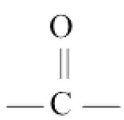
Chapter
12

ALDEHYDES AND KETONES

INTRODUCTION

Carbonyl Group:

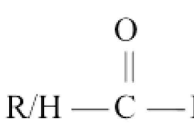
In carbonyl group, carbon atom is bonded with oxygen.



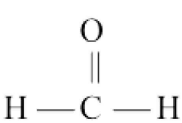
This carbonyl group > C = O is present in aldehydes, ketones, carboxylic acid, esters, anhydrides, acid halides and acid amides.

Aldehydes:

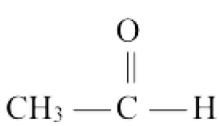
"The organic compounds in which carbonyl carbon is attached with at least one hydrogen atom, are called aldehydes." The general formula of aldehydes is.



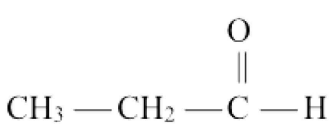
R/H — C — H where R is alkyl group e.g;



Formaldehyde

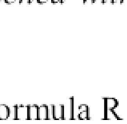


Acetadehyde

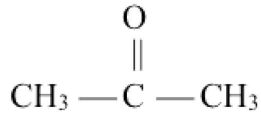


Propionaldelyde

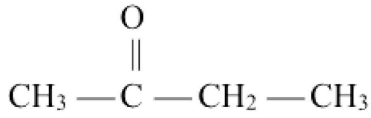
Ketone:

"The organic compounds in which carbonyl carbon is attached with two similar or dissimilar alkyl groups are called ketones." They have general formula 

e.g.,



Dimethyl Ketone (Acetone)



Ethyl methyl Ketone

The homologous series of both aldehydes and ketones have general formula $C_nH_{2n}O$.

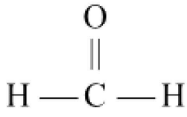
OCCURRENCE OF ALDEHYDES AND KETONES

Aldehydes and ketones are present in many naturally occurring compounds. The aldehyde group is present in most sugars. They are the principal constituents of a number of essential oils used as fragrances and flavours Ketonic group is present in camphor and menthone.

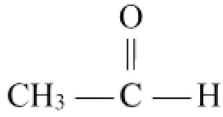
NOMENCLATURE OF ALDEHYDES

Common Names:

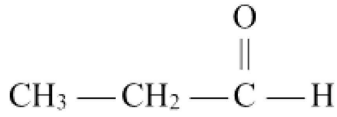
The common names of aldehydes are obtained from the common names of carboxylic acids containing the same number of carbon atoms. The ending –ic acid in the common name of the acid is replaced by the word aldehyde.



Formaldehyde

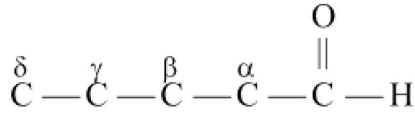


Acetadehyde

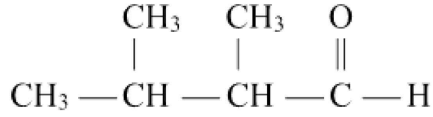


Propionaldelyde

The position of substituents on the chain are indicated by Greek letters (α, β, γ, δ). Lettering on the carbon adjacent to the carbonyl group.



For Example:



α-β-dimethyl butyraldehyde

IUPAC System:

(1) Select longest continuous chain of carbon atoms also containing carbonyl carbon atom.

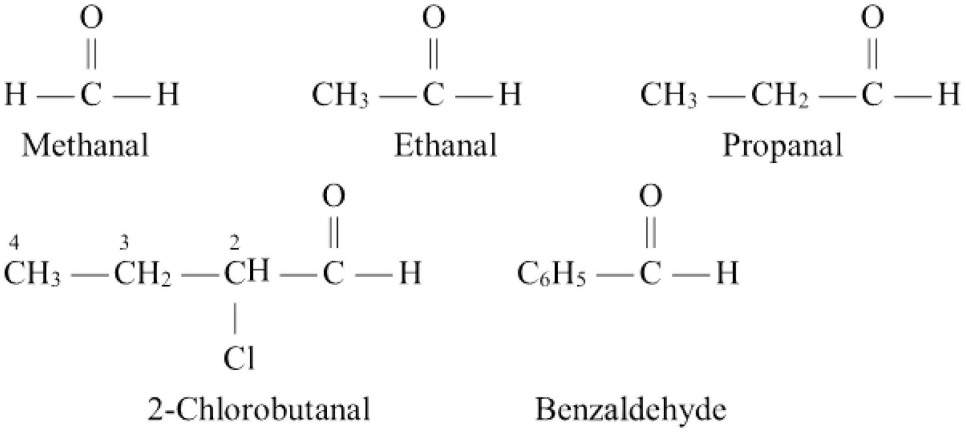
(2) Numbering is always started from carbonyl carbon atom.

(3) The suffix "–e" of alkane is replaced "–al" in aldehydes.

(4) The position and name of the branches are written before the name of aldehyde.

(5) Since aldehyde group is always at one terminal of the chain, no prefix is necessary to locate the position of the aldehyde group.

Examples:



Some More Examples:

Formula	**IUPAC Name**	**Common Name**
$H—CHO$	Methanal	Formaldehyde
$CH_3—CHO$	Ethanal	Acetaldehyde
$CH_3—CH_2—CHO$	Propanal	Propionaldehyde
$CH_3—CH_2—CH_2—CHO$	Butanal	Butyraldehyde
$CH_3—(CH_2)_3—CHO$	Pentanal	Valeraldehyde
$CH_3—(CH_2)_4—CHO$	Hexanal	Caproaldehyde
$CH_3—CH(CH_3)—CHO$	2-Methyl propanal	α-methyl propionaldehyde or iso-butylaldehyde
$CH_3—CH(CH_3)—C(CH_3)—CHO$	2, 2, 3 trimethyl butanal	α, α, β trimethyl butyraldelyde

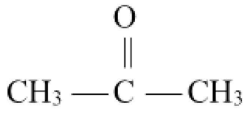
NOMENCLATURE OF KETONES

Common Names:

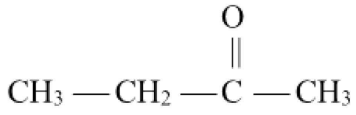
(1) Common names of ketones are obtained simply naming the two-alkyl groups attached to the carbonyl group and adding the word ketones.

(2) Prefix di is used for similar alkyl groups.

(3) The names of alkyl group are written according to mass of group. Alkyl groups with less mass is written first.



Dimethyl Ketone
(Acetone)



Ethyl methyl Ketone

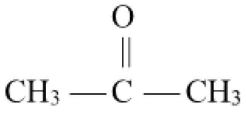
IUPAC Names:

(1) Select longest continuous carbon chain including carbonyl carbon atom.

(2) From the name of an alkane having corresponding number of carbon atoms "–e" is replaced by "–one".

(3) Start numbering from that end which is nearest to carbonyl carbon atom. Mention the position of carbonyl carbon before the stem name.

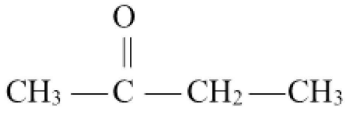
(4) The position and name of branches are written before the name of ketone.



Propanone

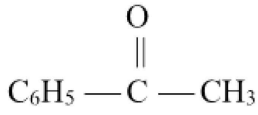
(Dimethyl ketone)

(Acetone)



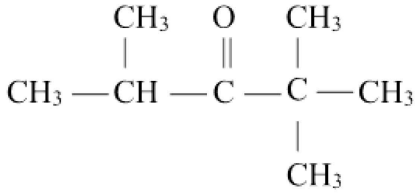
2-Butanone

(Ethyl methyl ketone)



Acetohphenon

(Methyl phenyl ketone)



2, 2, 4-trimethyl-3-pentanone

Table – Some Common Names and IUPAC Names of Ketones

Formula	IUPAC	Common Name
$CH_3—\overset{\overset{O}{\|}}{C}—CH_3$	2-Propanone	Dimethyl ketone (Acetone)
$CH_3—CH_2—\overset{\overset{O}{\|}}{C}—CH_3$	2-Butanone	Ethyl methyl ketone
$CH_3—\overset{\overset{O}{\|}}{C}—CH_2—CH_2—CH_3$	2-Pentanone	Methyl-n-propyl ketone

If similarly alkyl group are present an both side of carbonyl carbon, it is called symmetrical ketone and if dissimilar groups are present on both side of carbonyl carbon, it is called unsymmetrical ketone.

$CH_3—CH_2—\overset{\overset{O}{\|}}{C}—CH_2—CH_3$ — Symmetrical ketone (Diethyl ketone)

$CH_3—\overset{\overset{O}{\|}}{C}—CH_2—CH_2—CH_3$ — Unsymmetrical ketone (Methyl-n-propyl ketone)

PREPARATION OF ALDEHYDES

Mostly aldehydes are prepared by the oxidation of primary alcohol.

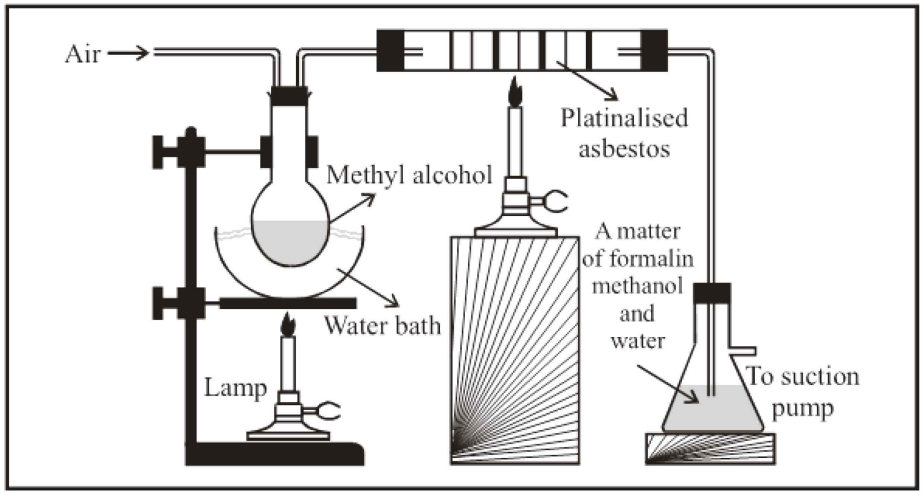
(a) Preparation of Formaldehyde or Methanal (Formalin):

(i) Laboratory Method:

Formaldehyde is prepared in the laboratory by passing a mixture of methyl alcohol vapours and air over platinized asbestos or copper or silver catalyst at 300°C.

$$2CH_3OH + O_2 \xrightarrow[300°C]{\text{Pt-asbestos}} 2H—\overset{\overset{O}{\|}}{C}—H + 2H_2O$$

Set up the apparatus is shown in figure. Air is drawn through methyl alcohol with the help of a suction pump. Methyl alcohol is oxidised to gaseous formaldehyde which is absorbed in water. The resulting mixture is called formalin. Formalin is a mixture of 40% formaldehyde, 8% methyl alcohol and 52% water.



Preparation of Formaldehyde (formalin)

(ii) Industrial Method:

Formaldehyde is manufactured by passing a mixture of methanol vapours and air over iron oxide, moleybdenum oxide or silver catalyst at 500°C.

$$2CH_3OH + O_2 \xrightarrow[500^\circ C]{FeO,\ Mo_2O_3} 2H-\overset{\overset{O}{\|}}{C}-H + 2H_2O$$

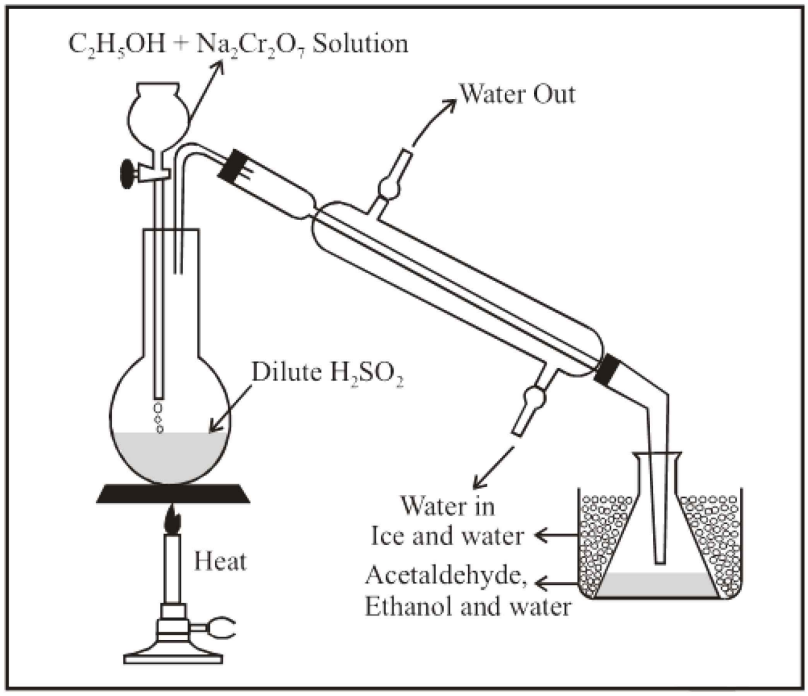
(b) Preparation of Acetaldehyde:

(i) Laboratory Method:

Acetaldehyde is prepared in the laboratory by the oxidation of ethyl alcohol with acidified sodium dichromate solution.

