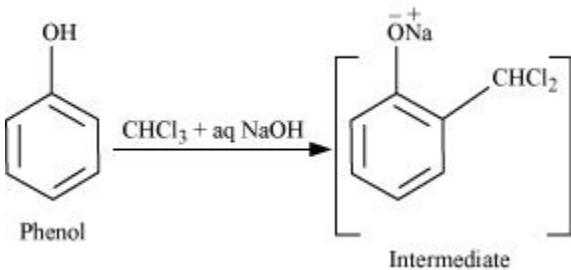
(i) Kolbe's reaction:

When phenol is treated with sodium hydroxide, sodium phenoxide is produced. This sodium phenoxide when treated with carbon dioxide, followed by acidification, undergoes electrophilic substitution to give ortho-hydroxybenzoic acid as the main product. This reaction is known as Kolbe's reaction.



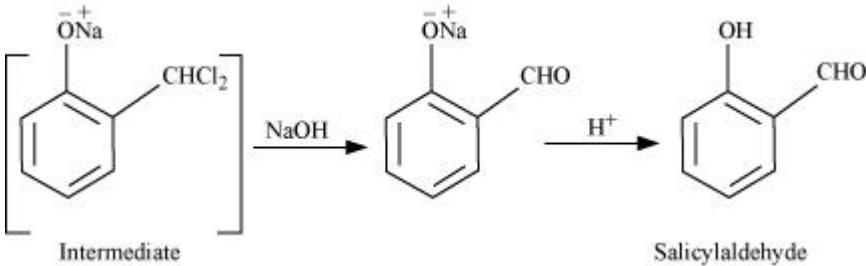
(ii) Reimer-Tiemann reaction:

When phenol is treated with chloroform (CHCl_3) in the presence of sodium hydroxide, a $-\text{CHO}$ group is introduced at the ortho position of the benzene ring.



This reaction is known as the Reimer-Tiemann reaction.

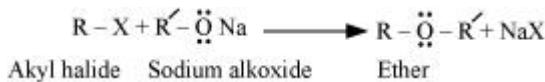
The intermediate is hydrolyzed in the presence of alkalis to produce salicylaldehyde.



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(iii) Williamson ether synthesis:

Williamson ether synthesis is a laboratory method to prepare symmetrical and unsymmetrical ethers by allowing alkyl halides to react with sodium alkoxides.



This reaction involves S_N2 attack of the alkoxide ion on the alkyl halide. Better results are obtained in case of primary alkyl halides.



If the alkyl halide is secondary or tertiary, then elimination competes over substitution.

(iv) Unsymmetrical ether:

An unsymmetrical ether is an ether where two groups on the two sides of an oxygen atom differ (i.e., have an unequal number of carbon atoms). For example: ethyl methyl ether ($\text{CH}_3-\text{O}-\text{CH}_2\text{CH}_3$).

Question 11.20:

How are the following conversions carried out?

(i) Propene \rightarrow Propan-2-ol

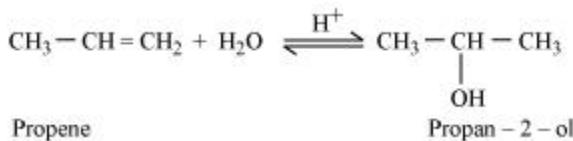
(ii) Benzyl chloride \rightarrow Benzyl alcohol

(iii) Ethyl magnesium chloride \rightarrow Propan-1-ol.

(iv) Methyl magnesium bromide \rightarrow 2-Methylpropan-2-ol.

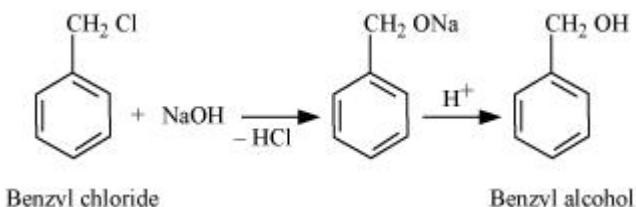
Answer

(i) If propene is allowed to react with water in the presence of an acid as a catalyst, then propan-2-ol is obtained.

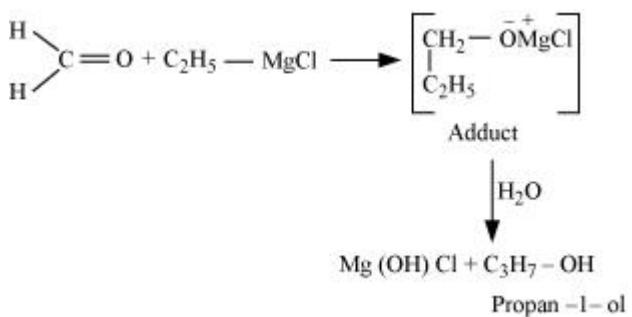


(ii) If benzyl chloride is treated with NaOH (followed by acidification) then benzyl alcohol is produced.

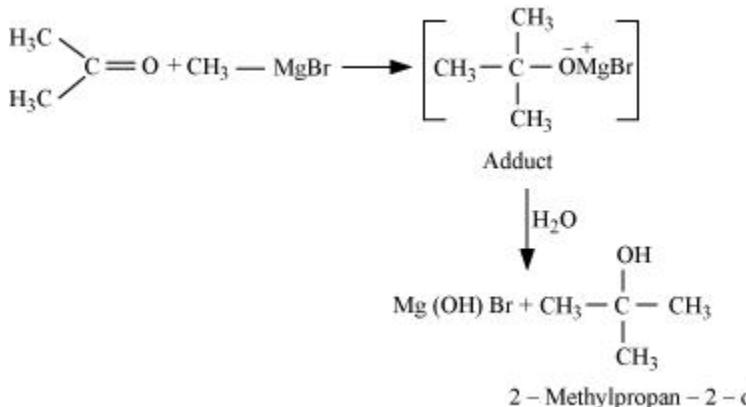
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(iii) When ethyl magnesium chloride is treated with methanal, an adduct is the produced which gives propan-1-ol on hydrolysis.



(iv) When methyl magnesium bromide is treated with propane, an adduct is the product which gives 2-methylpropane-2-ol on hydrolysis.



Question 11.21:

Name the reagents used in the following reactions:

(i) Oxidation of a primary alcohol to carboxylic acid.

(ii) Oxidation of a primary alcohol to aldehyde.

(iii) Bromination of phenol to 2,4,6-tribromophenol.

(iv) Benzyl alcohol to benzoic acid.

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(v) Dehydration of propan-2-ol to propene.

(vi) Butan-2-one to butan-2-ol.

Answer

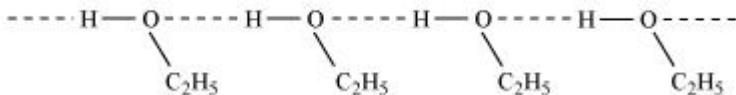
- (i) Acidified potassium permanganate
- (ii) Pyridinium chlorochromate (PCC)
- (iii) Bromine water
- (iv) Acidified potassium permanganate
- (v) 85% phosphoric acid
- (vi) NaBH_4 or LiAlH_4

Question 11.22:

Give reason for the higher boiling point of ethanol in comparison to methoxymethane.

Answer

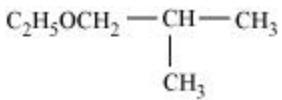
Ethanol undergoes intermolecular H-bonding due to the presence of $-\text{OH}$ group, resulting in the association of molecules. Extra energy is required to break these hydrogen bonds. On the other hand, methoxymethane does not undergo H-bonding. Hence, the boiling point of ethanol is higher than that of methoxymethane.



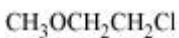
Question 11.23:

Give IUPAC names of the following ethers:

(i)



(ii)



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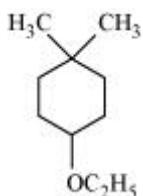
(iii)



(iv)



(v)



(vi)



Answer

(i) 1-Ethoxy-2-methylpropane

(ii) 2-Chloro-1-methoxyethane

(iii) 4-Nitroanisole

(iv) 1-Methoxypropane

(v) 1-Ethoxy-4, 4-dimethylcyclohexane

(vi) Ethoxybenzene

Question 11.24:

Write the names of reagents and equations for the preparation of the following ethers by Williamson's synthesis:

(i) 1-Propoxyp propane

(ii) Ethoxybenzene

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(iii) 2-Methoxy-2-methylpropane

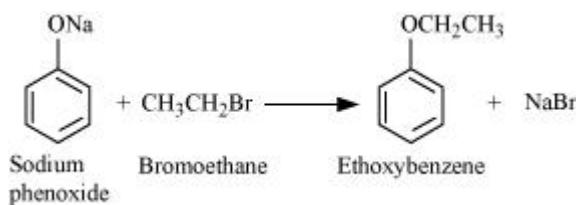
(iv) 1-Methoxyethane

Answer

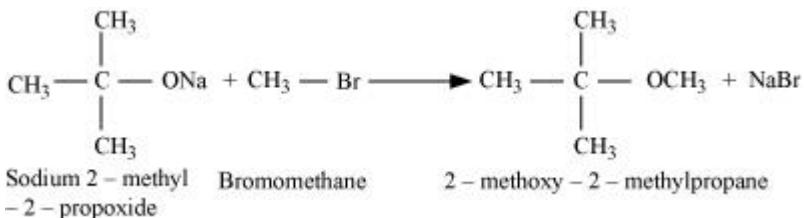


(i) Sodium propoxide 1-Bromopropane 1- Propoxypropane

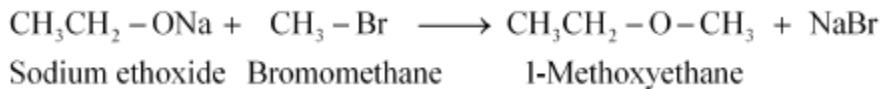
(ii)



(iii)



(iv)



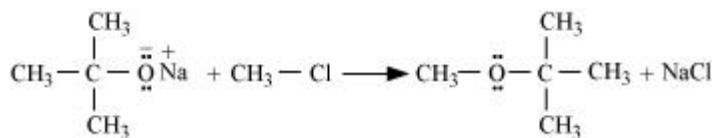
Question 11.25:

Illustrate with examples the limitations of Williamson synthesis for the preparation of certain types of ethers.

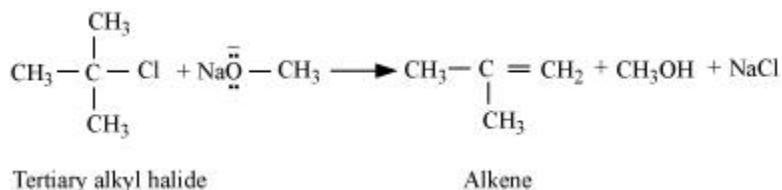
Answer

The reaction of Williamson synthesis involves S_N2 attack of an alkoxide ion on a primary alkyl halide.

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But if secondary or tertiary alkyl halides are taken in place of primary alkyl halides, then elimination would compete over substitution. As a result, alkenes would be produced. This is because alkoxides are nucleophiles as well as strong bases. Hence, they react with alkyl halides, which results in an elimination reaction.



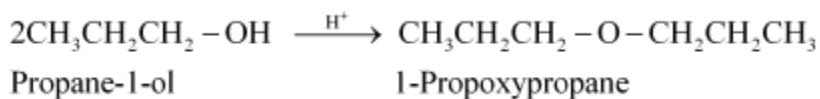
Question 11.26:

How is 1-propoxypropane synthesised from propan-1-ol? Write mechanism of this reaction.

Answer

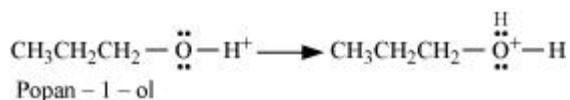
1-propoxypropane can be synthesized from propan-1-ol by dehydration.

Propan-1-ol undergoes dehydration in the presence of protic acids (such as H_2SO_4 , H_3PO_4) to give 1-propoxypyropane.

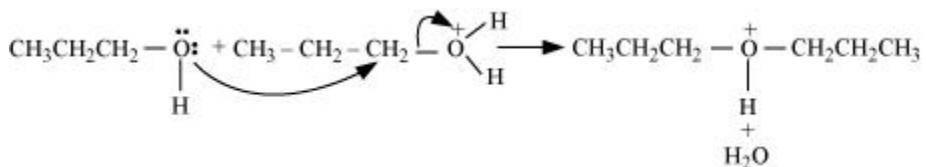


The mechanism of this reaction involves the following three steps:

Step 1: Protonation



Step 2: Nucleophilic attack



Step 3: Deprotonation

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Question 11.27:

Preparation of ethers by acid dehydration of secondary or tertiary alcohols is not a suitable method. Give reason.

Answer

The formation of ethers by dehydration of alcohol is a bimolecular reaction (S_N2) involving the attack of an alcohol molecule on a protonated alcohol molecule. In the method, the alkyl group should be unhindered. In case of secondary or tertiary alcohols, the alkyl group is hindered. As a result, elimination dominates substitution. Hence, in place of ethers, alkenes are formed.

Question 11.28:

Write the equation of the reaction of hydrogen iodide with:

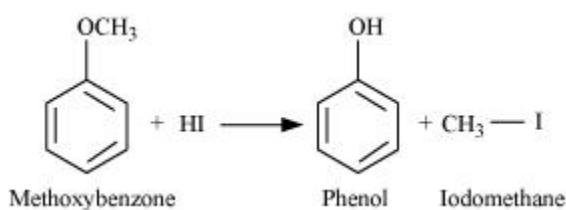
- (i) 1-propoxypropane
 - (ii) Methoxybenzene and
 - (iii) Benzyl ethyl ether

Answer

- (i)

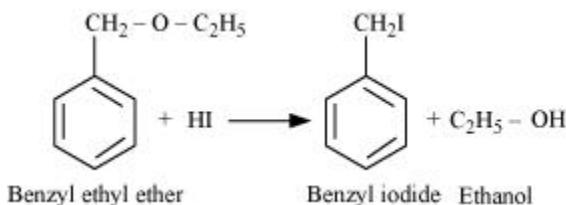


- (ii)



- (iii)

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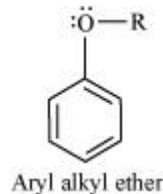


Question 11.29:

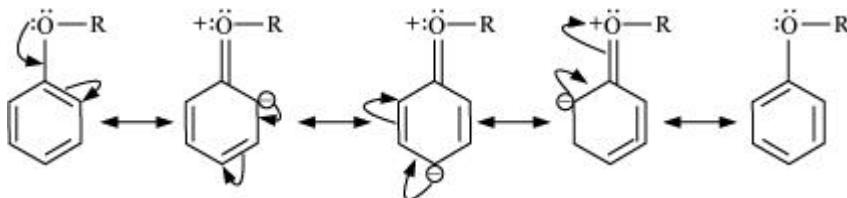
Explain the fact that in aryl alkyl ethers

- (i) The alkoxy group activates the benzene ring towards electrophilic substitution and
- (ii) It directs the incoming substituents to ortho and para positions in benzene ring.

Answer (i)



In aryl alkyl ethers, due to the $+R$ effect of the alkoxy group, the electron density in the benzene ring increases as shown in the following resonance structure.



Thus, benzene is activated towards electrophilic substitution by the alkoxy group.

- (ii) It can also be observed from the resonance structures that the electron density increases more at the ortho and para positions than at the meta position. As a result, the incoming substituents are directed to the ortho and para positions in the benzene ring

Question 11.30:

Write the mechanism of the reaction of HI with methoxymethane.

Answer

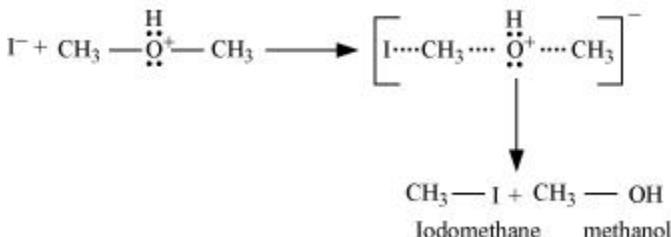
The mechanism of the reaction of HI with methoxymethane involves the following steps:

Step1: Protonation of methoxymethane:

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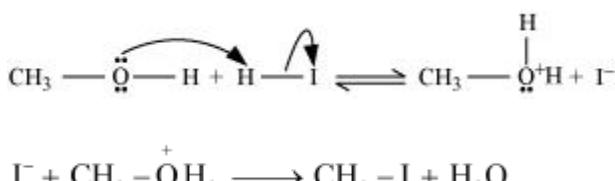


Step2: Nucleophilic attack of I^- :



Step3:

When HI is in excess and the reaction is carried out at a high temperature, the methanol formed in the second step reacts with another HI molecule and gets converted to methyl iodide



Question 11.31:

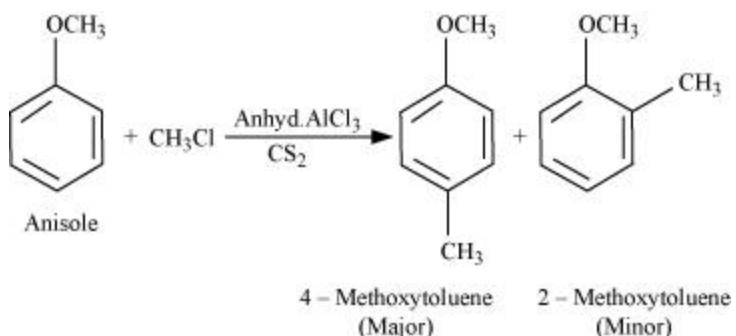
Write equations of the following reactions:

- (i) Friedel-Crafts reaction–alkylation of anisole.
- (ii) Nitration of anisole.
- (iii) Bromination of anisole in ethanoic acid medium.
- (iv) Friedel-Craft's acetylation of anisole.

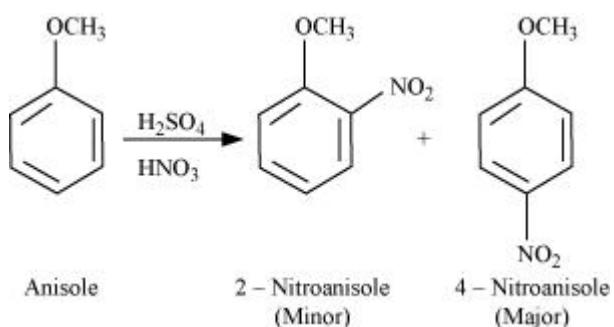
Answer

(i)

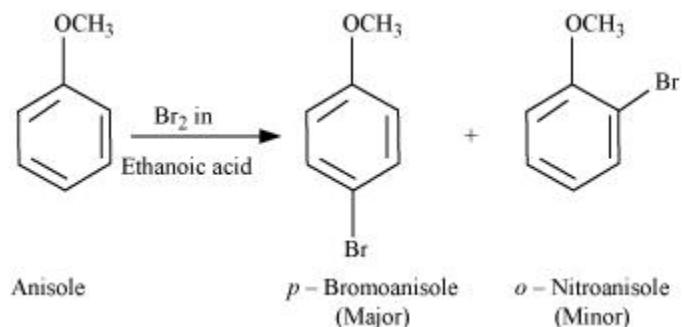
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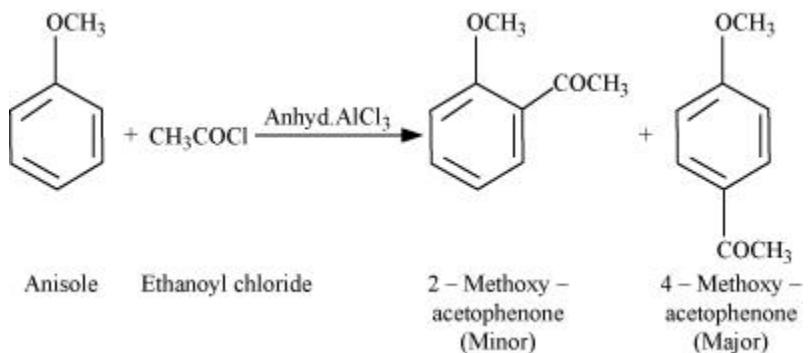
(ii)



(iii)



(iv)

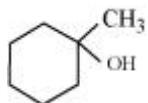


Question 11.32:

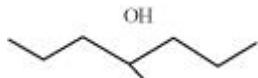
ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

Show how would you synthesise the following alcohols from appropriate alkenes?

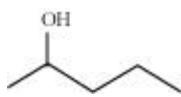
(i)



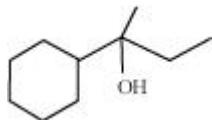
(ii)



(iii)



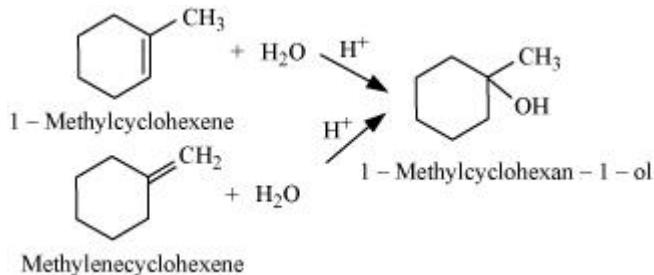
(iv)



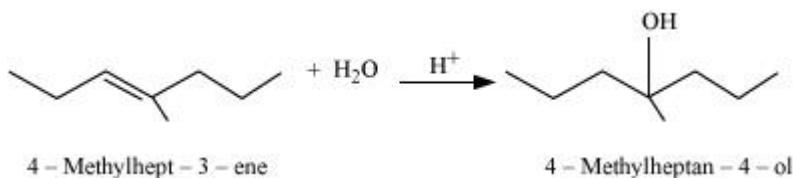
Answer

The given alcohols can be synthesized by applying Markovnikov's rule of acid-catalyzed hydration of appropriate alkenes.

(i)

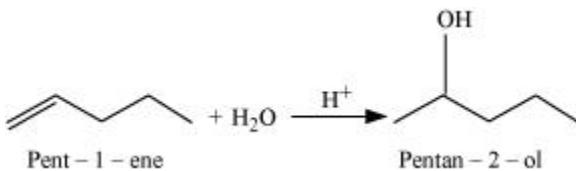


(ii)

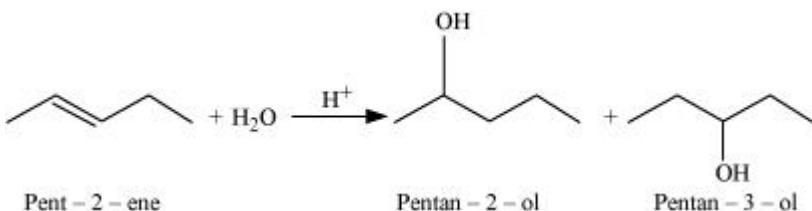


ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

(iii)

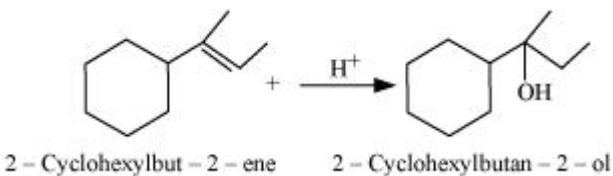


Acid-catalyzed hydration of pent-2-ene also produces pentan-2-ol but along with pentan-3-ol.



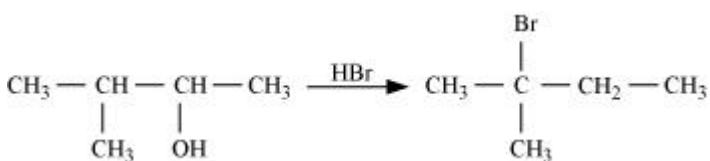
Thus, the first reaction is preferred over the second one to get pentan-2-ol.

(iv)



Question 11.33:

When 3-methylbutan-2-ol is treated with HBr, the following reaction takes place:



Give a mechanism for this reaction.

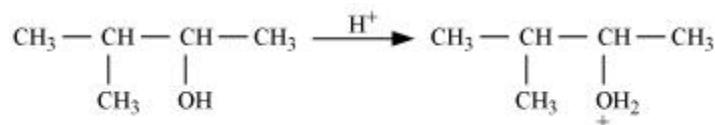
(Hint : The secondary carbocation formed in step II rearranges to a more stable tertiary carbocation by a hydride ion shift from 3rd carbon atom.

Answer

The mechanism of the given reaction involves the following steps:

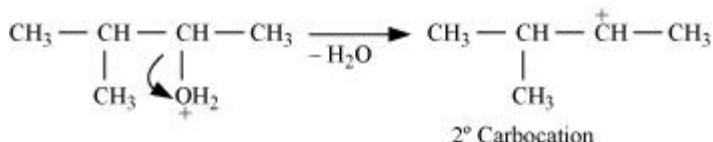
ALCOHOL, PHENOLS AND ETHERS NCERT SOLUTION

Step 1: Protonation

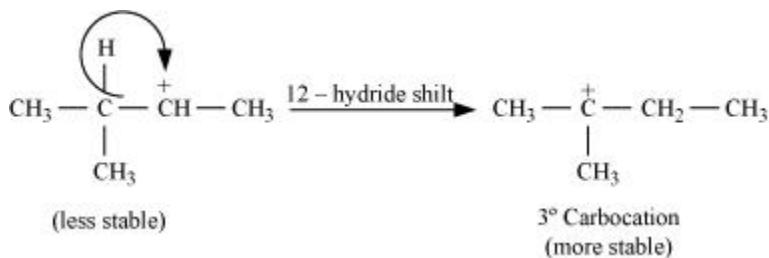


3 - Methylbutan - 2 - ol

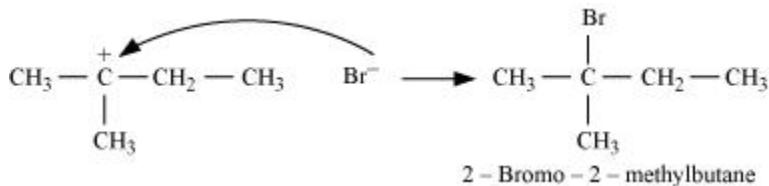
Step 2: Formation of 2° carbocation by the elimination of a water molecule



Step 3: Re-arrangement by the hydride-ion shift



Step 4: Nucleophilic attack



ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

ALDEHYDE, KETONE AND CARBOXYLIC ACID

Question 12.1:

Write the structures of the following compounds.

(i) α -Methoxypropionaldehyde

(ii) 3-Hydroxybutanal

(iii) 2-Hydroxycyclopentane carbaldehyde

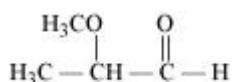
(iv) 4-Oxopentanal

(v) Di-sec-butyl ketone

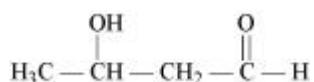
(vi) 4-Fluoroacetophenone

Answer

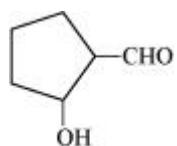
(i)



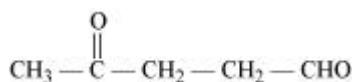
(ii)



(iii)

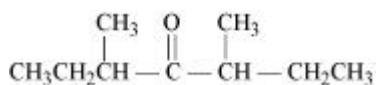


(iv)

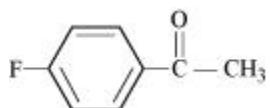


(v)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



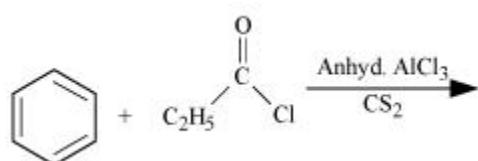
(vi)



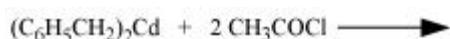
Question 12.2:

Write the structures of products of the following reactions;

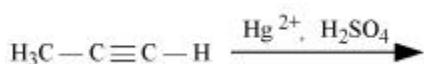
(i)



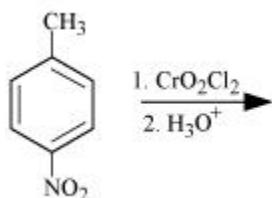
(ii)



(iii)



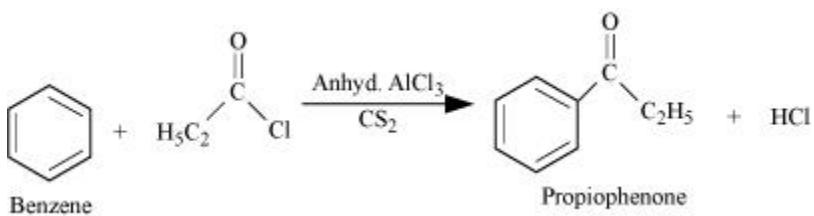
(iv)



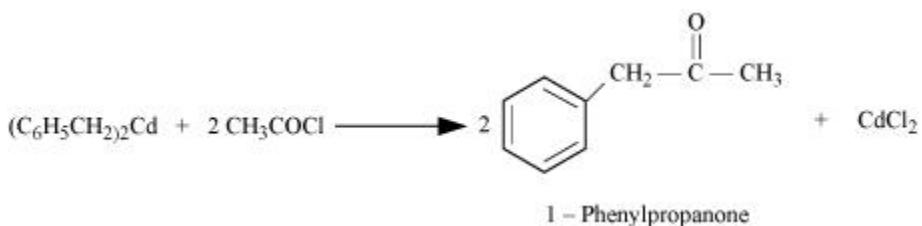
Answer

i.

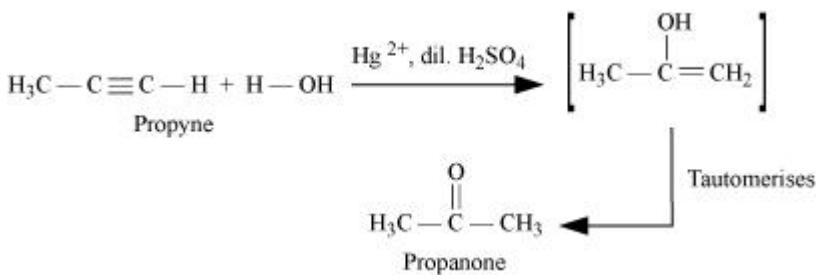
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



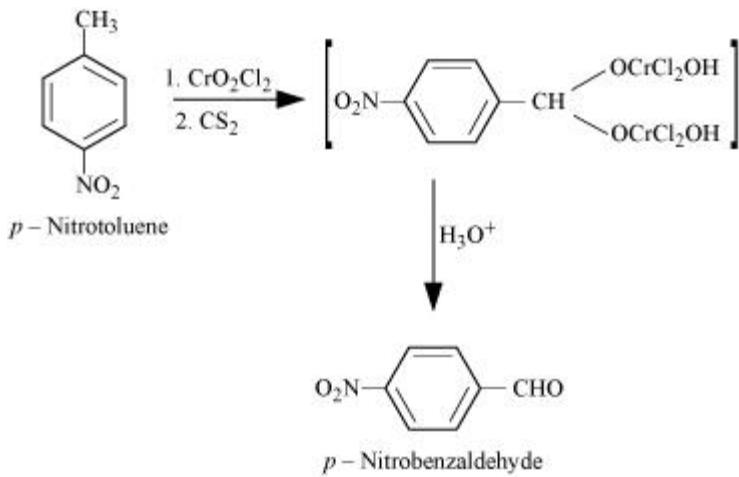
ii.



iii.



(iv)



Question 12.3:

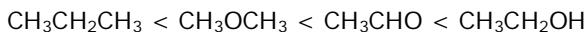
Arrange the following compounds in increasing order of their boiling points.

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

CH₃CHO, CH₃CH₂OH, CH₃OCH₃, CH₃CH₂CH₃

Answer

The molecular masses of the given compounds are in the range 44 to 46. CH₃CH₂OH undergoes extensive intermolecular H-bonding, resulting in the association of molecules. Therefore, it has the highest boiling point. CH₃CHO is more polar than CH₃OCH₃ and so CH₃CHO has stronger intermolecular dipole – dipole attraction than CH₃OCH₃. CH₃CH₂CH₃ has only weak van der Waals force. Thus, the arrangement of the given compounds in the increasing order of their boiling points is given by:



Question 12.4:

Arrange the following compounds in increasing order of their reactivity in nucleophilic addition reactions.

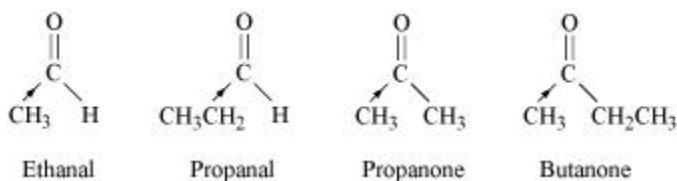
(i) Ethanal, Propanal, Propanone, Butanone.

(ii) Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone.

Hint: Consider steric effect and electronic effect.

