

**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

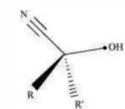
(viii) Imine

(ix) 2,4-DNP-derivative

(x) Schiff's base

Answer: (i) **Cyanohydrin:**

Cyanohydrin is organic compounds with the formula  $RR'C(OH)CN$ , where alkyl or aryl groups maybe R and R'.



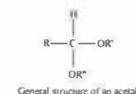
In the presence of excess sodium cyanide (NaCN) as a precursor to using cyanohydrin, aldehydes and ketones react with hydrogen cyanide (HCN). Such reactions are classified as reactions to cyanohydrins.



The useful synthetic intermediates are Cyanohydrins.

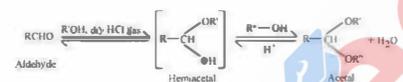
(ii) **Acetal:**

The gem-dialkoxy alkanes at the terminal carbon atom consisting of two groups of alkoxy are called Acetal. One bond is connected to an alkyl group, and the other to a hydrogen atom.



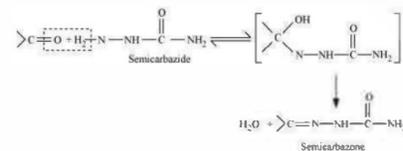
The general structure of an acetal.

Hemiacetals are formed in the presence of dry HCl water when aldehydes are treated with two monohydric alcohol equivalents. In addition, hemiacetals react with another alcohol molecule to yield acetal.



(iii) **Semicarbazone:**

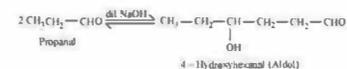
Semicarbazone comes from aldehydes and ketones, which is formed by the condensation reaction between a ketone or aldehyde and semicarbazide.



Semicarbazones serve to identify and characterize aldehydes and ketones.

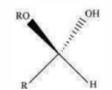
(iv) **Aldol:**

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



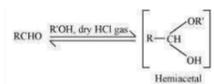
(v) **Hemiacetal:**

Hemiacetals are α-alkoxyalcohols



The general structure of a hemiacetal.

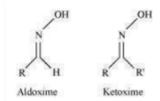
In the presence of dry HCl gas, aldehyde reacts with one single molecule of monohydrated alcohol.



**(vi) Oxime:**

General formula – RR'CNOH

Where R is an organic side chain and R' is either an organic side or hydrogen side chain. If R' is an organic side chain, then ketoxime is known, and if R' is H, it is called aldoxime.

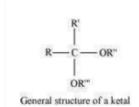


Aldehydes or ketones form oximes when treated with hydroxylamine in a weakly acidic medium.



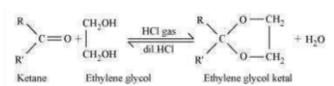
**(vii) Ketal:**

Ketals are gem-dialkoxyalkanes in which one carbon atom is comprised of two groups of alkoxy within the chain. The other two carbon atom bonds are related to two alkyl groups.



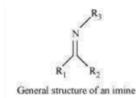
The general structure of a ketal.

A cyclic product is produced in the presence of dry HCl gas, called ethylene glycol ketals, when ketones react with ethylene glycol.

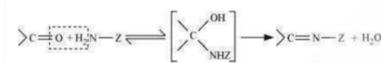


**(viii) Imine:**

Imines are chemical compounds which have a double bond between carbon-nitrogen.

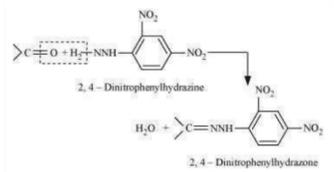


Aldehydes and ketones produce imines that they react with ammonia and derivatives thereof.



**(ix) 2, 4-DNP-derivative:**

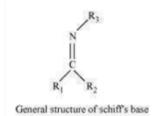
2, 4-dinitrophenylhydrazones are 2, 4-DNP-derivatives which are produced in a weakly acidic medium when aldehydes or ketones react with 2, 4-dinitrophenylhydrazine.



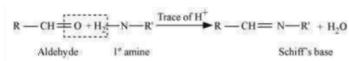
The 2, 4-DNP derivatives are used to identify and characterize aldehydes and ketones.

**(x) Schiff's base:**

Schiff's base is a chemical compound that contains a double bond between carbon-nitrogen and the nitrogen atom connected to an aryl or alkyl group-but, not hydrogen. They have the general R1R2C=NR3 formula. Thus, it's an imine. It's named for Hugo Schiff, a scientist.