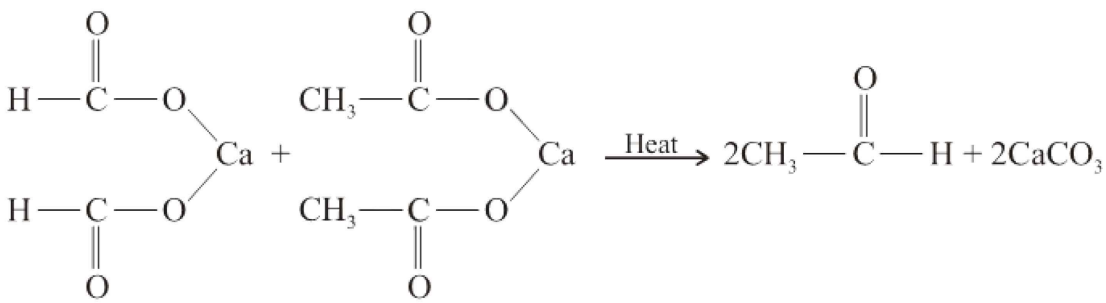
$$CH_3CH_2OH + [O] \xrightarrow[\Delta]{Na_2Cr_2O_7 + H_2SO_4} CH_3CHO + H_2O$$

A mixture of ethyl alcohol and sodium dichromate solution is run into boiling dilute sulphuric acid. Immediately a vigorous reaction takes place and the acetaldehyde formed in liquid state is immediately distilled off. This prevents the oxidation of acetaldehyde to acetic acid. Ethyl alcohol remains in solution untill it is oxidized. Pure acetaldehyde is obtained by re-distillation.



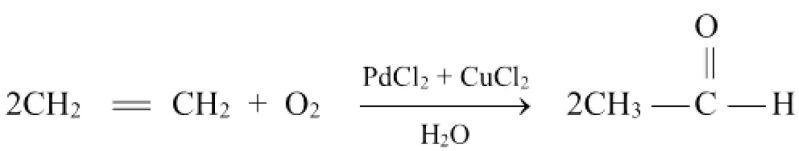
Preparation of Acetaldehyde

(ii) Acetaldehyde can also be prepared by the dry distillation of a mixture of calcium salts of formic acid and acetic acid.



Industrial Method for Preparation of Acetaldehyde:

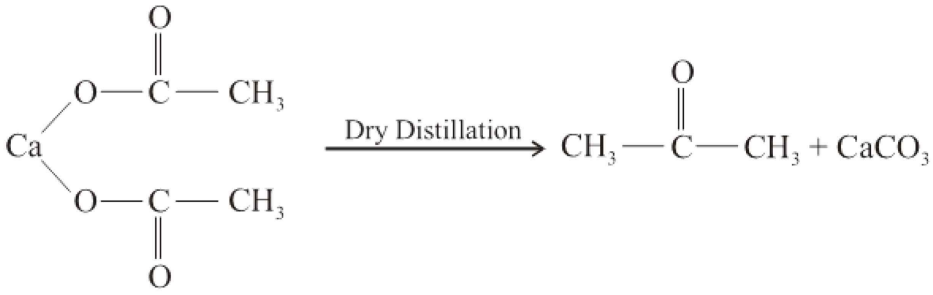
Acetaldehyde is prepared industrially by air oxidation of ethylene using palladium chloride catalyst with a cupric chloride promoter.



Ethylene Acetaldehyde

(c) Preparation of Acetone:

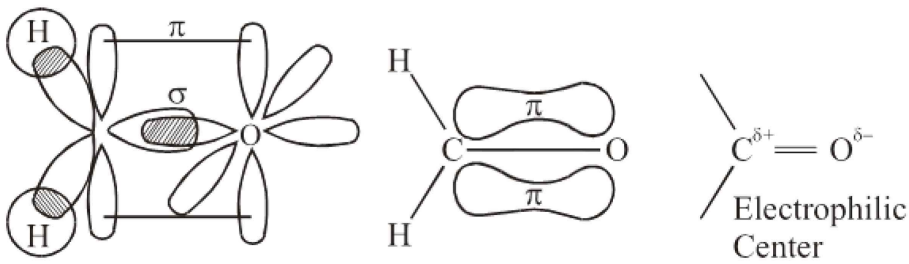
Acetone is prepared by the dry distillation of calcium acetate $Ca(CH_3COO)_2$.



REACTIVITY OF CARBONYL GROUP

The carbonyl group > C = O, has double bond between carbon and oxygen atom, one is sigma and other is π-bond. Carbon of carbonyl is sp^2 hybridized.

Most of the reactions of aldehyde and ketones are addition reactions. Due to greater electronegativity of oxygen, the carbonyl group is polar. π electrons are attracted toward oxygen and it has partial negative charge while carbon has partial positive charge.



Due to unsymmetrical distribution of electrons, carbon of the carbonyl group behave as an electrophilic center.

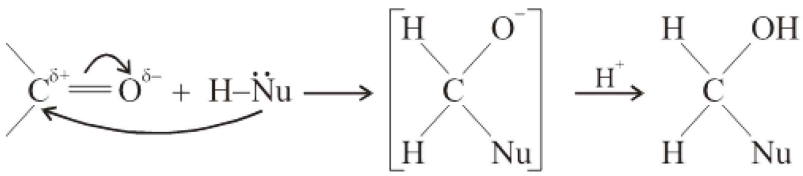
Both electrophile or nucleophile can attack on carbonyl group depending upon the reaction conditions and nature of electrophile or nucleophile.

Whatever the case may be, the **addition product or adduct** will be same. In aldehydes and ketones, however, nucleophilic addition is more common.

Nucleophilic Addition Reaction:

Suppose H–Nu is a general nucleophile, Nu^- attacks at the carbon atom of the carbonyl group and donate a pair of electron to it.

Double bond between carbon and oxygen > C = 0 changes to hydroxyl group.

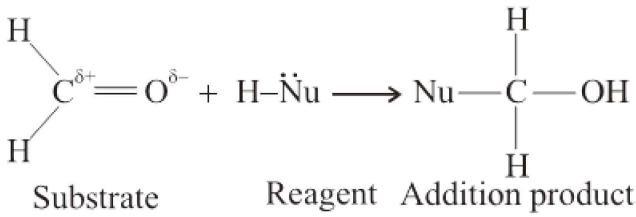


In nucleophilic addition reaction, the product will be either acid catalysed or base catalysed; A base catalyst increases the nucleophilic characters of the reagent. Acid catalyst, promotes the nucleophilic attack by increasing positive characters of carbonyl carbon atom.

REACTION OF CARBONYL COMPOUNDS

(a) Nucleophilic Addition Reactions:

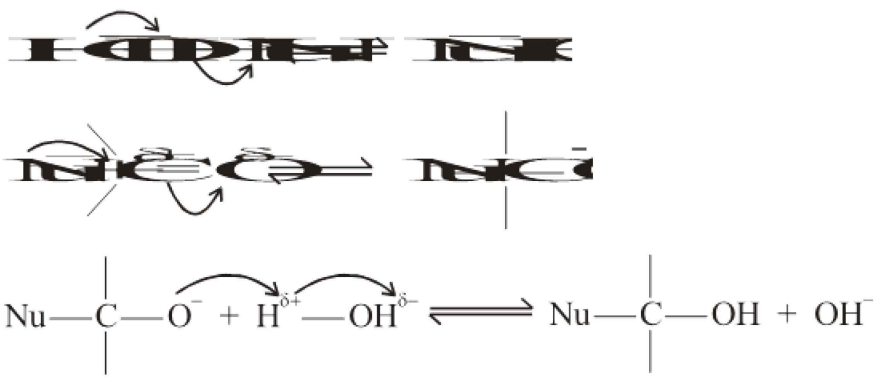
The most important reactions which takes place in aldehydes and ketones are nucleophilic addition reactions. Nucleophilie attacks at carbonyl carbon atom which has partial positive charge. A general reaction of a nucleophile is given below.



An acid or base is used as catalyst in nucleophilic addition reactions. In both cases, addition product is same. Mechanism of base catalyzed reaction is discussed below.

BASE CATALYZED NUCLEOPHILIC ADDITION REACTION

A base-catalysed nucleophilic addition reaction will take place with a strong nucleophilic reagent. The base reacts with the reagent and generates the nucleophile. The addition is initiated by the attack of a nucleophile on the electrophilic carbon of the carbonyl group. The general mechanism of the reactions is as follows.

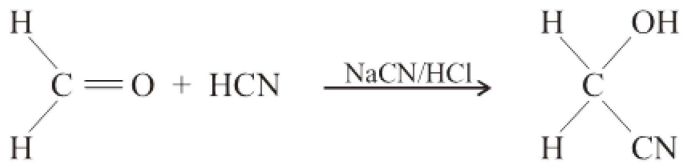


Some base catalysed nucleophilic addition reactions of aldehydes and ketones are given below:

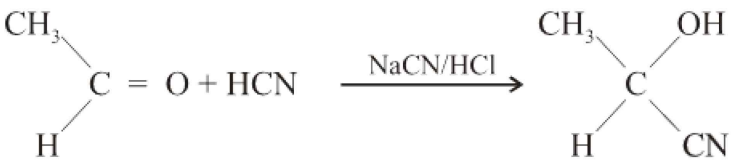
(1) Addition of Hydrogen Cyanide:

Hydrogen cyanide adds to aldehydes or ketones to form cyanohydrins. The reaction is carried out by adding slowly a mineral acid to an aqueous solution of sodium cyanide. The acid generates HCN from sodium cyanide in situ.

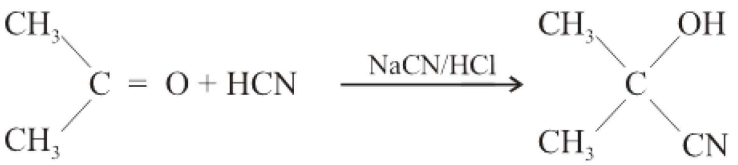
$$NaCN + HCl \rightleftharpoons NaCl + HCN$$



Formaldehyde — Formaldehyde Cyanohydrin



Acetaldehyde — Acetaldehyde Cyanohydrin



Acetone — Acetone Cyanohydrin

The cyano group, $-C \equiv N$ is hydrolysed by an aqueous acid into a carboxylic acid through an acid amide.

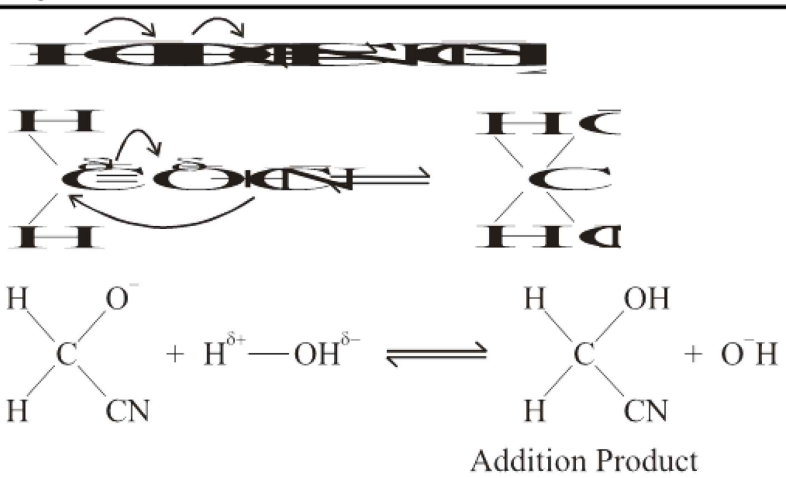


Acetaldehyde Cyanohydrin — 2-Hydroxypropanoic Acid (Latic Acid)

The reaction is used for the synthesis of α-hydroxy acids that contain one carbon atom more than the number of carbon atoms in the starting aldehydes or ketones.

Mechanism:

The reaction is base-catalysed because HCN has no lone pair of electrons on its carbon. the base (OH^-) generates cyanide ions which act as nucleophiles. The mechanism of the reaction is as follows.



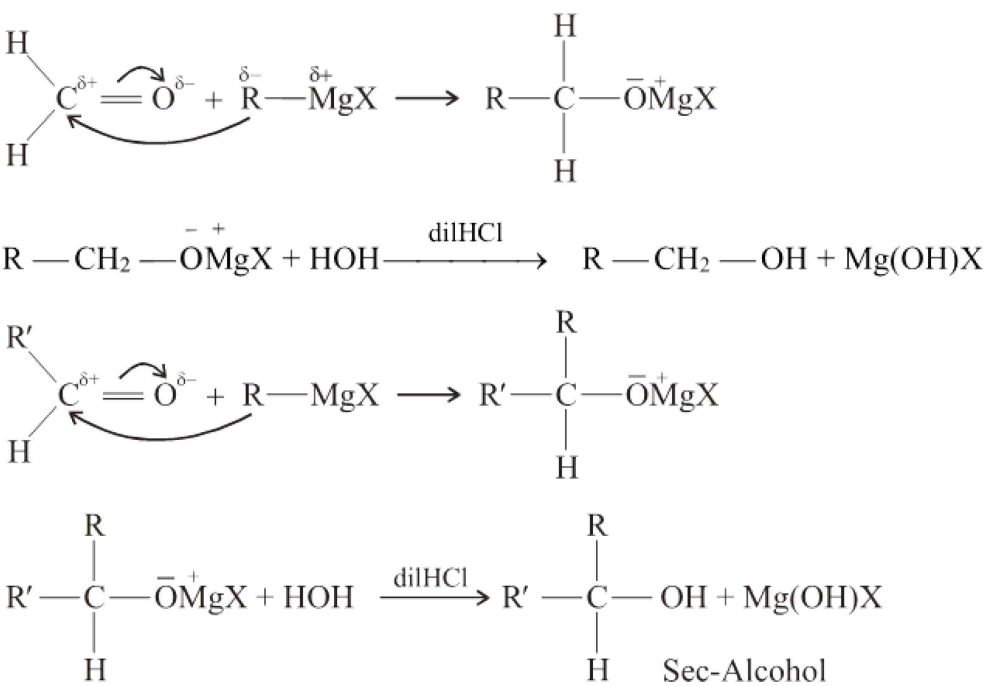
Addition Product

The hydroxide ion liberated in the formation of cyanohydrin reacts with undissociated hydrogen cyanide and produces more cyanide ions, which in turn react with more carbonyl compound.