Answer

(i)



The +I effect of the alkyl group increases in the order:

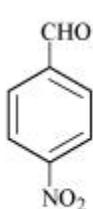


The electron density at the carbonyl carbon increases with the increase in the +I effect. As a result, the chances of attack by a nucleophile decrease. Hence, the increasing order of the reactivities of the given carbonyl compounds in nucleophilic addition reactions is:

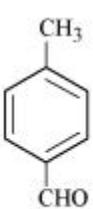


(ii)

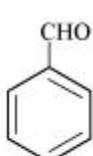
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



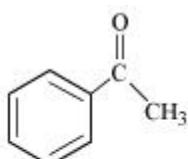
p – Nitrobenzaldehyde



p – Tolualdehyde



Benzaldehyde



Acetophenone

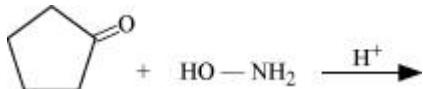
The +I effect is more in ketone than in aldehyde. Hence, acetophenone is the least reactive in nucleophilic addition reactions. Among aldehydes, the +I effect is the highest in *p*-tolualdehyde because of the presence of the electron-donating –CH₃ group and the lowest in *p*-nitrobenzaldehyde because of the presence of the electron-withdrawing –NO₂ group. Hence, the increasing order of the reactivities of the given compounds is:



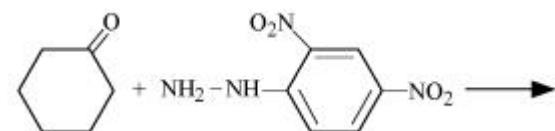
Question 12.5:

Predict the products of the following reactions:

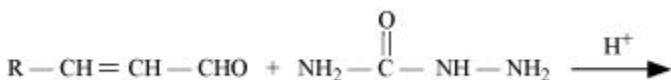
(i)



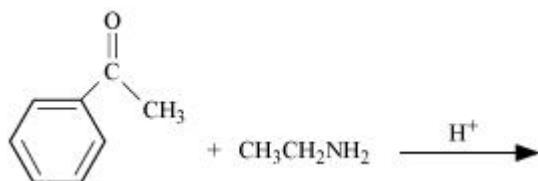
(ii)



(iii)



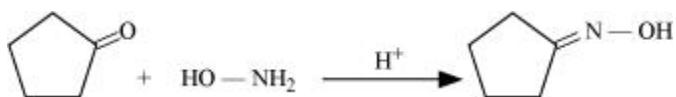
(iv)



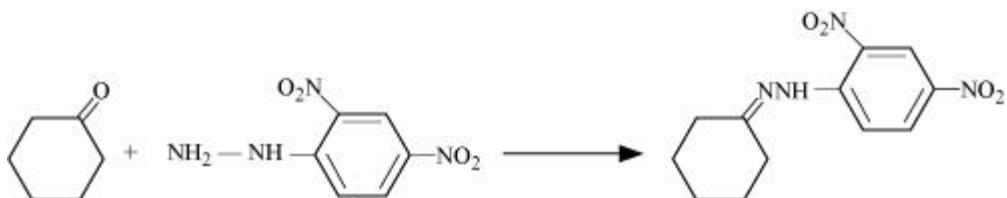
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

Answer

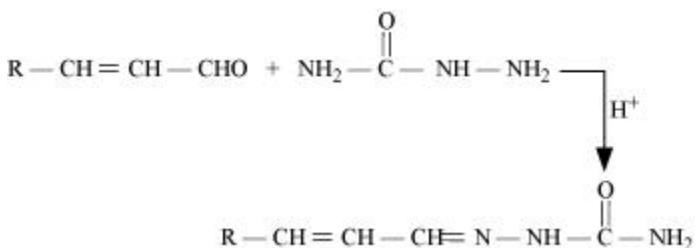
(i)



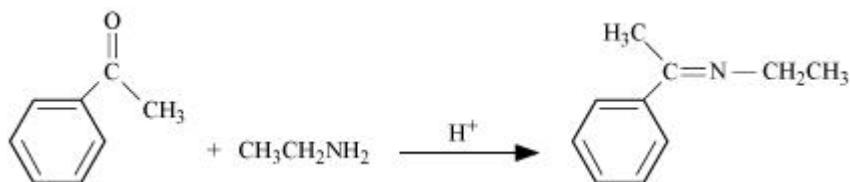
(ii)



(iii)



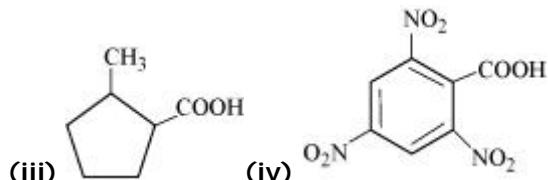
(iv)



Question 12.6:

Give the IUPAC names of the following compounds:

(i) $\text{PhCH}_2\text{CH}_2\text{COOH}$ (ii) $(\text{CH}_3)_2\text{C}=\text{CHCOOH}$



Answer

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

- (i) 3-Phenylpropanoic acid
- (ii) 3-Methylbut-2-enoic acid
- (iii) 2-Methylcyclopentanecarboxylic acid
- (iv) 2,4,6-Trinitrobenzoic acid

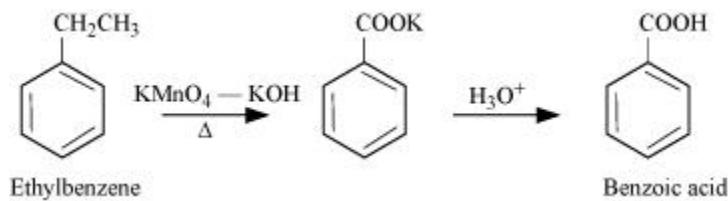
Question 12.7:

Show how each of the following compounds can be converted to benzoic acid.

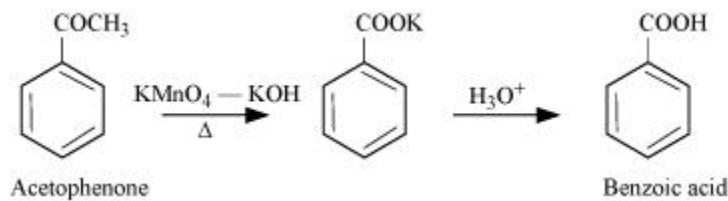
- (i) Ethylbenzene (ii) Acetophenone
- (iii) Bromobenzene (iv) Phenylethene (Styrene)

Answer

(i)

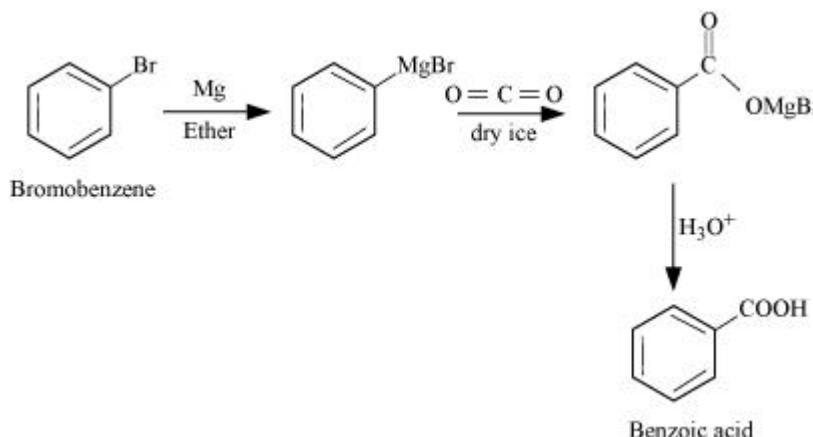


(ii)

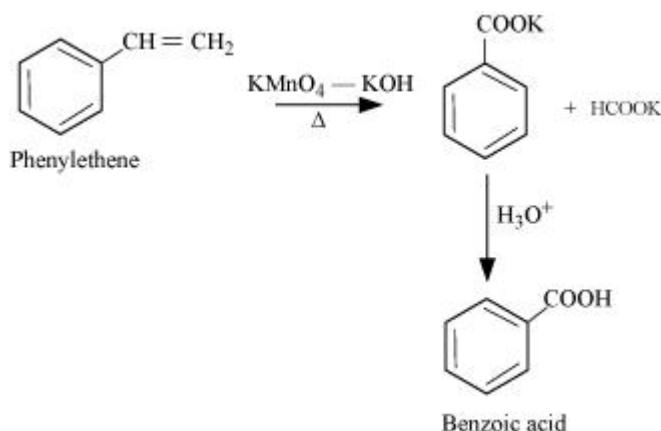


(iii)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



(iv)



Question 12.8:

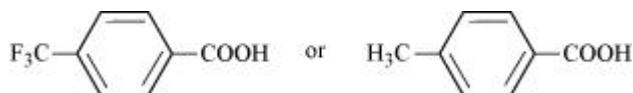
Which acid of each pair shown here would you expect to be stronger?

(i) CH₃CO₂H or CH₂FCO₂H

(ii) CH₂FCO₂H or CH₂CICO₂H

(iii) CH₂FCH₂CH₂CO₂H or CH₃CHFCH₂CO₂H

(iv)



Answer

(i)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



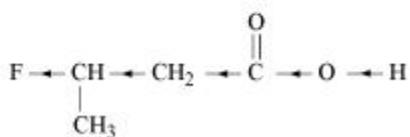
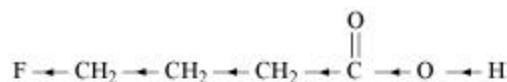
The $+I$ effect of $-\text{CH}_3$ group increases the electron density on the O–H bond. Therefore, release of proton becomes difficult. On the other hand, the $-I$ effect of F decreases the electron density on the O–H bond. Therefore, proton can be released easily. Hence, $\text{CH}_2\text{FCO}_2\text{H}$ is a stronger acid than $\text{CH}_3\text{CO}_2\text{H}$.

(ii)



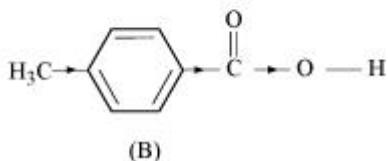
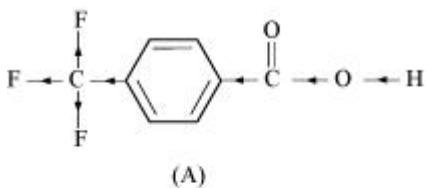
F has stronger $-I$ effect than Cl. Therefore, $\text{CH}_2\text{FCO}_2\text{H}$ can release proton more easily than $\text{CH}_2\text{ClCO}_2\text{H}$. Hence, $\text{CH}_2\text{FCO}_2\text{H}$ is stronger acid than $\text{CH}_2\text{ClCO}_2\text{H}$.

(iii)



Inductive effect decreases with increase in distance. Hence, the $+I$ effect of F in $\text{CH}_3\text{CHFCH}_2\text{CO}_2\text{H}$ is more than it is in $\text{CH}_2\text{FCH}_2\text{CH}_2\text{CO}_2\text{H}$. Hence, $\text{CH}_3\text{CHFCH}_2\text{CO}_2\text{H}$ is stronger acid than $\text{CH}_2\text{FCH}_2\text{CH}_2\text{CO}_2\text{H}$.

(iv)



Due to the $-I$ effect of F, it is easier to release proton in the case of compound (A). However, in the case of compound (B), release of proton is difficult due to the $+I$ effect of $-\text{CH}_3$ group. Hence, (A) is a stronger acid than (B).

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

Question 12.1:

What is meant by the following terms? Give an example of the reaction in each case.

(i) Cyanohydrin (ii) Acetal

(iii) Semicarbazone (iv) Aldol

(v) Hemiacetal (vi) Oxime

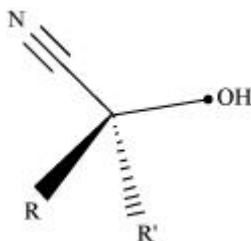
(vii) Ketal (viii) Imine

(ix) 2,4-DNP-derivative (x) Schiff's base

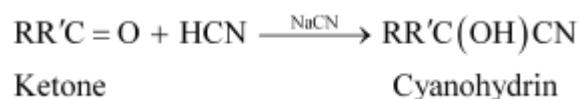
Answer

(i) Cyanohydrin:

Cyanohydrins are organic compounds having the formula $\text{RR}'\text{C}(\text{OH})\text{CN}$, where R and R' can be alkyl or aryl groups.



Aldehydes and ketones react with hydrogen cyanide (HCN) in the presence of excess sodium cyanide (NaCN) as a catalyst to yield cyanohydrin. These reactions are known as cyanohydrin reactions.



Cyanohydrins are useful synthetic intermediates.

(ii) Acetal:

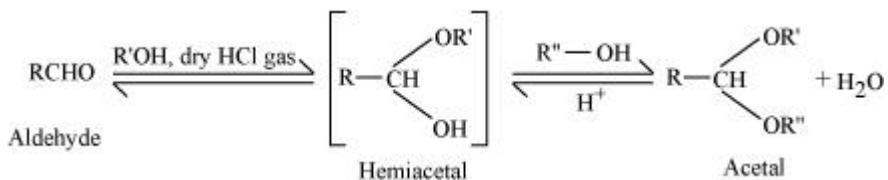
Acetals are gem-dialkoxy alkanes in which two alkoxy groups are present on the terminal carbon atom. One bond is connected to an alkyl group while the other is connected to a hydrogen atom.

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



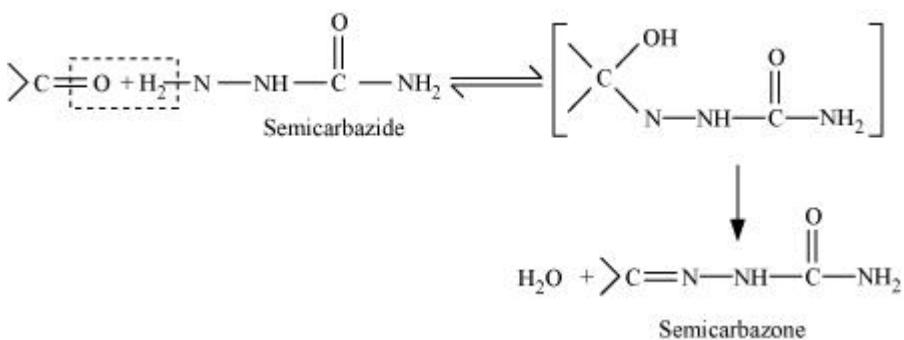
General structure of an acetal

When aldehydes are treated with two equivalents of a monohydric alcohol in the presence of dry HCl gas, hemiacetals are produced that further react with one more molecule of alcohol to yield acetal.



(iii) Semicarbazone:

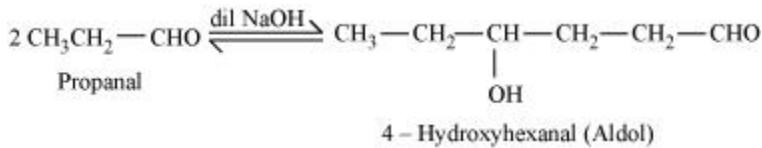
Semicarbazones are derivatives of aldehydes and ketones produced by the condensation reaction between a ketone or aldehyde and semicarbazide.



Semicarbazones are useful for identification and characterization of aldehydes and ketones.

(iv) Aldol:

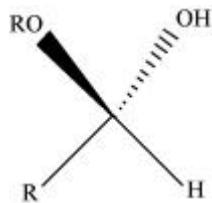
A β -hydroxy aldehyde or ketone is known as an aldol. It is produced by the condensation reaction of two molecules of the same or one molecule each of two different aldehydes or ketones in the presence of a base.



(v) Hemiacetal:

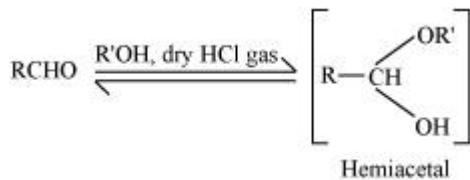
Hemiacetals are α -alkoxyalcohols

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



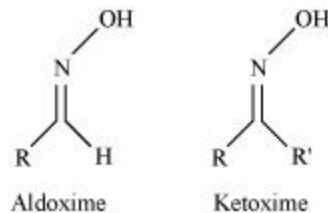
General structure of a hemiacetal

Aldehyde reacts with one molecule of a monohydric alcohol in the presence of dry HCl gas.

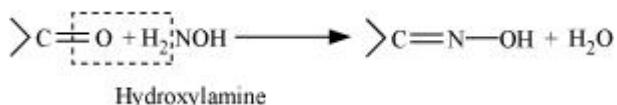


(vi) Oxime:

Oximes are a class of organic compounds having the general formula $\text{RR}'\text{CNOH}$, where R is an organic side chain and R' is either hydrogen or an organic side chain. If R' is H, then it is known as aldoxime and if R' is an organic side chain, it is known as ketoxime.

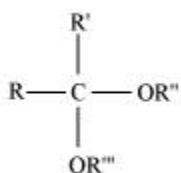


On treatment with hydroxylamine in a weakly acidic medium, aldehydes or ketones form oximes.



(vii) Ketal:

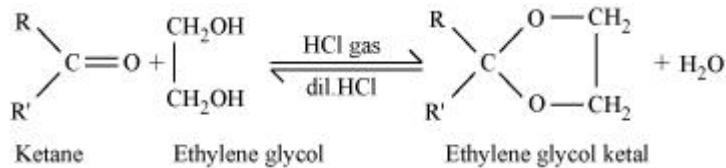
Ketals are gem-dialkoxyalkanes in which two alkoxy groups are present on the same carbon atom within the chain. The other two bonds of the carbon atom are connected to two alkyl groups.



General structure of a ketal

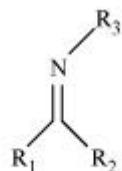
ALDEHYDE, KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

Ketones react with ethylene glycol in the presence of dry HCl gas to give a cyclic product known as ethylene glycol ketals.



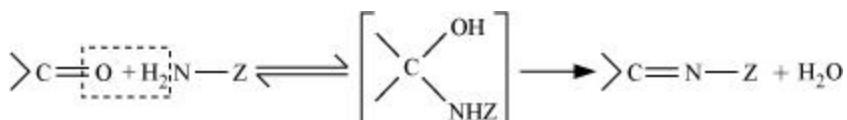
(viii) Imine:

Imines are chemical compounds containing a carbon nitrogen double bond.



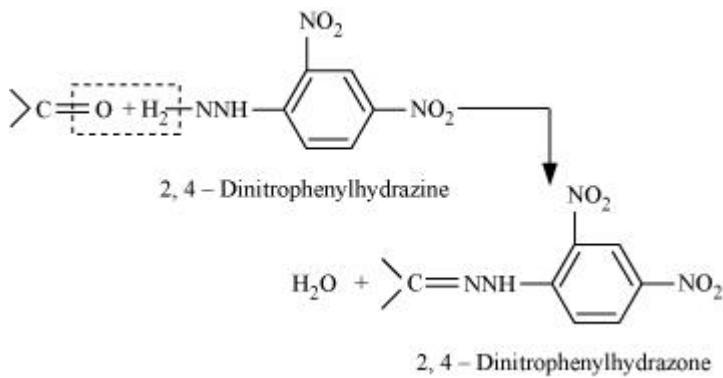
General structure of an imine

Imines are produced when aldehydes and ketones react with ammonia and its derivatives.



(ix) 2, 4-DNP-derivative:

2, 4-dinitrophenylhydragones are 2, 4-DNP-derivatives, which are produced when aldehydes or ketones react with 2, 4-dinitrophenylhydrazine in a weakly acidic medium.



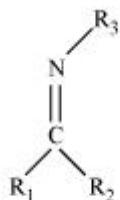
To identify and characterize aldehydes and ketones, 2, 4-DNP derivatives are used.

(x) Schiff's base:

Schiff's base (or azomethine) is a chemical compound containing a carbon-nitrogen double bond with the nitrogen atom connected to an aryl or alkyl group-but not hydrogen. They have the general formula $R_1R_2C = NR_3$. Hence, it is an imine.

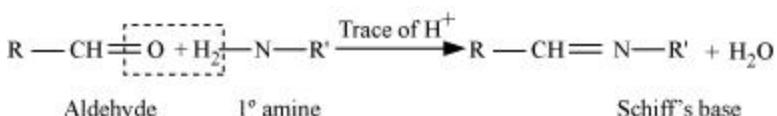
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

It is named after a scientist, Hugo Schiff.



General structure of Schiff's base

Aldehydes and ketones on treatment with primary aliphatic or aromatic amines in the presence of trace of an acid yields a Schiff's base.



Question 12.2:

Name the following compounds according to IUPAC system of nomenclature:

- (i) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CHO}$
- (ii) $\text{CH}_3\text{CH}_2\text{COCH}(\text{C}_2\text{H}_5)\text{CH}_2\text{CH}_2\text{Cl}$
- (iii) $\text{CH}_3\text{CH}=\text{CHCHO}$
- (iv) $\text{CH}_3\text{COCH}_2\text{COCH}_3$
- (v) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{C}(\text{CH}_3)_2\text{COCH}_3$
- (vi) $(\text{CH}_3)_3\text{CCH}_2\text{COOH}$
- (vii) $\text{OHCC}_6\text{H}_4\text{CHO}-p$

Answer

- (i) 4-methylpentanal
- (ii) 6-Chloro-4-ethylhexan-3-one
- (iii) But-2-en-1-al
- (iv) Pentane-2,4-dione
- (v) 3,3,5-Trimethylhexan-2-one

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(vi) 3,3-Dimethylbutanoic acid

(vii) Benzene-1,4-dicarbaldehyde

Question 12.3:

Draw the structures of the following compounds.

(i) 3-Methylbutanal (ii) *p*-Nitropropiophenone

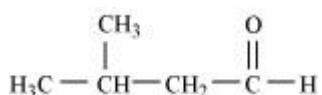
(iii) *p*-Methylbenzaldehyde (iv) 4-Methylpent-3-en-2-one

(v) 4-Chloropentan-2-one (vi) 3-Bromo-4-phenylpentanoic acid

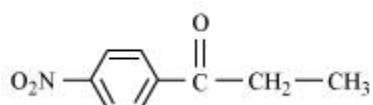
(vii) *p,p'*-Dihydroxybenzophenone (viii) Hex-2-en-4-yneic acid

Answer

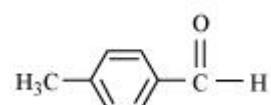
(i)



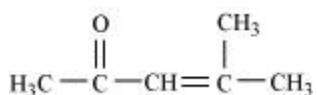
(ii)



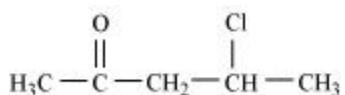
(iii)



(iv)

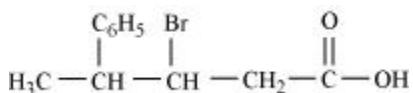


(v)

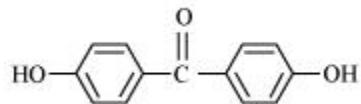


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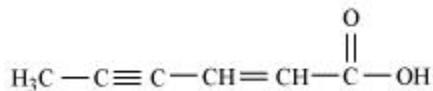
(vi)



(vii)



(viii)

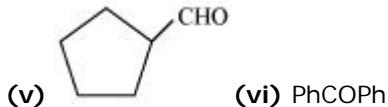


Question 12.4:

Write the IUPAC names of the following ketones and aldehydes. Wherever possible, give also common names.

(i) $\text{CH}_3\text{CO}(\text{CH}_2)_4\text{CH}_3$ **(ii)** $\text{CH}_3\text{CH}_2\text{CHBrCH}_2\text{CH}(\text{CH}_3)\text{CHO}$

(iii) $\text{CH}_3(\text{CH}_2)_5\text{CHO}$ **(iv)** $\text{Ph}-\text{CH}=\text{CH}-\text{CHO}$



Answer

(i) $\text{CH}_3\text{CO}(\text{CH}_2)_4\text{CH}_3$

IUPAC name: Heptan-2-one

Common name: Methyl n-propyl ketone

(ii) $\text{CH}_3\text{CH}_2\text{CHBrCH}_2\text{CH}(\text{CH}_3)\text{CHO}$

IUPAC name: 4-Bromo-2-methylhexanal

Common name: (γ -Bromo- α -methyl-caproaldehyde)

(iii) $\text{CH}_3(\text{CH}_2)_5\text{CHO}$

IUPAC name: Heptanal

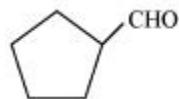
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

(iv) Ph-CH=CH-CHO

IUPAC name: 3-phenylprop-2-enal

Common name: β -Pheynolacrolein

(v)



IUPAC name: Cyclopentanecarbaldehyde

(vi) PhCOPh

IUPAC name: Diphenylmethanone

Common name: Benzophenone

Question 12.5:

Draw structures of the following derivatives.

(i) The 2,4-dinitrophenylhydrazone of benzaldehyde

(ii) Cyclopropanone oxime

(iii) Acetaldehydedimethylacetal

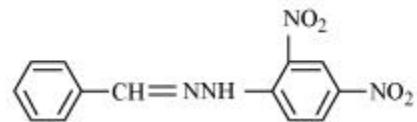
(iv) The semicarbazone of cyclobutanone

(v) The ethylene ketal of hexan-3-one

(vi) The methyl hemiacetal of formaldehyde

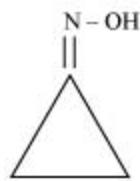
Answer

(i)

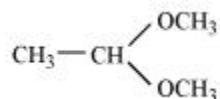


(ii)

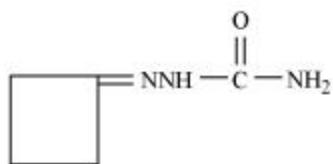
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



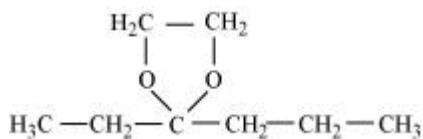
(iii)



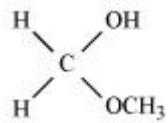
(iv)



(v)



(vi)



Question 12.6:

Predict the products formed when cyclohexanecarbaldehyde reacts with following reagents.

(i) PhMgBr and then H_3O^+

(ii) Tollens' reagent

(iii) Semicarbazide and weak acid

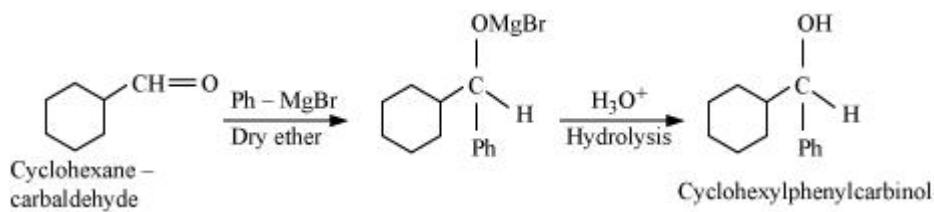
(iv) Excess ethanol and acid

(v) Zinc amalgam and dilute hydrochloric acid

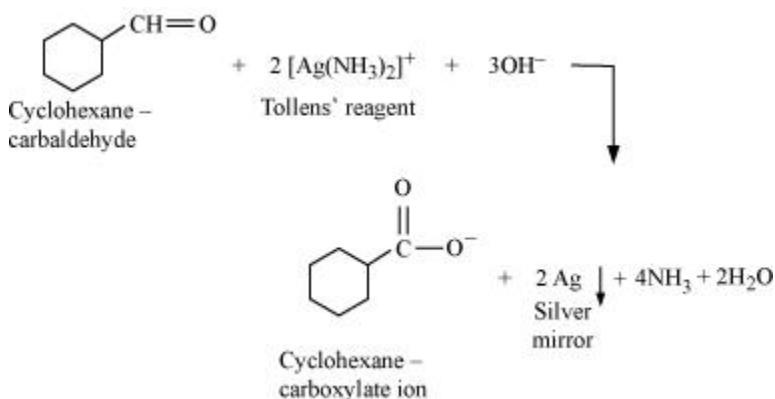
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Answer

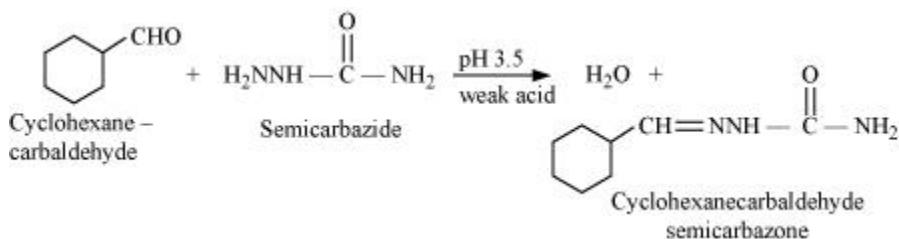
(i)



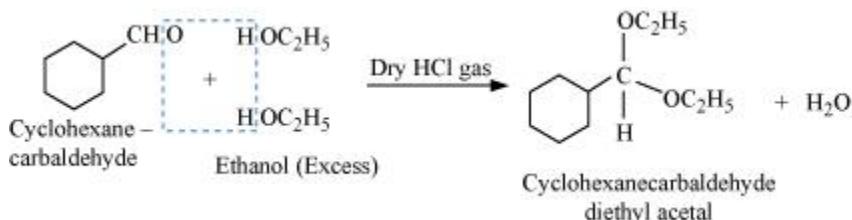
(ii)



(iii)

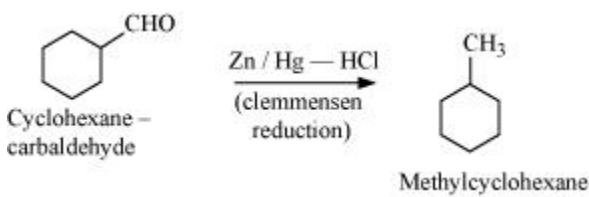


(iv)



(v)

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Question 12.7:

Which of the following compounds would undergo aldol condensation, which the Cannizzaro reaction and which neither? Write the structures of the expected products of aldol condensation and Cannizzaro reaction.

- (i) Methanal (ii) 2-Methylpentanal
- (iii) Benzaldehyde (iv) Benzophenone
- (v) Cyclohexanone (vi) 1-Phenylpropanone
- (vii) Phenylacetaldehyde (viii) Butan-1-ol
- (ix) 2, 2-Dimethylbutanal

Answer

Aldehydes and ketones having at least one α -hydrogen undergo aldol condensation. The compounds (ii) 2-methylpentanal, (v) cyclohexanone, (vi) 1-phenylpropanone, and (vii) phenylacetaldehyde contain one or more α -hydrogen atoms. Therefore, these undergo aldol condensation.

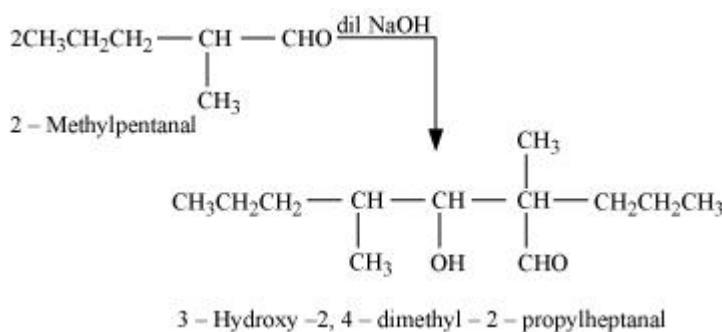
Aldehydes having no α -hydrogen atoms undergo Cannizzaro reactions. The compounds (i) Methanal, (iii) Benzaldehyde, and (ix) 2, 2-dimethylbutanal do not have any α -hydrogen. Therefore, these undergo cannizzaro reactions.

Compound (iv) Benzophenone is a ketone having no α -hydrogen atom and compound (viii) Butan-1-ol is an alcohol. Hence, these compounds do not undergo either aldol condensation or cannizzaro reactions.

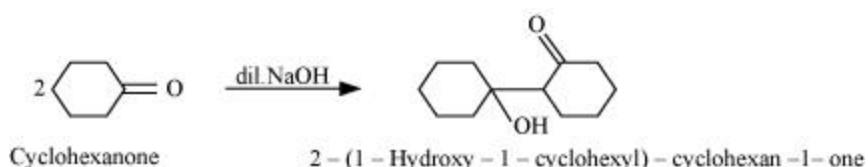
Aldol condensation

- (ii)

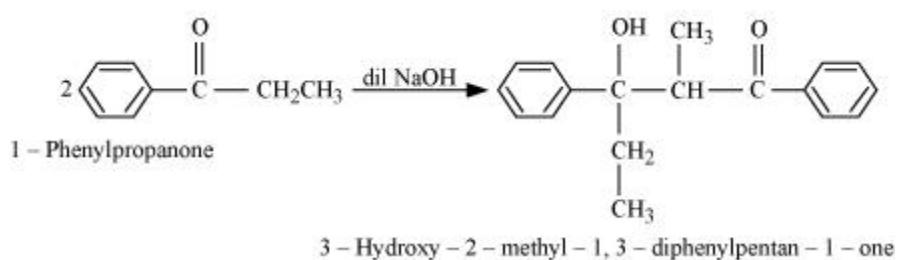
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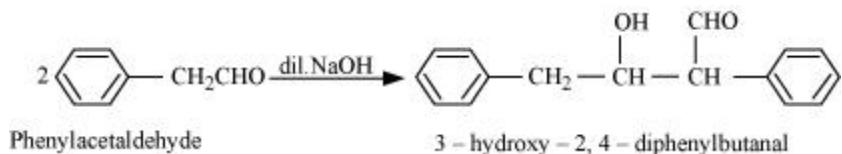
(v)



(vi)

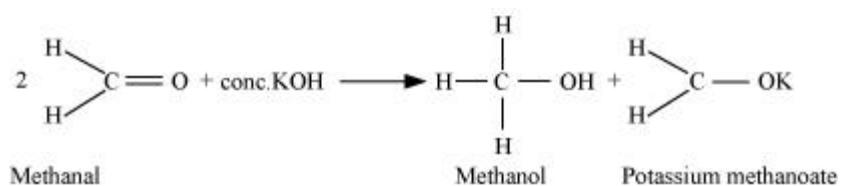


(vii)



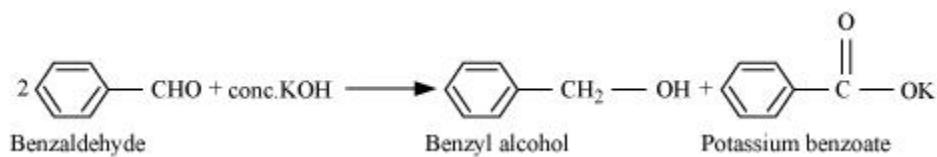
Cannizzaro reaction

(i)

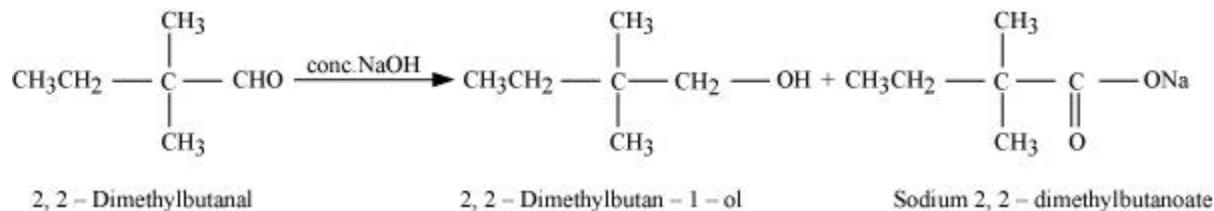


(iii)

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(ix)



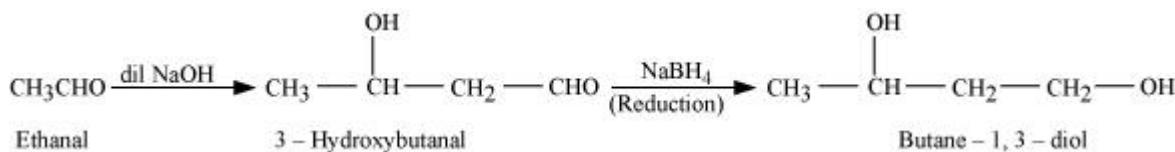
Question 12.8:

How will you convert ethanal into the following compounds?