Aldehydes and ketones in the presence of a residue of acid on treatment with primary aliphatic or aromatic amines yield a base of a Schiff.



**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)  $\text{OHCC}_6\text{H}_4\text{CHO-p}$

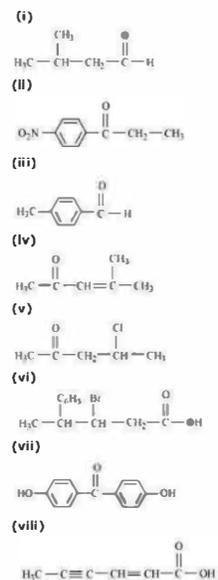
Soln:

- (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  
 (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-ynoic acid

Soln:



**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)  $\text{Ph}-\text{CH}=\text{CH}-\text{CHO}$   
 (v)



(vi) PhCOPh

Soln:

- (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: (v-Bromo-α-methyl-caproaldehyde)

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

IUPAC name: Heptanal

(iv)  $\text{Ph-CH=CH-CHO}$

IUPAC name: 3-phenylprop-2-enal

Common name:  $\beta$ -Phenylacrolein

(v)

IUPAC name: Cyclopentanecarbaldehyde

(vi)  $\text{PhCOPh}$

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

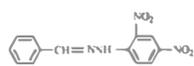
(iii) Acetaldehydedimethylacetal

(iv) The semicarbazone of cyclobutanone

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

(vi) The methyl hemiacetal of formaldehyde

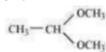
Soln:



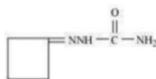
(ii)



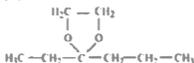
(iii)



(iv)



(v)



(vi)



**Question 12.6: Predict the products formed when cyclohexanecarbaldehyde reacts with following reagents.**

(i)  $\text{PhMgBr}$  and then  $\text{H}_3\text{O}^+$

(ii) Tollens' reagent

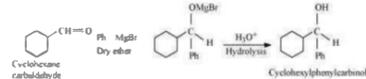
(iii) Semicarbazide and weak acid

(iv) Excess ethanol and acid

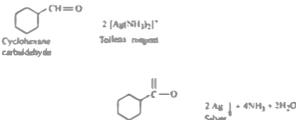
(v) Zinc amalgam and dilute hydrochloric acid

Soln:

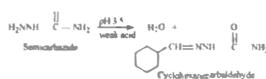
(i)

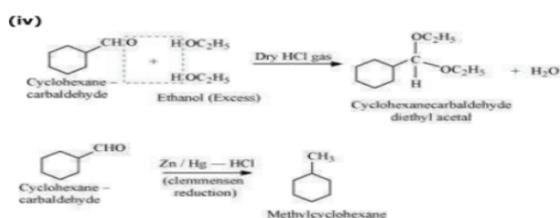


(ii)



(iii)





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

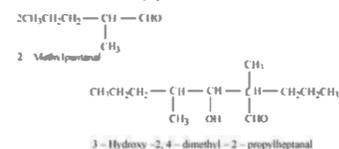
Soln: Aldehydes and ketones having at least one  $\alpha$ -hydrogen undergo aldol condensation. The compounds (ii) 2-methylpentanal, (v) cyclohexanone, (vi) 1-phenylpropanone, and (vii) phenylacetaldehyde contain one or more  $\alpha$ -hydrogen atoms. Therefore, these undergo aldol condensation.

Aldehydes having no  $\alpha$ -hydrogen atoms undergo Cannizzaro reactions. The compounds (i) Methanal, (iii) Benzaldehyde, and (ix) 2, 2 dimethylbutanal do not have any  $\alpha$ -hydrogen.

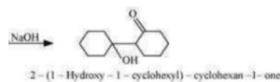
Therefore, these undergo cannizzaro reactions.

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

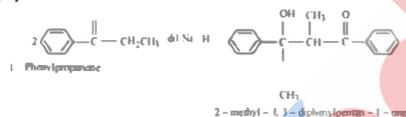
#### Aldol condensation (ii)



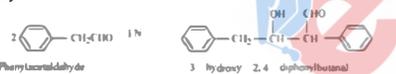
(v)



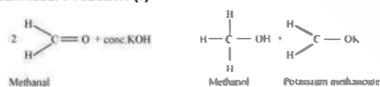
(vi)



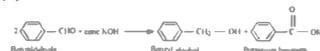
(vii)



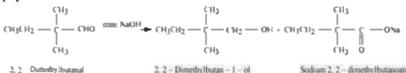
#### Cannizzaro reaction (i)



(iii)



(ix)



Question 12.8: How will you convert ethanal into the following compounds?