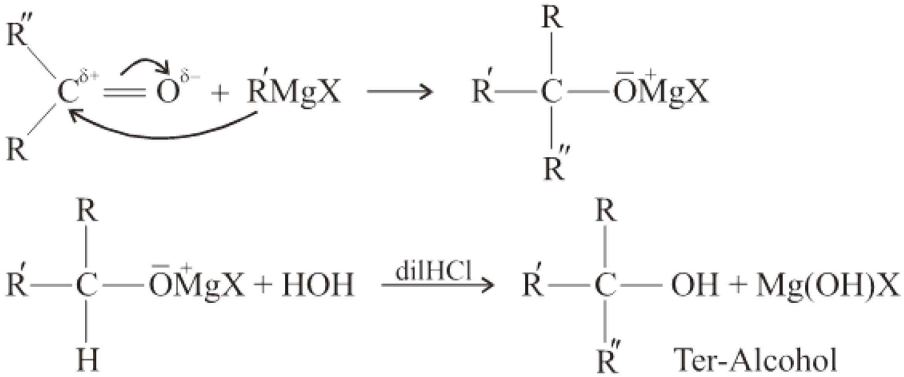
$$HCN + OH^- \longrightarrow H_2O + CN^-$$

(2) Addition of Grignard's Reagent:

Aldehydes reacts with Grignard's Reagent to form secondary alcohol. However, formaldehyde form primary alcohol.

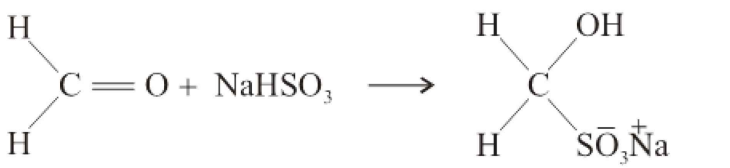


Ketones react with Grignard Reagents to form tertiary alcohols.

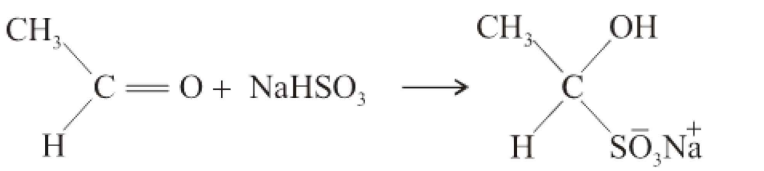


(3) Addition of Sodium Bisulphite:

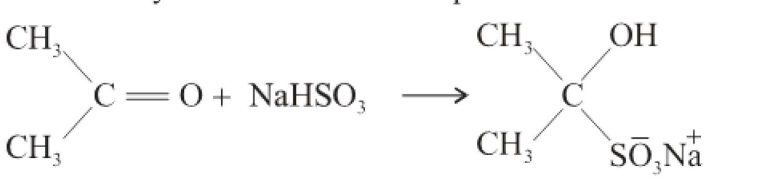
Aldehydes and small ketones react with a saturated aqueous solution of sodium bisulphite to form a crystalline white precipitate of sodium bisulphite adduct.



Formaldehyde Bisulphite Addition Product

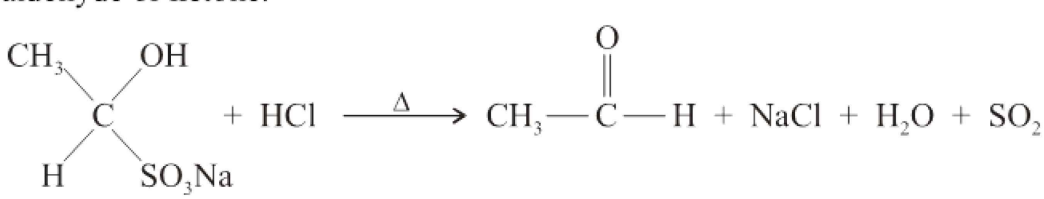


Acetaldehyde Bisulphite Addition Product



Acetone Bisulphite Addition Product

Bisulphite on heating with a dilute mineral acid (HCl or H_2SO_4), regenerates the parent aldehyde or ketone.



Bisulphite Addition Product Acetaldehyde

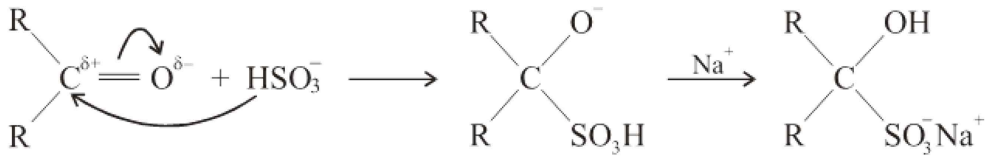
The reaction is used for the separation and purification of carbonyl compounds from non-carbonyl compounds such as alcohols.

Mechanism:

Sodium sulphite ionises to form hydrogen sulphite ion and sodium ion.

$$NaHSO_3 \rightleftharpoons Na^+ + HSO_3^-$$

Hydrogen sulphite ion act as nucleophile.



Bisulphite Addition Product

Ketones in which both alkyl groups are larger in size do not react with sodium bisulphite $NaHSO_3$.

(4) Condensation Reactions:

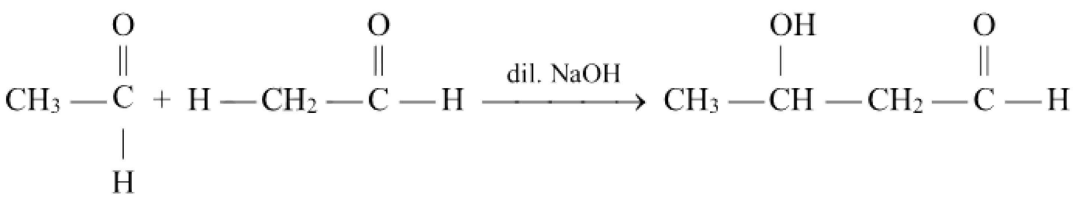
"The reactions in which two molecules of same or different compounds combine to form new compound is called condensation reaction."

(a) Aldol Condensation:

"Aldehydes and ketones possessing α-hydrogen atoms react with a cold dilute solution of an alkali to form addition products known as Aldol."

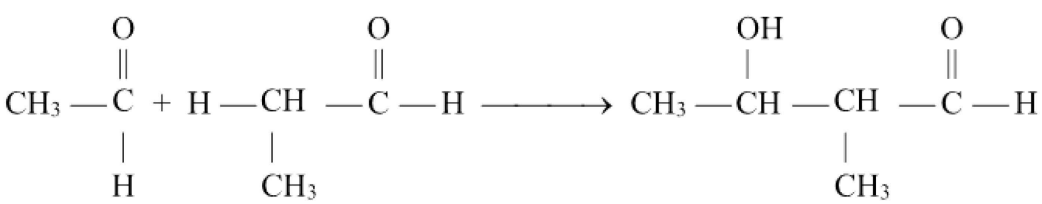
The name 'aldol' is given to the product because it contains both aldehyde and alcohol functional groups. Note that the name aldol condensation is reserved for the reaction that starts with two identical carbonyl compounds.

(i) Two Similar Aldehydes:



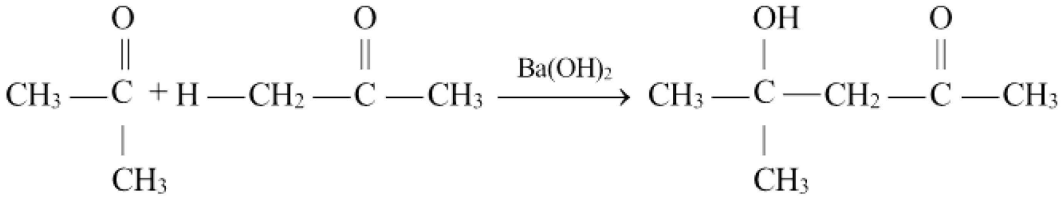
Ethanal Ethanal 3-Hydroxybutanal (aldol)

(ii) Two Dissimilar Aldehydes:



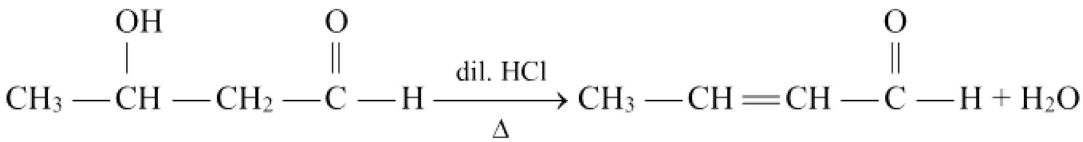
Ethanal Propanal 3-Hydroxyl-2-methyl butanal (aldol)

(iii) Two Similar Ketones:



Propanone Propanone 4-Hydroxy-4-methyl-2-pentanone

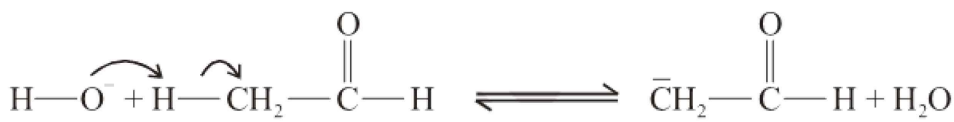
The aldol compound readily losses water on heating in the presence of dilute acid to form an unsaturated carbonyl compound. A carbon-carbon double bond is formed between the α-and β-carbon atoms.



3-Hydroxybutanal Crotonaldehyde

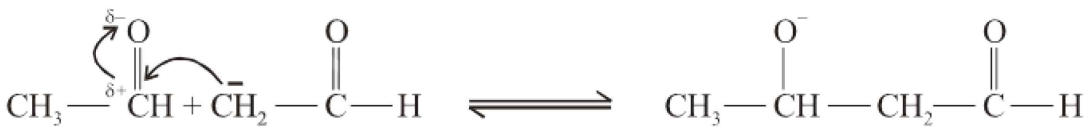
Mechanism of Aldol Condensation (Between Similar Aldehydes):

The hydroxide ion acts as a base. It removes a proton from α-carbon of one molecule of the carbonyl compound to form a carbanian.



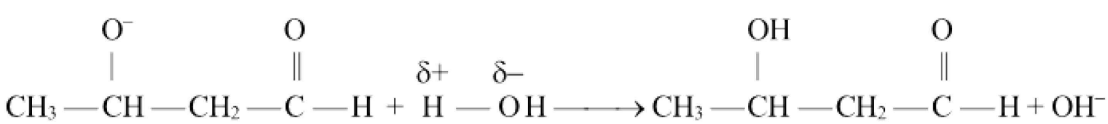
Hydroxide Ion Ethanal Carbanian

The carbanian acts as a nucleophile. It attacks the electrophilic carbonyl carbon atom of the unchanged second molecule of ethenal to form an alkoxide ion.



Ethanal Carbanian An alkoxide ion

The alkoxide removes a proton from water to form aldol.



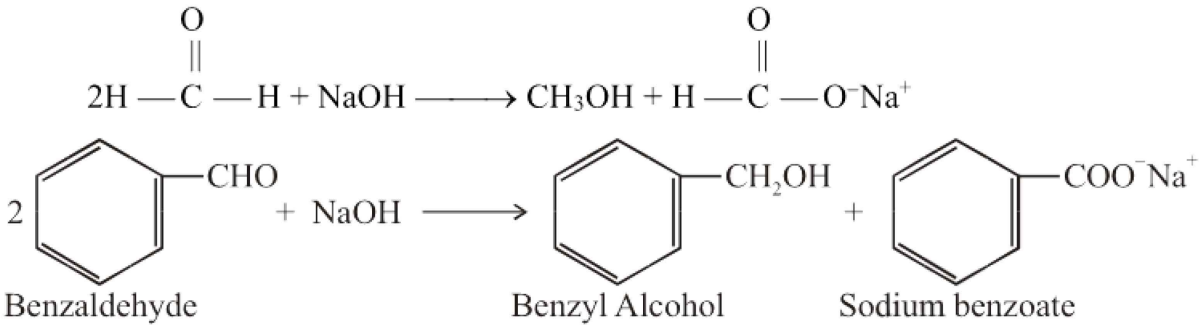
The basic catalyst hydroxide ion is regenerated.

(b) Cannizzaro's Reaction:

The aldehydes having no a-hydrogen at a-carbon atom do not undergo aldol condensation in the presence of base.

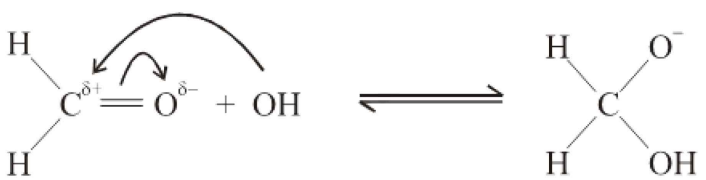
"The aldehydes having no a-hydrogen at a-carbon atom in the presence of base are converted to corresponding alcohol and carboxylic acid salt is called Cannizzaro reaction."

Cannizzaro reaction is a self oxidation-reduction reaction. In this reaction one molecule of aldehyde is oxidised to carboxylic acid while the other molecule is reduced to corresponding alcohol. This reaction is also called disproportionation reaction. For example, methanal or benzaldehyde have no a-hydrogen at a-carbon atom and undergo Cannizzaro reactions.