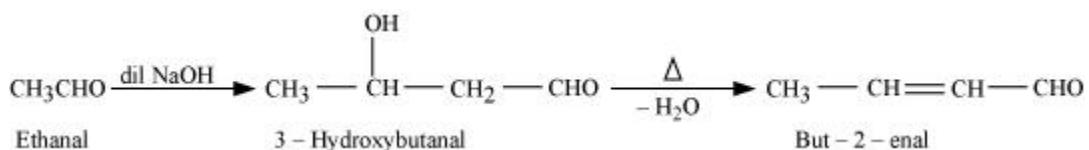
- (i)** Butane-1, 3-diol **(ii)** But-2-enal **(iii)** But-2-enoic acid

Answer

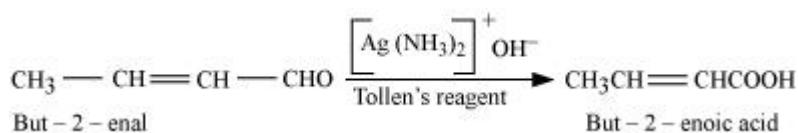
- (i)** On treatment with dilute alkali, ethanal produces 3-hydroxybutanal gives butane-1, 3-diol on reduction.



- (ii)** On treatment with dilute alkali, ethanal gives 3-hydroxybutanal which on heating produces but-2-enal.



- (iii)** When treated with Tollen's reagent, But-2-enal produced in the above reaction produces but-2-enoic acid .



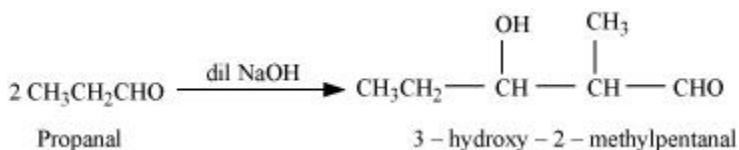
Question 12.9:

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

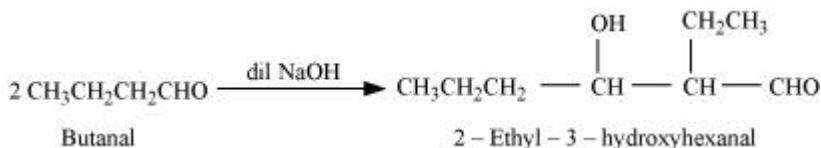
Write structural formulas and names of four possible aldol condensation products from propanal and butanal. In each case, indicate which aldehyde acts as nucleophile and which as electrophile.

Answer

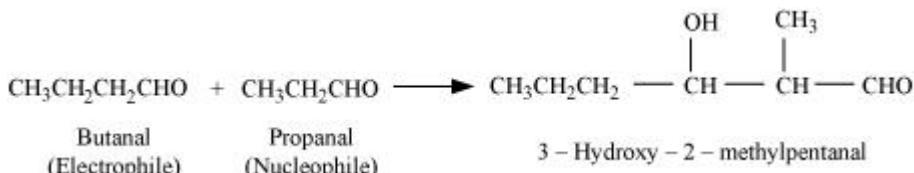
(i) Taking two molecules of propanal, one which acts as a nucleophile and the other as an electrophile.



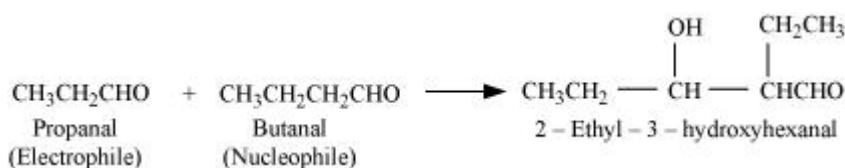
(ii) Taking two molecules of butanal, one which acts as a nucleophile and the other as an electrophile.



(iii) Taking one molecule each of propanal and butanal in which propanal acts as a nucleophile and butanal acts as an electrophile.



(iv) Taking one molecule each of propanal and butanal in which propanal acts as an electrophile and butanal acts as a nucleophile.



Question 12.10:

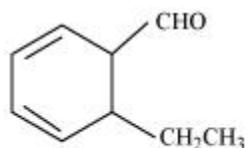
An organic compound with the molecular formula $C_9H_{10}O$ forms 2, 4-DNP derivative, reduces Tollens' reagent and undergoes Cannizzaro reaction. On vigorous oxidation, it gives 1, 2-benzenedicarboxylic acid. Identify the compound.

Answer

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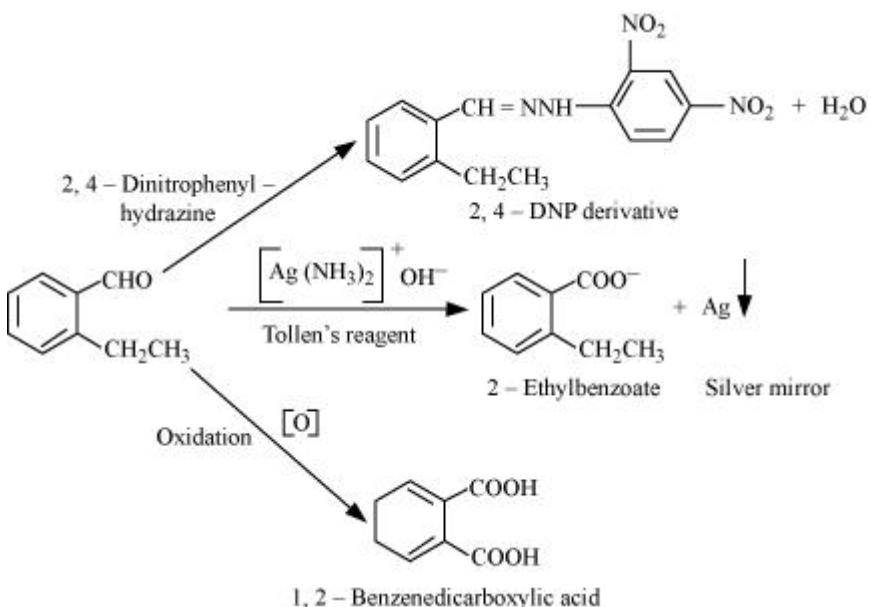
It is given that the compound (with molecular formula $C_9H_{10}O$) forms 2, 4-DNP derivative and reduces Tollen's reagent. Therefore, the given compound must be an aldehyde.

Again, the compound undergoes cannizzaro reaction and on oxidation gives 1, 2-benzenedicarboxylic acid. Therefore, the $-CHO$ group is directly attached to a benzene ring and this benzaldehyde is ortho-substituted. Hence, the compound is 2-ethylbenzaldehyde.



2 – Ethylbenzaldehyde

The given reactions can be explained by the following equations.



Question 12.11:

An organic compound (A) (molecular formula $C_8H_{16}O_2$) was hydrolysed with dilute sulphuric acid to give a carboxylic acid (B) and an alcohol (C). Oxidation of (C) with chromic acid produced (B). (C) on dehydration gives but-1-ene. Write equations for the reactions involved.

Answer

An organic compound A with molecular formula $C_8H_{16}O_2$ gives a carboxylic acid (B) and an alcohol (C) on hydrolysis with dilute sulphuric acid. Thus, compound A must be an ester. Further, alcohol C gives acid B on oxidation with chromic acid. Thus, B and C must contain equal number of carbon atoms.

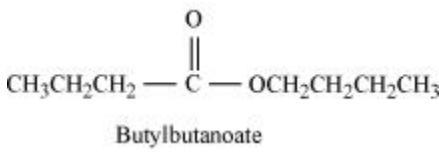
Since compound A contains a total of 8 carbon atoms, each of B and C contain 4 carbon atoms.

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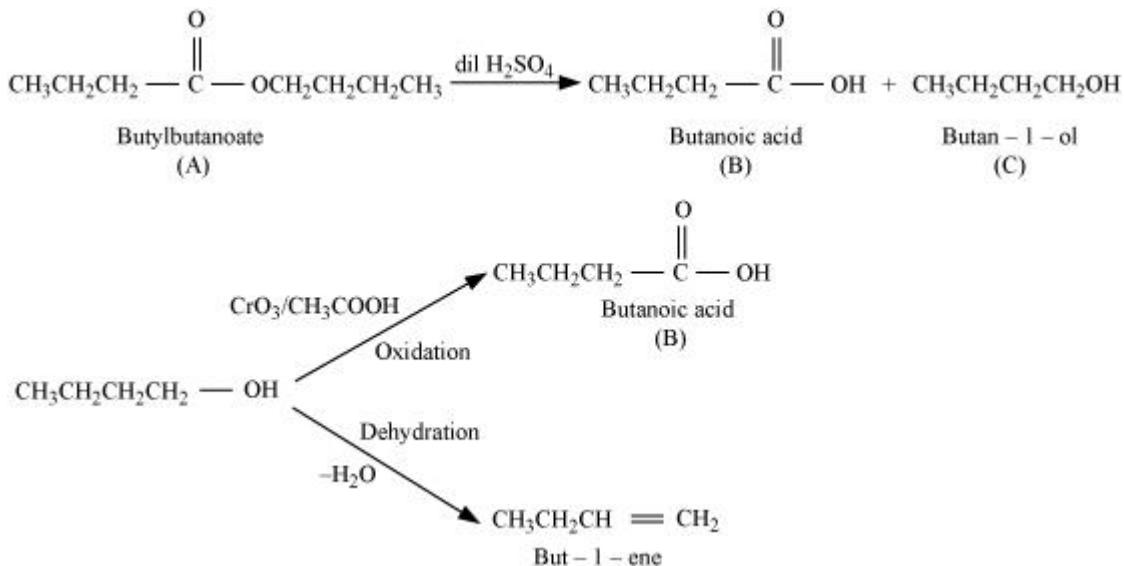
Again, on dehydration, alcohol C gives but-1-ene. Therefore, C is of straight chain and hence, it is butan-1-ol.

On oxidation, Butan-1-ol gives butanoic acid. Hence, acid B is butanoic acid.

Hence, the ester with molecular formula $C_8H_{16}O_2$ is butylbutanoate.



All the given reactions can be explained by the following equations.



Question 12.12:

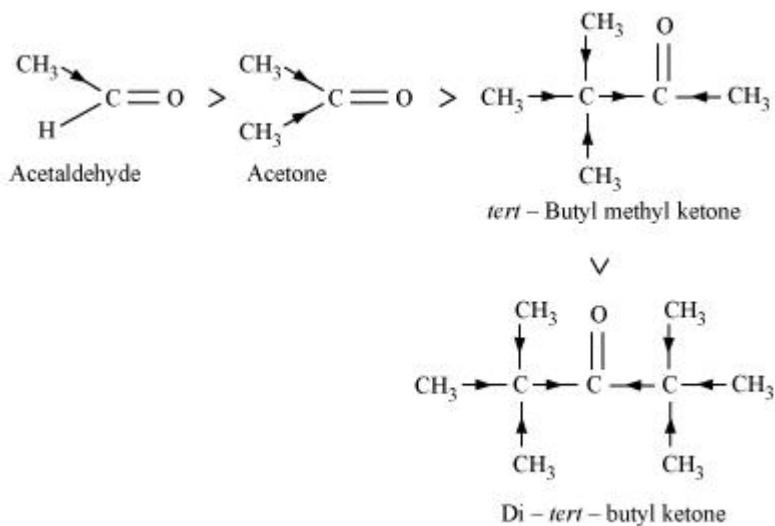
Arrange the following compounds in increasing order of their property as indicated:

- (i) Acetaldehyde, Acetone, Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone (reactivity towards HCN)
- (ii) $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{COOH}$, $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{COOH}$, $(\text{CH}_3)_2\text{CHCOOH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ (acid strength)
- (iii) Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid (acid strength)

Answer

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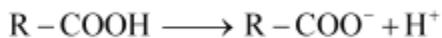
(i) When HCN reacts with a compound, the attacking species is a nucleophile, CN^- . Therefore, as the negative charge on the compound increases, its reactivity with HCN decreases. In the given compounds, the +I effect increases as shown below. It can be observed that steric hindrance also increases in the same



Hence, the given compounds can be arranged according to their increasing reactivities toward HCN as:



(ii) After losing a proton, carboxylic acids gain a negative charge as shown:

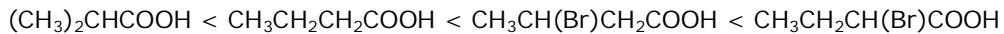


Now, any group that will help stabilise the negative charge will increase the stability of the carboxyl ion and as a result, will increase the strength of the acid. Thus, groups having +I effect will decrease the strength of the acids and groups having -I effect will increase the strength of the acids. In the given compounds, $-\text{CH}_3$ group has +I effect and Br^- group has -I effect. Thus, acids containing Br^- are stronger.

Now, the +I effect of isopropyl group is more than that of *n*-propyl group. Hence, $(\text{CH}_3)_2\text{CHCOOH}$ is a weaker acid than $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$.

Also, the -I effect grows weaker as distance increases. Hence, $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{COOH}$ is a weaker acid than $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{COOH}$.

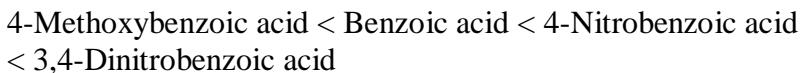
Hence, the strengths of the given acids increase as:



(iii) As we have seen in the previous case, electron-donating groups decrease the strengths of acids, while electron-withdrawing groups increase the strengths of acids. As methoxy group is an electron-donating group, 4-methoxybenzoic acid is a weaker acid than benzoic acid. Nitro group is an electron-withdrawing group and will increase the strengths of acids. As 3,4-

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dinitrobenzoic acid contains two nitro groups, it is a slightly stronger acid than 4-nitrobenzoic acid. Hence, the strengths of the given acids increase as:



Question 12.13:

Give simple chemical tests to distinguish between the following pairs of compounds.

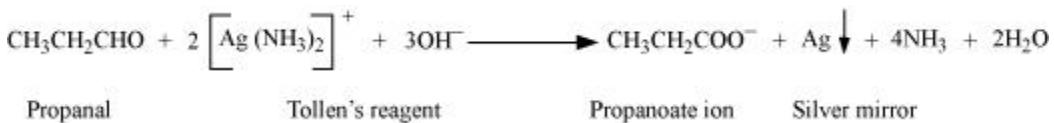
- (i) Propanal and Propanone
- (ii) Acetophenone and Benzophenone
- (iii) Phenol and Benzoic acid
- (iv) Benzoic acid and Ethyl benzoate
- (v) Pentan-2-one and Pentan-3-one
- (vi) Benzaldehyde and Acetophenone
- (vii) Ethanal and Propanal

Answer

(i) Propanal and propanone can be distinguished by the following tests.

(a) Tollen's test

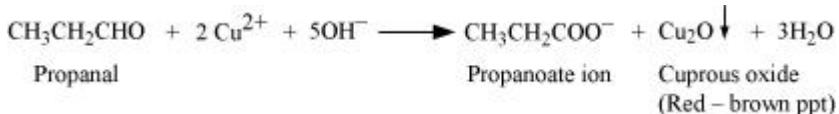
Propanal is an aldehyde. Thus, it reduces Tollen's reagent. But, propanone being a ketone does not reduce Tollen's reagent.



(b) Fehling's test

Aldehydes respond to Fehling's test, but ketones do not.

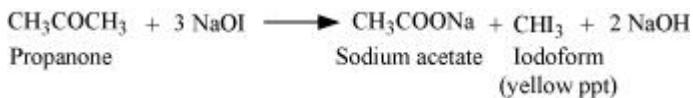
Propanal being an aldehyde reduces Fehling's solution to a red-brown precipitate of Cu_2O , but propanone being a ketone does not.



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(c) Iodoform test:

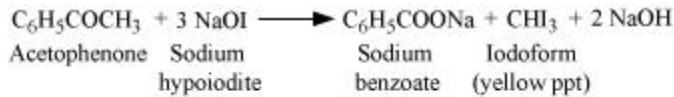
Aldehydes and ketones having at least one methyl group linked to the carbonyl carbon atom respond to iodoform test. They are oxidized by sodium hypoiodite (NaOI) to give iodoforms. Propanone being a methyl ketone responds to this test, but propanal does not.



(ii) Acetophenone and Benzophenone can be distinguished using the iodoform test.

Iodoform test:

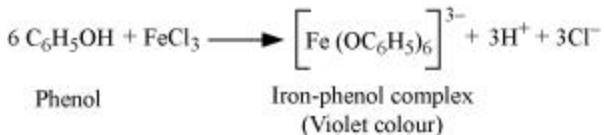
Methyl ketones are oxidized by sodium hypoiodite to give yellow ppt. of iodoform. Acetophenone being a methyl ketone responds to this test, but benzophenone does not.



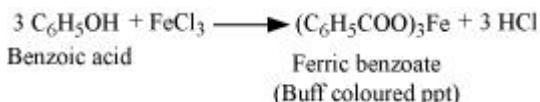
(iii) Phenol and benzoic acid can be distinguished by ferric chloride test.

Ferric chloride test:

Phenol reacts with neutral FeCl_3 to form an iron-phenol complex giving violet colouration.



But benzoic acid reacts with neutral FeCl_3 to give a buff coloured ppt. of ferric benzoate.



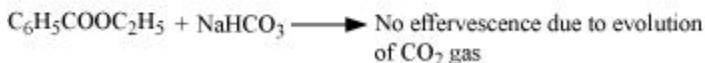
(iv) Benzoic acid and Ethyl benzoate can be distinguished by sodium bicarbonate test.

Sodium bicarbonate test:

Acids react with NaHCO_3 to produce brisk effervescence due to the evolution of CO_2 gas.

Benzoic acid being an acid responds to this test, but ethylbenzoate does not.

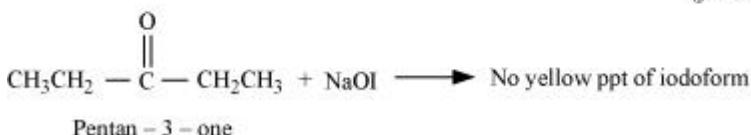
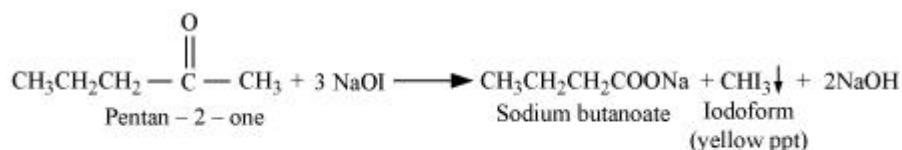
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



(v) Pentan-2-one and pentan-3-one can be distinguished by iodoform test.

Iodoform test:

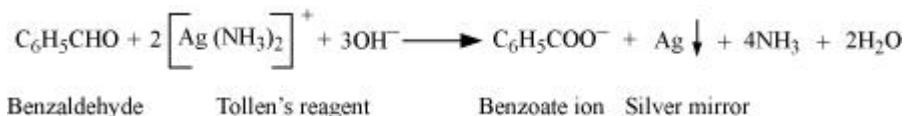
Pentan-2-one is a methyl ketone. Thus, it responds to this test. But pentan-3-one not being a methyl ketone does not respond to this test.



(vi) Benzaldehyde and acetophenone can be distinguished by the following tests.

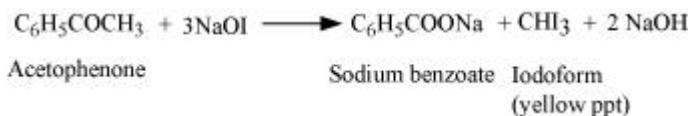
(a) Tollen's Test

Aldehydes respond to Tollen's test. Benzaldehyde being an aldehyde reduces Tollen's reagent to give a red-brown precipitate of Cu_2O , but acetophenone being a ketone does not.



(b) Iodoform test

Acetophenone being a methyl ketone undergoes oxidation by sodium hypoiodite ($\text{NaO}I$) to give a yellow ppt. of iodoform. But benzaldehyde does not respond to this test.

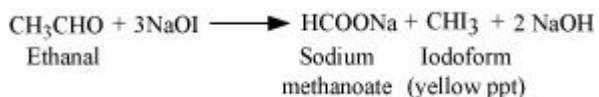


(vii) Ethanal and propanal can be distinguished by iodoform test.

Iodoform test

Aldehydes and ketones having at least one methyl group linked to the carbonyl carbon atom responds to the iodoform test. Ethanal having one methyl group linked to the carbonyl carbon atom responds to this test. But propanal does not have a methyl group linked to the carbonyl carbon atom and thus, it does not respond to this state.

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



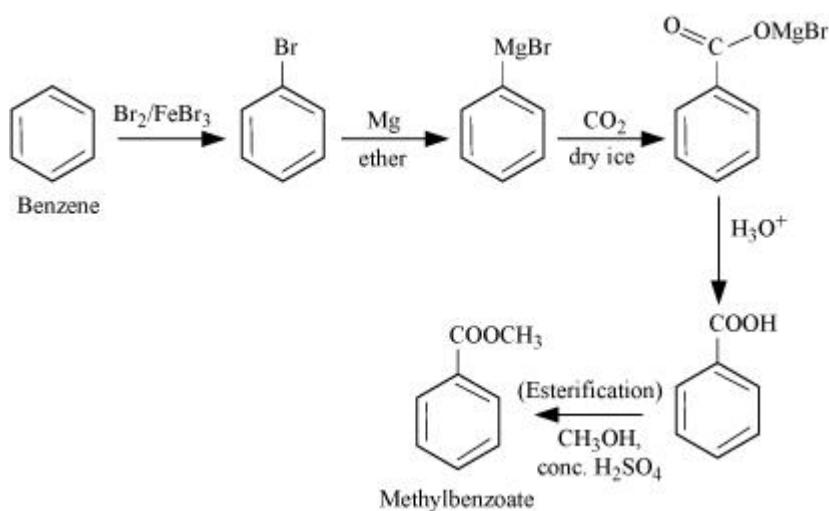
Question 12.14:

How will you prepare the following compounds from benzene? You may use any inorganic reagent and any organic reagent having not more than one carbon atom

- (i) Methyl benzoate (ii) *m*-Nitrobenzoic acid
- (iii) *p*-Nitrobenzoic acid (iv) Phenylacetic acid
- (v) *p*-Nitrobenzaldehyde.

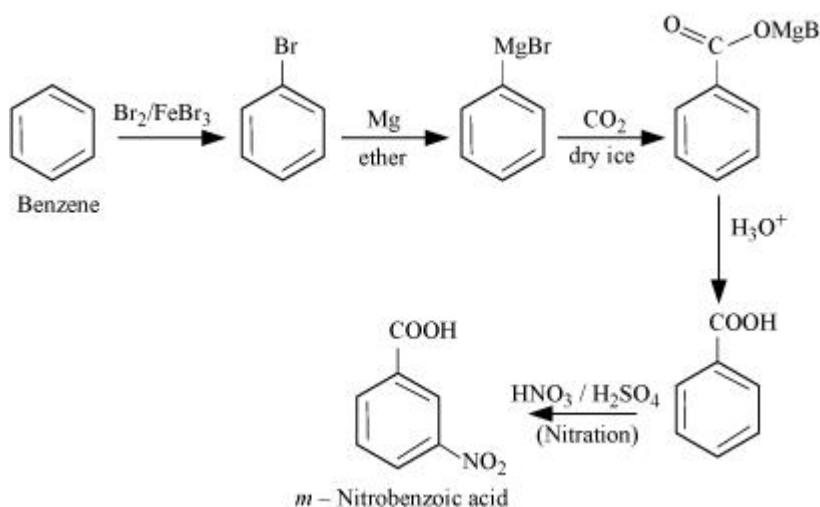
Answer

(i)

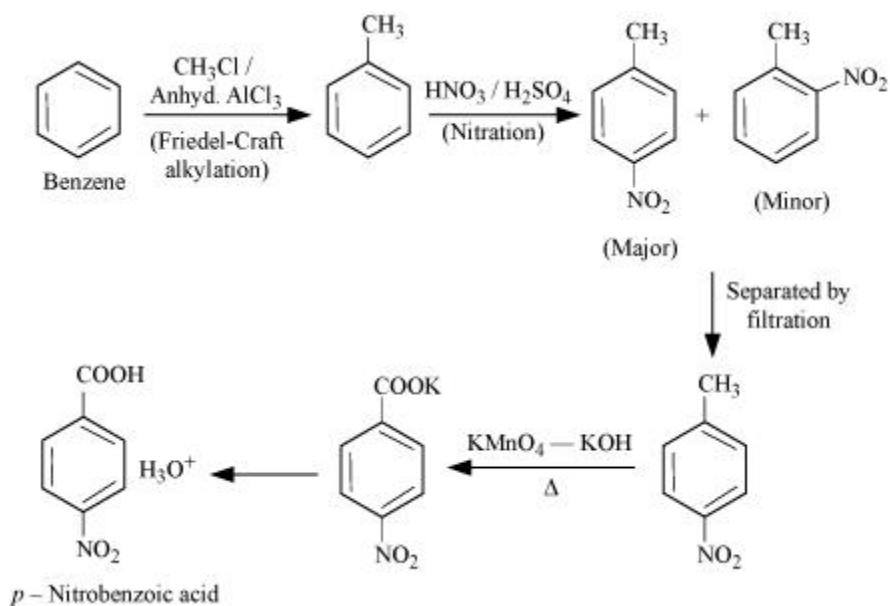


(ii)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

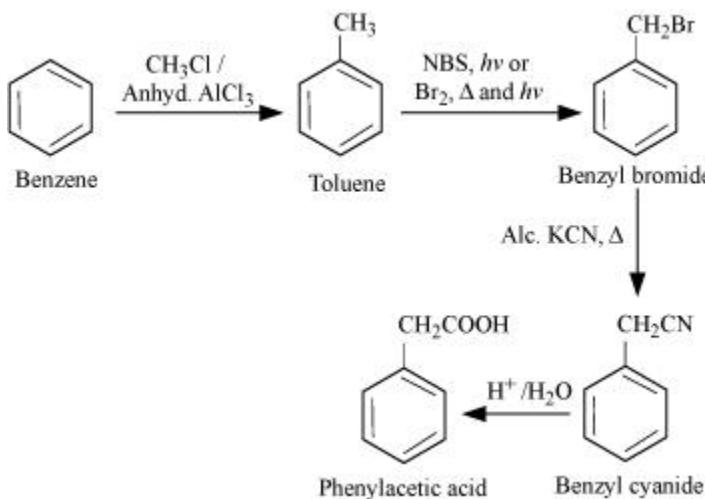


(iii)

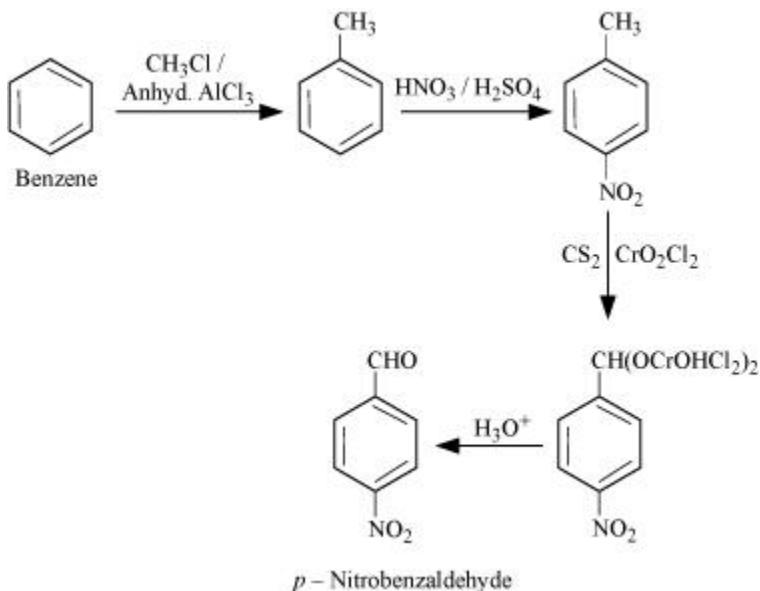


(iv)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



(v)



Question 12.15:

How will you bring about the following conversions in not more than two steps?

- (i) Propanone to Propene
- (ii) Benzoic acid to Benzaldehyde
- (iii) Ethanol to 3-Hydroxybutanal
- (iv) Benzene to *m*-Nitroacetophenone

ALDEHYDE, KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

(v) Benzaldehyde to Benzophenone

(vi) Bromobenzene to 1-Phenylethanol

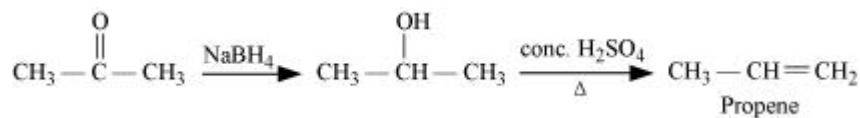
(vii) Benzaldehyde to 3-Phenylpropan-1-ol

(viii) Benazaldehyde to α -Hydroxyphenylacetic acid

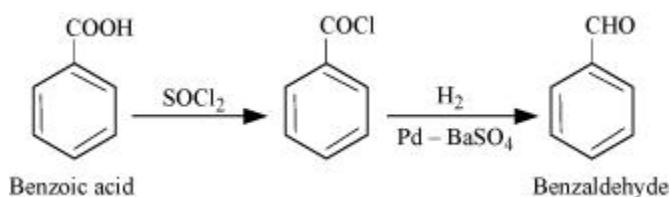
(ix) Benzoic acid to *m*- Nitrobenzyl alcohol

Answer

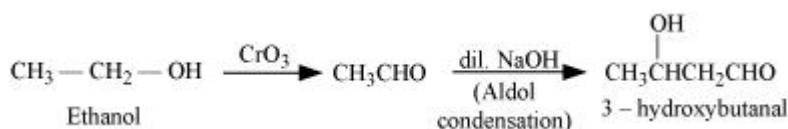
(i)



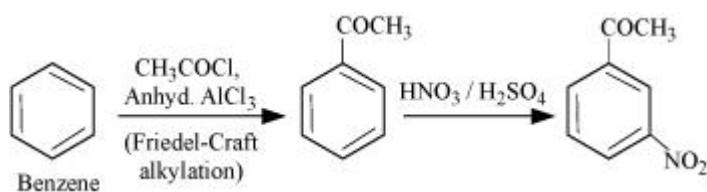
(ii)



(iii)

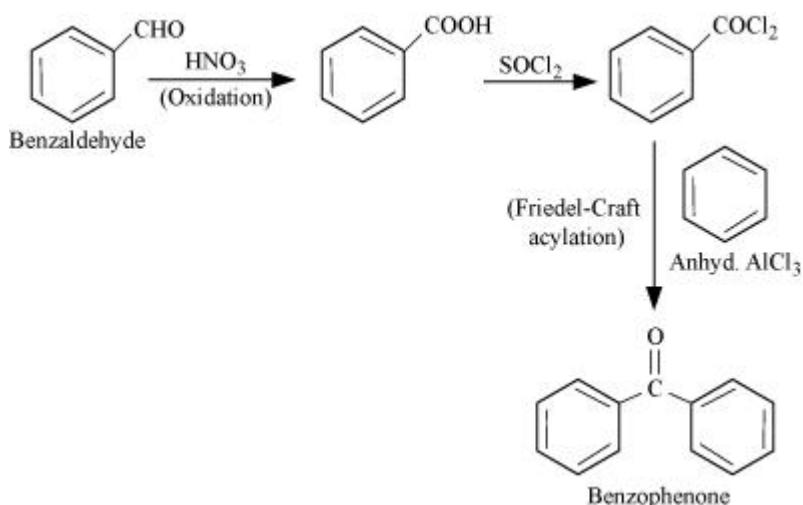


(iv)

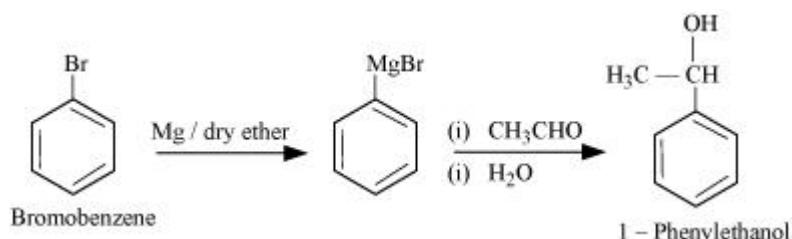


(v)

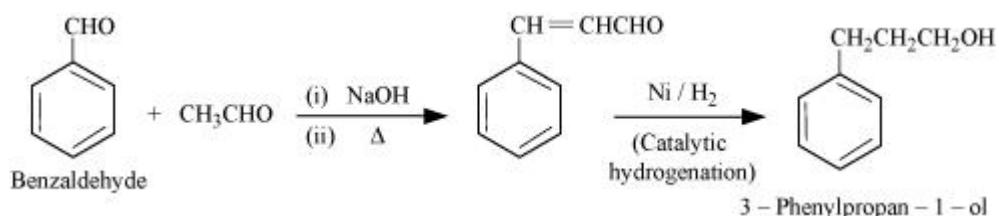
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



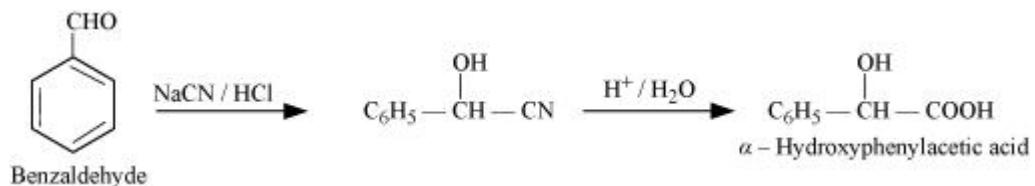
(vi)



(vii)

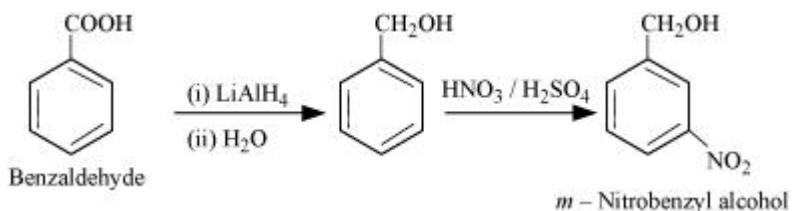


(viii)



(ix)

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



Question 12.16:

Describe the following:

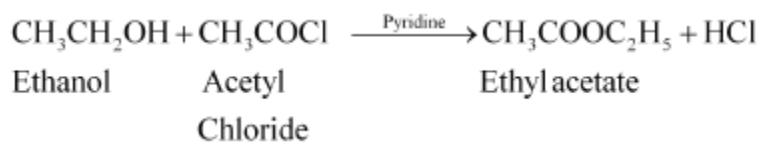
- (i) Acetylation
- (ii) Cannizzaro reaction
- (iii) Cross aldol condensation
- (iv) Decarboxylation

Answer

(i) Acetylation

The introduction of an acetyl functional group into an organic compound is known as acetylation. It is usually carried out in the presence of a base such as pyridine, diisopropylethylamine, etc. This process involves the substitution of an acetyl group for an active hydrogen atom. Acetyl chloride and acetic anhydride are commonly used as acetylating agents.