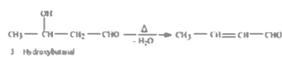
- (i) Butane-1, 3-diol  
 (ii) But-2-enal  
 (iii) But-2-enoic acid

Soln:

(i) Ethanal produces 3-hydroxybutanal gives butane-1, 3-diol on reduction when it is treated with dilute alkali.



(ii) Ethanal gives 3-hydroxybutanal which on heating produces but-2-enal when it is treated with dilute alkali.



(iii) But 2 enal produced in the above reaction produces but-2-enoic acid when it is treated with Tollen's reagent.



**Question 12.9:**

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

Soln:

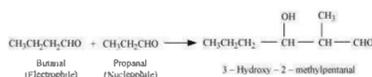
(i) One molecule of propanal acts as a nucleophile and the other molecule acts as an electrophile.



(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.



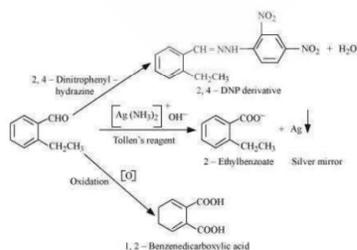
**Question 12.10:**

An organic compound with the molecular formula C<sub>9</sub>H<sub>10</sub>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.

Soln: The compound having molecular formula C<sub>9</sub>H<sub>10</sub>O forms 2,4-DNP derivative and reduces Tollens' reagent. Therefore, the given compound must be an aldehyde. Again, the compound gives 1,2 benzenedicarboxylic acids and undergoes Cannizzaro reaction followed by oxidation. Therefore, the -CHO group is directly attached to a benzene ring and this benzaldehyde is ortho-substituted. Hence, the compound is found to be 2-ethylbenzaldehyde.



The given reactions can be explained by the following equations.



**Question 12.11: An organic compound (A) (molecular formula C<sub>8</sub>H<sub>16</sub>O<sub>2</sub>) 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.**

Soln: A is an organic compound with a molecular formula C<sub>8</sub>H<sub>16</sub>O<sub>2</sub>. This gives a carboxylic acid (B) and alcohol (C) on hydrolysis with dilute sulphuric acid. Thus, compound A must be an ester.

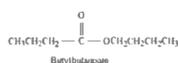
Further, oxidation of alcohol (C) with chromic acid gives acid B. Thus, B and C must contain an equal number of carbon atoms.

A total of 8 carbon atoms are present in compound A, each of B and C contain 4 carbon atoms.

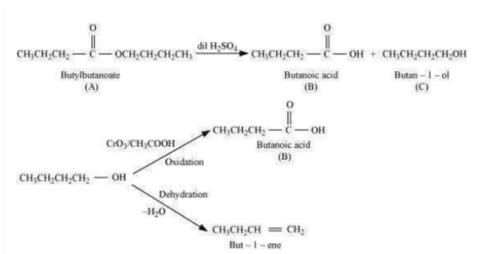
Again, alcohol C gives but-1-ene on dehydration. Therefore, C is of straight chain and hence, it is butan-1-ol.

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

Hence, the ester with molecular formula C<sub>8</sub>H<sub>16</sub>O<sub>2</sub> is butylbutanoate.



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



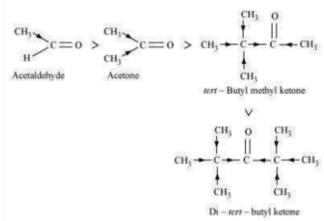
**Question 12.12: Arrange the following compounds in increasing order of their property as indicated:**

- Acetaldehyde, Acetone, Di-tert-butyl ketone, Methyl tert-butyl ketone (reactivity towards HCN)
- CH<sub>3</sub>CH<sub>2</sub>CH(Br)COOH, CH<sub>3</sub>CH(Br)CH<sub>2</sub>COOH, (CH<sub>3</sub>)<sub>2</sub>CHCOOH, CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH (acid strength)
- Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid (acid strength)

Soln:

(i) When HCN reacts with a compound, the attacking species is a nucleophile, CN<sup>-</sup>. Therefore, the reactivity with HCN decreases, when the negative charge on the compound increases. The +I effect increases in the given compound. Steric hindrance also increases in the same.