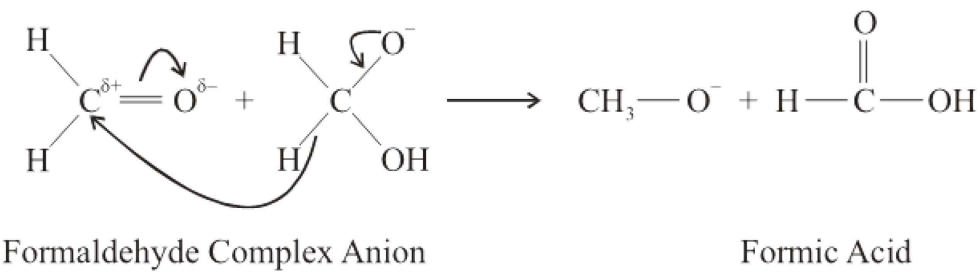


Mechanism:

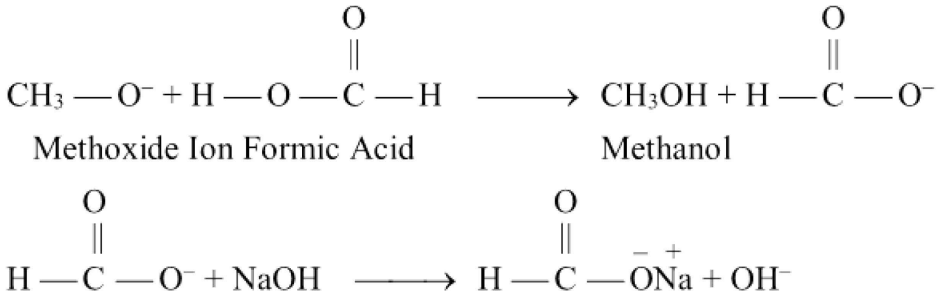
(i) The reaction of methanal with base gives alcohol and salt of carboxylic acid. The hydroxide ion acts as a nucleophile. It attacks on the electrophilic carbonyl carbon to form a complex anion.



(ii) The anion transfers a hydride ion to second molecule of formaldehyde. The presence of the negative charge on oxygen of the anion helps in the loss of hydride ion.



(iii) The methoxide ion acts as a base and attracts a proton from formic acid to form methanol and formate ion. The formate ion in the presence of alkali gives a salt of the acid.



Methoxide Ion Formic Acid Methanol

(5) Haloform Reaction:

The compounds which have methyl ketone $CH_3-\overset{\overset{O}{\|}}{C}-$ group in them undergo haloform reactions. Only acetaldehyde CH_3-CHO and methyl ketones $CH_3-\overset{\overset{O}{\|}}{C}-R$ reacts with halogens in the presence of base NaOH. The term haloform is derived from halogen. The products of the reactions are chloroform, bromoform or iodoform e.g;



R = alkyl, aryl or hydrogen Halogen Haloform

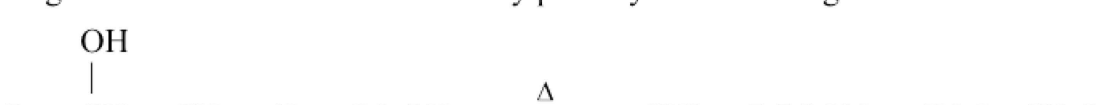


Acetaldehyde Iodine Iodoform (yellow ppt.)



Acetone Iodine Iodoform (yellow ppt.)

Secondary alcohols containing the hydroxyl group on the second carbon atom also undergo this reaction. Ethanol is the only primary alcohol that gives this reaction.



A secondary alcohol Iodoform (yellow ppts)

$$CH_3CH_2OH + 4I_2 + 6NaOH \xrightarrow{\Delta} CHI_3 + HCOONa + 5NaI + 5H_2O$$

Ehtanol Yellow ppts of Iodoform

Form a synthetic point of view the halofrom reaction, affords a convenient method for converting a methyl ketone to a carboxylic acid containing one carbon atom less than parent compound.

Iodoform Test:

"The halogen reaction using iodine and aqueous sodium hydroxide is called iodoform test".

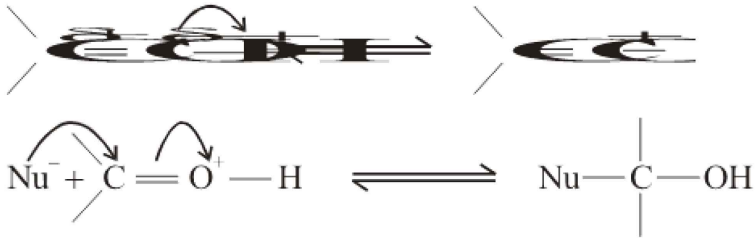
In this test water insoluble, yellow crystalline iodoform CHI_3 is formed. This iodoform can be used to distinguish.

(1) Methyl ketones $CH_3 - \overset{\overset{O}{\|}}{C} - R$ and other higher ketones. (R. may be ethyl or higher alkyl group).

(2) Methanol and Ethanol. Ethanol forms CHI_3 while methanol does not do so. Primary alcohols do not perform iodoform test except ethanol.

(b) Acid Catalyzed Nucleophilic Reaction:

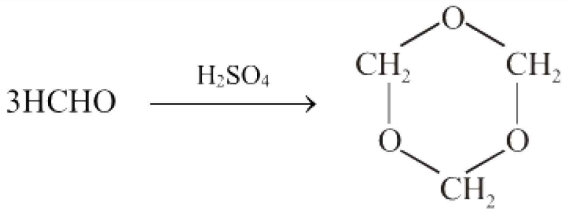
The acid catalysed nucleophilic addition reaction will take place with a weak nucleophilic reagent. The addition is intiated by the proton (H^+) liberated by the acid. The proton combines with the carbonyl oxygen atom and increases the electrophilic character on the carbonyl carbon. As a result, the attack of the weaker nucleophile on the electrophilic carbon becomes easier.



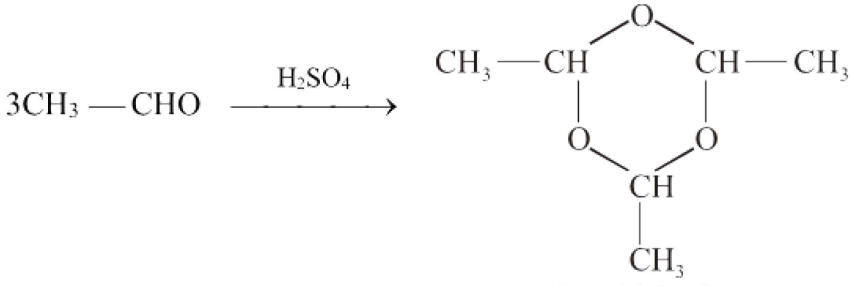
The acid-catalysed nucleophilic addition reactions of aldehydes and ketones are the following.

(1) Polymerization:

Both formaldehyde and acetaldehyde polymerize in the presence of dil. H_2SO_4 to give metaformaldehyde and paraldehyde respectively.



Metaformaldehyde
(a methanal trimer)

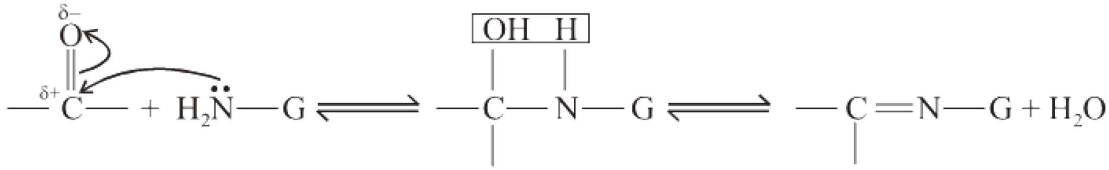


Paraldehyde
Ethanal Trimer
(sleep-inducing drug)

(2) Addition of Ammonia Derivatives:

Aldehydes and ketones react with ammonia derivatives, G — NH_2 to form compounds containing the group, > C = N — G and water. The reaction is known as condensation reaction or addition-elimination reaction because water is lost during addition. The reactions are acid catalysed.

The general reaction is:



Aldehyde or ketone | Ammonia derivative | Amino Alcohol (unstable) | Condensation product

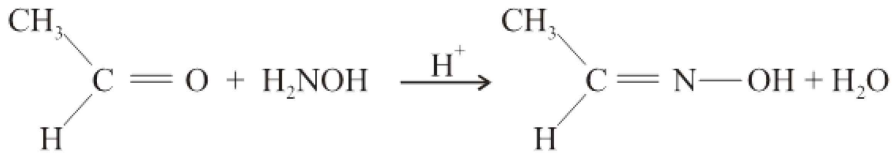
Where G = H, — H_2, — HC_6H_5, — $HCONH_2$, etc.

Some commonly used ammonia derivative are hydroxylamine, NH_2OH, hydrazine, NH_2NH_2, phenyldydrazine, $C_6H_5NHNH_2$, semicarbazide $NH_2NHCONH_2$ and 2, 4 dinitro-phenyl-hydrazine.

The reaction of the above stated ammonia derivatives with aldehydes and ketones are as follow:

(i) Reaction with Hydroxylamine:

Aldehydes and ketones react with hydroxylamine to form oximes in the presence of an acid.

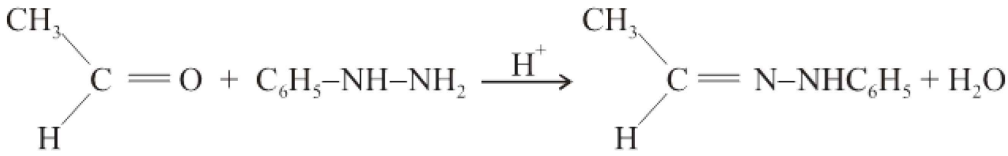


Ethanal Oxime

(ii) Reaction with Phenyl Hydrazine ($NH_2 - NHC_6H_5$):

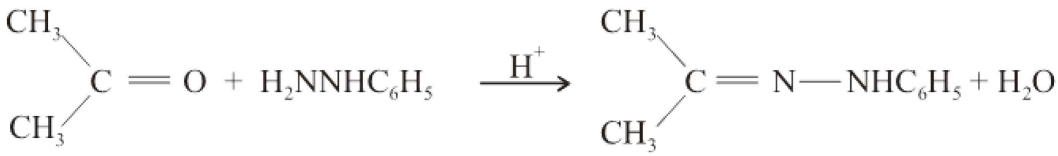
Aldehydes and ketones react with phenyldydrazine to form phenyl hydrazones in the presence of an acid.

(a)



Ethanal Phenylhydrazone

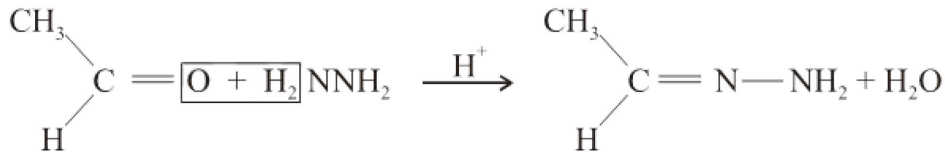
(b)



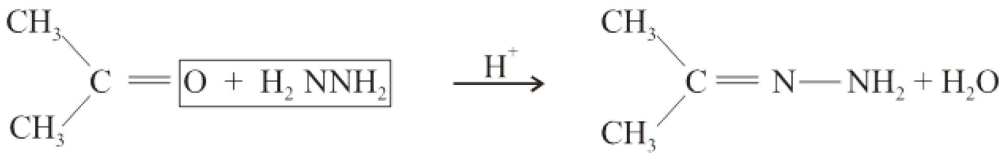
Propanone Propanone phenylhydrazone

(iii) Reaction with Hydrazine ($NH_2 - NH_2$):

Aldehydes and ketones react with hydrazine to form hydrazones in the presence of an acid.



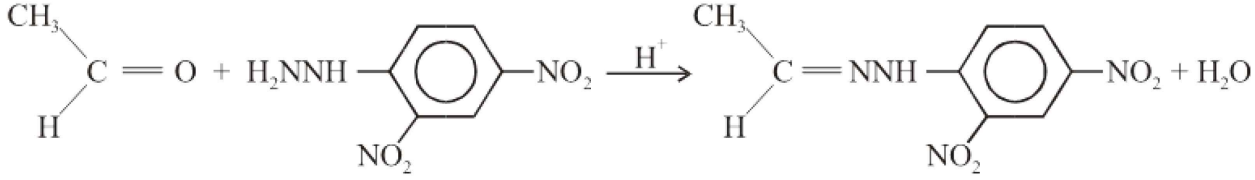
Acetaldehyde Acetaldehyde Hydrazone



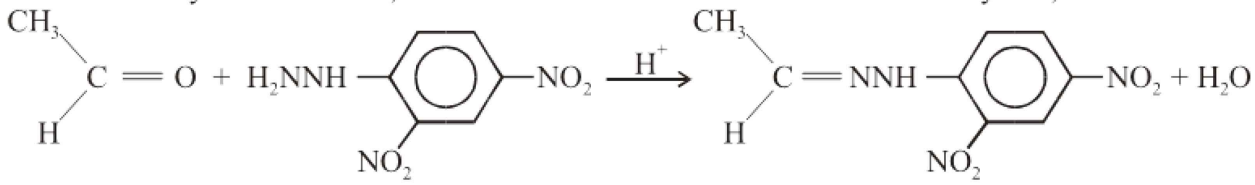
Acetone Acetone Hydrazone

(iv) Reaction with 2, 4 Dinitrophenylhydrazine [2, 4, DNPH]:

Aldehydes and ketones react with 2, 4-dinitrophenylhydrazine to form 2, 4-dinitrophyenylhydrazones in the presence of acid.



Acetaldehyde 2, 4-DNPH



Acetone 2, 4-DNPH

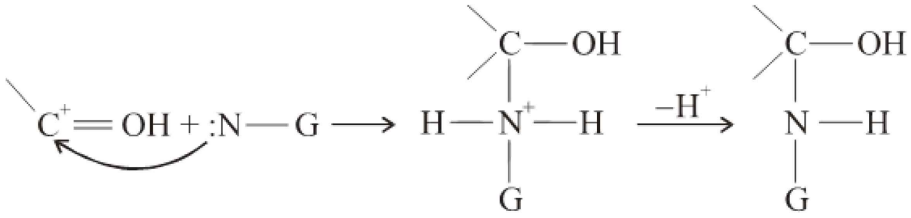
The reaction can be used for the identification of aldehydes and ketones because 2, 4-dinitropenylhydrazones are usually yellow or orange crystalline solids.