For example, acetylation of ethanol produces ethyl acetate.

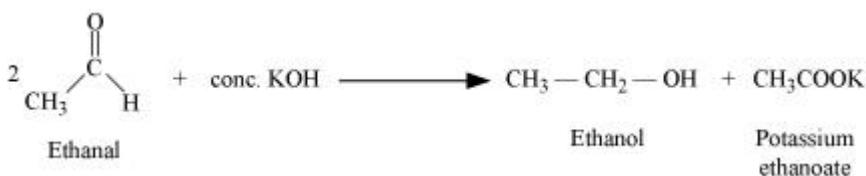


(ii) Cannizzaro reaction:

The self oxidation-reduction (disproportionation) reaction of aldehydes having no α -hydrogens on treatment with concentrated alkalis is known as the Cannizzaro reaction. In this reaction, two molecules of aldehydes participate where one is reduced to alcohol and the other is oxidized to carboxylic acid.

For example, when ethanol is treated with concentrated potassium hydroxide, ethanol and potassium ethanoate are produced.

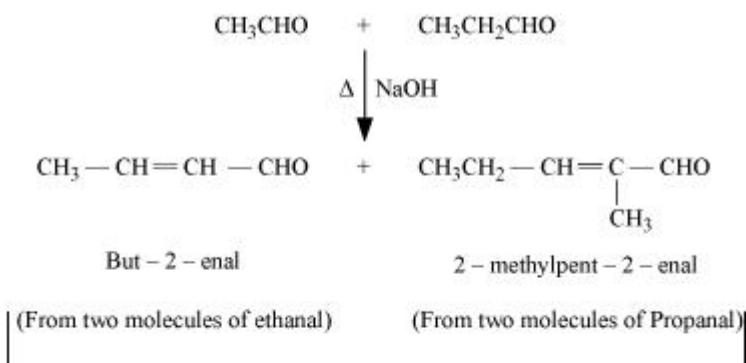
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



(iii) Cross-alcohol condensation:

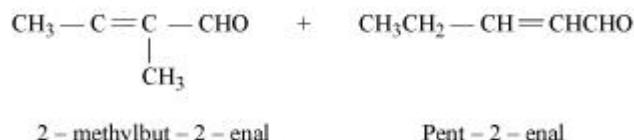
When aldol condensation is carried out between two different aldehydes, or two different ketones, or an aldehyde and a ketone, then the reaction is called a cross-alcohol condensation. If both the reactants contain α -hydrogens, four compounds are obtained as products.

For example, ethanal and propanal react to give four products.



Self-alcohol products

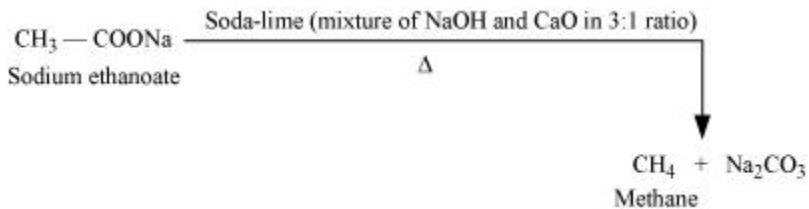
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Cross-alcohol products

(iv) Decarboxylation:

Decarboxylation refers to the reaction in which carboxylic acids lose carbon dioxide to form hydrocarbons when their sodium salts are heated with soda-lime.



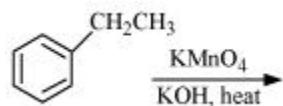
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

Decarboxylation also takes place when aqueous solutions of alkali metal salts of carboxylic acids are electrolyzed. This electrolytic process is known as Kolbe's electrolysis.

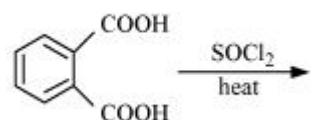
Question 12.17:

Complete each synthesis by giving missing starting material, reagent or products

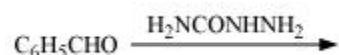
(i)



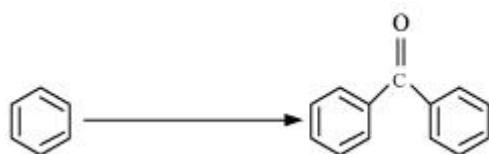
(ii)



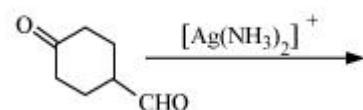
(iii)



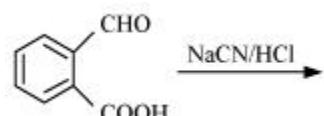
(iv)



(v)

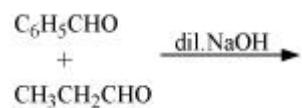


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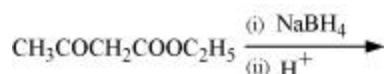


ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

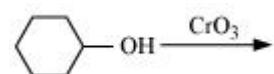
(vii)



(viii)



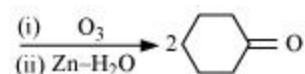
(ix)



(x)

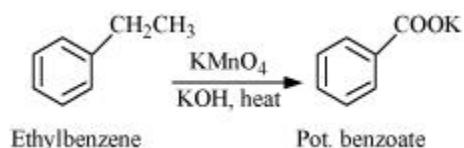


(xi)

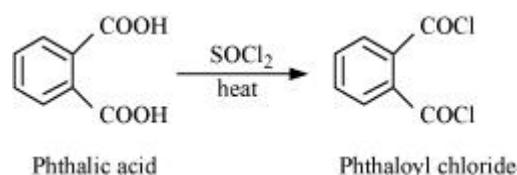


Answer

(i)



(ii)

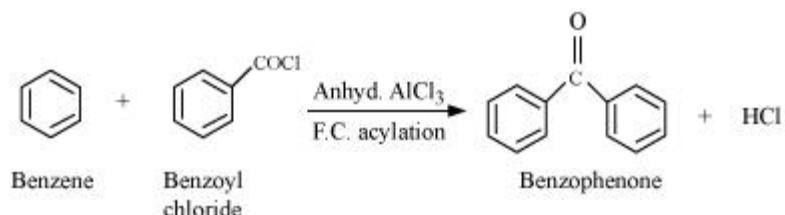


(iii)

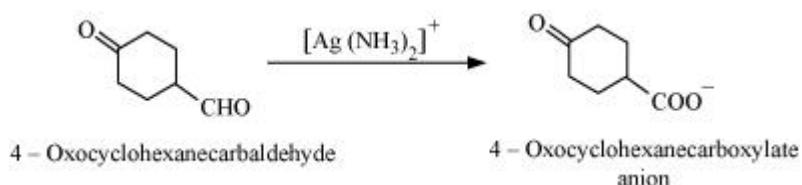
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



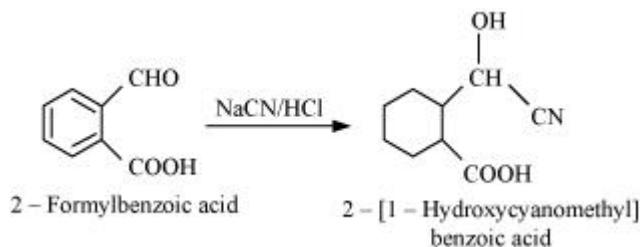
(iv)



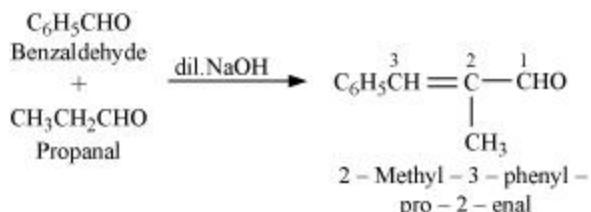
(v)



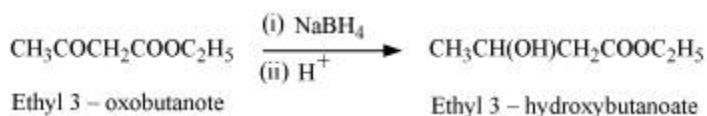
(vi)



(vii)

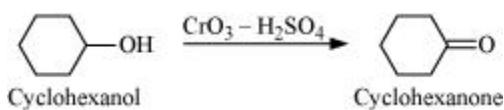


(viii)

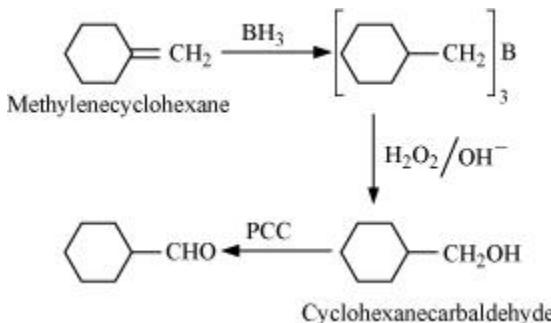


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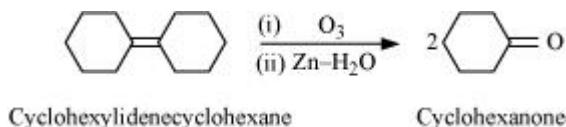
ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION



(x)



(xi)



Question 12.18:

Give plausible explanation for each of the following:

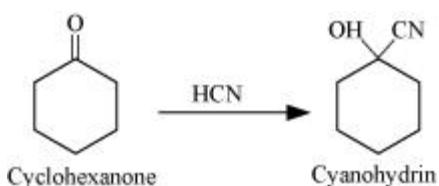
(i) Cyclohexanone forms cyanohydrin in good yield but 2, 2, 6 trimethylcyclohexanone does not.

(ii) There are two $-\text{NH}_2$ groups in semicarbazide. However, only one is involved in the formation of semicarbazones.

(iii) During the preparation of esters from a carboxylic acid and an alcohol in the presence of an acid catalyst, the water or the ester should be removed as soon as it is formed.

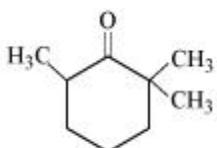
Answer

(i) Cyclohexanones form cyanohydrins according to the following equation.



ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

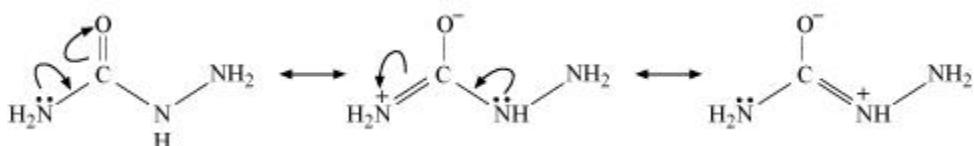
In this case, the nucleophile CN^- can easily attack without any steric hindrance. However, in the case of 2, 2, 6 trimethylcyclohexanone, methyl groups at α -positions offer steric hindrances and as a result, CN^- cannot attack effectively.



2, 2, 6 – Trimethylcyclohexanone

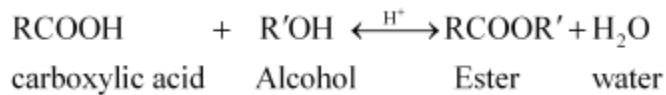
For this reason, it does not form a cyanohydrin.

(ii) Semicarbazide undergoes resonance involving only one of the two $-\text{NH}_2$ groups, which is attached directly to the carbonyl-carbon atom.



Therefore, the electron density on $-\text{NH}_2$ group involved in the resonance also decreases. As a result, it cannot act as a nucleophile. Since the other $-\text{NH}_2$ group is not involved in resonance; it can act as a nucleophile and can attack carbonyl-carbon atoms of aldehydes and ketones to produce semicarbazones.

(iii) Ester along with water is formed reversibly from a carboxylic acid and an alcohol in presence of an acid.



If either water or ester is not removed as soon as it is formed, then it reacts to give back the reactants as the reaction is reversible. Therefore, to shift the equilibrium in the forward direction i.e., to produce more ester, either of the two should be removed.

Question 12.19:

An organic compound contains 69.77% carbon, 11.63% hydrogen and rest oxygen. The molecular mass of the compound is 86. It does not reduce Tollens' reagent but forms an addition compound with sodium hydrogensulphite and give positive iodoform test. On vigorous oxidation it gives ethanoic and propanoic acid. Write the possible structure of the compound.

Answer

$$\% \text{ of carbon} = 69.77 \%$$

$$\% \text{ of hydrogen} = 11.63 \%$$

$$\% \text{ of oxygen} = \{100 - (69.77 + 11.63)\}\%$$

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

$$= 18.6 \%$$

Thus, the ratio of the number of carbon, hydrogen, and oxygen atoms in the organic compound can be given as:

$$\text{C:H:O} = \frac{69.77}{12} : \frac{11.63}{1} : \frac{18.6}{16}$$

$$= 5.81 : 11.63 : 1.16$$

$$= 5 : 10 : 1$$

Therefore, the empirical formula of the compound is $\text{C}_5\text{H}_{10}\text{O}$. Now, the empirical formula mass of the compound can be given as:

$$5 \times 12 + 10 \times 1 + 1 \times 16$$

$$= 86$$

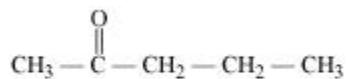
Molecular mass of the compound = 86

Therefore, the molecular formula of the compound is given by $\text{C}_5\text{H}_{10}\text{O}$.

Since the given compound does not reduce Tollen's reagent, it is not an aldehyde. Again, the compound forms sodium hydrogen sulphate addition products and gives a positive iodoform test. Since the compound is not an aldehyde, it must be a methyl ketone.

The given compound also gives a mixture of ethanoic acid and propanoic acid.

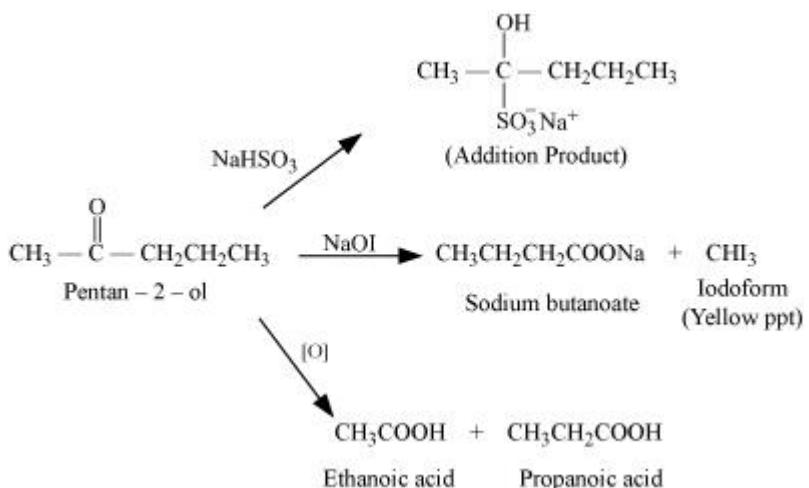
Hence, the given compound is pentan-2-ol.



Pentan - 2 - ol

The given reactions can be explained by the following equations:

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

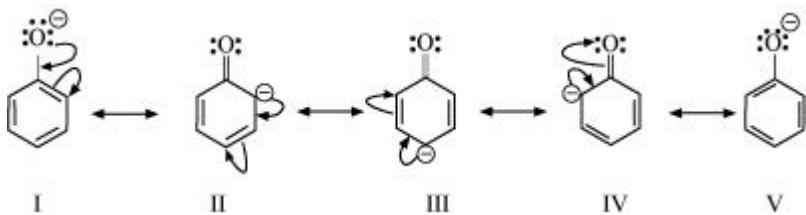


Question 12.20:

Although phenoxide ion has more number of resonating structures than carboxylate ion, carboxylic acid is a stronger acid than phenol. Why?

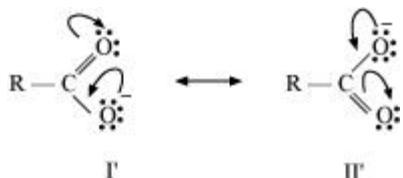
Answer

Resonance structures of phenoxide ion are:



It can be observed from the resonance structures of phenoxide ion that in II, III and IV, less electronegative carbon atoms carry a negative charge. Therefore, these three structures contribute negligibly towards the resonance stability of the phenoxide ion. Hence, these structures can be eliminated. Only structures I and V carry a negative charge on the more electronegative oxygen atom.

Resonance structures of carboxylate ion are:



In the case of carboxylate ion, resonating structures I' and II' contain a charge carried by a more electronegative oxygen atom.

Further, in resonating structures I' and II', the negative charge is delocalized over two oxygen atoms. But in resonating structures I and V of the phexoxide ion, the negative charge is

ALDEHYDE , KETONES AND CARBOXYLIC ACID : NCERT SOLUTION

localized on the same oxygen atom. Therefore, the resonating structures of carboxylate ion contribute more towards its stability than those of phenoxide ion. As a result, carboxylate ion is more resonance-stabilized than phenoxide ion. Hence, carboxylic acid is a stronger acid than phenol.

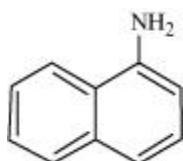
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

AMINES

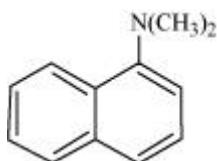
Question 13.1:

Classify the following amines as primary, secondary or tertiary:

(i)



(ii)



(iii) $(C_2H_5)_2CHNH_2$

(iv) $(C_2H_5)_2NH$

Answer

Primary: (i) and (iii)

Secondary: (iv)

Tertiary: (ii)

Question 13.2:

(i) Write structures of different isomeric amines corresponding to the molecular formula, $C_4H_{11}N$

(ii) Write IUPAC names of all the isomers.

(iii) What type of isomerism is exhibited by different pairs of amines?

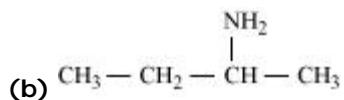
Answer

(i), (ii) The structures and their IUPAC names of different isomeric amines corresponding to the molecular formula, $C_4H_{11}N$ are given below:

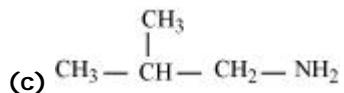
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(a) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-NH}_2$

Butanamine (1°)

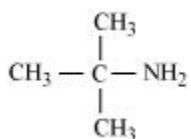


Butan-2-amine (1°)



2-Methylpropanamine (1°)

(d)



2-Methylpropan-2-amine (1°)

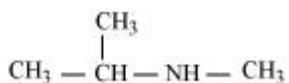
(e) $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-NH-CH}_3$

N-Methylpropanamine (2°)

(f) $\text{CH}_3\text{-CH}_2\text{-NH-CH}_2\text{-CH}_3$

N-Ethylethanamine (2°)

(g)



N-Methylpropan-2-amine (2°)

(h)



N,N-Dimethylethanamine (3°)

(iii) The pairs (a) and (b) and (e) and (g) exhibit position isomerism.

The pairs (a) and (c); (a) and (d); (b) and (c); (b) and (d) exhibit chain isomerism.

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The pairs (e) and (f) and (f) and (g) exhibit metamerism.

All primary amines exhibit functional isomerism with secondary and tertiary amines and vice-versa.

Question 13.3:

How will you convert?

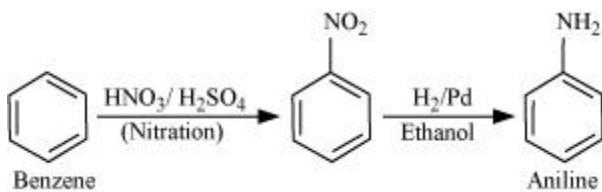
(i) Benzene into aniline

(ii) Benzene into N, N-dimethylaniline

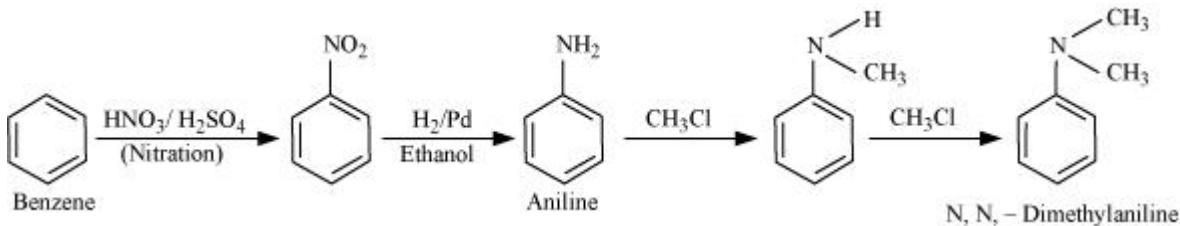
(iii) Cl-(CH₂)₄-Cl into hexan-1, 6-diamine?

Answer

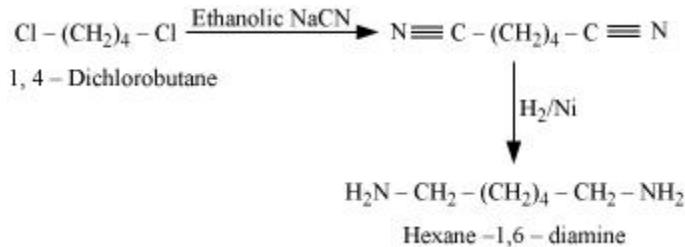
(i)



(ii)



(iii)



Question 13.4:

Arrange the following in increasing order of their basic strength:

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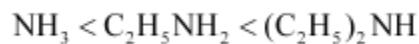
(i) $\text{C}_2\text{H}_5\text{NH}_2$, $\text{C}_6\text{H}_5\text{NH}_2$, NH_3 , $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ and $(\text{C}_2\text{H}_5)_2\text{NH}$

(ii) $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_2\text{NH}$, $(\text{C}_2\text{H}_5)_3\text{N}$, $\text{C}_6\text{H}_5\text{NH}_2$

(iii) CH_3NH_2 , $(\text{CH}_3)_2\text{NH}$, $(\text{CH}_3)_3\text{N}$, $\text{C}_6\text{H}_5\text{NH}_2$, $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$.

Answer

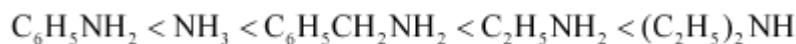
(i) Considering the inductive effect of alkyl groups, NH_3 , $\text{C}_2\text{H}_5\text{NH}_2$, and $(\text{C}_2\text{H}_5)_2\text{NH}$ can be arranged in the increasing order of their basic strengths as:



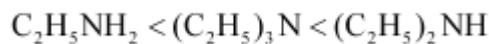
Again, $\text{C}_6\text{H}_5\text{NH}_2$ has proton acceptability less than NH_3 . Thus, we have:



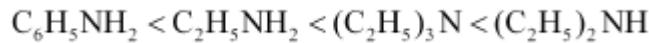
Due to the $-I$ effect of C_6H_5 group, the electron density on the N-atom in $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ is lower than that on the N-atom in $\text{C}_2\text{H}_5\text{NH}_2$, but more than that in NH_3 . Therefore, the given compounds can be arranged in the order of their basic strengths as:



(ii) Considering the inductive effect and the steric hindrance of the alkyl groups, $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_2\text{NH}_2$, and their basic strengths as follows:



Again, due to the $-R$ effect of C_6H_5 group, the electron density on the N atom in $\text{C}_6\text{H}_5\text{NH}_2$ is lower than that on the N atom in $\text{C}_2\text{H}_5\text{NH}_2$. Therefore, the basicity of $\text{C}_6\text{H}_5\text{NH}_2$ is lower than that of $\text{C}_2\text{H}_5\text{NH}_2$. Hence, the given compounds can be arranged in the increasing order of their basic strengths as follows:



(iii) Considering the inductive effect and the steric hindrance of alkyl groups, CH_3NH_2 , $(\text{CH}_3)_2\text{NH}$, and $(\text{CH}_3)_3\text{N}$ can be arranged in the increasing order of their basic strengths as:



AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

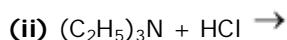
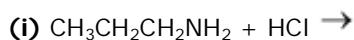
In $C_6H_5NH_2$, N is directly attached to the benzene ring. Thus, the lone pair of electrons on the N-atom is delocalized over the benzene ring. In $C_6H_5CH_2NH_2$, N is not directly attached to the benzene ring. Thus, its lone pair is not delocalized over the benzene ring. Therefore, the electrons on the N atom are more easily available for protonation in $C_6H_5CH_2NH_2$ than in $C_6H_5NH_2$ i.e., $C_6H_5CH_2NH_2$ is more basic than $C_6H_5NH_2$.

Again, due to the $-I$ effect of C_6H_5 group, the electron density on the N-atom in $C_6H_5CH_2NH_2$ is lower than that on the N-atom in $(CH_3)_3N$. Therefore, $(CH_3)_3N$ is more basic than $C_6H_5CH_2NH_2$. Thus, the given compounds can be arranged in the increasing order of their basic strengths as follows.

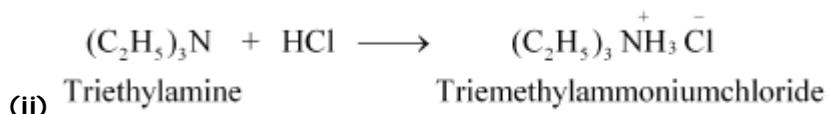
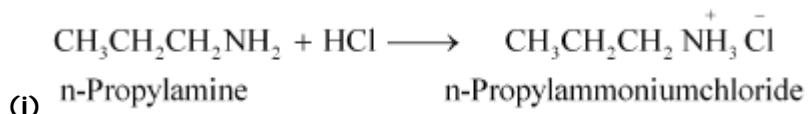


Question 13.5:

Complete the following acid-base reactions and name the products:



Answer



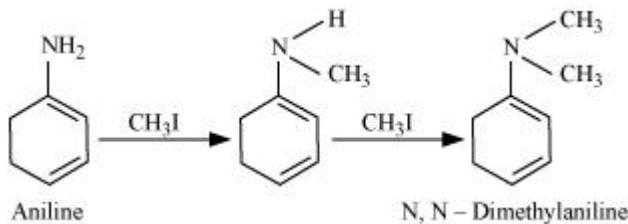
Question 13.6:

Write reactions of the final alkylation product of aniline with excess of methyl

iodide in the presence of sodium carbonate solution.

Answer

Aniline reacts with methyl iodide to produce N, N-dimethylaniline.



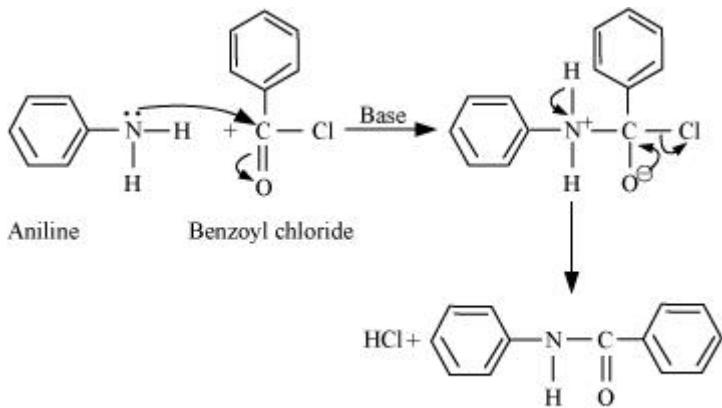
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

With excess methyl iodide, in the presence of Na_2CO_3 solution, N, N-dimethylaniline produces N, N, N-trimethylanilinium carbonate.



Question 13.7:

Write chemical reaction of aniline with benzoyl chloride and write the name of the product obtained.



Answer

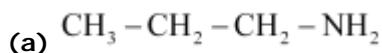
N – Phenylbenzamide

Question 13.8:

Write structures of different isomers corresponding to the molecular formula, $\text{C}_3\text{H}_9\text{N}$. Write IUPAC names of the isomers which will liberate nitrogen gas on treatment with nitrous acid.

Answer

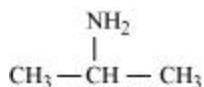
The structures of different isomers corresponding to the molecular formula, $\text{C}_3\text{H}_9\text{N}$ are given below:



AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

Propan-1-amine (1^0)

(b)



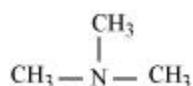
Propan-2-amine (1^0)

(c)



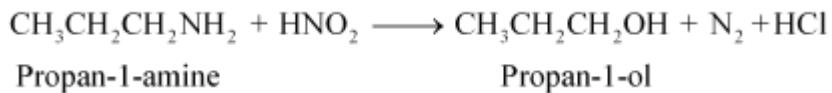
N-Methylethanamine (2^0)

(d)



N,N-Dimethylmethanamine (3^0)

1^0 amines, (a) propan-1-amine, and (b) Propan-2-amine will liberate nitrogen gas on treatment with nitrous acid.



Question 13.9:

Convert

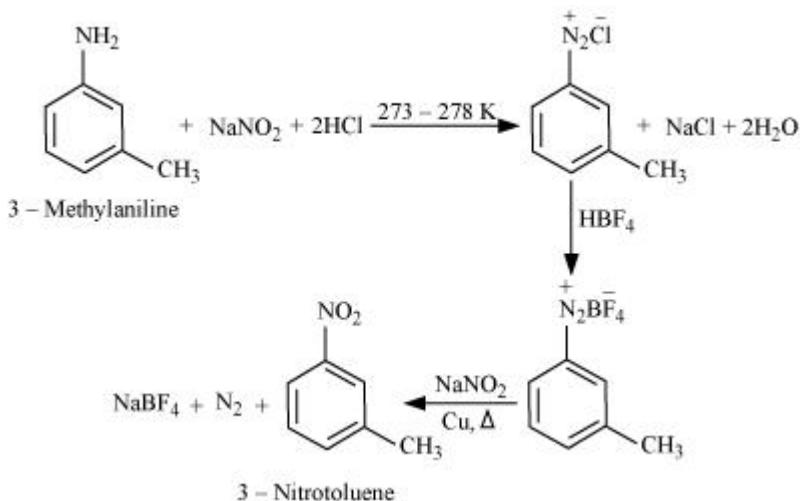
(i) 3-Methylaniline into 3-nitrotoluene.

(ii) Aniline into 1,3,5-tribromobenzene.