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



Di-tert-butyl ketone < Methyl tert-butyl ketone < Acetone < Acetaldehyde

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



Now, the stability of the carboxyl ion increases by any group that helps to stabilize the negative charge, will increase the strength of the acid. Thus, groups having -I effect will increase the strength of the acids and groups having +I effect will decrease the strength of the acids. In the given compounds, Br- group has -I effect and -CH<sub>3</sub> 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, CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH is a stronger acid than (CH<sub>3</sub>)<sub>2</sub>CHCOOH.

Also, as the distance increases, +I effect grows weaker. Hence, CH<sub>3</sub>CH<sub>2</sub>CH(Br)COOH is a stronger acid than CH<sub>3</sub>CH(Br)CH<sub>2</sub>COOH.

Hence, the strengths of the given acids increase as:



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

- Propanal and Propanone
- Acetophenone and Benzophenone
- Phenol and Benzoic acid
- Benzoic acid and Ethyl benzoate
- Pentan-2-one and Pentan-3-one
- Benzaldehyde and Acetophenone
- Ethanal and Propanal

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

(a) Tollen's test

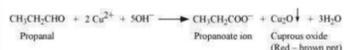
Tollen's reagent is reduced by propanal as it is an aldehyde. But, Tollen's reagent is not reduced as propanone is a ketone.



(b) Fehling's test

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

Propanone being a ketone does not reduce Fehling's solution to a red-brown precipitate of Cu<sub>2</sub>O, but Propanal being an aldehyde does the reaction.



**(c) Iodoform test:**

At least one methyl group should be present in aldehydes and ketones linked to the carbonyl carbon atom to 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.

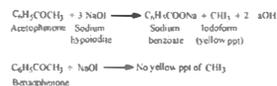


(ii) Acetophenone and Benzophenone can be distinguished using the iodoform test.

**Iodoform test:**

yellow ppt. of iodoform is produced when methyl ketones are oxidized by sodium hypoiodite.

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<sub>3</sub> to form an iron-phenol complex giving violet coloration.



A buff coloured ppt of ferric benzoate is produced when benzoic acid reacts with neutral FeCl<sub>3</sub>.

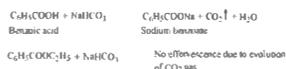


(iv) Benzoic acid and Ethyl benzoate can be distinguished by sodium bicarbonate test.

**Sodium bicarbonate test:**

Brisk effervescence is produced when acids react with NaHCO<sub>3</sub> due to the evolution of CO<sub>2</sub> gas.

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



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

**Iodoform test:**

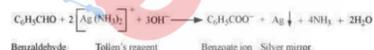
Pentan-2-one responds to this test as it is a methyl ketone. But pentan-3-one not being a methyl ketone does not respond to this test.



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

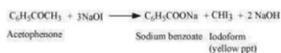
**(a) Tollen's Test**

Aldehydes respond to Tollen's test. Red-brown precipitate of Cu<sub>2</sub>O is produced by Benzaldehyde reduces Tollen's reagent, but acetophenone being a ketone does not.



**(b) Iodoform test**

A yellow precipitate of iodoform is given by acetophenone (a methyl ketone) when it undergoes oxidation by sodium hypoiodite (NaOI). But benzaldehyde does not respond to this test.



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

**Iodoform test**

Carbonyl carbon atom having at least one methyl group in aldehydes and ketones responds to the iodoform test. Also, Ethanal having one methyl group linked to the carbonyl carbon atom responds to this test. But, there are no methyl group linked to the carbonyl carbon atom in propanal and thus, it does not respond to this state.



**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

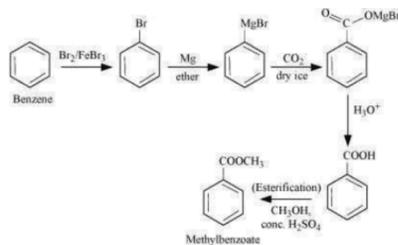
(iii) p-Nitrobenzoic acid

(iv) Phenylacetic acid

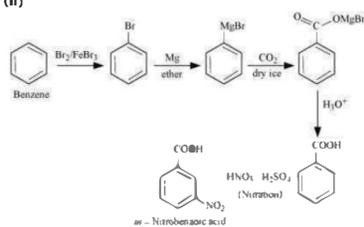
(v) p-Nitrobenzaldehyde

**Soln:**

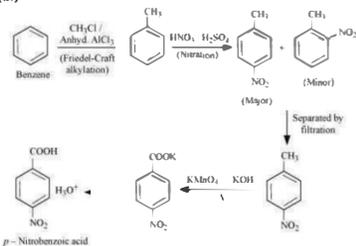
(i)