Mechanism of the Reaction of Amonia Derivatives:

Step-I: Protonation of the carbonyl group.

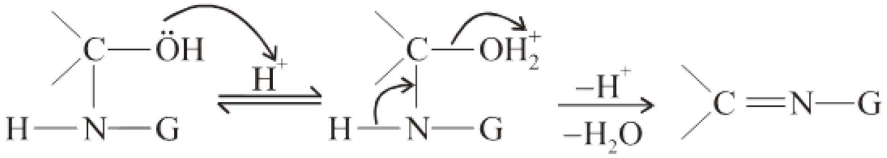


Step-II: Nucleophilic attack on nitrogen of ammonia derivative on the electrophilic positively charged carbon and deprotonation of the adduct.



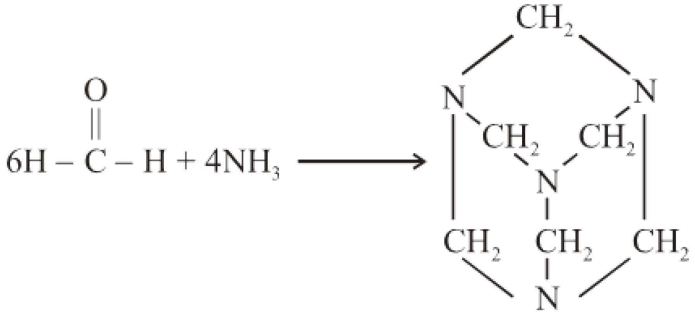
Adduct

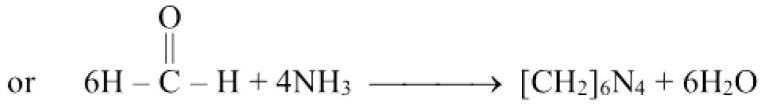
Step-III: Protonation of oxygen of hydroxyl group followed by the removal of water.



Reaction between Formaldehyde and NH_3:

Formaldehyde reacts with NH_3 to form hexamethylene tetra-amine (urotropine).

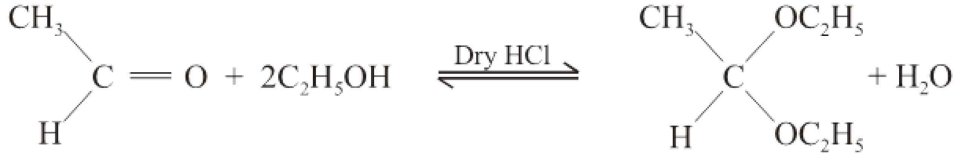




Urotropine is uninary antiseptic. It is also used to prepare antipolio vaccine.

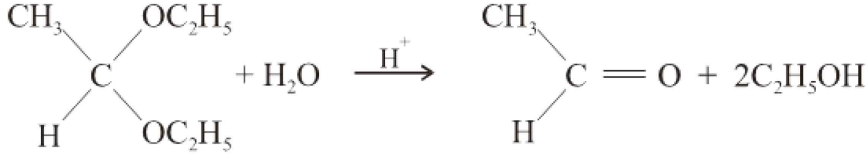
Addition of Alcohols:

Aldehydes combine with alcohols in the presence of hydrogen chloride gas to form acetals. The hydrogen chloride acts as a catalyst. Both the alcohol and the hydrogen must be dry.



An Acetal

The reaction may be used to protect the aldehyde group against alkaline oxidizing agents. To regenerate aldehyde, the acetal is hydrolysed in the presence of an acid.



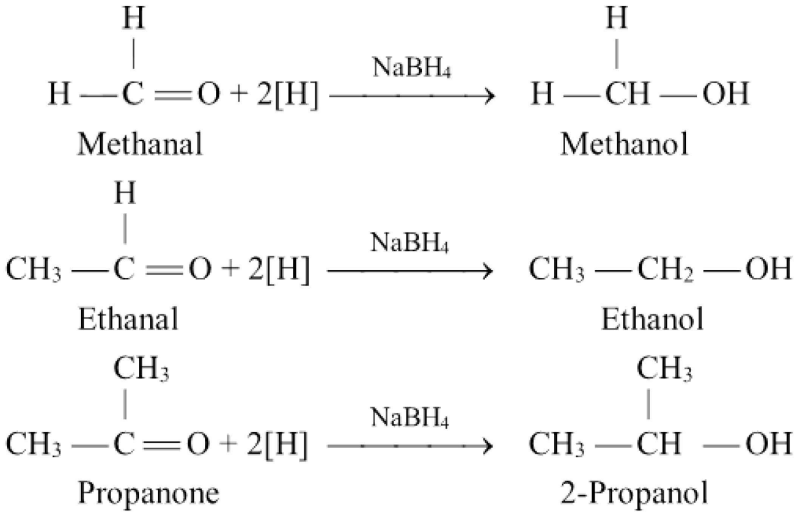
Ketones do not react under these conditions.

(3) Reduction of Carbonyl Compounds:

Aldehydes and ketones can both be reduced. Aldehydes are reduced to primary alcohols whereas ketones to secondary alcohols. The carbonyl group is converted into an alcohol.

(i) Reduction with Sodium Borohydride:

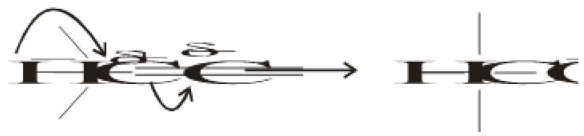
Aldehydes and ketones are reduced to alcohols with sodium borohydride, $NaBH_4$. The reaction is carried out by adding sodium borohydride to an aqueous or alcoholic solution of an aldehyde or ketone.



Sodium borohydride reduces the carbon-oxygen double bond but not the carbon-carbon multiple bond.

Mechanism:

The tetrahydriborate (III) ion, BH is source of hydride ion, H^-. The hydride ion acts as a nulceophile. It attacks on the electrophilic carbon of the carbonyl group to give an alkoxide ion.

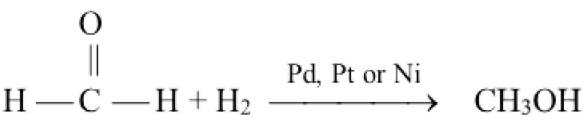




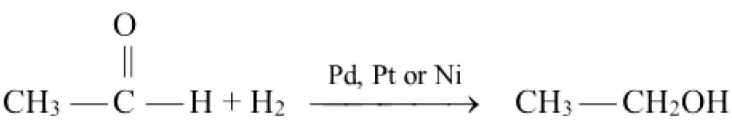
Alkoxide Ion An Alcohol

(ii) Catalytic Reduction:

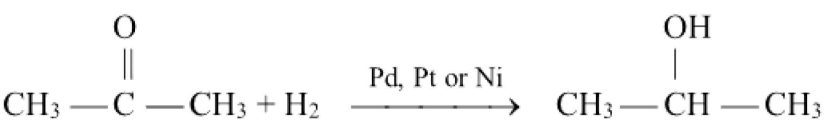
Aldehydes and ketones on reduction with hydrogen in the presence of a metal catalyst like Pd, Pt or Ni form primary alcohols and secondary alcohols respectively. Hydrogen is added across the carbonyl group.



Formaldehyde Methyl Alcohol



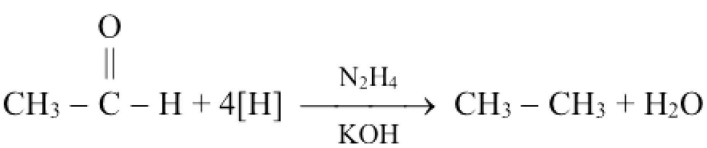
Acetaldehyde Ethyl Alcohol



Acetone iso-propyl alcohol

(iii) Wolf-Kishner's Reduction:

Aldehydes are reduced in the presence of N_2H_4 and KOH to form alkanes.



(iv) Clemenson's Reduction:

Ketones react with zinc amalgam and HCl ketones react with zinc amalgam and HCl to form alkanes.

$$CH_3 - \overset{\overset{O}{\|}}{C} - CH_3 + 4[H] \xrightarrow[HCl]{Zn - Hg} CH_3 - CH_2 - CH_3 + H_2O$$

(4) Oxidation of Carbonyl Compounds:

(a) Oxidation of Aldehydes:

(i) Strong oxidizing agents like $K_2Cr_2O_7$, $KMnO_4/H_2SO_4$, or dilute HNO_3 can oxidize aldehydes as well as ketones. In aldehydes, hydrogen atom of aldehyde changes to –OH and carboxylic acid is formed. Carboxylic acid has some carbon atoms in aldehydes.

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - OH$$

Acetaldehyde Acetic Acid

$$CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - H + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - OH$$

Propionaldehyde Propionic Acid

(ii) Mild oxidizing agents like Benedict solution Fehling solution or Tollen reagent (ammonical silver nitrate) can only oxidizes to aldehydes and not to ketones, e.g;

Aldehydes reacts with ammonical silver nitrate (Tollen's reagent) to form metallic silver. Silver deposit inside the test tube and seems like mirror so it also called silver mirror test.

$$AgNO_3 + 2NH_3 \longrightarrow [Ag(NH_3)_2]NO_3$$

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + [Ag(NH_3)_2]^+ + 2OH^- \longrightarrow CH_3\overset{\overset{O}{\|}}{C} - ONH_4 + NH_3 + Ag + H_2O$$

Oxidation state of silver in $AgNO_3$ is +1 which changes to Ag^0. This test is not performed by ketones.

Fehling Solution:

Fehling solution is a solution of copper (II) sulphate $CuS0_4$, sodium hydroxide and tartaric acid. Fehling solution oxidizes aldehydes to carboxylic acids and cupric Cu^{++} ions are reduced to cuprous ion Cu^{+}. When Fehling solution reacts with aldehydes, brick red precipitate of cuprous oxide Cu_2O, is formed.

$$RCHO + 2Cu(OH)_2 + NaOH \longrightarrow RCOONa + \underset{\text{(red ppts)}}{Cu_2O\downarrow} + 3H_2O$$

Benedict Solution:

It is mixture of NaOH, $CuSO_4$ and citric acid. Aliphatic aldehydes react with benedict solution and brick red precipitate of Cu_2O is formed. In this peaction, Cu^{2+} ions are reduced to Cu^{1+} ions.

$$RCHO + 2Cu(OH)_2 + 2NaOH \longrightarrow RCOONa + \underset{\text{(red ppts)}}{Cu_2O} + 3H_2O$$

Aromatic aldehydes and ketones do not perform this test.

Oxidation of Ketones:

Ketones are not oxidized by mild oxidizing agents like Fehling solution, Benedict solution or Tollen reagent. Ketones are oxidizes by strong oxidizing agents like $KMnO_4/H_2SO_4$, $K_2Cr_2O_7/H_2SO_4$, etc.

In oxidation of ketones, only the carbon atoms adjacent to the carbonyl group are attacked. The carbon atom joined to smaller number of hydrogen atoms is preferentially oxidized. In case of symmetrical ketones only one carbon atom adjacent to the carbonyl group is oxidized and a mixture of two carboxylic acids is always obtained.

$$\underset{\text{Acetone}}{CH_3-\overset{\overset{O}{\|}}{C}-CH_3} + 3[O] \xrightarrow{K_2Cr_2O_7/H_2SO_4} \underset{\text{Acetic Acid}}{CH_3-\overset{\overset{O}{\|}}{C}-OH} + \underset{\text{Formic Acid}}{HCOOH}$$

However, in case of unsymmetrical ketones, the carbon atom joined to the smaller number of hydrogen atoms is preferentially oxdized and the carbonyl group remains with the smaller alkyl group.

$$\underset{\text{2-Butanone}}{CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3} + 3[O] \xrightarrow{K_2Cr_2O_7/H_2SO_4} \underset{\text{Acetic Acid}}{2CH_3-\overset{\overset{O}{\|}}{C}-OH}$$

IDENTIFICATION TESTS FOR CARBONYL COMPOUNDS

Detection Test for Aldehydes and Ketones:

Test	Aldehyde	Ketone
(1) 2, 4-DNPH test	Aldehydes give this test and yellow crystalline ppt. is formed.	Ketones also give this test and yellow crystalline ppt. is formed.
(2) $NaHSO_3$ test	Aldehydes give this test and white crystalline ppt. is formed.	Small ketones only give this test and white crystalline ppt. is formed.
(3) Tollen's test	Aliphatic aldehydes give this test and silver mirror is formed.	Aromatic aldehyde and ketones do not perform this test.
(4) Benedict's solution test	Aliphatic aldehydes give this test and brick red ppt. of Cu_2O is formed.	Ketones do not perform this test.
(5) Fehling's solution test	Aliphatic aldehydes give this test and brick red ppt. of Cu_2O is formed.	Ketones do not perform this test.
(6) Sodium nitroprusside test	Aldehydes do not perform this test.	Ketones react with sodium nitroprusside and wine red or orange red colour is formed.

USES OF FORMALDEHYDE

(i) It is used in the manufacture of resins like urea-formaldehyde and plastics such as bakelite.

(ii) It is used in the manufacture of dyes such as indigo, para-rosaniline, etc.

(iii) Its 40% aqueous solution called formalin is used as an antiseptic, disinfectant, a germicide, a fungicide and for preserving animal specimens and sterilizing surgical instruments.

(iv) It is used as a decolourising agent in vat dyeing.

(v) It is used in the silvering of mirrors.

(vi) It is used in making medicine urotropine used as a urinary antiseptic.

(vii) It is used in making formamint (formaldehyde + lactose) used as throat lozenges.

(viii) It is used in the processing of anti-polio vaccine.

USES OF ACETALDEHYDE

(i) It is used in the production of acetic acid, acetic anhydride, n-butanol, ethanol, 2-ethy-1-hexanol, vinyl acetate, paraldehyde, ethylacetate, etc.