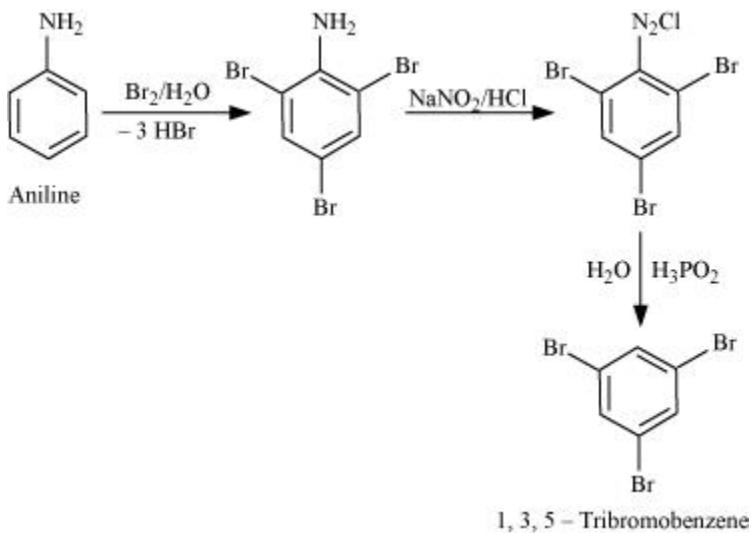
Answer

(i)

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



(ii)



Question 13.1:

Write IUPAC names of the following compounds and classify them into primary, secondary and tertiary amines.

(i) (CH₃)₂CHNH₂ (ii) CH₃(CH₂)₂NH₂

(iii) CH₃NHCH(CH₃)₂ (iv) (CH₃)₃CNH₂

(v) C₆H₅NHCH₃ (vi) (CH₃CH₂)₂NCH₃

(vii) *m*-BrC₆H₄NH₂

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Answer

- (i) 1-Methylethanamine (1^0 amine)
- (ii) Propan-1-amine (1^0 amine)
- (iii) N-Methyl-2-methylethanamine (2^0 amine)
- (iv) 2-Methylpropan-2-amine (1^0 amine)
- (v) N-Methylbenzamine or N-methylaniline (2^0 amine)
- (vi) N-Ethyl-N-methylethanamine (3^0 amine)
- (vii) 3-Bromobenzenamine or 3-bromoaniline (1^0 amine)

Question 13.2:

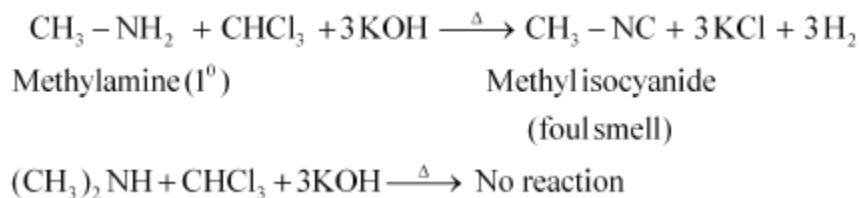
Give one chemical test to distinguish between the following pairs of compounds.

- (i) Methylamine and dimethylamine
- (ii) Secondary and tertiary amines
- (iii) Ethylamine and aniline
- (iv) Aniline and benzylamine
- (v) Aniline and N-methylaniline.

Answer

- (i) Methylamine and dimethylamine can be distinguished by the carbylamine test.

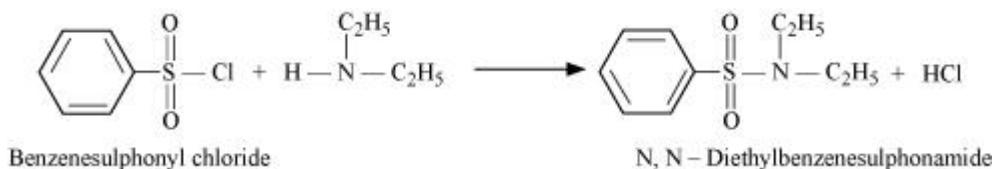
Carbylamine test: Aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form foul-smelling isocyanides or carbylamines. Methylamine (being an aliphatic primary amine) gives a positive carbylamine test, but dimethylamine does not.



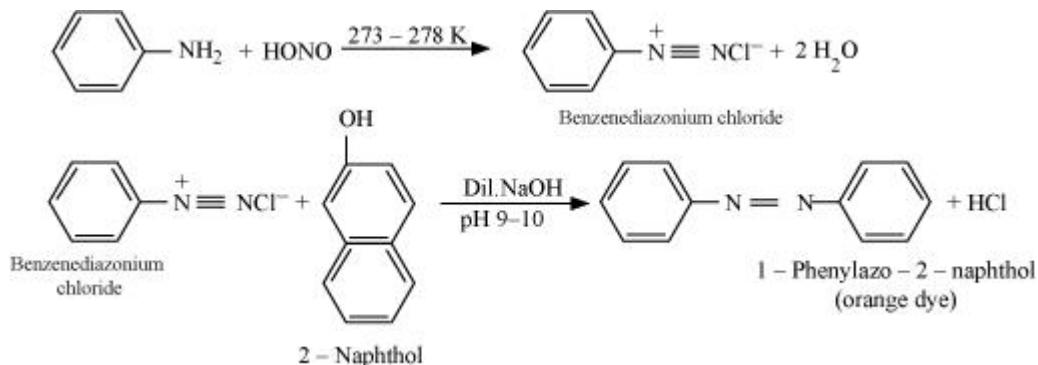
- (ii) Secondary and tertiary amines can be distinguished by allowing them to react with Hinsberg's reagent (benzenesulphonyl chloride, $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$).

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

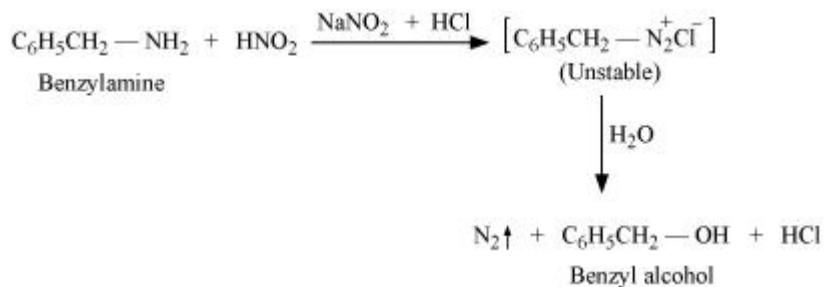
Secondary amines react with Hinsberg's reagent to form a product that is insoluble in an alkali. For example, N, N-diethylamine reacts with Hinsberg's reagent to form N, N-diethylbenzenesulphonamide, which is insoluble in an alkali. Tertiary amines, however, do not react with Hinsberg's reagent.



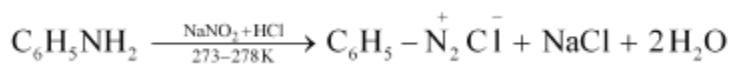
(iii) Ethylamine and aniline can be distinguished using the azo-dye test. A dye is obtained when aromatic amines react with HNO_2 ($\text{NaNO}_2 + \text{dil.HCl}$) at $0-5^\circ\text{C}$, followed by a reaction with the alkaline solution of 2-naphthol. The dye is usually yellow, red, or orange in colour. Aliphatic amines give a brisk effervescence due (to the evolution of N_2 gas) under similar conditions.



(iv) Aniline and benzylamine can be distinguished by their reactions with the help of nitrous acid, which is prepared in situ from a mineral acid and sodium nitrite. Benzylamine reacts with nitrous acid to form unstable diazonium salt, which in turn gives alcohol with the evolution of nitrogen gas.

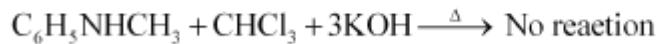


On the other hand, aniline reacts with HNO_2 at a low temperature to form stable diazonium salt. Thus, nitrogen gas is not evolved.



AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(v) Aniline and N-methylaniline can be distinguished using the Carbylamine test. Primary amines, on heating with chloroform and ethanolic potassium hydroxide, form foul-smelling isocyanides or carbylamines. Aniline, being an aromatic primary amine, gives positive carbylamine test. However, N-methylaniline, being a secondary amine does not.



N-Methylaniline

Question 13.3:

Account for the following:

(i) pK_b of aniline is more than that of methylamine.

(ii) Ethylamine is soluble in water whereas aniline is not.

(iii) Methylamine in water reacts with ferric chloride to precipitate hydrated ferric oxide.

(iv) Although amino group is *o*, *p*-directing in aromatic electrophilic substitution reactions, aniline on nitration gives a substantial amount of *m*-nitroaniline.

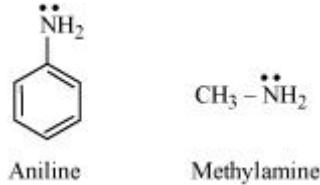
(v) Aniline does not undergo Friedel-Crafts reaction.

(vi) Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

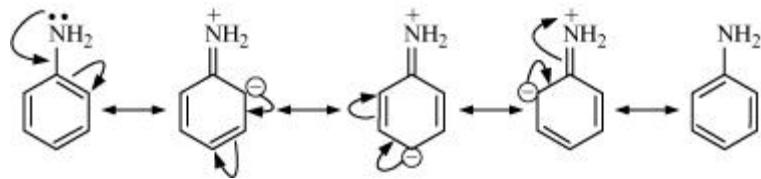
(vii) Gabriel phthalimide synthesis is preferred for synthesising primary amines.

Answer

(i) pK_b of aniline is more than that of methylamine:



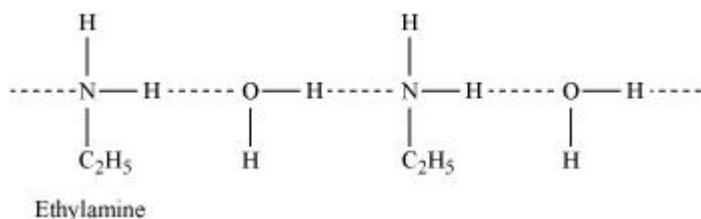
Aniline undergoes resonance and as a result, the electrons on the N-atom are delocalized over the benzene ring. Therefore, the electrons on the N-atom are less available to donate.



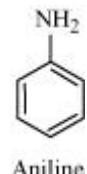
On the other hand, in case of methylamine (due to the +I effect of methyl group), the electron density on the N-atom is increased. As a result, aniline is less basic than methylamine. Thus, pK_b of aniline is more than that of methylamine.

(ii) Ethylamine is soluble in water whereas aniline is not:

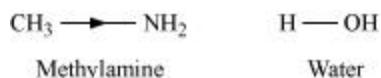
Ethylamine when added to water forms intermolecular H–bonds with water. Hence, it is soluble in water.



But aniline does not undergo H–bonding with water to a very large extent due to the presence of a large hydrophobic $-\text{C}_6\text{H}_5$ group. Hence, aniline is insoluble in water.



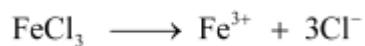
(iii) Methylamine in water reacts with ferric chloride to precipitate hydrated ferric oxide:



Due to the +I effect of $-\text{CH}_3$ group, methylamine is more basic than water. Therefore, in water, methylamine produces OH^- ions by accepting H^+ ions from water.



Ferric chloride (FeCl_3) dissociates in water to form Fe^{3+} and Cl^- ions.



Then, OH^- ion reacts with Fe^{3+} ion to form a precipitate of hydrated ferric oxide.

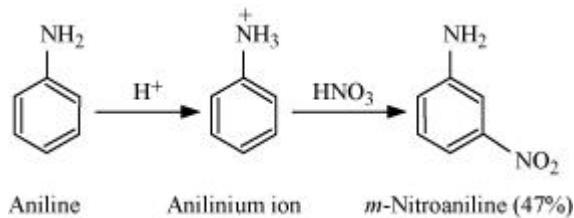
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



Hydrated
ferric oxide

(iv) Although amino group is *o,p*- directing in aromatic electrophilic substitution reactions, aniline on nitration gives a substantial amount of *m*-nitroaniline:

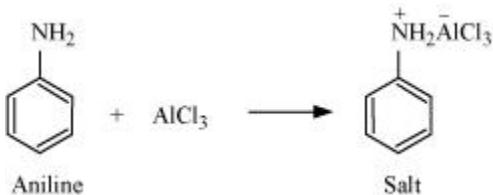
Nitration is carried out in an acidic medium. In an acidic medium, aniline is protonated to give anilinium ion (which is meta-directing).



For this reason, aniline on nitration gives a substantial amount of *m*-nitroaniline.

(v) Aniline does not undergo Friedel-Crafts reaction:

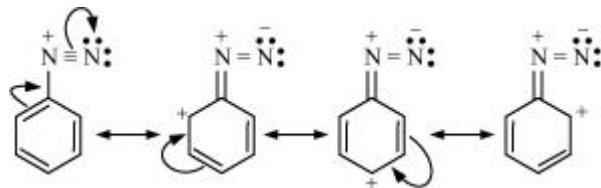
A Friedel-Crafts reaction is carried out in the presence of AlCl_3 . But AlCl_3 is acidic in nature, while aniline is a strong base. Thus, aniline reacts with AlCl_3 to form a salt (as shown in the following equation).



Due to the positive charge on the N-atom, electrophilic substitution in the benzene ring is deactivated. Hence, aniline does not undergo the Friedel-Crafts reaction.

(vi) Diazonium salts of aromatic amines are more stable than those of aliphatic amines:

The diazonium ion undergoes resonance as shown below:



This resonance accounts for the stability of the diazonium ion. Hence, diazonium salts of aromatic amines are more stable than those of aliphatic amines.

(vii) Gabriel phthalimide synthesis is preferred for synthesising primary amines:

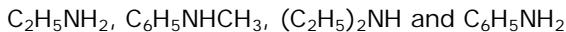
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

Gabriel phthalimide synthesis results in the formation of 1° amine only. 2° or 3° amines are not formed in this synthesis. Thus, a pure 1° amine can be obtained. Therefore, Gabriel phthalimide synthesis is preferred for synthesizing primary amines.

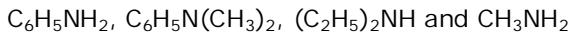
Question 13.4:

Arrange the following:

(i) In decreasing order of the pK_b values:



(ii) In increasing order of basic strength:

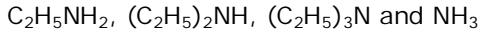


(iii) In increasing order of basic strength:

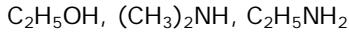
(a) Aniline, *p*-nitroaniline and *p*-toluidine

(b) $\text{C}_6\text{H}_5\text{NH}_2, \text{C}_6\text{H}_5\text{NHCH}_3, \text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$.

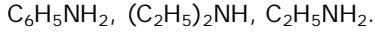
(iv) In decreasing order of basic strength in gas phase:



(v) In increasing order of boiling point:



(vi) In increasing order of solubility in water:

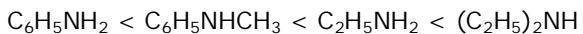


Answer

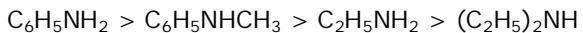
(i) In $\text{C}_2\text{H}_5\text{NH}_2$, only one $-\text{C}_2\text{H}_5$ group is present while in $(\text{C}_2\text{H}_5)_2\text{NH}$, two $-\text{C}_2\text{H}_5$ groups are present. Thus, the +I effect is more in $(\text{C}_2\text{H}_5)_2\text{NH}$ than in $\text{C}_2\text{H}_5\text{NH}_2$. Therefore, the electron density over the N-atom is more in $(\text{C}_2\text{H}_5)_2\text{NH}$ than in $\text{C}_2\text{H}_5\text{NH}_2$. Hence, $(\text{C}_2\text{H}_5)_2\text{NH}$ is more basic than $\text{C}_2\text{H}_5\text{NH}_2$.

Also, both $\text{C}_6\text{H}_5\text{NHCH}_3$ and $\text{C}_6\text{H}_5\text{NH}_2$ are less basic than $(\text{C}_2\text{H}_5)_2\text{NH}$ and $\text{C}_2\text{H}_5\text{NH}_2$ due to the delocalization of the lone pair in the former two. Further, among $\text{C}_6\text{H}_5\text{NHCH}_3$ and $\text{C}_6\text{H}_5\text{NH}_2$, the former will be more basic due to the +T effect of $-\text{CH}_3$ group. Hence, the order of increasing basicity of the given compounds is as follows:

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



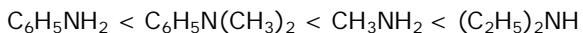
We know that the higher the basic strength, the lower is the pK_b values.



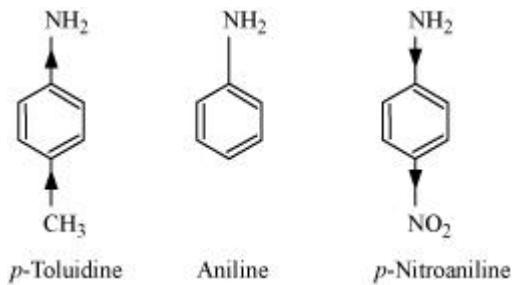
(ii) $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$ is more basic than $\text{C}_6\text{H}_5\text{NH}_2$ due to the presence of the +I effect of two $-\text{CH}_3$ groups in $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$. Further, CH_3NH_2 contains one $-\text{CH}_3$ group while $(\text{C}_2\text{H}_5)_2\text{NH}$ contains two $-\text{C}_2\text{H}_5$ groups. Thus, $(\text{C}_2\text{H}_5)_2\text{NH}$ is more basic than $\text{C}_6\text{H}_5\text{NH}_2$.

Now, $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$ is less basic than CH_3NH_2 because of the -R effect of $-\text{C}_6\text{H}_5$ group.

Hence, the increasing order of the basic strengths of the given compounds is as follows:



(iii) (a)



In *p*-toluidine, the presence of electron-donating $-\text{CH}_3$ group increases the electron density on the N-atom.

Thus, *p*-toluidine is more basic than aniline.

On the other hand, the presence of electron-withdrawing

$-\text{NO}_2$ group decreases the electron density over the N-atom in *p*-nitroaniline. Thus, *p*-nitroaniline is less basic than aniline.

Hence, the increasing order of the basic strengths of the given compounds is as follows:



(b) $\text{C}_6\text{H}_5\text{NHCH}_3$ is more basic than $\text{C}_6\text{H}_5\text{NH}_2$ due to the presence of electron-donating $-\text{CH}_3$ group in $\text{C}_6\text{H}_5\text{NHCH}_3$.

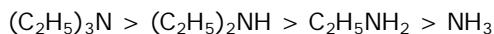
Again, in $\text{C}_6\text{H}_5\text{NHCH}_3$, $-\text{C}_6\text{H}_5$ group is directly attached to the N-atom. However, it is not so in $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$. Thus, in $\text{C}_6\text{H}_5\text{NHCH}_3$, the -R effect of $-\text{C}_6\text{H}_5$ group decreases the electron density over the N-atom. Therefore, $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ is more basic than $\text{C}_6\text{H}_5\text{NHCH}_3$.

Hence, the increasing order of the basic strengths of the given compounds is as follows:



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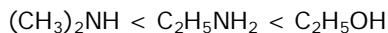
(iv) In the gas phase, there is no solvation effect. As a result, the basic strength mainly depends upon the +I effect. The higher the +I effect, the stronger is the base. Also, the greater the number of alkyl groups, the higher is the +I effect. Therefore, the given compounds can be arranged in the decreasing order of their basic strengths in the gas phase as follows:



(v) The boiling points of compounds depend on the extent of H-bonding present in that compound. The more extensive the H-bonding in the compound, the higher is the boiling point. $(CH_3)_2NH$ contains only one H-atom whereas $C_2H_5NH_2$ contains two H-atoms. Then, $C_2H_5NH_2$ undergoes more extensive H-bonding than $(CH_3)_2NH$. Hence, the boiling point of $C_2H_5NH_2$ is higher than that of $(CH_3)_2NH$.

Further, O is more electronegative than N. Thus, C_2H_5OH forms stronger H-bonds than $C_2H_5NH_2$. As a result, the boiling point of C_2H_5OH is higher than that of $C_2H_5NH_2$ and $(CH_3)_2NH$.

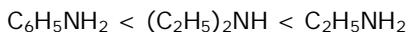
Now, the given compounds can be arranged in the increasing order of their boiling points as follows:



(vi) The more extensive the H-bonding, the higher is the solubility. $C_2H_5NH_2$ contains two H-atoms whereas $(C_2H_5)_2NH$ contains only one H-atom. Thus, $C_2H_5NH_2$ undergoes more extensive H-bonding than $(C_2H_5)_2NH$. Hence, the solubility in water of $C_2H_5NH_2$ is more than that of $(C_2H_5)_2NH$.

Further, the solubility of amines decreases with increase in the molecular mass. This is because the molecular mass of amines increases with an increase in the size of the hydrophobic part. The molecular mass of $C_6H_5NH_2$ is greater than that of $C_2H_5NH_2$ and $(C_2H_5)_2NH$.

Hence, the increasing order of their solubility in water is as follows:



Question 13.5:

How will you convert:

(i) Ethanoic acid into methanamine

(ii) Hexanenitrile into 1-aminopentane

(iii) Methanol to ethanoic acid

(iv) Ethanamine into methanamine

(v) Ethanoic acid into propanoic acid

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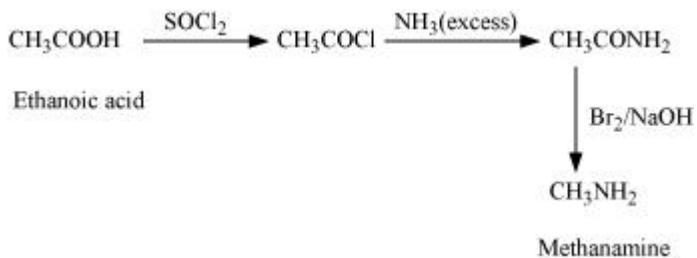
(vi) Methanamine into ethanamine

(vii) Nitromethane into dimethylamine

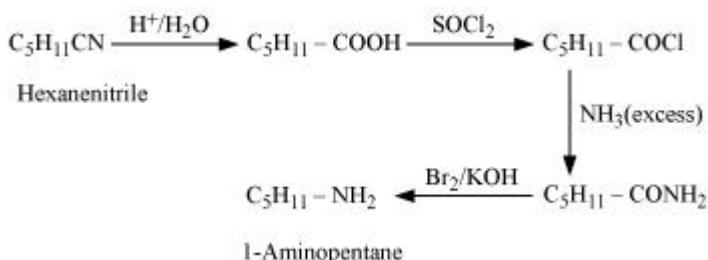
(viii) Propanoic acid into ethanoic acid

Answer

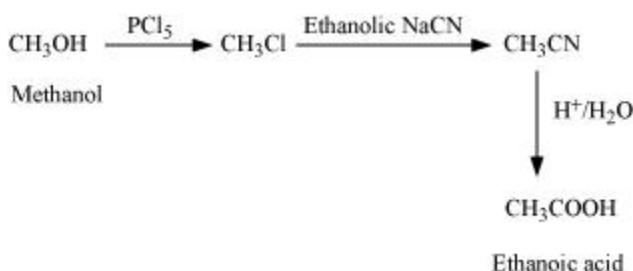
(i)



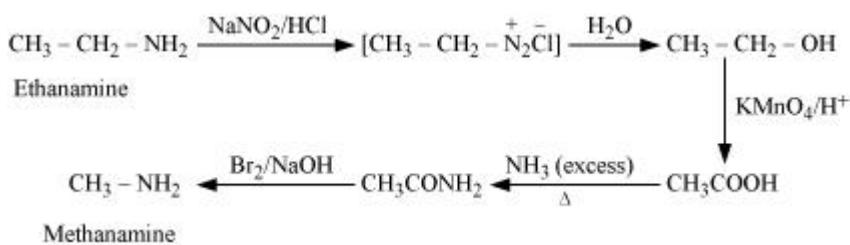
(ii)



(iii)

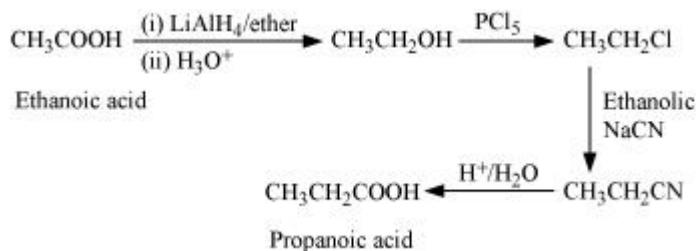


(iv)

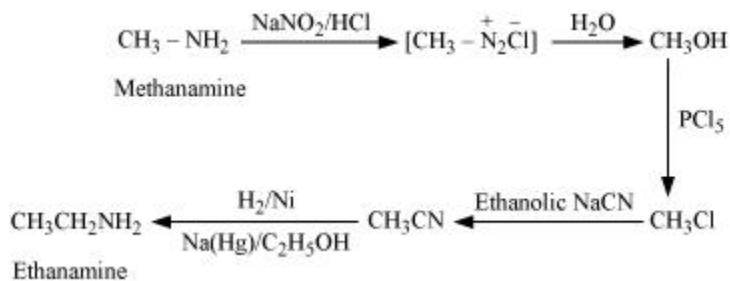


AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

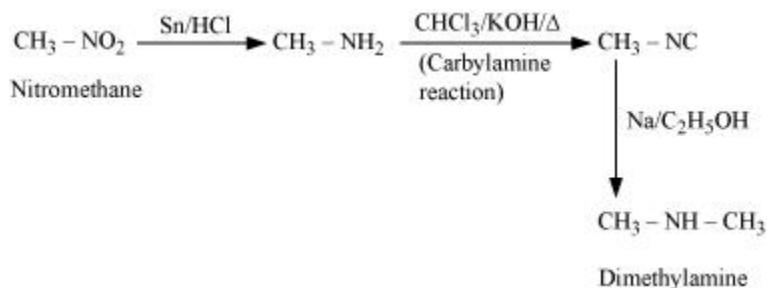
(v)



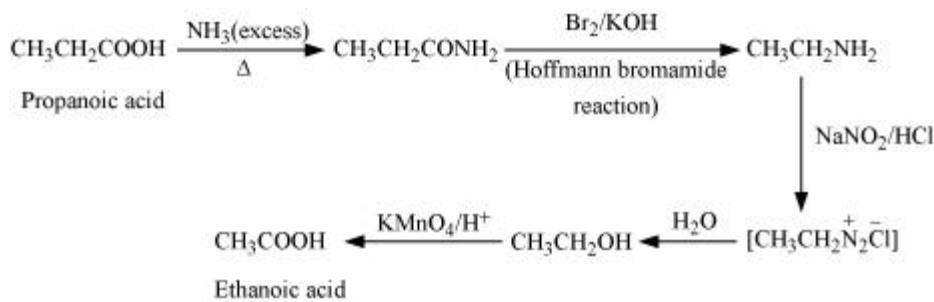
(vi)



(vii)



(viii)



Question 13.6:

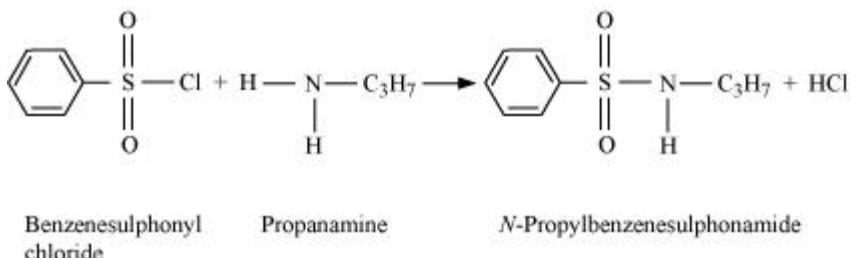
Describe a method for the identification of primary, secondary and tertiary amines. Also write chemical equations of the reactions involved.

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

Answer

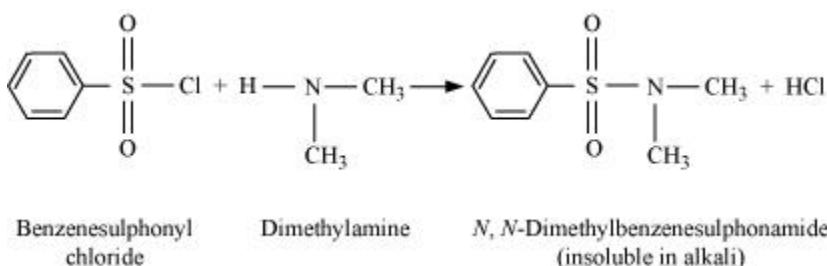
Primary, secondary and tertiary amines can be identified and distinguished by Hinsberg's test. In this test, the amines are allowed to react with Hinsberg's reagent, benzenesulphonyl chloride ($C_6H_5SO_2Cl$). The three types of amines react differently with Hinsberg's reagent. Therefore, they can be easily identified using Hinsberg's reagent.

Primary amines react with benzenesulphonyl chloride to form N-alkylbenzenesulphonamide which is soluble in alkali.



Due to the presence of a strong electron-withdrawing sulphonyl group in the sulphonamide, the H-atom attached to nitrogen can be easily released as proton. So, it is acidic and dissolves in alkali.

Secondary amines react with Hinsberg's reagent to give a sulphonamide which is insoluble in alkali.



There is no H-atom attached to the N-atom in the sulphonamide. Therefore, it is not acidic and insoluble in alkali.

On the other hand, tertiary amines do not react with Hinsberg's reagent at all.

Question 13.7:

Write short notes on the following:

- (i) Carbylamine reaction (ii) Diazotisation
- (iii) Hofmann's bromamide reaction (iv) Coupling reaction
- (v) Ammonolysis (vi) Acetylation

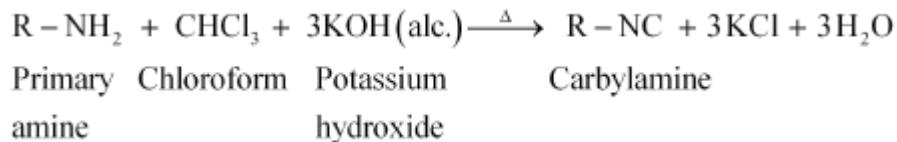
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(vii) Gabriel phthalimide synthesis.

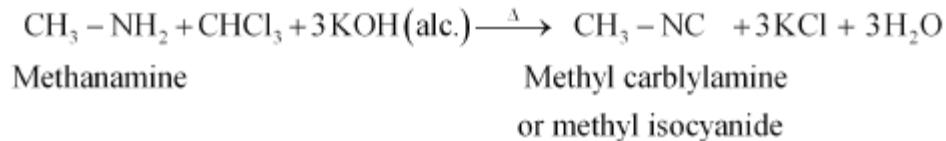
Answer

(i) Carbylamine reaction

Carbylamine reaction is used as a test for the identification of primary amines. When aliphatic and aromatic primary amines are heated with chloroform and ethanolic potassium hydroxide, carbylamines (or isocyanides) are formed. These carbylamines have very unpleasant odours. Secondary and tertiary amines do not respond to this test.



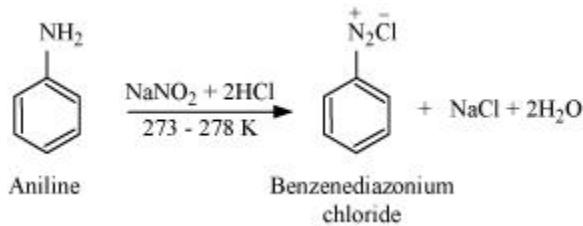
For example,



(ii) Diazotisation

Aromatic primary amines react with nitrous acid (prepared in situ from NaNO_2 and a mineral acid such as HCl) at low temperatures (273–278 K) to form diazonium salts. This conversion of aromatic primary amines into diazonium salts is known as diazotization.

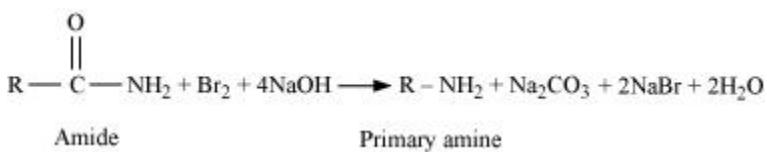
For example, on treatment with NaNO_2 and HCl at 273–278 K, aniline produces benzenediazonium chloride, with NaCl and H_2O as by-products.



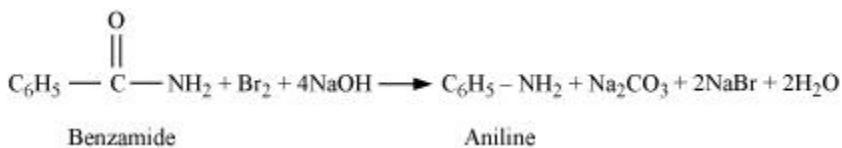
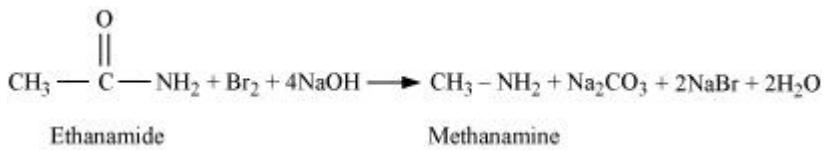
(iii) Hoffmann bromamide reaction

When an amide is treated with bromine in an aqueous or ethanolic solution of sodium hydroxide, a primary amine with one carbon atom less than the original amide is produced. This degradation reaction is known as Hoffmann bromamide reaction. This reaction involves the migration of an alkyl or aryl group from the carbonyl carbon atom of the amide to the nitrogen atom.