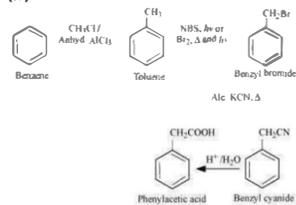
(ii)



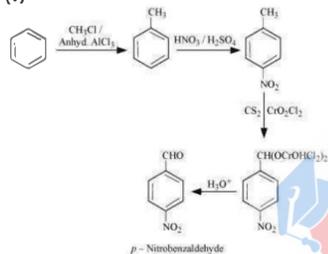
(iii)



(iv)



(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

(v) Benzaldehyde to Benzophenone

(vi) Bromobenzene to 1-Phenylethanol

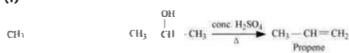
(vii) Benzaldehyde to 3-Phenylpropan-1-ol

(viii) Benzaldehyde to  $\alpha$ -Hydroxyphenylacetic acid

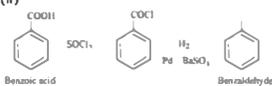
(ix) Benzoic acid to *m*-Nitrobenzyl alcohol

Soln:

(i)



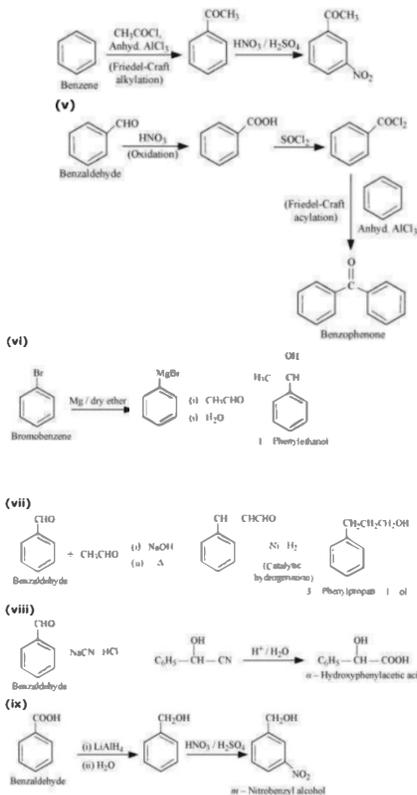
(ii)



(iii)



(iv)



Question 12.16: Describe the following:

(i) Acetylation

(ii) Cannizzaro reaction

(iii) Cross aldol condensation

(iv) Decarboxylation

Soln:

(i) Acetylation

When an organic compound is introduced with an acetyl function group, it is known as acetylation. Bases such as pyridine, dimethylaniline, etc. are present when this process is carried out. An acetyl group is substituted with an active hydrogen atom in this process. Acetylating agents such as acetyl chloride and acetic anhydride are commonly used in the process.

For example, acetylation of ethanol produces ethyl acetate.

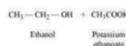


(ii) Cannizzaro reaction:

Cannizzaro reaction is the self disproportionation (oxidation-reduction) reaction of aldehydes with no  $\alpha$ -hydrogens on treatment with concentrated alkalis.

One molecule of aldehyde is reduced to alcohol and the other is oxidized to carboxylic acid, in this reaction.

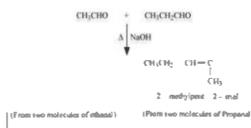
For example, ethanol and potassium ethanoate are produced when ethanol is treated with concentrated potassium hydroxide.



(iii) Cross-aldol condensation:

Cross – aldol condensation is carried out between two different aldehydes, or two different ketones, or an aldehyde and a ketone. Four compounds are obtained as products if both the reactants contain  $\alpha$ -hydrogens.

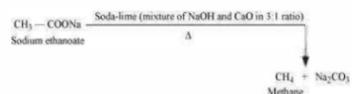
For example, reaction of ethanal and propanal gives four products.



(iv) Decarboxylation:

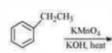
The reaction in which carboxylic acids lose carbon dioxide to form hydrocarbons when their sodium salts are heated with soda-lime is called decarboxylation.

When aqueous solutions of alkali metal salts of carboxylic acids are electrolyzed also results in decarboxylation. This electrolytic process is known as Kolbe's electrolysis.