(ii) It is used to make acetaldehyde ammonia used as a rubber-accelerator.

(iii) It is used to make chloral hydrate, ethanal trimer and tetramer. Chloral hydrate and ethanal trimer are both used as hypnotic drugs (medicine having power to induce sleep) whereas ethanal tetramer is used as a slug poison.

(iv) It is used as an antiseptic inhalent in nasal infections.

(v) It is used in silvering of mirrors.

(vi) It is used to make phenolic resins and synthetic drugs.

EXERCISE

Q.1 Fill in the blanks:

(i) Aldehydes are the first oxidation product of ————.

(ii) Ketones are the first oxidation product of ————.

(iii) Aldehydes and ketones undergo ———— addition reactions.

(iv) Formaldehyde reacts with ———— to give primary alcohol.

(v) Acetaldehyde reacts with ———— to give 2-butanol.

(vi) Aldehydes are strong ———— agents.

(vii) The oxidation of an ———— always gives a carboxylic acid.

(viii) The reduction of a ———— always gives a secondary alcohol.

(ix) Formaldehyde gives ———— test with Tollen's reagent.

(x) Acetaldehyde gives a ———— precipitate with Fehling's solution.

ANSWERS

(i)	pri-alcohol	**(ii)**	sec-alcohol	**(iii)**	nucleophile
(iv)	grignard reagent	**(v)**	C_2H_5MgBr	**(vi)**	reducing
(vii)	aldehyde	**(viii)**	ketone	**(ix)**	silver mirror test
(x)	brick red				

Q.2 Indicate True or False:

(i) Formaldehyde is used in the silvering of mirrors.

(ii) Ketones combine with alcohols in the presence of HCl gas to form acetals.

(iii) Acetaldehyde undergoes Cannizzaro's reaction.

(iv) Formaldehyde is used for silvering of mirrors.

(v) Aldol condensation reaction is given by only those aldehydes and ketones which contain an α-hydrogen atom.

(vi) Cannizzaro's reaction is given by only those aldehydes containing no α-hydrogen atom.

(vii) Propanol and propanone behave differently with Tollen's reagent.

(viii) Acetone reacts with sodium bisulphite to give a yellow crystalline product.

(ix) Acetone on reduction gives a primary alcohol.

(x) 40% aqueous solution of formaldehyde is called formalin.

ANSWERS

(i)	True	**(ii)**	False	**(iii)**	False	**(iv)**	True	**(v)**	True
(vi)	True	**(vii)**	True	**(viii)**	False	**(ix)**	False	**(x)**	True

Q.3 Multiple choice questions. Encircle the correct answer:

(i) The carbon atom of a carbonyl group is:

(a) sp hybridized **(b)** sp^2 hybridized

(c) sp^3 hybridized **(d)** None of these

(ii) Formalin is:

(a) 10% solution of formaldehyde in water + 8% methyl alcohol

(b) 20% solution of formaldehyde in water + 8% methyl alcohol

(c) 40% solution of formaldehyde in water + 8% methyl alcohol

(d) 60% solution of formaldehyde in water + 8% methyl alcohol

(iii) Which of the following will have the highest boiling point:

(a) Mathanal **(b)** Ethanal

(c) Propanal **(d)** 2-Hexanone

(iv) Ketones are prepared by the oxidation of:

(a) Primary alcohol **(b)** Secondary alcohol

(c) Tertiary alcohol **(d)** None of these

(v) Acetone reacts with HCN to form a cyanohydrin. It is an example of:

(a) Electrophilic addition **(b)** Electrophilic substitution

(c) Nucleophilic addition **(d)** Nucleophilic substitution

(vi) Which of the following compounds will not give iodoform test on treatment with I_2/NaOH:

(a) Acetaldehyde **(b)** Acetone

(c) Butanone **(d)** 3-pentanone

(vii) Which of the following compounds will react with Tollen's reagent:

(a) $CH_3-\overset{\overset{O}{\|}}{C}-H$ **(b)** $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

(c) $CH_3-\overset{\overset{O}{\|}}{C}-OH$ **(d)** $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2$

(viii) Cannizzaro's reaction is not given by:

(a) Formaldehyde **(b)** Acetaldehyde

(c) Benzaldehyde **(d)** Trimethylacetaldehyde

(ix) Which of the following reagents will react with both aldehydes and ketones:

(a) Grignard reagent **(b)** Tollen's reagent

(c) Fehling's reagent **(d)** Benedict's reagent

ANSWERS

(i)	(b)	**(ii)**	(c)	**(iii)**	(d)	**(iv)**	(b)	**(v)**	(c)
(vi)	(d)	**(vii)**	(a)	**(viii)**	(b)	**(ix)**	(a)		

Q.5 How does formaldehyde react with the following reagents?

(i) CH_3MgI **(ii) HCN** **(iii) $NaHSO_3$**

(iv) NaOH **(v) Hydrogen** **(vi) Tollen's Reagent**

(vii) Fehling's Reagent

Ans.

(i) CH_3MgI:

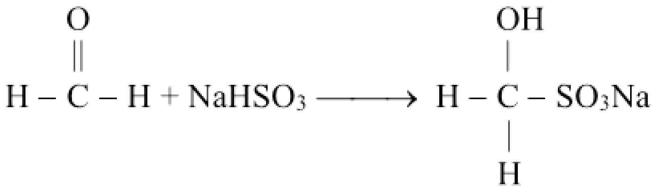
$$HCHO + CH_3MgI \longrightarrow CH_3 - CH_2 - O^-Mg^+I^-$$

$$CH_3 - CH_2 - OMg^+I^- + H_3O^+ \xrightarrow{\text{aq. HCl}} CH_3 - CH_2 - OH + Mg\begin{matrix} I \\ Cl \end{matrix}$$

(ii) HCN:

$$H-\overset{\overset{O}{\|}}{C}-H + HCN \longrightarrow H-\overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}}-CN$$

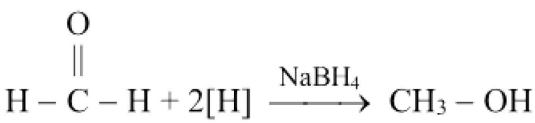
(iii) $NaHSO_3$:



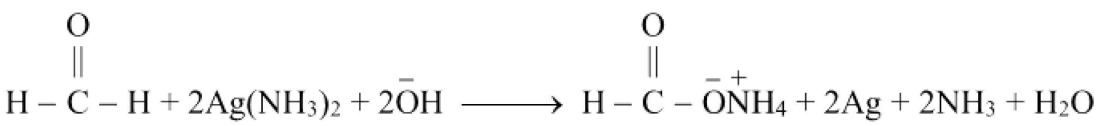
(iv) NaOH:



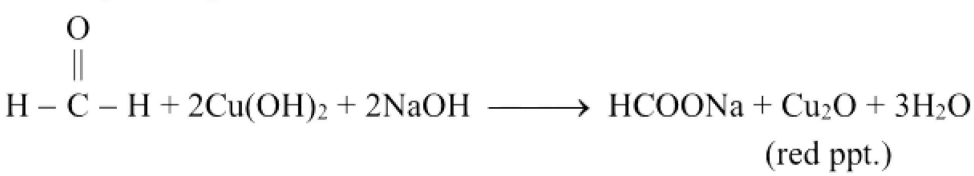
(v) Hydrogen:



(vi) Tollen's Reagent:



(vii) Fehling's Reagent:



Q.7 How does acetaldehyde reacts with following?

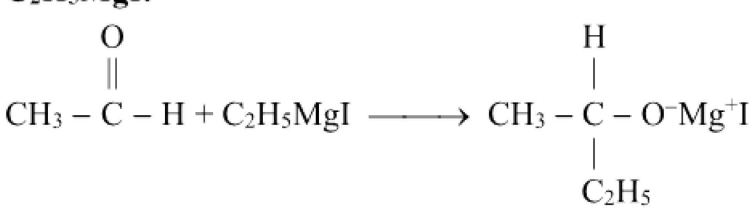
(i) C_2H_5MgI **(ii) HCN** **(iii) $NaHSO_3$**

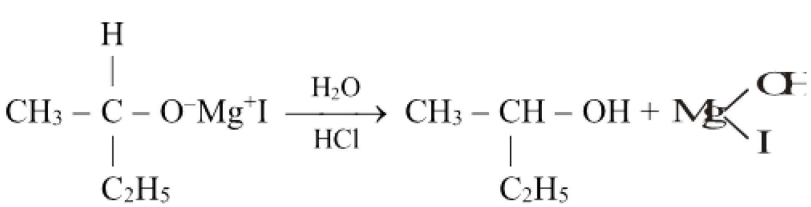
(iv) dil. NaOH **(v) I_2/NaOH** **(vi) $NaBH_4/H_2O$**

(vii) NH_2OH **(viii) $K_2Cr_2O_7$ / H_2SO_4**

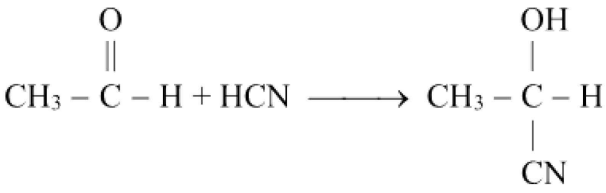
Ans.

(i) C_2H_5MgI:

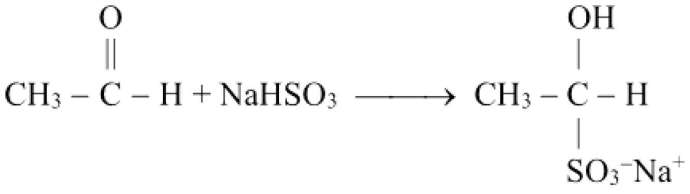




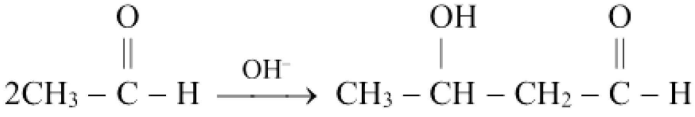
(ii) HCN:



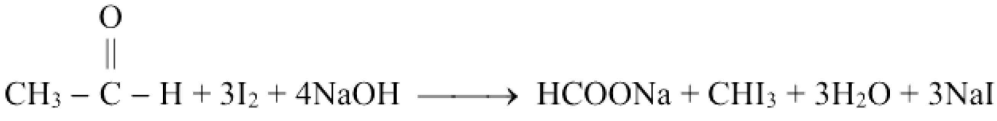
(iii) $NaHSO_3$:



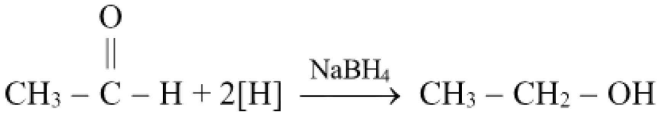
(iv) dil. NaOH:



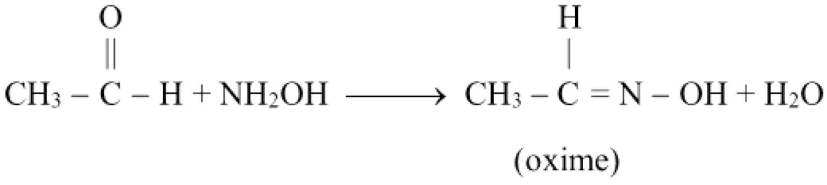
(v) I_2/NaOH:



(vi) $NaBH_4/H_2O$:

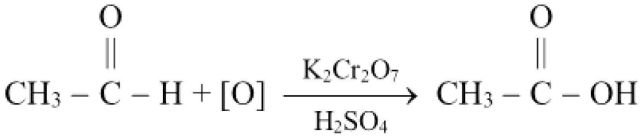


(vii) NH_2OH:



(oxime)

(viii) $K_2Cr_2O_7$ / H_2SO_4:



Q.14 Using ethyne as starting material how would you get acetaldehyde, acetone and ethyl alcohol?

Ans.

(i) Acetaldehyde:

$$CH \equiv CH + H_2O \xrightarrow[10\%\ H_2SO_4]{HgSO_4} CH_2 = CH - OH$$

$$CH_2 = CH - OH \rightleftharpoons CH_3 - \overset{\overset{O}{\|}}{C} - H$$

(ii) Acetone:

$$CH \equiv CH + NaNH_2 \longrightarrow CH \equiv \overset{-}{C}\overset{+}{N}a + NH_3$$

$$CH \equiv \overset{-}{C}\overset{+}{N}a + CH_3I \longrightarrow CH \equiv C - CH_3 + NaI$$

$$CH \equiv C - CH_3 + H_2O \longrightarrow CH_2 = \overset{\overset{OH}{|}}{C} - CH_3$$

$$CH_2 = \overset{\overset{OH}{|}}{C} - CH_3 \rightleftharpoons CH_3 - \overset{\overset{O}{\|}}{C} - CH_3$$

(iii) Ethyl Alcohol:

$$CH \equiv CH + H_2O \longrightarrow CH_2 = CH - OH$$

$$CH_2 = CH - OH \rightleftharpoons CH_3 - \overset{\overset{O}{\|}}{C} - H$$

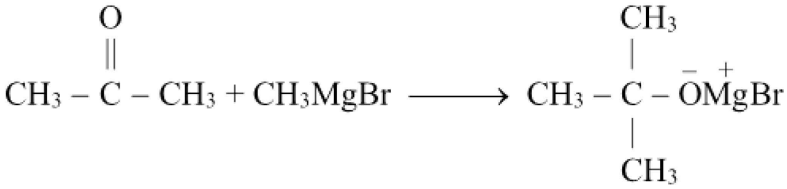
$$CH_3 - \overset{\overset{O}{\|}}{C} - H + H_2 \xrightarrow{Pd} CH_3 - CH_2 - OH$$

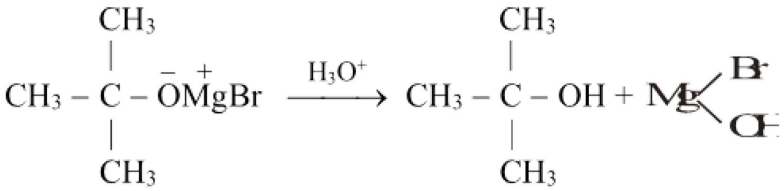
Q.16 How would you bring about the following conversions?