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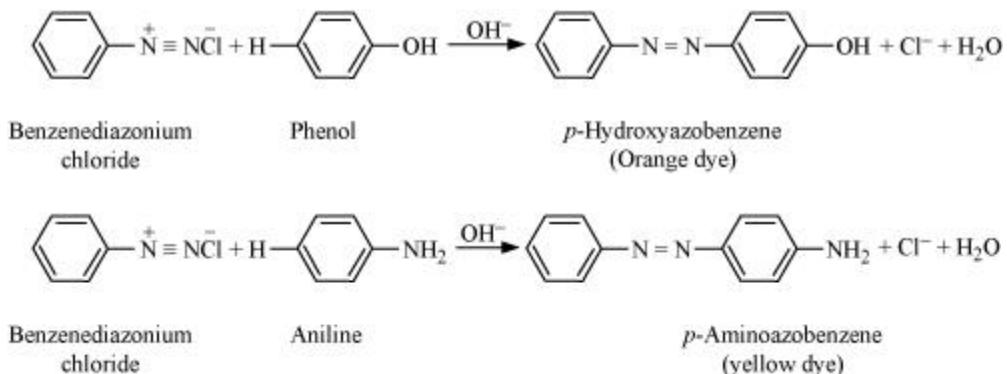


For example,



(iv) Coupling reaction

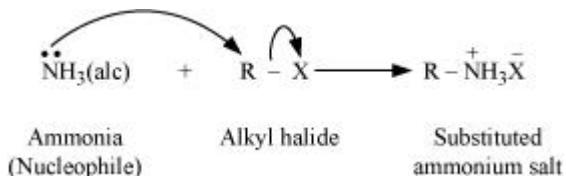
The reaction of joining two aromatic rings through the $-\text{N}=\text{N}-$ bond is known as coupling reaction. Arenediazonium salts such as benzene diazonium salts react with phenol or aromatic amines to form coloured azo compounds.



It can be observed that, the para-positions of phenol and aniline are coupled with the diazonium salt. This reaction proceeds through electrophilic substitution.

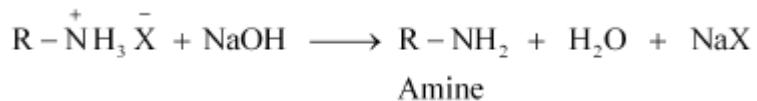
(v) Ammonolysis

When an alkyl or benzyl halide is allowed to react with an ethanolic solution of ammonia, it undergoes nucleophilic substitution reaction in which the halogen atom is replaced by an amino ($-\text{NH}_2$) group. This process of cleavage of the carbon-halogen bond is known as ammonolysis.

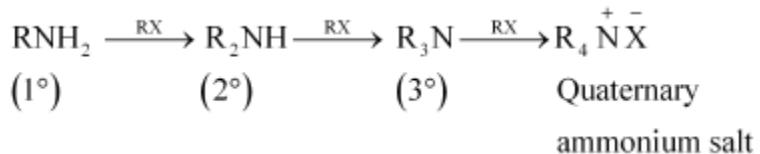


AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

When this substituted ammonium salt is treated with a strong base such as sodium hydroxide, amine is obtained.

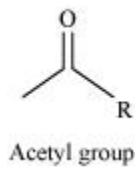


Though primary amine is produced as the major product, this process produces a mixture of primary, secondary and tertiary amines, and also a quaternary ammonium salt as shown.

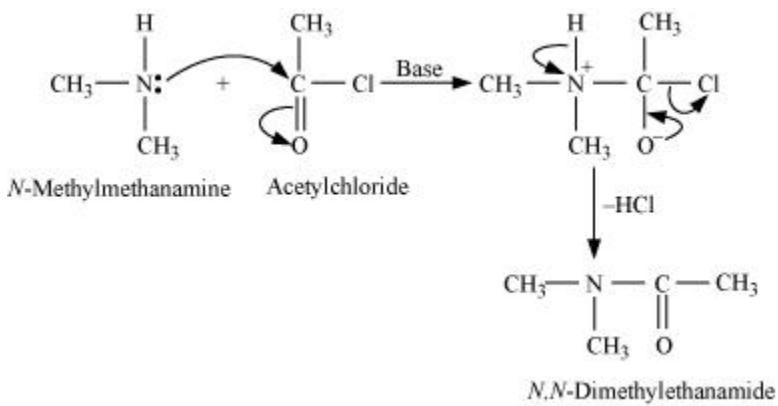


(vi) Acetylation

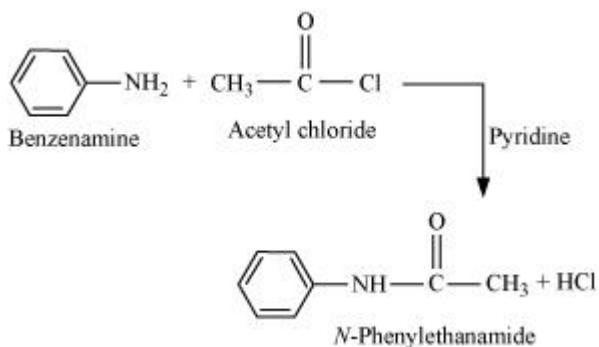
Acetylation (or ethanoylation) is the process of introducing an acetyl group into a molecule.



Aliphatic and aromatic primary and secondary amines undergo acetylation reaction by nucleophilic substitution when treated with acid chlorides, anhydrides or esters. This reaction involves the replacement of the hydrogen atom of $-\text{NH}_2$ or $>\text{NH}$ group by the acetyl group, which in turn leads to the production of amides. To shift the equilibrium to the right hand side, the HCl formed during the reaction is removed as soon as it is formed. This reaction is carried out in the presence of a base (such as pyridine) which is stronger than the amine.

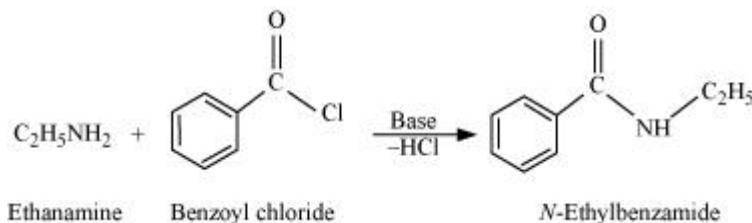


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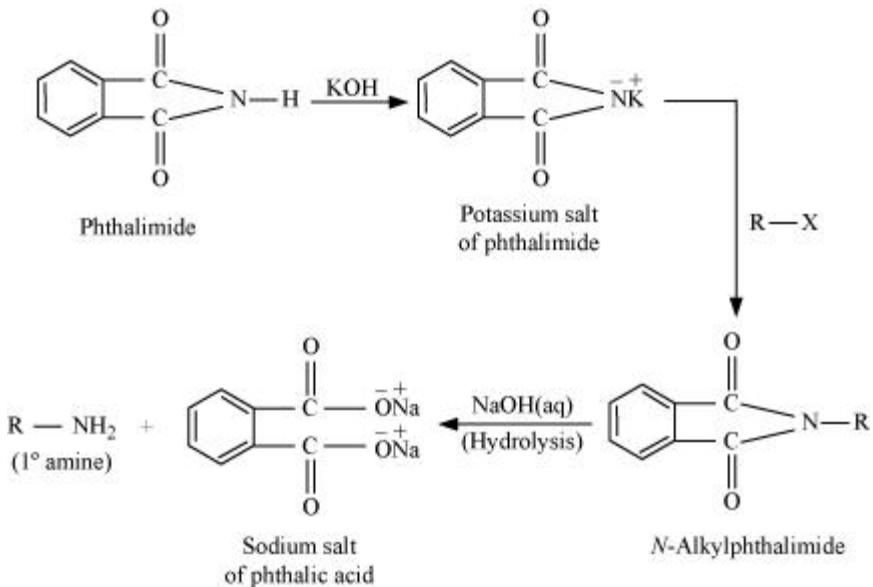
When amines react with benzoyl chloride, the reaction is also known as benzoylation.

For example,



(vii) Gabriel phthalimide synthesis

Gabriel phthalimide synthesis is a very useful method for the preparation of aliphatic primary amines. It involves the treatment of phthalimide with ethanolic potassium hydroxide to form potassium salt of phthalimide. This salt is further heated with alkyl halide, followed by alkaline hydrolysis to yield the corresponding primary amine.



Question 13.8:

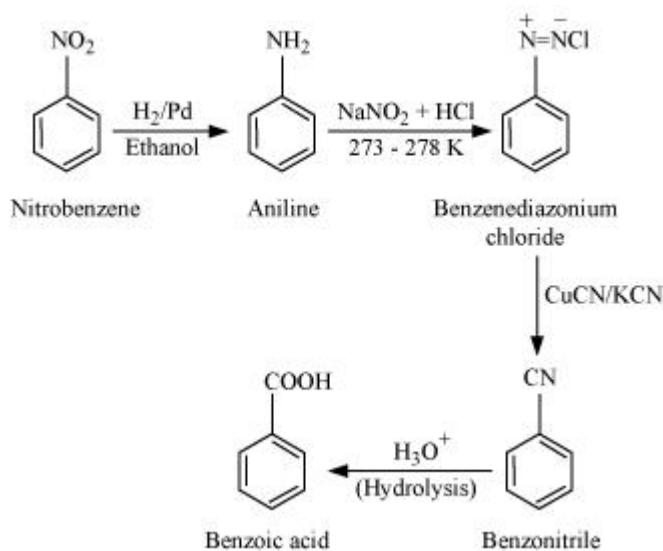
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

Accomplish the following conversions:

- (i) Nitrobenzene to benzoic acid
- (ii) Benzene to *m*-bromophenol
- (iii) Benzoic acid to aniline
- (iv) Aniline to 2,4,6-tribromofluorobenzene
- (v) Benzyl chloride to 2-phenylethanamine
- (vi) Chlorobenzene to *p*-chloroaniline
- (vii) Aniline to *p*-bromoaniline
- (viii) Benzamide to toluene
- (ix) Aniline to benzyl alcohol.

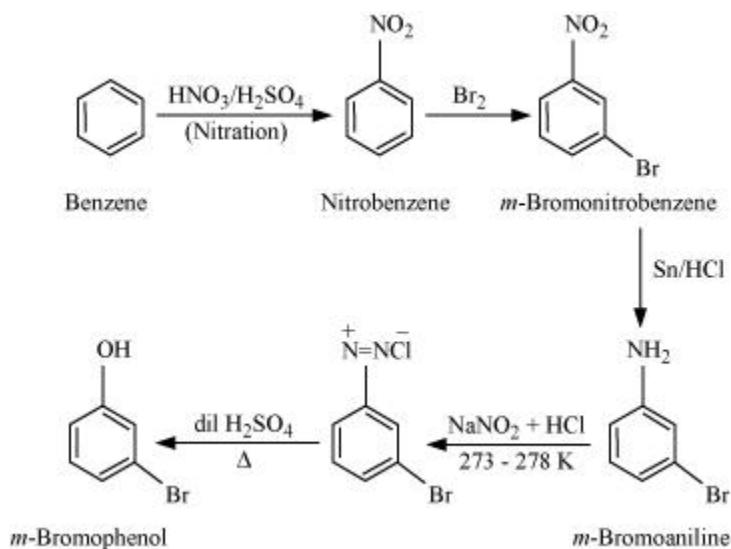
Answer

(i)

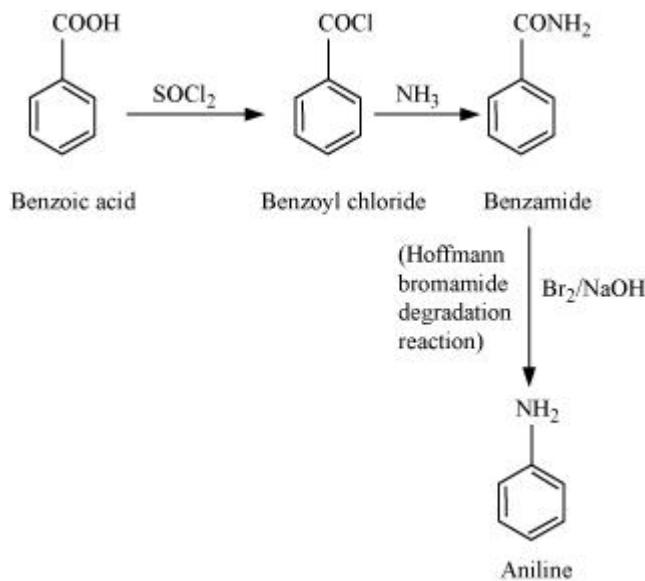


(ii)

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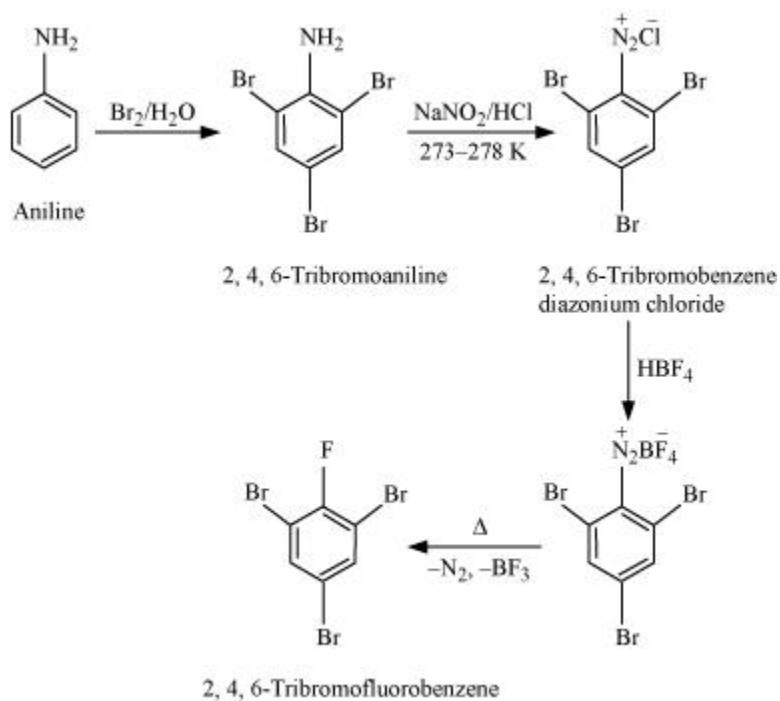


(iii)

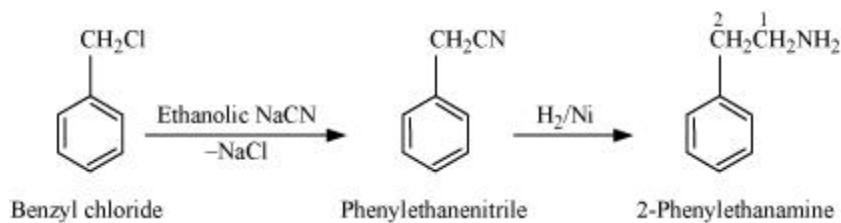


(iv)

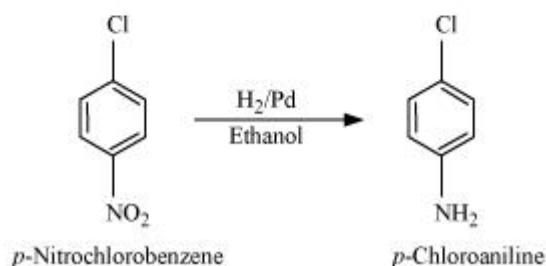
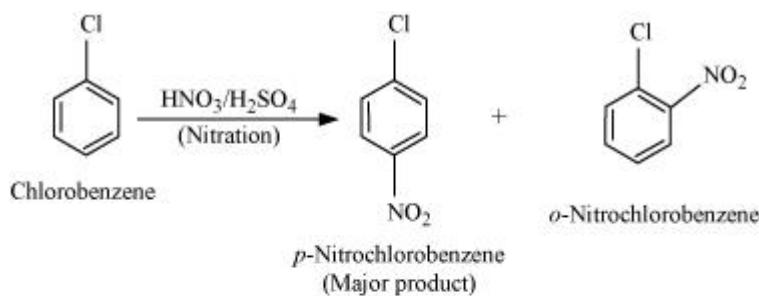
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



(v)

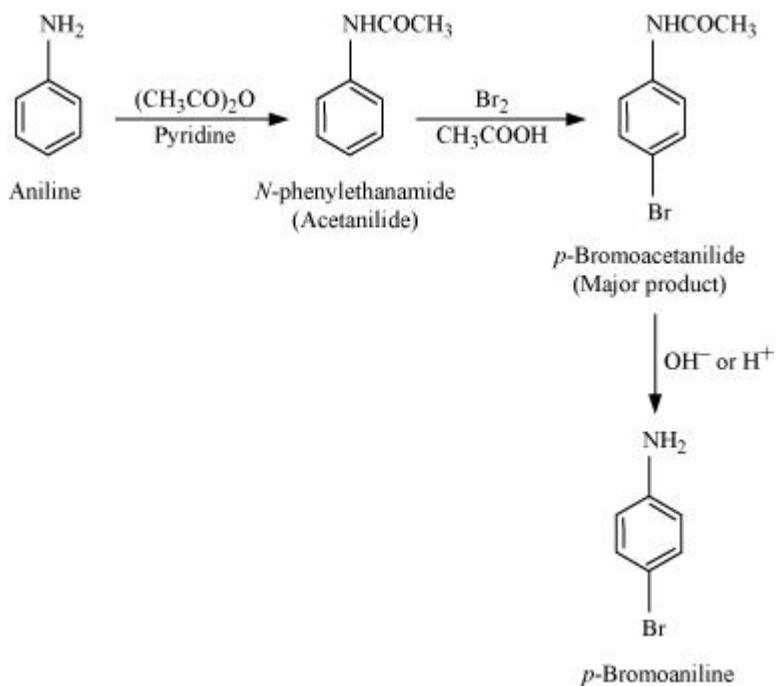


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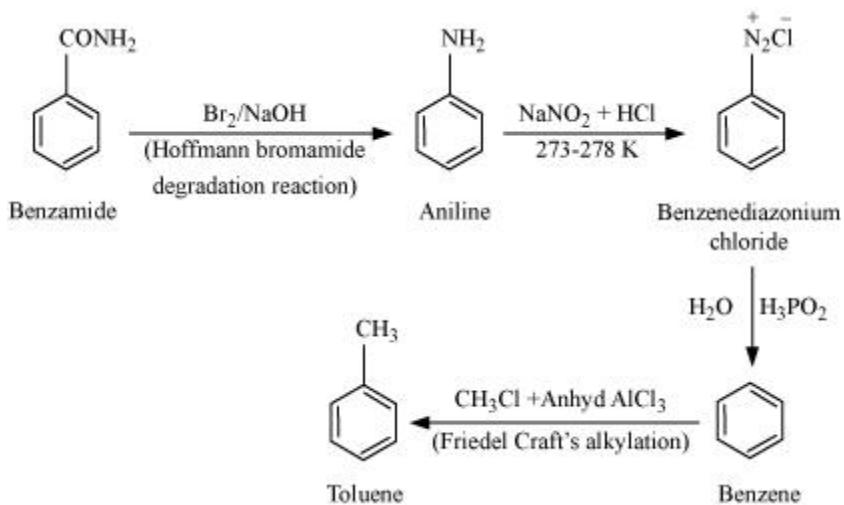


AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(vii)

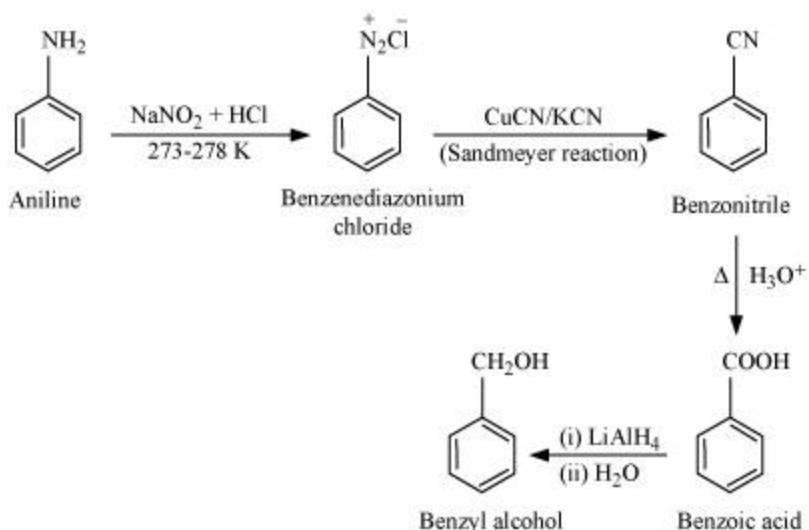


(viii)



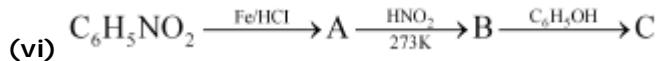
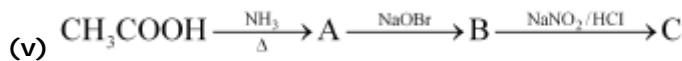
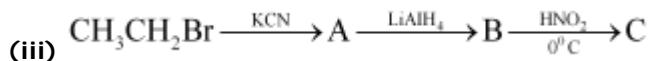
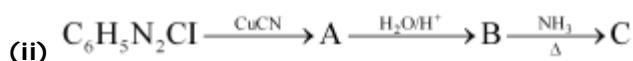
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Question 13.9:

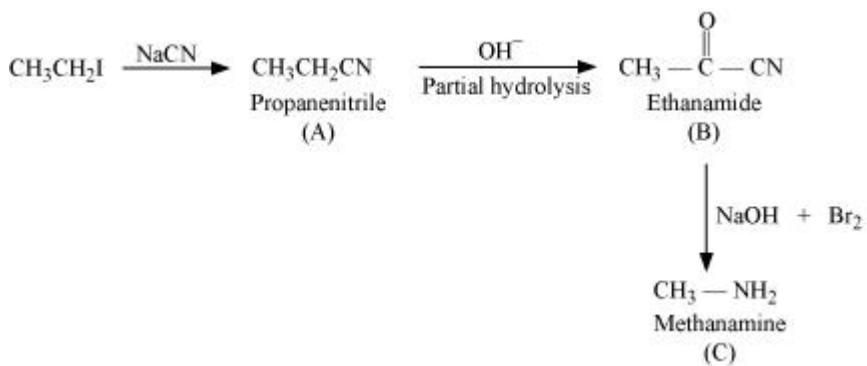
Give the structures of A, B and C in the following reactions:



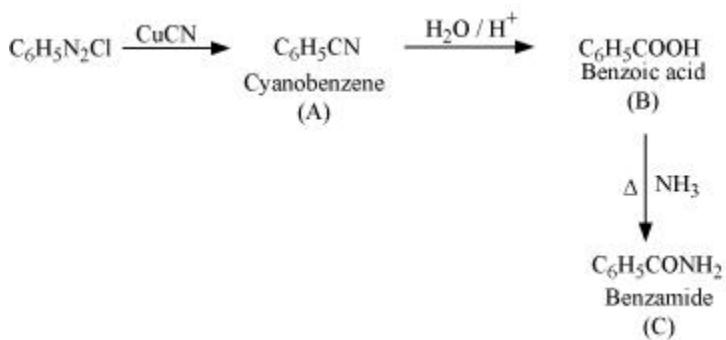
Answer

(i)

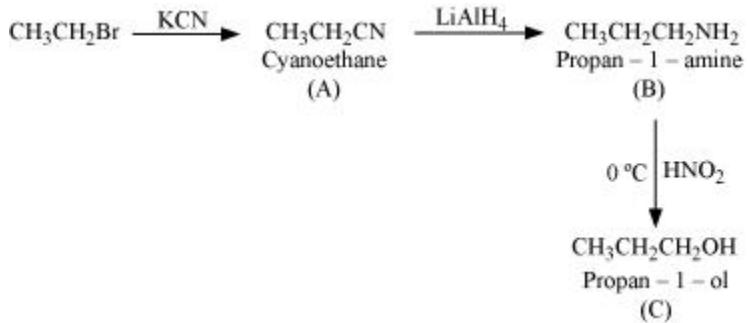
AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



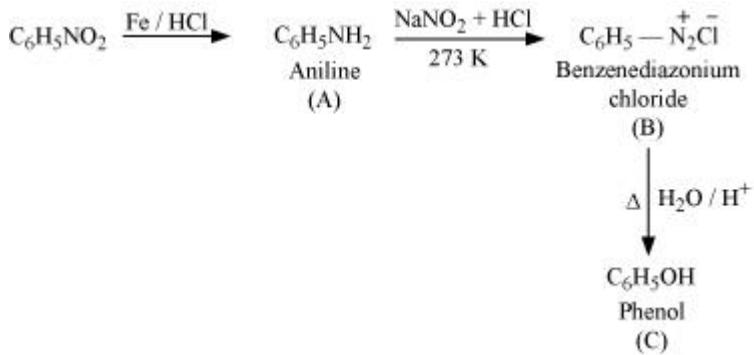
(ii)



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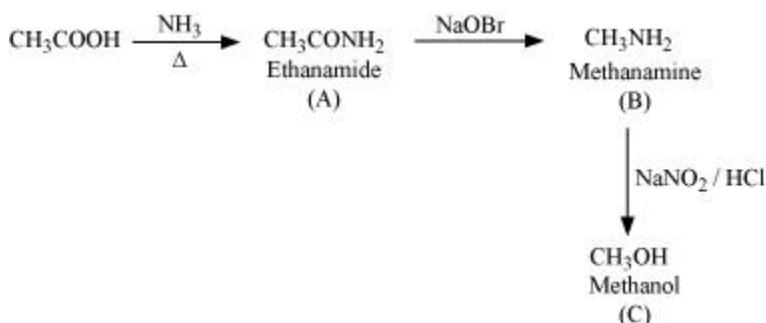


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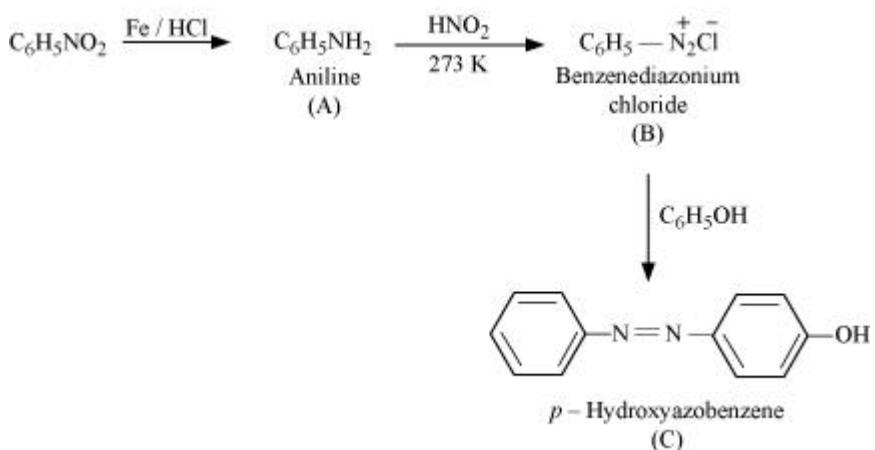


AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(v)



(vi)



Question 13.10:

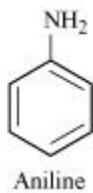
An aromatic compound 'A' on treatment with aqueous ammonia and heating

forms compound 'B' which on heating with Br_2 and KOH forms a compound 'C'

of molecular formula $\text{C}_6\text{H}_7\text{N}$. Write the structures and IUPAC names of compounds A, B and C.

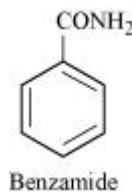
Answer

It is given that compound 'C' having the molecular formula, $\text{C}_6\text{H}_7\text{N}$ is formed by heating compound 'B' with Br_2 and KOH. This is a Hoffmann bromamide degradation reaction. Therefore, compound 'B' is an amide and compound 'C' is an amine. The only amine having the molecular formula, $\text{C}_6\text{H}_7\text{N}$ is aniline, ($\text{C}_6\text{H}_5\text{NH}_2$).

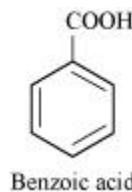


AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

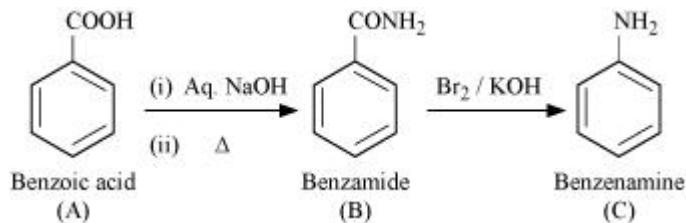
Therefore, compound 'B' (from which 'C' is formed) must be benzamide, ($C_6H_5CONH_2$).



Further, benzamide is formed by heating compound 'A' with aqueous ammonia. Therefore, compound 'A' must be benzoic acid.

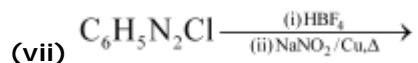
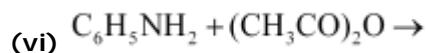
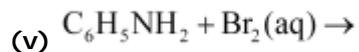
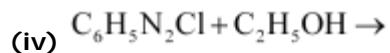
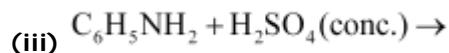
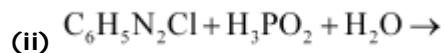


The given reactions can be explained with the help of the following equations:



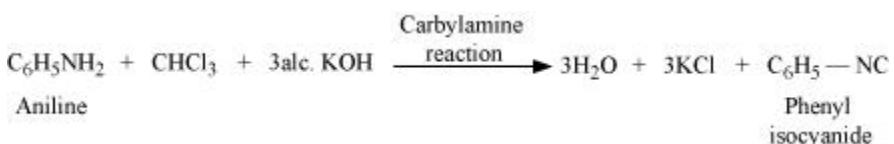
Question 13.11:

Complete the following reactions:

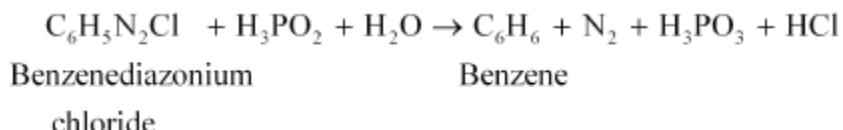


Answer

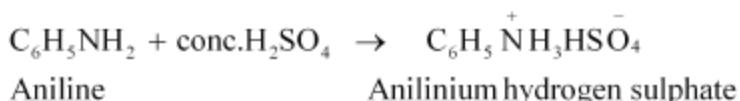
(i)



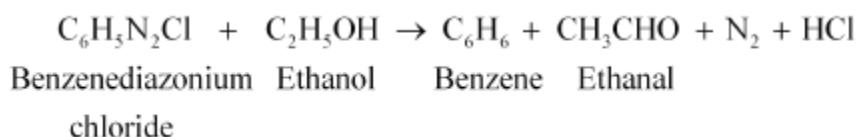
(ii)



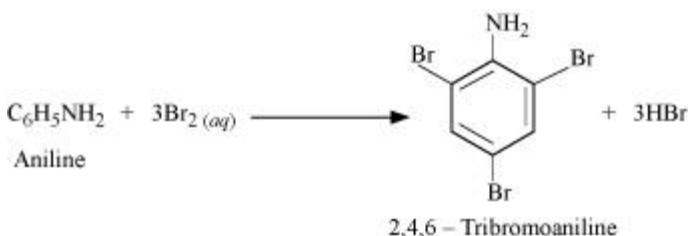
(iii)



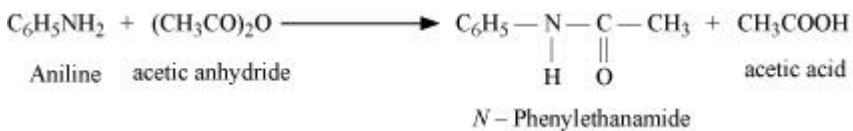
(iv)



(v)

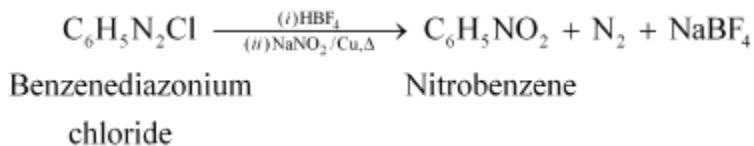


(vi)



(vii)

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

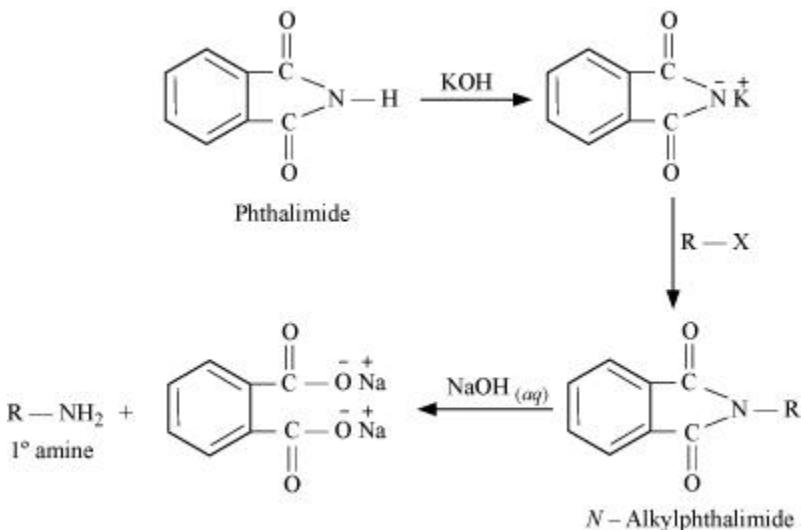


Question 13.12:

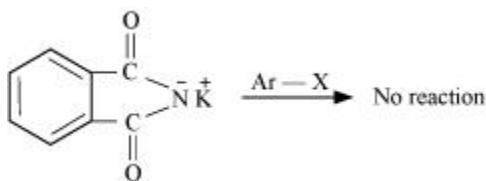
Why cannot aromatic primary amines be prepared by Gabriel phthalimide synthesis?

Answer

Gabriel phthalimide synthesis is used for the preparation of aliphatic primary amines. It involves nucleophilic substitution (S_N2) of alkyl halides by the anion formed by the phthalimide.



But aryl halides do not undergo nucleophilic substitution with the anion formed by the phthalimide.