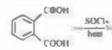


Question 12.17: Complete each synthesis by giving missing starting material, reagent or products

(i)



(ii)



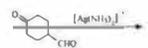
(iii)



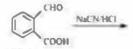
(iv)



(v)



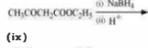
(vi)



(vii)



(viii)



(ix)



(x)

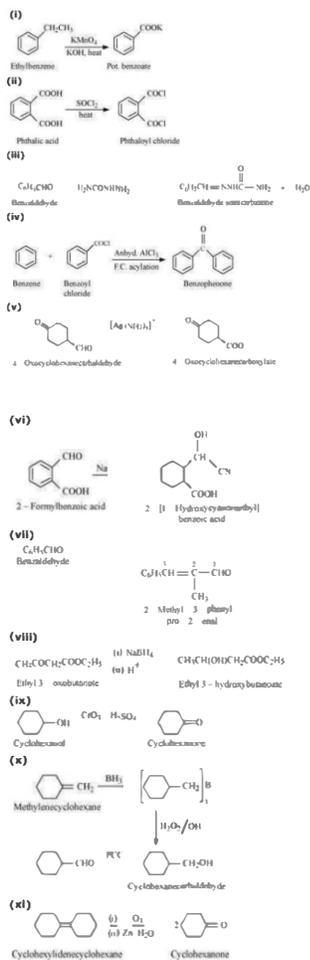


(xi)



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Soln:



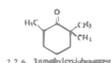
Question 12.18: Give a plausible explanation for each of the following:

- (i) Cyclohexanone forms cyanohydrin in good yield but 2, 2, 6 trimethylcyclohexanone does not.
- (ii) There are two  $-NH_2$  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.

Soln: (i) Cyanohydrins are formed by cyclohexanones according to the following equation.

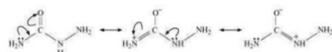


In this case, there will not be any steric hindrance, hence the nucleophile  $CN^-$  can easily attack. However, in the case of 2, 2, 6 trimethylcyclohexanone, methyl groups at  $\alpha$ -positions offer steric hindrances and as a result,  $CN^-$  cannot attack effectively.



For this reason, it does not form a cyanohydrin.

(ii) Semicarbazide undergoes resonance involving only one of the two  $-NH_2$  groups, which is attached directly to the carbonyl-carbon atom.



Therefore, the electron density on  $-NH_2$  group involved in the resonance also decreases.

As a result, it cannot act as a nucleophile. Since the other  $-NH_2$  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 Iodine's 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.

Soln: % of carbon = 69.77 %

% of hydrogen = 11.63 %

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

= 18.6 %

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

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

$$= 5.81 : 11.63 : 1.16$$

$$= 5 : 10 : 1$$

Therefore, the empirical formula of the compound is C<sub>5</sub>H<sub>10</sub>O. Now, the empirical formula mass of the compound can be given as:

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

$$= 86$$

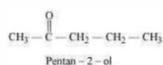
Molecular mass of the compound = 86

Therefore, the molecular formula of the compound is given by C<sub>5</sub>H<sub>10</sub>O.

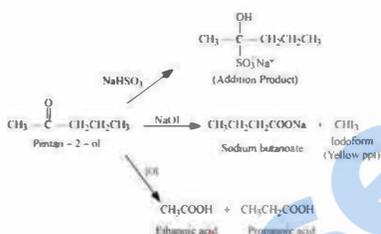
Tollen's reagent is not reduced by the given compound, hence it is not an aldehyde. A positive iodoform test is given by the compound and also forms sodium hydrogen sulphate addition products. Since the compound is not an aldehyde, it must be a methyl ketone.

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

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

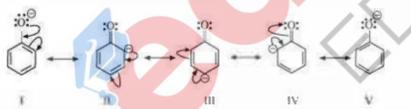


The given reactions can be explained by the following equations:



**Question 12.20: Although phenoxide ion has more number of resonating structures than carboxylate ion, carboxylic acid is a stronger acid than phenol. Why?**

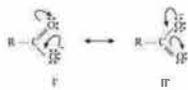
Soln: Resonance structures of phenoxide ion are:



In II, III and IV, less electronegative carbon atoms carry a negative charge which is observed from the resonance structures of phenoxide ion. Therefore, the resonance stability of the phenoxide ion gets a negligible contribution from these three structures.

Hence, these structures can be eliminated. The more electronegative oxygen atom contains negative charge by the structures I and V.

Resonance structures of carboxylate ion are:



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