(i) Acetone into t-Butyl alcohol
(ii) Propanal into 1-propanol
(iii) Propanone into 2-propanol
(iv) Methanal into Ethanal
(v) Ethanal into propanone
(vi) Ethanal into 2-propanol
(vii) Ethene into Ethanal
(viii) Ethanal into Ethanol
(ix) Ethanol into 2-butanone
(x) Methanol into Ethanal
(xi) Ethanal into Ethanoic acid

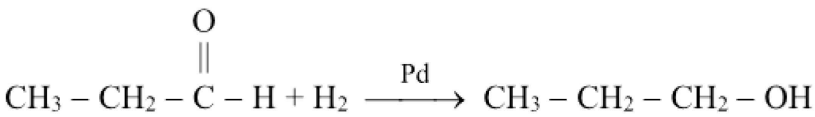
Ans.

(i) Acetone ⟶ Tert-butyl alcohol

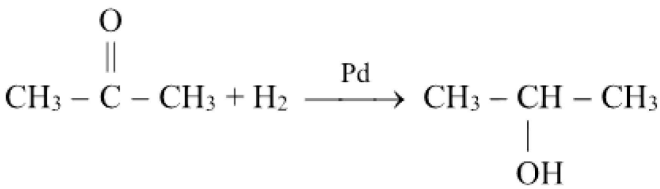




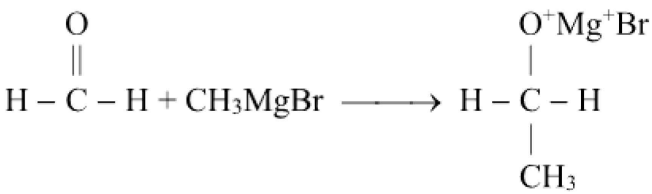
(ii) Propanal ⟶ 1-propanol:

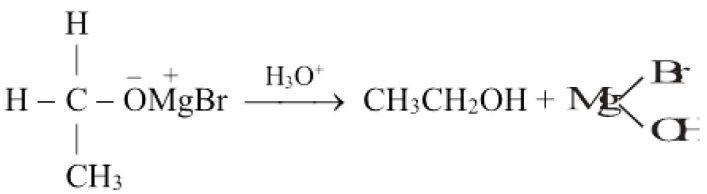


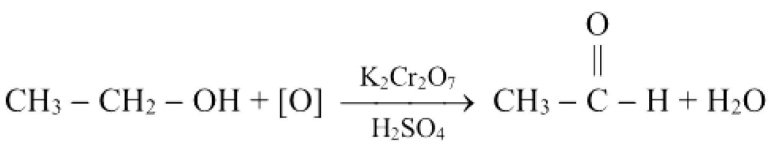
(iii) Propanone ⟶ 2-propanol:



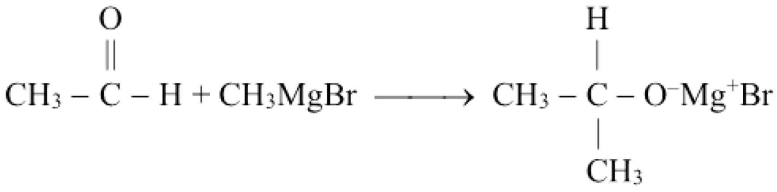
(iv) Methanal ⟶ Ethanal:

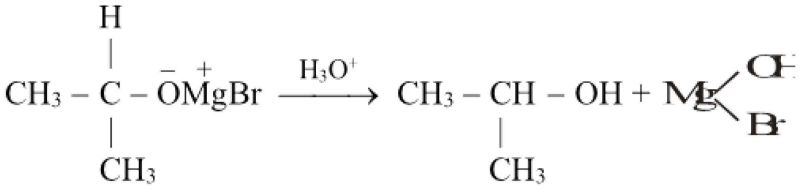


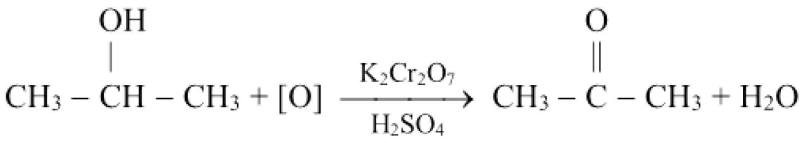




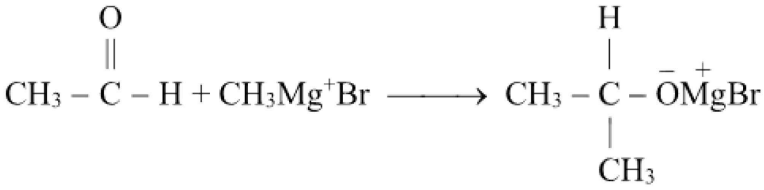
(v) Ethanal ⟶ propanone:

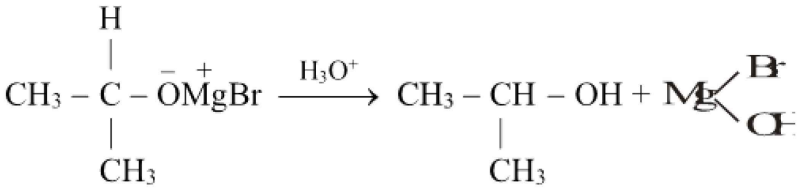




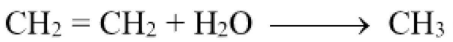


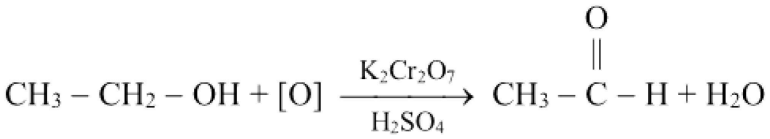
(vi) Ethanal ⟶ 2-propanol:



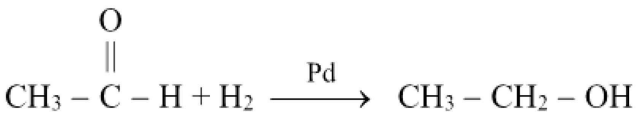


(vii) Ethene ⟶ Ethanal:





(viii) Ethanal ⟶ Ethanol:



(ix) Ethanol ⟶ 2-butanone:

$$CH_3 - CH_2OH + HBr \longrightarrow CH_3CH_2Br + H_2O$$

$$CH_3CH_2Br + Mg \longrightarrow CH_3CH_2MgBr$$

$$CH_3CH_2MgBr + CH_3 - \overset{\overset{O}{\|}}{C} - H \longrightarrow CH_3 - \overset{\overset{OMgBr}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3$$

$$CH_3 - \overset{\overset{OMgBr}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + H_2O \longrightarrow CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + Mg\begin{matrix}Br^- \\ Cl^-\end{matrix}$$

$$CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - CH_2 - CH_3 + H_2O$$

(x) Methanol ⟶ Ethanal:

$$CH_3OH + [O] \longrightarrow H - \overset{\overset{O}{\|}}{C} - H + H_2O$$

$$H - \overset{\overset{O}{\|}}{C} - H + CH_3MgBr \longrightarrow CH_3 - CH_2 - O^-Mg^+Br$$

$$CH_3 - CH_2OMgBr + H_2O \xrightarrow{H_3O^+} CH_3CH_2OH + Mg\begin{matrix}Br^- \\ Cl^-\end{matrix}$$

$$CH_3CH_2OH + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - H + H_2O$$

(xi) Ethanal ⟶ Ethanoic Acid:

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - OH$$

Q.17 How will you distinguish between:

(i) Methanal and ethanal **(ii) Ethanal and propanone**

(iii) Ethanal and propanal **(iv) Acetone and ethyl alcohol**

(v) Butanone and 3-pentanone **(vi) Acetaldehyde and benzaldehyde**

(vii) 2-pentanone and 3-pentanone

Ans.

(i) Methanal and Ethanal: Both can be distinguish by iodoform test.

$$CH_3-\overset{\overset{O}{\|}}{C}-H + 4NaOH + 3I_2 \longrightarrow CHI_3 + 3NaI + 3H_2O + HCOONa$$

$$H-\overset{\overset{O}{\|}}{C}-H + 4NaOH + 3I_2 \longrightarrow \text{No iodoform test}$$

(ii) Ethanal and Propanal: Both can be distinguished by iodoform test.

$$CH_3-\overset{\overset{O}{\|}}{C}-H + 4NaOH + 3I_2 \longrightarrow CHI_3 + 3NaI + 3H_2O + HCOONa$$

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-H + NaOH + I_2 \longrightarrow \text{No reaction}$$

(iii) Ethanal and Propanone: Both can be distinguish by mild oxidizing agent. e.g., Benedict's, Fehling's.

$$CH_3-\overset{\overset{O}{\|}}{C}-H + 2Cu(OH)_2 + 2NaOH \longrightarrow CH_3COONa + Cu_2O + 3H_2O$$

(red ppt.)

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + \text{Benedict's solution} \longrightarrow \text{No reaction}$$

(iv) Acetone and Ethyl Alcohol: Both can be distinguished by reacting with phenylhydrazine.

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + NH_2-NHC_6H_5 \longrightarrow$$



$$CH_3CH_2OH + NH_2-NHC_6H_5 \longrightarrow \text{No reaction}$$

(v) **Butanone and 3-pentanone:** Both can be distinguished by iodoform test.

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3+4NaOH+3I_2 \longrightarrow CH_3-CH_2COONa+3NaI+CHI_3+3H_2O$$

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3+NaOH+I_2 \longrightarrow \text{No reaction}$$

(vi) **Acetaldehyde and Benzaldehyde:**

1. Acetaldehyde give iodoform test while benzaldehyde give no iodoform test.
2. Benzaldehyde give cannizzaro reaction while acetaldehyde gives aldo product.

(vii) **2-pentanone and 3-pentanone:** Both can be distinguished by iodoform test.

$$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-CH_3+4NaOH+3I_2 \longrightarrow CH_3-CH_2-CH_2COONa + CHI_3+3NaI+3H_2O$$

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3+NaOH+I_2 \longrightarrow \text{No reaction}$$

Q.18 **Discuss oxidation of (a) aldehydes (b) ketones with:**

(i) **$K_2Cr_2O_7$** **(ii)** **Tollen's reagent** **(iii)** **Fehling's solution**

Ans. **(a)** **Oxidation of Aldehydes:**

Aldehydes are oxidized by strong as well as weak oxidising agents. Mixture of conc. H_2SO_4 and $K_2Cr_2O_7$ is strong oxidizing agent. Fehling solution, Benedict's solution and ammonical silver nitrate are weak oxidizing agent.

(i) $$R-\overset{\overset{O}{\|}}{C}-H+[O] \xrightarrow[\text{Conc. } H_2SO_4]{K_2Cr_2O_7} R-\overset{\overset{O}{\|}}{C}-OH$$

(ii) $$R-\overset{\overset{O}{\|}}{C}-H+[Ag(NH_3)_2]^+ + 2OH^- \longrightarrow R-\overset{\overset{O}{\|}}{C}-\overset{- +}{O}NH_4 + Ag\downarrow + H_2O + NH_3$$

(iii) $$R-\overset{\overset{O}{\|}}{C}-H+2Cu(OH)_2+2NaOH \longrightarrow RCOONa + Cu_2O + 3H_2O$$

(b) Oxidation of Ketones:

(i) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + 3[O] \xrightarrow[\text{Conc. } H_2SO_4]{K_2Cr_2O_7} CH_3COOH + HCOOH$

(ii) Ketones are note oxidized by tollen's reagent.

(iii) Ketones are note oxidized by Fehling's solution or Banldict's solution.

Q.19 Discuss reduction of (a) aldehydes (b) ketones with.

(i) $NaBH_4/H_2O$ (ii) H_2/Pd

(a) Reduction of Aldehydes:

Aldehyde after reduction changes to primary alcohol.

$$CH_3-\overset{\overset{O}{\|}}{C}-H + 2[H] \xrightarrow[H_2O]{NaBH_4} CH_3CH_2OH$$

$$CH_3-\overset{\overset{O}{\|}}{C}-H + H_2 \xrightarrow{Pd/Pt} CH_3CH_2OH$$

(b) Reduction of Ketones:

Ketones on reduction form secondary alcohols.

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + 2[H] \xrightarrow[H_2O]{NaBH_4} CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$$

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 + H_2 \xrightarrow{Pd/Pt} CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$$

DO YOU KNOW?

(1) Aldehydes and ketones are called carbonyl compounds.

(2) Formaline contains 40% formaldehyde 8% methyl alcohol and 52% water.

(3) Formaline is used as preservative for biological specimens.

(4) Calcium acetate on heating forms acetone.

(5) Acetone is used as nail polish remover.

(6) Aldehydes and Ketones having no α-hydrogen atom do not undergo aldol condensation.

(7) Formaldehyde reacts with NH_3 to form hexa methylene tetramine which is used as urinary antiseptic. Its trade name is urotropine.

(8) Formaldehyde is also used to prepare antipolio vaccine.

(9) ($AgNO_3$ + NH_4OH) is called Tollen's reagent.

(10) Ketones produce orange red colour with sodium nitro prusside after addition of NaOH. Aldehydes do not give this reaction.

(11) Aldehydes are strong reducing agents.

(12) Acetaldehyde is used for silvering of mirrors.

(13) Formaldehyde + Lactose (Formamint) is used as throat lozenges.

(14) Formaldehyde is used in the preparation of Bakelite (plastic).

(15) Ethyne on hydration with 10% H_2SO_4 and $HgSO_4$ forms acetaldehyde while propyne on hydration forms acetone.