Hence, aromatic primary amines cannot be prepared by this process.

Question 13.13:

Write the reactions of (i) aromatic and (ii) aliphatic primary amines with nitrous acid.

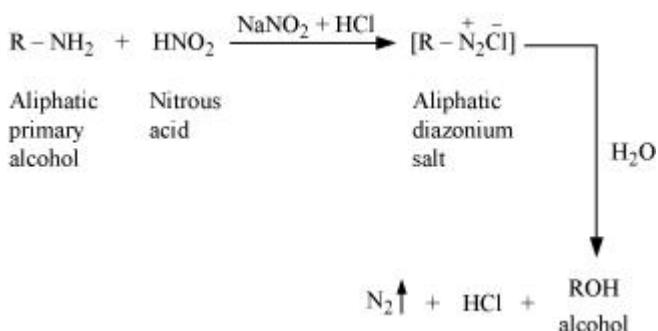
Answer

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION

(i) Aromatic amines react with nitrous acid (prepared in situ from NaNO_2 and a mineral acid such as HCl) at 273 – 278 K to form stable aromatic diazonium salts i.e., NaCl and H_2O .



(ii) Aliphatic primary amines react with nitrous acid (prepared in situ from NaNO_2 and a mineral acid such as HCl) to form unstable aliphatic diazonium salts, which further produce alcohol and HCl with the evolution of N_2 gas.



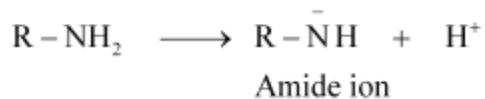
Question 13.14:

Give plausible explanation for each of the following:

- (i)** Why are amines less acidic than alcohols of comparable molecular masses?
- (ii)** Why do primary amines have higher boiling point than tertiary amines?
- (iii)** Why are aliphatic amines stronger bases than aromatic amines?

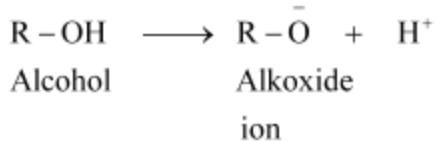
Answer

- (i)** Amines undergo protonation to give amide ion.



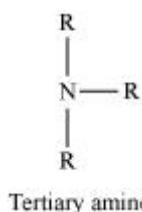
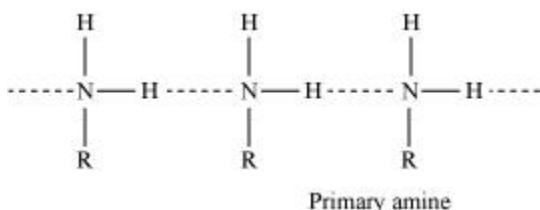
Similarly, alcohol loses a proton to give alkoxide ion.

AMINES ORGANIC FUNCTIONAL GROUP IV NCERT SOLUTION



In an amide ion, the negative charge is on the N-atom whereas in alkoxide ion, the negative charge is on the O-atom. Since O is more electronegative than N, O can accommodate the negative charge more easily than N. As a result, the amide ion is less stable than the alkoxide ion. Hence, amines are less acidic than alcohols of comparable molecular masses.

(ii) In a molecule of tertiary amine, there are no H-atoms whereas in primary amines, two hydrogen atoms are present. Due to the presence of H-atoms, primary amines undergo extensive intermolecular H-bonding.



As a result, extra energy is required to separate the molecules of primary amines. Hence, primary amines have higher boiling points than tertiary amines.

(iii) Due to the $-R$ effect of the benzene ring, the electrons on the N-atom are less available in case of aromatic amines. Therefore, the electrons on the N-atom in aromatic amines cannot be donated easily. This explains why aliphatic amines are stronger bases than aromatic amines.

BIOMOLECULES NCERT SOLUTION

BIOMOLECULES

Question 14.1:

Glucose or sucrose are soluble in water but cyclohexane or benzene (simple six membered ring compounds) are insoluble in water. Explain.

Answer

A glucose molecule contains five –OH groups while a sucrose molecule contains eight –OH groups. Thus, glucose and sucrose undergo extensive H-bonding with water.

Hence, these are soluble in water.

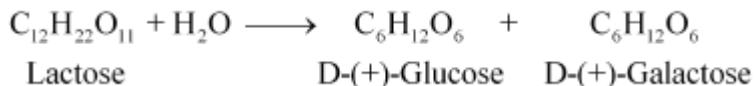
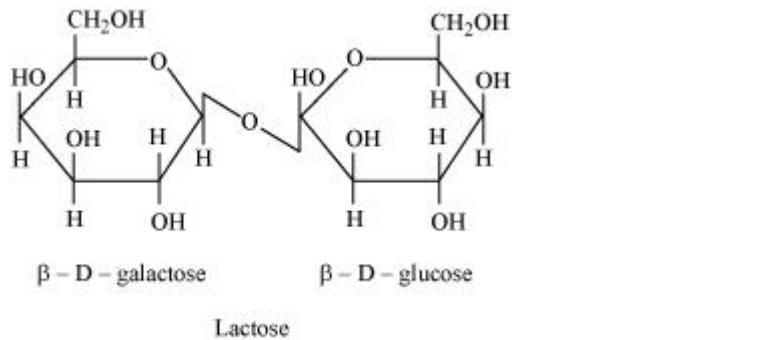
But cyclohexane and benzene do not contain –OH groups. Hence, they cannot undergo H-bonding with water and as a result, are insoluble in water.

Question 14.2:

What are the expected products of hydrolysis of lactose?

Answer

Lactose is composed of β -D galactose and β -D glucose. Thus, on hydrolysis, it gives β -D galactose and β -D glucose.



Question 14.3:

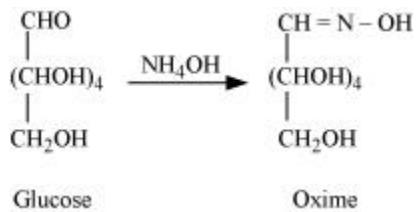
How do you explain the absence of aldehyde group in the pentaacetate of D-glucose?

Answer

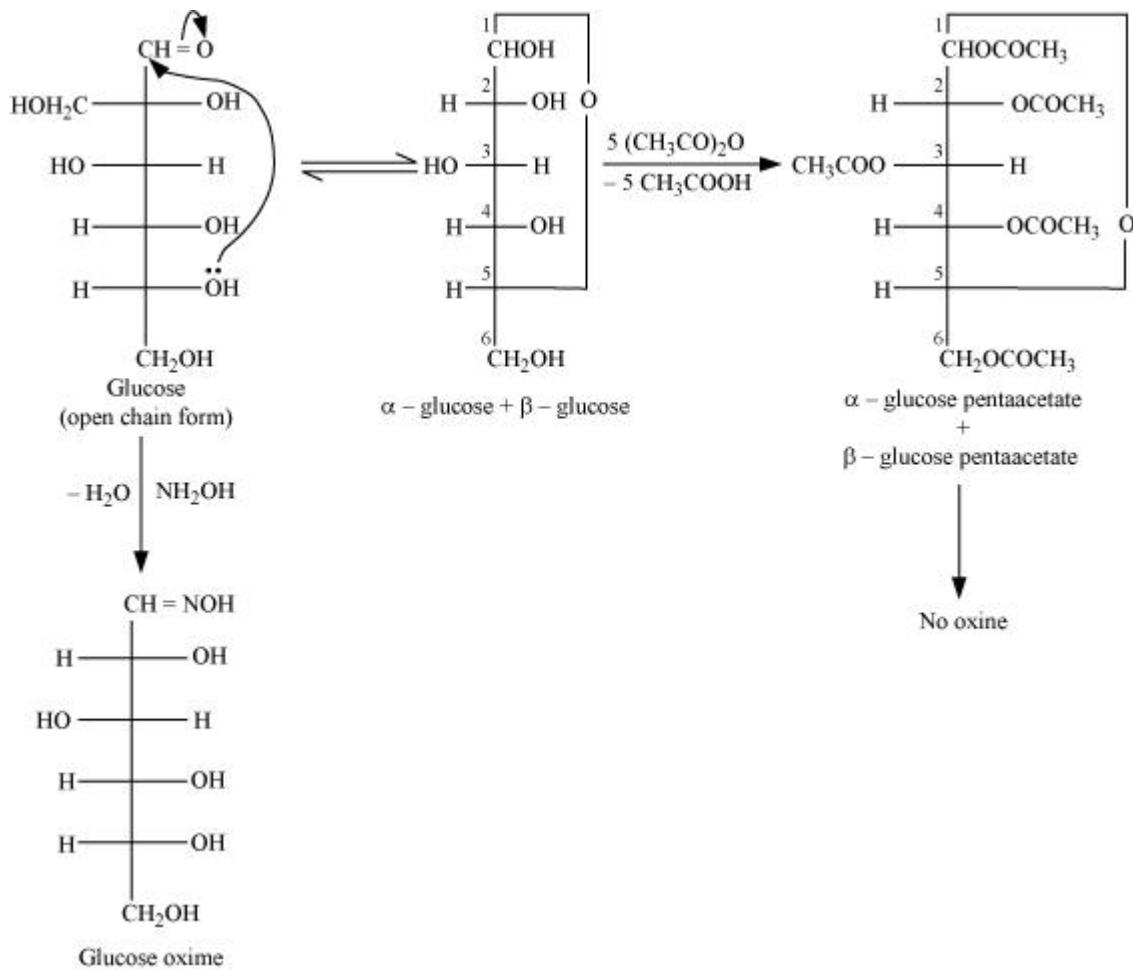
D-glucose reacts with hydroxylamine (NH_2OH) to form an oxime because of the presence of aldehydic ($-\text{CHO}$) group or carbonyl carbon. This happens as the cyclic structure of glucose

BIOMOLECULES NCERT SOLUTION

forms an open chain structure in an aqueous medium, which then reacts with NH_2OH to give an oxime.



But pentaacetate of D-glucose does not react with NH_2OH . This is because pentaacetate does not form an open chain structure.



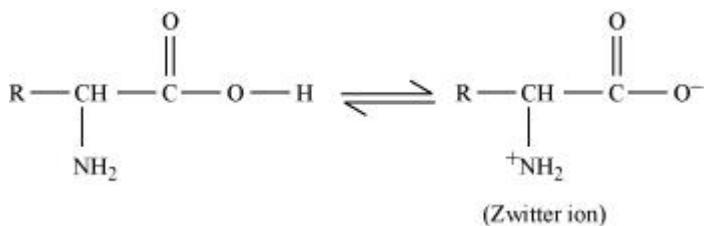
Question 14.4:

The melting points and solubility in water of amino acids are generally higher than that of the corresponding halo acids. Explain.

Answer

BIOMOLECULES NCERT SOLUTION

Both acidic (carboxyl) as well as basic (amino) groups are present in the same molecule of amino acids. In aqueous solutions, the carboxyl group can lose a proton and the amino group can accept a proton, thus giving rise to a dipolar ion known as a zwitter ion.



Due to this dipolar behaviour, they have strong electrostatic interactions within them and with water. But halo-acids do not exhibit such dipolar behaviour.

For this reason, the melting points and the solubility of amino acids in water is higher than those of the corresponding halo-acids.

Question 14.5:

Where does the water present in the egg go after boiling the egg?

Answer

When an egg is boiled, the proteins present inside the egg get denatured and coagulate. After boiling the egg, the water present in it is absorbed by the coagulated protein through H-bonding

Question 14.6:

Why cannot vitamin C be stored in our body?

Answer

Vitamin C cannot be stored in our body because it is water soluble. As a result, it is readily excreted in the urine

Question 14.7:

What products would be formed when a nucleotide from DNA containing thymine is hydrolysed?

Answer

When a nucleotide from the DNA containing thymine is hydrolyzed, thymine β -D-2-deoxyribose and phosphoric acid are obtained as products

Question 14.8:

BIOMOLECULES NCERT SOLUTION

When RNA is hydrolysed, there is no relationship among the quantities of different bases obtained. What does this fact suggest about the structure of RNA?

Answer

A DNA molecule is double-stranded in which the pairing of bases occurs. Adenine always pairs with thymine, while cytosine always pairs with guanine. Therefore, on hydrolysis of DNA, the quantity of adenine produced is equal to that of thymine and similarly, the quantity of cytosine is equal to that of guanine.

But when RNA is hydrolyzed, there is no relationship among the quantities of the different bases obtained. Hence, RNA is single-stranded

Question 14.1:

What are monosaccharides?

Answer

Monosaccharides are carbohydrates that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone.

Monosaccharides are classified on the bases of number of carbon atoms and the functional group present in them. Monosaccharides containing an aldehyde group are known as aldoses and those containing a keto group are known as ketoses. Monosaccharides are further classified as trioses, tetroses, pentoses, hexoses, and heptoses according to the number of carbon atoms they contain. For example, a ketose containing 3 carbon atoms is called ketotriose and an aldose containing 3 carbon atoms is called aldotoriose

Question 14.2:

What are reducing sugars?

Answer

Reducing sugars are carbohydrates that reduce Fehling's solution and Tollen's reagent. All monosaccharides and disaccharides, excluding sucrose, are reducing sugars.

Question 14.3:

Write two main functions of carbohydrates in plants.

Answer

Two main functions of carbohydrates in plants are:

- (i) Polysaccharides such as starch serve as storage molecules.
- (ii) Cellulose, a polysaccharide, is used to build the cell wall

BIOMOLECULES NCERT SOLUTION

Question 14.4:

Classify the following into monosaccharides and disaccharides.

Ribose, 2-deoxyribose, maltose, galactose, fructose and lactose

Answer

Monosaccharides:

Ribose, 2-deoxyribose, galactose, fructose

Disaccharides:

Maltose, lactose

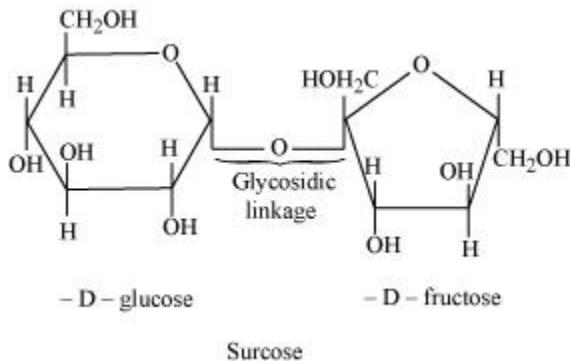
Question 14.5:

What do you understand by the term glycosidic linkage?

Answer

Glycosidic linkage refers to the linkage formed between two monosaccharide units through an oxygen atom by the loss of a water molecule.

For example, in a sucrose molecule, two monosaccharide units, α -glucose and β -fructose, are joined together by a glycosidic linkage.



Question 14.6:

What is glycogen? How is it different from starch?

Answer

Glycogen is a carbohydrate (polysaccharide). In animals, carbohydrates are stored as glycogen.

BIOMOLECULES NCERT SOLUTION

Starch is a carbohydrate consisting of two components – amylose (15 – 20%) and amylopectin (80 – 85%).

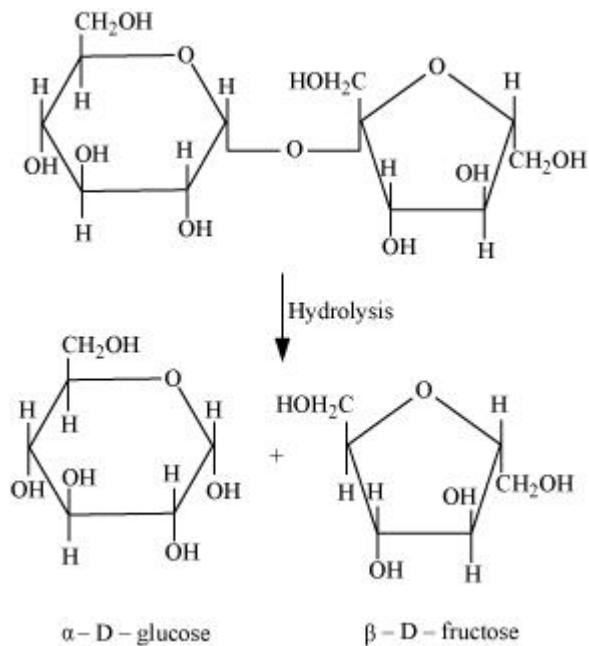
However, glycogen consists of only one component whose structure is similar to amylopectin. Also, glycogen is more branched than amylopectin.

Question 14.7:

What are the hydrolysis products of (i) sucrose and (ii) lactose?

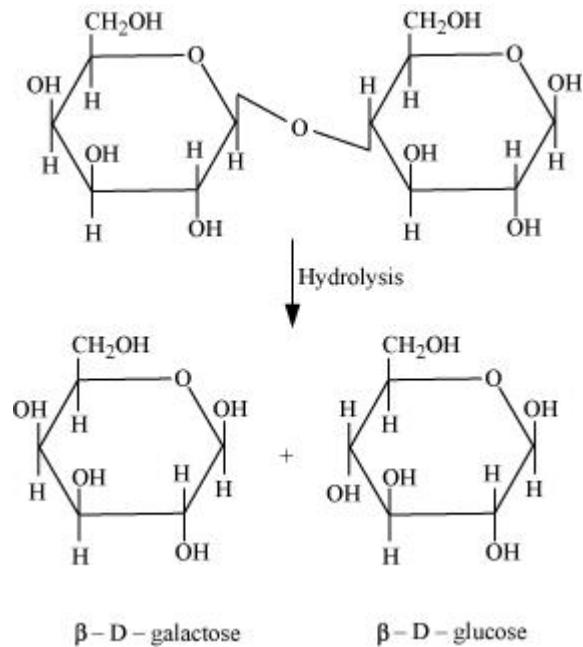
Answer

(i) On hydrolysis, sucrose gives one molecule of α -D glucose and one molecule of β -D-fructose.



(ii) The hydrolysis of lactose gives β -D-galactose and β -D-glucose.

BIOMOLECULES NCERT SOLUTION

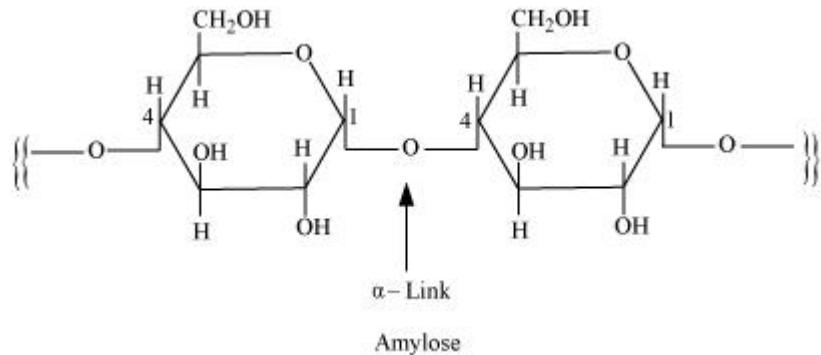


Question 14.8:

What is the basic structural difference between starch and cellulose?

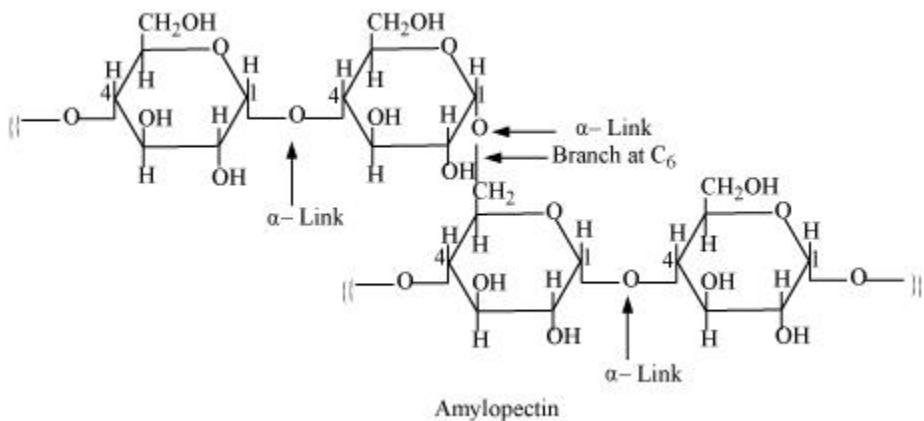
Answer

Starch consists of two components – amylose and amylopectin. Amylose is a long linear chain of α -D-(+)-glucose units joined by C1-C4 glycosidic linkage (α -link).

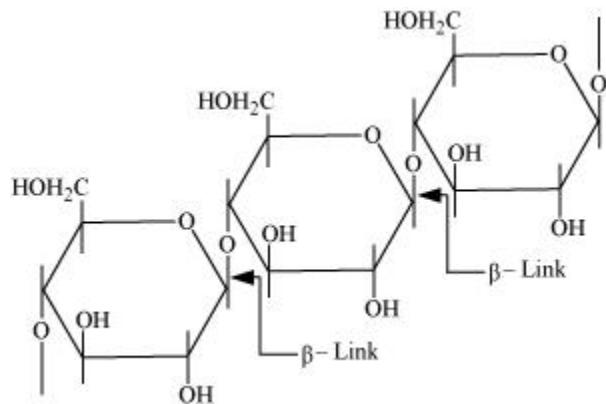


Amylopectin is a branched-chain polymer of α -D-glucose units, in which the chain is formed by C1-C4 glycosidic linkage and the branching occurs by C1-C6 glycosidic linkage.

BIOMOLECULES NCERT SOLUTION



On the other hand, cellulose is a straight-chain polysaccharide of β -D-glucose units joined by C1–C4 glycosidic linkage (β -link).



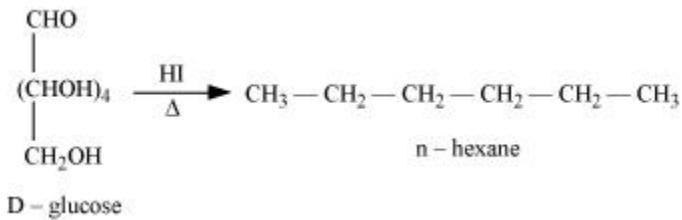
Question 14.9:

What happens when D-glucose is treated with the following reagents?

- (i) HI (ii) Bromine water (iii) HNO_3

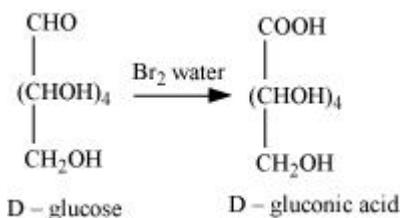
Answer

- (i) When D-glucose is heated with HI for a long time, n-hexane is formed.

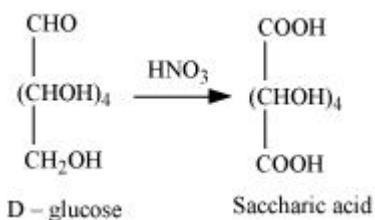


- (ii) When D-glucose is treated with Br_2 water, D- gluconic acid is produced.

BIOMOLECULES NCERT SOLUTION



(iii) On being treated with HNO_3 , D-glucose get oxidised to give saccharic acid.



Question 14.10:

Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.

Answer

- (1)** Aldehydes give 2, 4-DNP test, Schiff's test, and react with NaHSO_4 to form the hydrogen sulphite addition product. However, glucose does not undergo these reactions.
- (2)** The pentaacetate of glucose does not react with hydroxylamine. This indicates that a free $-\text{CHO}$ group is absent from glucose.
- (3)** Glucose exists in two crystalline forms – α and β . The α -form (m.p. = 419 K) crystallises from a concentrated solution of glucose at 303 K and the β -form (m.p. = 423 K) crystallises from a hot and saturated aqueous solution at 371 K. This behaviour cannot be explained by the open chain structure of glucose

Question 14.11:

What are essential and non-essential amino acids? Give two examples of each type.

Answer

Essential amino acids are required by the human body, but they cannot be synthesised in the body. They must be taken through food. For example: valine and leucine

Non-essential amino acids are also required by the human body, but they can be synthesised in the body. For example: glycine, and alanine

Question 14.12:

Define the following as related to proteins

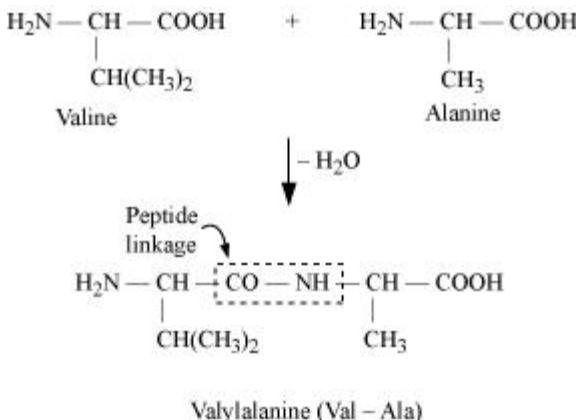
BIOMOLECULES NCERT SOLUTION

(i) Peptide linkage (ii) Primary structure (iii) Denaturation.

Answer

(i) Peptide linkage:

The amide formed between --COOH group of one molecule of an amino acid and --NH_2 group of another molecule of the amino acid by the elimination of a water molecule is called a peptide linkage.



(ii) Primary structure:

The primary structure of protein refers to the specific sequence in which various amino acids are present in it, i.e., the sequence of linkages between amino acids in a polypeptide chain. The sequence in which amino acids are arranged is different in each protein. A change in the sequence creates a different protein.

(iii) Denaturation:

In a biological system, a protein is found to have a unique 3-dimensional structure and a unique biological activity. In such a situation, the protein is called native protein. However, when the native protein is subjected to physical changes such as change in temperature or chemical changes such as change in pH, its H-bonds are disturbed. This disturbance unfolds the globules and uncoils the helix. As a result, the protein loses its biological activity. This loss of biological activity by the protein is called denaturation. During denaturation, the secondary and the tertiary structures of the protein get destroyed, but the primary structure remains unaltered.

One of the examples of denaturation of proteins is the coagulation of egg white when an egg is boiled.

Question 14.13:

What are the common types of secondary structure of proteins?

Answer

There are two common types of secondary structure of proteins:

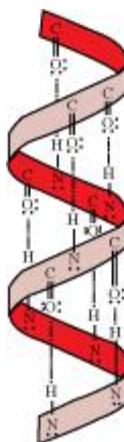
BIOMOLECULES NCERT SOLUTION

(i) α -helix structure

(ii) β -pleated sheet structure

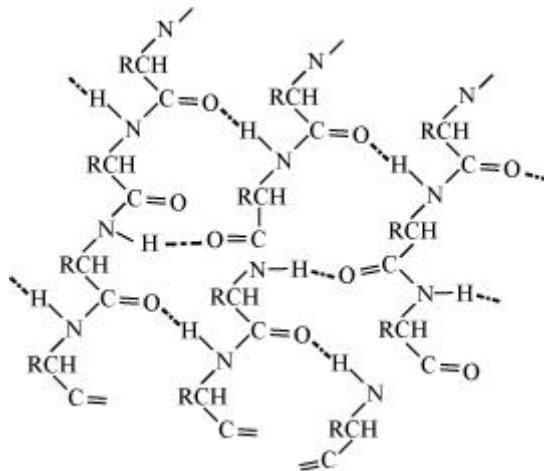
α - Helix structure:

In this structure, the $-NH$ group of an amino acid residue forms H-bond with the $>C=O$ group of the adjacent turn of the right-handed screw (α -helix).



β -pleated sheet structure:

This structure is called so because it looks like the pleated folds of drapery. In this structure, all the peptide chains are stretched out to nearly the maximum extension and then laid side by side. These peptide chains are held together by intermolecular hydrogen bonds.



Question 14.14:

What type of bonding helps in stabilising the α -helix structure of proteins?

Answer

BIOMOLECULES NCERT SOLUTION

The H-bonds formed between the $-NH$ group of each amino acid residue and

the $\text{>} \text{C=O}$ group of the adjacent turns of the α -helix help in stabilising the helix.

Question 14.15:

Differentiate between globular and fibrous proteins.

Answer

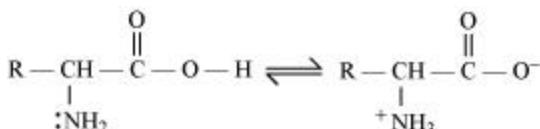
Fibrous protein		Globular protein	
1.	It is a fibre-like structure formed by the polypeptide chain. These proteins are held together by strong hydrogen and disulphide bonds.	1.	The polypeptide chain in this protein is folded around itself, giving rise to a spherical structure.
2.	It is usually insoluble in water.	2.	It is usually soluble in water.
3.	Fibrous proteins are usually used for structural purposes. For example, keratin is present in nails and hair; collagen in tendons; and myosin in muscles.	3.	All enzymes are globular proteins. Some hormones such as insulin are also globular proteins.

Question 14.16:

How do you explain the amphoteric behaviour of amino acids?

Answer

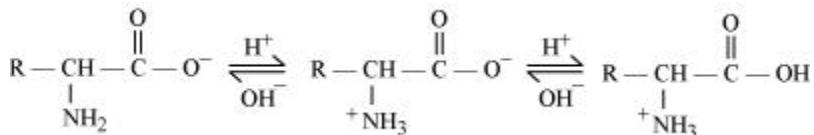
In aqueous solution, the carboxyl group of an amino acid can lose a proton and the amino group can accept a proton to give a dipolar ion known as zwitter ion.



Zwitter ion

Therefore, in zwitter ionic form, the amino acid can act both as an acid and as a base.

BIOMOLECULES NCERT SOLUTION



Thus, amino acids show amphoteric behaviour.

Question 14.17:

What are enzymes?

Answer

Enzymes are proteins that catalyse biological reactions. They are very specific in nature and catalyse only a particular reaction for a particular substrate. Enzymes are usually named after the particular substrate or class of substrate and some times after the particular reaction.

For example, the enzyme used to catalyse the hydrolysis of maltose into glucose is named as maltase.



Again, the enzymes used to catalyse the oxidation of one substrate with the simultaneous reduction of another substrate are named as oxidoreductase enzymes.

The name of an enzyme ends with ‘- ase’

Question 14.18:

What is the effect of denaturation on the structure of proteins?

Answer

As a result of denaturation, globules get unfolded and helices get uncoiled. Secondary and tertiary structures of protein are destroyed, but the primary structures remain unaltered. It can be said that during denaturation, secondary and tertiary-structured proteins get converted into primary-structured proteins. Also, as the secondary and tertiary structures of a protein are destroyed, the enzyme loses its activity.

Question 14.19:

How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

Answer

On the basis of their solubility in water or fat, vitamins are classified into two groups.

(i) **Fat-soluble vitamins:** Vitamins that are soluble in fat and oils, but not in water, belong to this group. For example: Vitamins A, D, E, and K

BIOMOLECULES NCERT SOLUTION

(ii) Water-soluble vitamins: Vitamins that are soluble in water belong to this group. For example: B group vitamins (B_1 , B_2 , B_6 , B_{12} , etc.) and vitamin C

However, biotin or vitamin H is neither soluble in water nor in fat.

Vitamin K is responsible for the coagulation of blood

Question 14.20:

Why are vitamin A and vitamin C essential to us? Give their important sources.

Answer

The deficiency of vitamin A leads to xerophthalmia (hardening of the cornea of the eye) and night blindness. The deficiency of vitamin C leads to scurvy (bleeding gums).

The sources of vitamin A are fish liver oil, carrots, butter, and milk. The sources of vitamin C are citrus fruits, *amla*, and green leafy vegetables

Question 14.21:

What are nucleic acids? Mention their two important functions.

Answer

Nucleic acids are biomolecules found in the nuclei of all living cells, as one of the constituents of chromosomes. There are mainly two types of nucleic acids – deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Nucleic acids are also known as polynucleotides as they are long-chain polymers of nucleotides.

Two main functions of nucleic acids are:

(i) DNA is responsible for the transmission of inherent characters from one generation to the next. This process of transmission is called heredity.

(ii) Nucleic acids (both DNA and RNA) are responsible for protein synthesis in a cell. Even though the proteins are actually synthesised by the various RNA molecules in a cell, the message for the synthesis of a particular protein is present in DNA

Question 14.22:

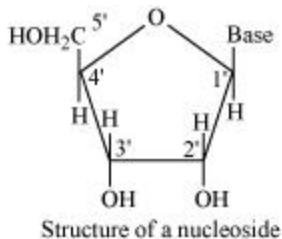
What is the difference between a nucleoside and a nucleotide?

Answer

A nucleoside is formed by the attachment of a base to $1'$ position of sugar.

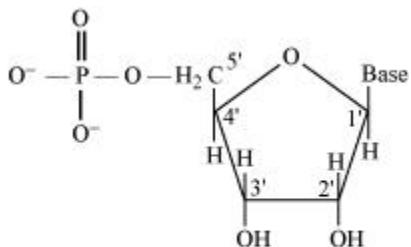
Nucleoside = Sugar + Base

BIOMOLECULES NCERT SOLUTION



On the other hand, all the three basic components of nucleic acids (i.e., pentose sugar, phosphoric acid, and base) are present in a nucleotide.

Nucleotide = Sugar + Base + Phosphoric acid



Structure of a nucleotide

Question 14.23:

The two strands in DNA are not identical but are complementary. Explain.

Answer

In the helical structure of DNA, the two strands are held together by hydrogen bonds between specific pairs of bases. Cytosine forms hydrogen bond with guanine, while adenine forms hydrogen bond with thymine. As a result, the two strands are complementary to each other

Question 14.24:

Write the important structural and functional differences between DNA and RNA.

Answer

The structural differences between DNA and RNA are as follows:

DNA		RNA	
1.	The sugar moiety in DNA molecules is β -D-2-deoxyribose.	1.	The sugar moiety in RNA molecules is β -D-ribose.
2.	DNA contains uracil (U). It	2.	RNA contains thymine (T).

BIOMOLECULES NCERT SOLUTION

	does not contain thymine (T).		It does not contain uracil (U).
3.	The helical structure of DNA is double-stranded.	3.	The helical structure of RNA is single-stranded.

The functional differences between DNA and RNA are as follows:

DNA		RNA	
1.	DNA is the chemical basis of heredity.	1.	RNA is not responsible for heredity.
2.	Proteins are synthesised by RNA molecules in the cells.	2.	DNA molecules do not synthesise proteins, but transfer coded message for the synthesis of proteins in the cells.

Question 14.25:

What are the different types of RNA found in the cell?

Answer

- (i) Messenger RNA (m-RNA)
- (ii) Ribosomal RNA (r-RNA)
- (iii) Transfer RNA (t-RNA)

CHEMISTRY IN ACTION NCERT SOLUTION

CHEMISTRY IN ACTION

Question 16.1:

Sleeping pills are recommended by doctors to the patients suffering from sleeplessness but it is not advisable to take its doses without consultation with the doctor, Why?

Answer

Most drugs when taken in doses higher than recommended may cause harmful effects and sometimes, may even lead to death. Hence, a doctor should always be consulted before taking any medicine

Question 16.2:

With reference to which classification has the statement, 'ranitidine is an antacid' been given?

Answer

The given statement refers to the classification of pharmacological effects of the drug. This is because any drug that is used to counteract the effects of excess acid in the stomach is called an antacid.

Question 16.3:

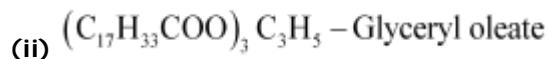
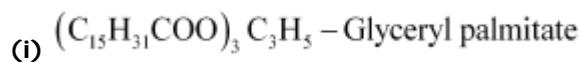
Why do we require artificial sweetening agents?

Answer

A large number of people are suffering from diseases such as diabetes and obesity. These people cannot take normal sugar i.e., sucrose as it is harmful for them. Therefore, artificial sweetening agents that do not add to the calorie intake of a person are required. Saccharin, aspartame, and alitame are a few examples of artificial sweeteners

Question 16.4:

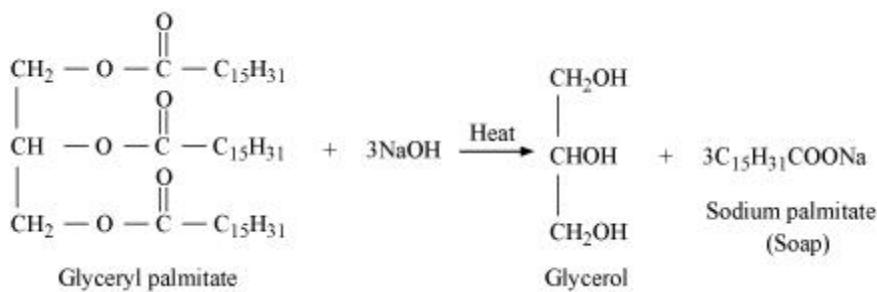
Write the chemical equation for preparing sodium soap from glyceryl oleate and glyceryl palmitate. Structural formulae of these compounds are given below.



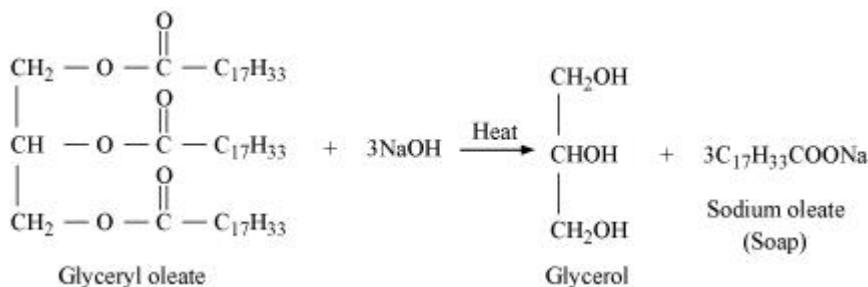
Answer

(i)

CHEMISTRY IN ACTION NCERT SOLUTION

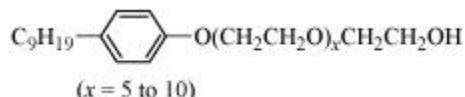


(ii)

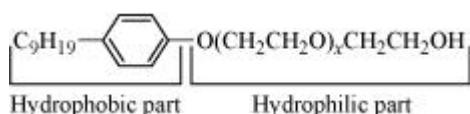


Question 16.5:

Following type of non-ionic detergents are present in liquid detergents, emulsifying agents and wetting agents. Label the hydrophilic and hydrophobic parts in the molecule. Identify the functional group (s) present in the molecule.



Answer



Functional groups present in the molecule are:

(i) Ether, and

(ii) primary alcoholic group

Question 16.1:

Why do we need to classify drugs in different ways?

Answer

CHEMISTRY IN ACTION NCERT SOLUTION

The classification of drugs and the reasons for classification are as follows:

(i) On the basis of pharmacological effect:

This classification provides doctors the whole range of drugs available for the treatment of a particular type of problem. Hence, such a classification is very useful to doctors.

(ii) On the basis of drug action:

This classification is based on the action of a drug on a particular biochemical process. Thus, this classification is important.

(iii) On the basis of chemical structure:

This classification provides the range of drugs sharing common structural features and often having similar pharmacological activity.

(iv) On the basis of molecular targets:

This classification provides medicinal chemists the drugs having the same mechanism of action on targets. Hence, it is the most useful to medicinal chemists

Question 16.2:

Explain the term target molecules or drug targets as used in medicinal chemistry.

Answer

In medicinal chemistry, drug targets refer to the key molecules involved in certain metabolic pathways that result in specific diseases. Carbohydrates, proteins, lipids, and nucleic acids are examples of drug targets.

Drugs are chemical agents designed to inhibit these target molecules by binding with the active sites of the key molecules

Question 16.3:

Name the macromolecules that are chosen as drug targets.

Answer

The macromolecules chosen as drug targets are carbohydrates, lipids, proteins, and nucleic acids

Question 16.4:

Why should not medicines be taken without consulting doctors?

Answer

CHEMISTRY IN ACTION NCERT SOLUTION

A medicine can bind to more than one receptor site. Thus, a medicine may be toxic for some receptor sites. Further, in most cases, medicines cause harmful effects when taken in higher doses than recommended. As a result, medicines may be poisonous in such cases. Hence, medicines should not be taken without consulting doctors

Question 16.5:

Define the term chemotherapy.

Answer

The use of chemicals for therapeutic effect is called chemotherapy. For example: the use of chemicals in the diagnosis, prevention, and treatment of diseases

Question 16.6:

Which forces are involved in holding the drugs to the active site of enzymes?

Answer

Either of the following forces can be involved in holding drugs to the active sites of enzymes.

- (i) Ionic bonding
- (ii) Hydrogen bonding
- (iii) Dipole – dipole interaction
- (iv) van der Waals force

Question 16.7:

While antacids and antiallergic drugs interfere with the function of histamines, why do these not interfere with the function of each other?

Answer

Specific drugs affect particular receptors. Antacids and anti-allergic drugs work on different receptors. This is the reason why antacids and anti-allergic drugs do not interfere with each other's functions, but interfere with the functions of histamines

Question 16.8:

Low level of noradrenaline is the cause of depression. What types of drugs are needed to cure this problem? Name two drugs.

Answer

CHEMISTRY IN ACTION NCERT SOLUTION

Anti-depressant drugs are needed to counteract the effect of depression. These drugs inhibit enzymes catalysing the degradation of the neurotransmitter, noradrenaline. As a result, the important neurotransmitter is slowly metabolised and then it can activate its receptor for longer periods of time.

Two anti-depressant drugs are:

(i) Iproniazid

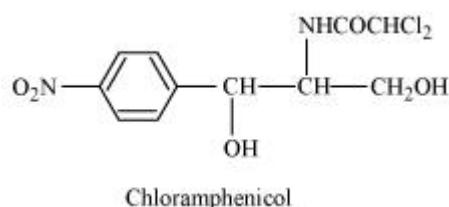
(ii) Phenelzine

Question 16.9:

What is meant by the term 'broad spectrum antibiotics'? Explain.

Answer

Antibiotics that are effective against a wide range of gram-positive and gram-negative bacteria are known as broad spectrum antibiotics. Chloramphenicol is a broad spectrum antibiotic.



It can be used for the treatment of typhoid, dysentery, acute fever, pneumonia, meningitis, and certain forms of urinary infections. Two other broad spectrum antibiotics are vancomycin and ofloxacin. Ampicillin and amoxicillin –synthetically modified from penicillin – are also broad spectrum antibiotics.

Question 16.10:

How do antiseptics differ from disinfectants? Give one example of each.

Answer

Antiseptics and disinfectants are effective against micro-organisms. However, antiseptics are applied to the living tissues such as wounds, cuts, ulcers, and diseased skin surfaces, while disinfectants are applied to inanimate objects such as floors, drainage system, instruments, etc. Disinfectants are harmful to the living tissues.

Iodine is an example of a strong antiseptic. Tincture of iodine (2 – 3 percent of solution of iodine in alcohol – water mixture) is applied to wounds. 1 percent solution of phenol is used as a disinfectant.

Question 16.11:

CHEMISTRY IN ACTION NCERT SOLUTION

Why are cimetidine and ranitidine better antacids than sodium hydrogen carbonate or magnesium or aluminium hydroxide?

Answer

Antacids such as sodium hydrogen carbonate, magnesium hydroxide, and aluminium hydroxide work by neutralising the excess hydrochloric acid present in the stomach. However, the root cause for the release of excess acid remains untreated.

Cimetidine and rantidine are better antacids as they control the root cause of acidity. These drugs prevent the interaction of histamine with the receptors present in the stomach walls. Consequently, there is a decrease in the amount of acid released by the stomach. This is why cimetidine and rantidine are better antacids than sodium hydrogen carbonate, magnesium hydroxide, and aluminium hydroxide

Question 16.12:

Name a substance which can be used as an antiseptic as well as disinfectant.

Answer

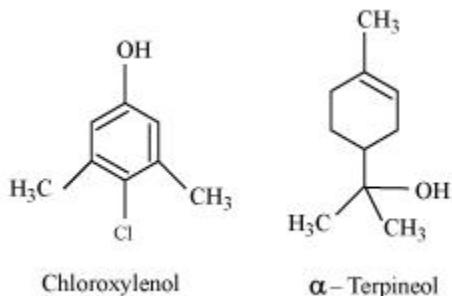
Phenol can be used as an antiseptic as well as a disinfectant. 0.2 percent solution of phenol is used as an antiseptic, while 1 per cent of its solution is used as a disinfectant

Question 16.13:

What are the main constituents of dettol?

Answer

The main constituents of dettol are chloroxylenol and α -terpineol.



Question 16.14:

What is tincture of iodine? What is its use?

Answer

CHEMISTRY IN ACTION NCERT SOLUTION

Tincture of iodine is a 2 – 3 percent solution of iodine in alcohol – water mixture. It is applied to wounds as an antiseptic

Question 16.15:

What are food preservatives?

Answer

Food preservatives are chemicals that prevent food from spoilage due to microbial growth. Table salt, sugar, vegetable oil, sodium benzoate (C_6H_5COONa), and salts of propanoic acid are some examples of food preservatives.

Question 16.16:

Why is use of aspartame limited to cold foods and drinks?

Answer

Aspartame becomes unstable at cooking temperature. This is the reason why its use is limited to cold foods and drinks

Question 16.17:

What are artificial sweetening agents? Give two examples.

Answer

Artificial sweetening agents are chemicals that sweeten food. However, unlike natural sweeteners, they do not add calories to our body. They do not harm the human body. Some artificial sweeteners are aspartame, saccharin, sucrose, and alitame

Question 16.18:

Name a sweetening agent used in the preparation of sweets for a diabetic patient.

Answer

Artificial sweetening agents such as saccharin, alitame, and aspartame can be used in preparing sweets for diabetic patients

Question 16.19:

What problem arises in using alitame as artificial sweetener?

Answer

Alitame is a high potency sweetener. It is difficult to control the sweetness of food while using alitame as an artificial sweetener

CHEMISTRY IN ACTION NCERT SOLUTION

Question 16.20:

How are synthetic detergents better than soap?

Answer

Soaps work in soft water. However, they are not effective in hard water. In contrast, synthetic detergents work both in soft water and hard water.

Therefore, synthetic detergents are better than soaps

Question 16.21:

Explain the following terms with suitable examples

(i) Cationic detergents

(ii) Anionic detergents and

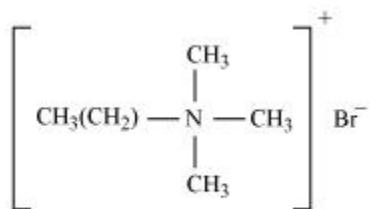
(iii) Non-ionic detergents

Answer

(i) Cationic detergent

Cationic detergents are quaternary ammonium salts of acetates, chlorides, or bromides. These are called cationic detergents because the cationic part of these detergents contains a long hydrocarbon chain and a positive charge on the N atom.

For example: cetyltrimethylammonium bromide



Cetyltrimethylammonium bromide

(ii) Anionic detergents

Anionic detergents are of two types:

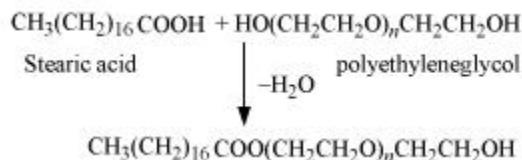
1. Sodium alkyl sulphates: These detergents are sodium salts of long chain alcohols. They are prepared by first treating these alcohols with concentrated sulphuric acid and then with sodium hydroxide. Examples of these detergents include sodium lauryl sulphate ($\text{C}_{11}\text{H}_{23}\text{CH}_2\text{OSO}_3^-\text{Na}^+$) and sodium stearyl sulphate ($\text{C}_{17}\text{H}_{35}\text{CH}_2\text{OSO}_3^-\text{Na}^+$).

CHEMISTRY IN ACTION NCERT SOLUTION

2. Sodium alkylbenzenesulphonates: These detergents are sodium salts of long chain alkylbenzenesulphonic acids. They are prepared by Friedel-Crafts alkylation of benzene with long chain alkyl halides or alkenes. The obtained product is first treated with concentrated sulphuric acid and then with sodium hydroxide. Sodium 4-(1-dodecy) benzenesulphonate (SDS) is an example of anionic detergents.

(iii) Non-ionic detergents

Molecules of these detergents do not contain any ions. These detergents are esters of alcohols having high molecular mass. They are obtained by reacting polyethylene glycol and stearic acid.



Question 16.22:

What are biodegradable and non-biodegradable detergents? Give one example of each.

Answer

Detergents that can be degraded by bacteria are called biodegradable detergents. Such detergents have straight hydrocarbon chains. For example: sodium lauryl sulphate

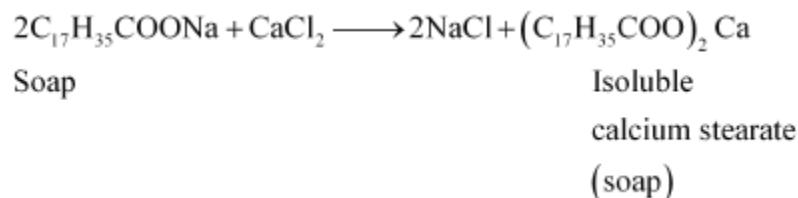
Detergents that cannot be degraded by bacteria are called non-biodegradable detergents. Such detergents have highly-branched hydrocarbon chains. For example: sodium -4- (1, 3, 5, 7- tetra methyl octyl) benzene sulphonate

Question 16.23:

Why do soaps not work in hard water?

Answer

Soaps are sodium or potassium salts of long-chain fatty acids. Hard water contains calcium and magnesium ions. When soaps are dissolved in hard water, these ions displace sodium or potassium from their salts and form insoluble calcium or magnesium salts of fatty acids. These insoluble salts separate as scum.



This is the reason why soaps do not work in hard water

CHEMISTRY IN ACTION NCERT SOLUTION

Question 16.24:

Can you use soaps and synthetic detergents to check the hardness of water?

Answer

Soaps get precipitated in hard water, but not in soft water. Therefore, soaps can be used for checking the hardness of water.

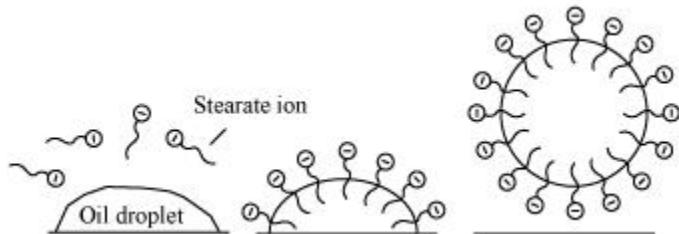
However, synthetic detergents do not get precipitated either in hard water or in soft water. Therefore, synthetic detergents cannot be used for checking the hardness of water.

Question 16.25:

Explain the cleansing action of soaps.

Answer

Soap molecules form micelles around an oil droplet (dirt) in such a way that the hydrophobic parts of the stearate ions attach themselves to the oil droplet and the hydrophilic parts project outside the oil droplet. Due to the polar nature of the hydrophilic parts, the stearate ions (along with the dirt) are pulled into water, thereby removing the dirt from the cloth.



POLYMERS: NCERT SOLUTION

POLYMERS

Question 15.1:

What are polymers?

Answer

Polymers are high molecular mass macromolecules, which consist of repeating structural units derived from monomers. Polymers have a high molecular mass ($10^3 - 10^7$ u). In a polymer, various monomer units are joined by strong covalent bonds. These polymers can be natural as well as synthetic. Polythene, rubber, and nylon 6, 6 are examples of polymers

Question 15.2:

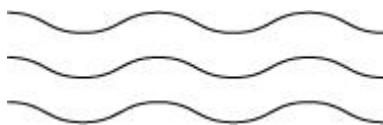
How are polymers classified on the basis of structure?

Answer

Polymers are classified on the basis of structure as follows:

1. Linear polymers:

These polymers are formed of long straight chains. They can be depicted as:



For e.g., high density polythene (HDP), polyvinyl chloride, etc.

2. Branched chain polymers:

These polymers are basically linear chain polymers with some branches. These polymers are represented as:

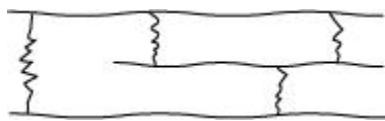


For e.g., low density polythene (LDP), amylopectin, etc.

3. Cross-linked or Network polymers:

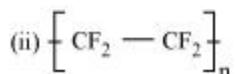
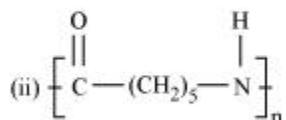
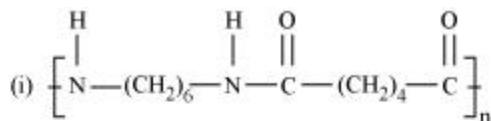
These polymers have many cross-linking bonds that give rise to a network-like structure. These polymers contain bi-functional and tri-functional monomers and strong covalent bonds between various linear polymer chains. Examples of such polymers include bakelite and melmac.

POLYMERS: NCERT SOLUTION



Question 15.3:

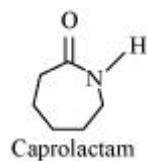
Write the names of monomers of the following polymers:



Answer

(i) Hexamethylenediamine $[\text{H}_2\text{N}-\text{(CH}_2\text{)}_6-\text{NH}_2]$ and adipic acid $[\text{HOOC}-\text{(CH}_2\text{)}_4-\text{COOH}]$

(ii)



(iii) Tetrafluoroethylene ($\text{CF}_2=\text{CF}_2$)

Question 15.4:

Classify the following as addition and condensation polymers: Terylene, Bakelite, Polyvinyl chloride, Polythene.

Answer

Addition polymers:

Polyvinyl chloride, polythene

POLYMERS: NCERT SOLUTION

Condensation polymers:

Terylene, bakelite

Question 15.5:

Explain the difference between Buna-N and Buna-S.

Answer

Buna – N is a copolymer of 1, 3–butadiene and acrylonitrile.

Buna – S is a copolymer of 1, 3–butadiene and styrene

Question 15.6:

Arrange the following polymers in increasing order of their intermolecular forces.

(i) Nylon 6, 6, Buna-S, Polythene.

(ii) Nylon 6, Neoprene, Polyvinyl chloride.

Answer

Different types of polymers have different intermolecular forces of attraction. Elastomers or rubbers have the weakest while fibres have the strongest intermolecular forces of attraction. Plastics have intermediate intermolecular forces of attraction. Hence, the increasing order of the intermolecular forces of the given polymers is as follows:

(i) Buna – S < polythene < Nylon 6, 6

(ii) Neoprene < polyvinyl chloride < Nylon 6

Question 15.1:

Explain the terms polymer and monomer.

Answer

Polymers are high molecular mass macromolecules composed of repeating structural units derived from monomers. Polymers have a high molecular mass (10^3 – 10^7 u). In a polymer, various monomer units are joined by strong covalent bonds. Polymers can be natural as well as synthetic. Polythene, rubber, and nylon 6, 6 are examples of polymers.

Monomers are simple, reactive molecules that combine with each other in large numbers through covalent bonds to give rise to polymers. For example, ethene, propene, styrene, vinyl chloride

POLYMERS: NCERT SOLUTION

Question 15.2:

What are natural and synthetic polymers? Give two examples of each type.

Answer

Natural polymers are polymers that are found in nature. They are formed by plants and animals. Examples include protein, cellulose, starch, etc.

Synthetic polymers are polymers made by human beings. Examples include plastic (polythene), synthetic fibres (nylon 6, 6), synthetic rubbers (Buna – S).

Question 15.3:

Distinguish between the terms homopolymer and copolymer and give an example of each.

Answer

Homopolymer	Copolymer
The polymers that are formed by the polymerization of a single monomer are known as homopolymers. In other words, the repeating units of homopolymers are derived only from one monomer. For example, polythene is a homopolymer of ethane.	The polymers whose repeating units are derived from two types of monomers are known as copolymers. For example, Buna-S is a copolymer of 1, 3-butadiene and styrene.

Question 15.4:

How do you explain the functionality of a monomer?

Answer

The functionality of a monomer is the number of binding sites that is/are present in that monomer.

For example, the functionality of monomers such as ethene and propene is one and that of 1, 3-butadiene and adipic acid is two.

Question 15.5:

Define the term polymerisation.

Answer

POLYMERS: NCERT SOLUTION

Polymerization is the process of forming high molecular mass ($10^3 - 10^7$ u) macromolecules, which consist of repeating structural units derived from monomers. In a polymer, various monomer units are joined by strong covalent bonds.

Question 15.6:

Is $\text{--}(\text{NH--CHR--CO})_n\text{--}$, a homopolymer or copolymer?

Answer

$\text{--}(\text{NH--CHR--CO})_n\text{--}$ is a homopolymer because it is obtained from a single monomer unit, $\text{NH}_2\text{--CHR--COOH}$

Question 15.7:

In which classes, the polymers are classified on the basis of molecular forces?

Answer

On the basis of magnitude of intermolecular forces present in polymers, they are classified into the following groups:

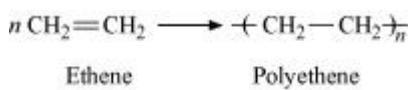
- (i) Elastomers
- (ii) Fibres
- (iii) Thermoplastic polymers
- (iv) Thermosetting polymers

Question 15.8:

How can you differentiate between addition and condensation polymerisation?

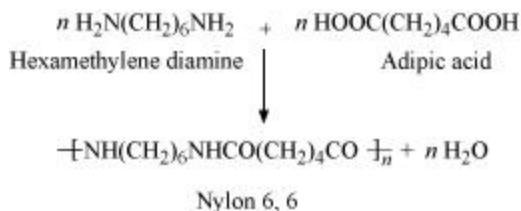
Answer

Addition polymerization is the process of repeated addition of monomers, possessing double or triple bonds to form polymers. For example, polythene is formed by addition polymerization of ethene.



Condensation polymerization is the process of formation of polymers by repeated condensation reactions between two different bi-functional or tri-functional monomers. A small molecule such as water or hydrochloric acid is eliminated in each condensation. For example, nylon 6, 6 is formed by condensation polymerization of hexamethylenediamine and adipic acid.

POLYMERS: NCERT SOLUTION

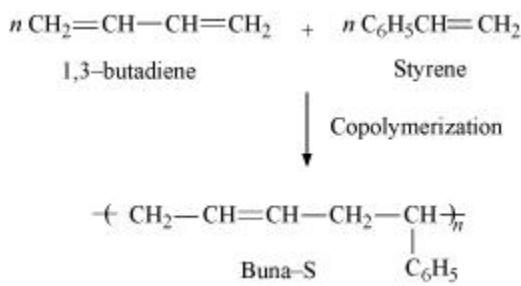


Question 15.9:

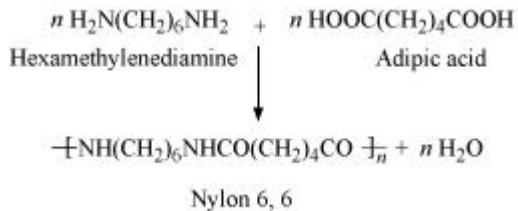
Explain the term copolymerisation and give two examples.

Answer

The process of forming polymers from two or more different monomeric units is called copolymerization. Multiple units of each monomer are present in a copolymer. The process of forming polymer Buna-S from 1, 3-butadiene and styrene is an example of copolymerization



Nylon 6, 6 is also a copolymer formed by hexamethylenediamine and adipic acid.



Question 15.10:

Write the free radical mechanism for the polymerisation of ethene.

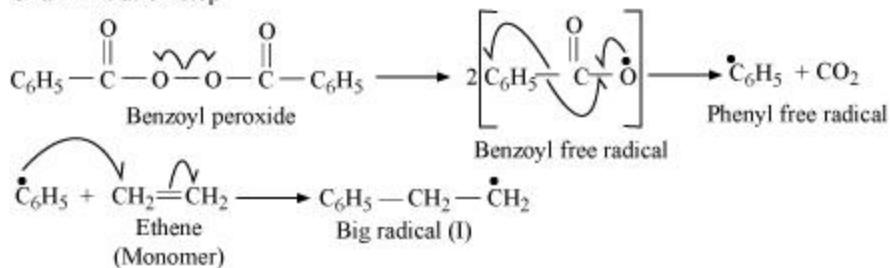
Answer

Polymerization of ethene to polythene consists of heating or exposing to light a mixture of ethene with a small amount of benzoyl peroxide as the initiator.

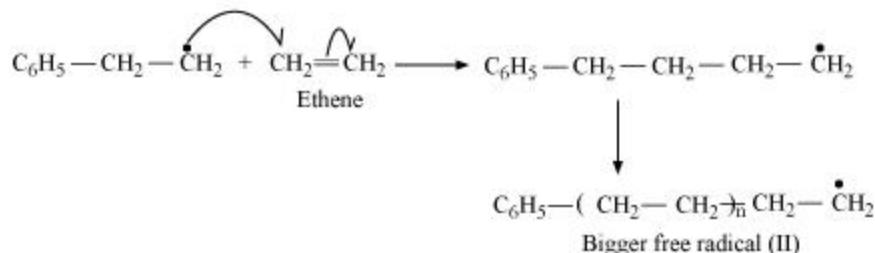
The reaction involved in this process is given below:

POLYMERS: NCERT SOLUTION

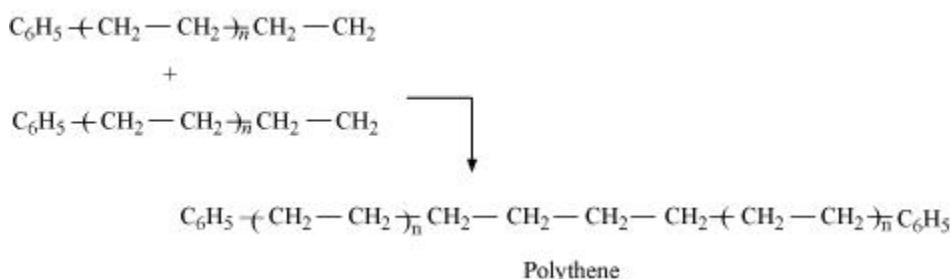
Chain initiation step



Chain Propagating step



Chain Terminating step



Question 15.11:

Define thermoplastics and thermosetting polymers with two examples of each.

Answer

Thermoplastic polymers are linear (slightly branched) long chain polymers, which can be repeatedly softened and hardened on heating. Hence, they can be modified again and again. Examples include polythene, polystyrene.

Thermosetting polymers are cross-linked or heavily branched polymers which get hardened during the molding process. These plastics cannot be softened again on heating. Examples of thermosetting plastics include bakelite, urea-formaldehyde resins

Question 15.12:

Write the monomers used for getting the following polymers.

- (i) Polyvinyl chloride (ii) Teflon (iii) Bakelite

POLYMERS: NCERT SOLUTION

Answer

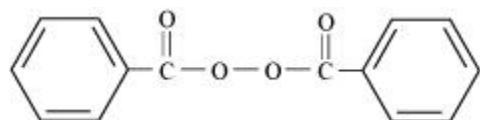
- (i) Vinyl chloride ($\text{CH}_2=\text{CHCl}$)
- (ii) Tetrafluoroethylene ($\text{CF}_2 = \text{CF}_2$)
- (iii) Formaldehyde (HCHO) and phenol ($\text{C}_6\text{H}_5\text{OH}$)

Question 15.13:

Write the name and structure of one of the common initiators used in free radical addition polymerisation.

Answer

One common initiator used in free radical addition polymerization is benzoyl peroxide. Its structure is given below.

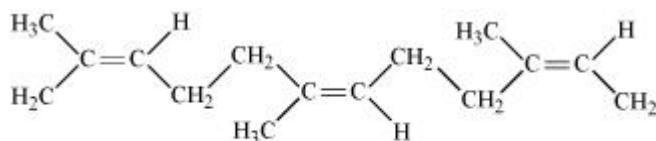


Question 15.14:

How does the presence of double bonds in rubber molecules influence their structure and reactivity?

Answer

Natural rubber is a linear cis-polyisoprene in which the double bonds are present between C_2 and C_3 of the isoprene units.



Because of this cis-configuration, intermolecular interactions between the various strands of isoprene are quite weak. As a result, various strands in natural rubber are arranged randomly. Hence, it shows elasticity.

Question 15.15:

Discuss the main purpose of vulcanisation of rubber.

POLYMERS: NCERT SOLUTION

Answer

Natural rubber though useful has some problems associated with its use. These limitations are discussed below:

1. Natural rubber is quite soft and sticky at room temperature. At elevated temperatures ($> 335\text{ K}$), it becomes even softer. At low temperatures ($< 283\text{ K}$), it becomes brittle. Thus, to maintain its elasticity, natural rubber is generally used in the temperature range of $283\text{ K}-335\text{ K}$.
2. It has the capacity to absorb large amounts of water.
3. It has low tensile strength and low resistance to abrasion.
4. It is soluble in non-polar solvents.
5. It is easily attacked by oxidizing agents.

Vulcanization of natural rubber is done to improve upon all these properties. In this process, a mixture of raw rubber with sulphur and appropriate additive is heated at a temperature range between 373 K and 415 K .

Question 15.16:

What are the monomeric repeating units of Nylon-6 and Nylon-6, 6?

Answer

The monomeric repeating unit of nylon 6 is $\left[\text{NH} - (\text{CH}_2)_5 - \text{CO} \right]$, which is derived from Caprolactam.

The monomeric repeating unit of nylon 6, 6 is $\left[\text{NH} - (\text{CH}_2)_6 - \text{NH} - \text{CO} - (\text{CH}_2)_4 - \text{CO} \right]$, which is derived from hexamethylene diamine and adipic acid

Question 15.17:

Write the names and structures of the monomers of the following polymers:

(i) Buna-S (ii) Buna-N

(iii) Dacron (iv) Neoprene

Answer

Polymer	Monomer	Structure of monomer
i Buna-S	1, 3-butadiene	$\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$

POLYMERS: NCERT SOLUTION

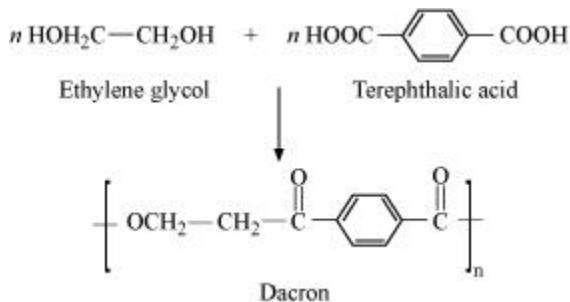
		Styrene	$C_6H_5CH=CH_2$
ii	Buna-N	1, 3-butadiene	$CH_2=CH-CH=CH_2$
		Acrylonitrile	$CH_2=CH-CN$
iii	Neoprene	Chloroprene	$CH_2=C\begin{matrix} Cl \\ \end{matrix}-CH=CH_2$
iv	Dacron	Ethylene glycol	$HOCH_2-CH_2OH$
		Terephthalic acid	$COOH-C_6H_4-COOH$

Question 15.19:

How is dacron obtained from ethylene glycol and terephthalic acid?

Answer

The condensation polymerisation of ethylene glycol and terephthalic acid leads to the formation of dacron.



Question 15.20:

What is a biodegradable polymer? Give an example of a biodegradable aliphatic polyester.

Answer

A polymer that can be decomposed by bacteria is called a biodegradable polymer.

Poly- β -hydroxybutyrate-CO- β - hydroxyvalerate (PHBV) is a biodegradable aliphatic polyester.