CHAPTER

12

ALDEHYDES AND KETONES

MULTIPLE CHOICE QUESTIONS

1. Mild oxidizing agent among the following is:

(a) $K_2Cr_2O_7$ (acidified) **(b)** $KMnO_4$ (alkaline)

(c) Ammonical $AgNO_3$ **(d)** All of above

2. C = O and C = C bonds are differentiated by:

(a) Hybridization of C-atom **(b)** Planar structures

(c) Bond length **(d)** Undergo addition reaction

3. Reactivity of carbonyl compounds is due to:

(a) Electrophilic carbon **(b)** Less stearic hindrance

(c) Unsaturation of  **(d)** All of above

4. For the preparation of CH_3CHO from calcium acetate we need:

(a) 2 molecules of $Ca(CH_3COO)_2$

(b) 1 mole of $Ca(CH_3COO)_2$ and 1 molecule of $Ca(HCOO)_2$

(c) 2 molecules of $Ca(HCOO)_2$

(d) None of these

5. Which is a mixed ketone:

(a) Acetone **(b)** Benzophenone

(c) Diethyl ketone **(d)** Acetophenone

6. Which of the following can produce ketone:

(a) Sec-alcohol **(b)** Calcium acetate

(c) Propyne **(d)** All of above

7. Which of the following is resistant to oxidation under normal condition:

(a) CH_3OH **(b)** C_2H_5OH

(c) CH_3CHO **(d)** CH_3COCH_3

8. Which of the following aldehyde is most reactive:

(a) HCHO **(b)** CH_3CHO

(c) C_6H_5CHO **(d)** All of above

9. Ketones are prepared by the oxidation of:

(a) P° alcohol **(b)** S° alcohol

(c) T° alcohol **(d)** None of these

10. Which of the following don't give cannizzare reaction:

(a) Formaldehyde **(b)** Acetaldehyde

(c) Benzaldehyde **(d)** None of above

11. Ethanal has ———— sigma bonds:

(a) 5 **(b)** 6

(c) 7 **(d)** 8

12. Which of the following compounds is acetophenone:

(a) $C_6H_5COCH_3$ **(b)** $C_6H_5COC_6H_5$

(c) CH_3COCH_3 **(d)** C_6H_5CHO

13. Which of the following tests is shown by ketones:

(a) Fehling solution test **(b)** Tollen's reagent test

(c) Schiff's reagent test **(d)** Sodium nitroprusside test

14. Which of the following will undergo nucleophilic addition reaction more easily:

(a) Aldehyde **(b)** Alkene

(c) Aldehyde and ketone **(d)** All of these

15. Which of the following aldehdyes is used to prepare urotropine medicine:

(a) Acetaldehyde **(b)** Acetone

(c) Formaldehyde **(d)** Ethyl alcohol

16. In which of the following compounds, carbon number is decreased during the oxidation:

(a) Aldehyde **(b)** Ketone

(c) Alcohol **(d)** Ether

17. Which of the following is used as ink preservative:

(a) Alcohol **(b)** Aldehyde

(c) Ether **(d)** Phenol

18. Which one of the following compounds is not derivative of NH_3:

(a) Aniline **(b)** Hydrazine

(c) Phenyl hydrazine **(d)** Picric acid

19. Aldol compound consists of:

(a) Aldehyde group **(b)** Hydroxyl group

(c) Carboxylic group **(d)** Both (a) and (b)

20. Which one of the following is the strongest reducing agent:

(a) C_3H_8 **(b)** CH_2O

(c) C_3H_7OH **(d)** CH_3COCH_3

21. When aldehyde reacts with Tollen's reagent:

(a) A ketone is produced **(b)** An alcohol is produced

(c) Ag^+ ions are produced **(d)** Ag^+ ions are reduced

22. Which of the following reagents will react with both aldehydes and Ketones?

(a) Grignard reagent **(b)** Tollen's reagent

(c) Fehling's reagent **(d)** Sodium nitroprusside

23. Cannizzaro's reaction is not given by:

(a) Formaldehyde **(b)** Acetaldehyde

(c) Benzaldehyde **(d)** Trichloro acetaldehyde

24. Which of the following will form brick red ppt. (Cu_2O) with Benedict's solution:

(a) $CH_3 - \overset{\overset{O}{\|}}{C} - H$ **(b)** $CH_3 - \overset{\overset{O}{\|}}{C} - CH_3$

(c) $CH_3 - \overset{\overset{O}{\|}}{C} - OH$ **(d)** $CH_3 - \overset{\overset{O}{\|}}{C} - CH_2 - CH_3$

25. Which of the following compounds will not give iodoform test on treatment with I_2/NaOH:

(a) Acetaldehyde **(b)** Acetone

(c) 2-butanone **(d)** 3-pentanone

26. Aldehyde and ketone have higher boiling point than corresponding compounds of the following except:

(a) Alkanes **(b)** Alkenes

(c) Ethers **(d)** Alcohols

27. The hybridization of C-atom in carbonyl group is:

(a) sp **(b)** sp^2

(c) sp^3 **(d)** dsp^2

28. Cyanohydrins are formed from carbonyl compounds by ———— reactions mechanism:

(a) Free radical **(b)** Nucleophilic substituion

(c) Nucleophilic addition **(d)** Electrophilic addition

29. The red brown ppt. of Fehling solution and Benedict solution tests are of:

(a) Ag **(b)** CuO

(c) Cu_2O **(d)** AgBr

30. Carbonyl compounds react with hydroxyl amine (NH_2OH) to form:

(a) Hydrazone **(b)** Oxime

(c) Cyanohydrin **(d)** Bisulphite addition product

31. Paraldehyde is polymer of:

(a) HCHO **(b)** CH_3CHO

(c) CH_3COCH_3 **(d)** $CH_3CH_2CH_2OH$

32. Paraldehyde is used as a:

(a) Medicine **(b)** Poison

(c) Dye **(d)** Polymer

33. Calcium formate $Ca(HCOO)_2$ on dry heating yields:

(a) HCHO **(b)** CH_3CHO

(c) CH_3COCH_3 **(d)** CH_3COOH

34. Aldehydes combine with alcohol in presence of hydrogen chloride gas to form:

(a) Alkane **(b)** Acetal

(c) Carboxylic acid **(d)** Ketones

35. Which of the following is not a use of formaldehyde:

(a) Manufacture of dyes **(b)** Silvering of mirror

(c) Making formamint **(d)** Antiseptic inhalent

36. Which of the following test is not given by aldehyde:

(a) 2, 4 DNPH test **(b)** $NaHSO_3$ test

(c) Tollen's test **(d)** Sodium nitroprusside test

37. Ketones on reduction produce:

(a) P° alcohol **(b)** S° alcohol

(c) T° alcohol **(d)** None

38. Which is not true about Cannizzaro's reaction:

(a) Self oxidation reduction **(b)** Concentrated NaOH

(c) Disproportionation reaction **(d)** Dilute NaOH

39. Aldehyde give precipitate with Fehling solution on:

(a) Cooling **(b)** Heating

(c) Boiling **(d)** Do not give ppt.

40. Which of the following compound is least reactive:

(a) HCHO **(b)** CH_3CHO

(c) CH_3COCH_3 **(d)** C_6H_5CHO

answers

1.	(c)	**2.**	(c)	**3.**	(d)	**4.**	(b)	**5.**	(d)
6.	(d)	**7.**	(d)	**8.**	(a)	**9.**	(b)	**10.**	(b)
11.	(b)	**12.**	(a)	**13.**	(d)	**14.**	(a)	**15.**	(c)
16.	(b)	**17.**	(d)	**18.**	(d)	**19.**	(d)	**20.**	(b)
21.	(d)	**22.**	(a)	**23.**	(b)	**24.**	(a)	**25.**	(d)
26.	(d)	**27.**	(b)	**28.**	(c)	**29.**	(c)	**30.**	(b)
31.	(b)	**32.**	(a)	**33.**	(a)	**34.**	(b)	**35.**	(d)
36.	(d)	**37.**	(b)	**38.**	(d)	**39.**	(c)	**40.**	(c)

SOLVED EXERCISE

Q.1 Fill in the blanks:

(i) Aldehydes are the first oxidation product of ————.

(ii) Ketones are the first oxidation product of ————.

(iii) Aldehydes and ketones undergo ———— addition reactions.

(iv) Formaldehyde reacts with ———— to give primary alcohol.

(v) Acetaldehyde reacts with ———— to give 2-butanol.

(vi) Aldehydes are strong ———— agents.

(vii) The oxidation of an ———— always gives a carboxylic acid.

(viii) The reduction of a ———— always gives a secondary alcohol.

(ix) Formaldehyde gives ———— test with Tollen's reagent.

(x) Acetaldehyde gives a ———— precipitate with Fehling's solution.

answers

(i)	Pri-alcohol	**(ii)**	Sec-alcohol	**(iii)**	nucleophile
(iv)	Grignard reagent	**(v)**	C_2H_5MgBr	**(vi)**	reducing
(vii)	aldehyde	**(viii)**	ketone	**(ix)**	silver mirror test
(x)	brick red				

Q.2 Indicate True or False:

(i) Formaldehyde is used in the silvering of mirrors.

(ii) Ketones combine with alcohols in the presence of HCl gas to form acetals.

(iii) Acetaldehyde undergoes Cannizzaro's reaction.

(iv) Formaldehyde is used for silvering of mirrors.

(v) Aldol condensation reaction is given by only those aldehydes and ketones which contain an α-hydrogen atom.

(vi) Cannizzaro's reaction is given by only those aldehydes containing no α-hydrogen atom.

(vii) Propanol and propanone behave differently with Tollen's reagent.

(viii) Acetone reacts with sodium bisulphite to give a yellow crystalline product.

(ix) Acetone on reduction gives a primary alcohol.

(x) 40% aqueous solution of formaldehyde is called formalin.

answers

(i)	True	**(ii)**	False	**(iii)**	False	**(iv)**	True	**(v)**	True
(vi)	True	**(vii)**	True	**(viii)**	False	**(ix)**	False	**(x)**	True

Q.3 Multiple choice questions. Encircle the correct answer:

(i) The carbon atom of a carbonyl group is:

(a) sp hybridized **(b)** sp^2 hybridized

(c) sp^3 hybridized **(d)** None of these

(ii) Formalin is:

(a) 10% solution of formaldehyde in water + 8% methyl alcohol

(b) 20% solution of formaldehyde in water + 8% methyl alcohol

(c) 40% solution of formaldehyde in water + 8% methyl alcohol

(d) 60% solution of formaldehyde in water + 8% methyl alcohol

(iii) Which of the following will have the highest boiling point:

(a) Methanal **(b)** Ethanal

(c) Propanal **(d)** 2-Hexanone

(iv) Ketones are prepared by the oxidation of:

(a) Primary alcohol **(b)** Secondary alcohol

(c) Tertiary alcohol **(d)** None of these

(v) Acetone reacts with HCN to form a cyanohydrin. It is an example of:

(a) Electrophilic addition **(b)** Electrophilic substitution

(c) Nucleophilic addition **(d)** Nucleophilic substitution

(vi) Which of the following compounds will not give iodoform test on treatment with I_2/NaOH:

(a) Acetaldehyde **(b)** Acetone

(c) Butanone **(d)** 3-pentanone

(vii) Which of the following compounds will react with Tollen's reagent:

(a) $CH_3-\overset{\overset{O}{\|}}{C}-H$ **(b)** $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

(c) $CH_3-\overset{\overset{O}{\|}}{C}-OH$ **(d)** $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2$

(viii) Cannizzaro's reaction is not given by:

(a) Formaldehyde **(b)** Acetaldehyde

(c) Benzaldehyde **(d)** Trimethylacetaldehyde

(ix) Which of the following reagents will react with both aldehydes and ketones:

(a) Grignard reagent **(b)** Tollen's reagent

(c) Fehling's reagent **(d)** Benedict's reagent

answers

(i)	(b)	**(ii)**	(c)	**(iii)**	(d)	**(iv)**	(b)	**(v)**	(c)
(vi)	(d)	**(vii)**	(a)	**(viii)**	(b)	**(ix)**	(a)		

Q.5 How does formaldehyde react with the following reagents?

(i) CH_3MgI **(ii) HCN** **(iii) $NaHSO_3$**

(iv) NaOH **(v) Hydrogen** **(vi) Tollen's Reagent**

(vii) Fehling's Reagent

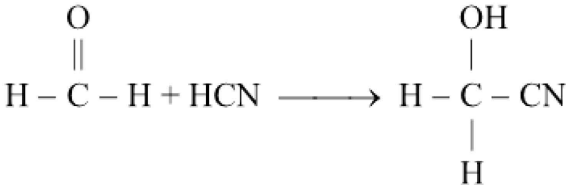
Ans.

(i) CH_3MgI:

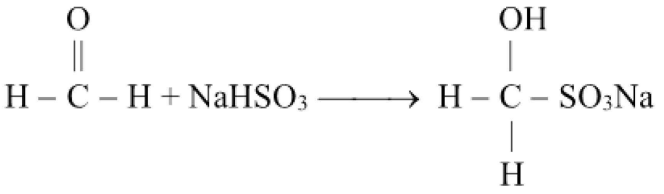
$$HCHO + CH_3MgI \longrightarrow CH_3 - CH_2 - O^-Mg^+I^-$$

$$CH_3 - CH_2 - OMg^+I^- + H_3O^+ \xrightarrow{\text{aq. HCl}} CH_3 - CH_2 - OH + Mg\begin{matrix} I \\ Cl \end{matrix}$$

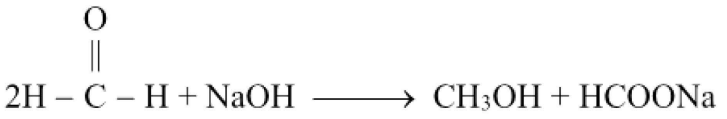
(ii) HCN:



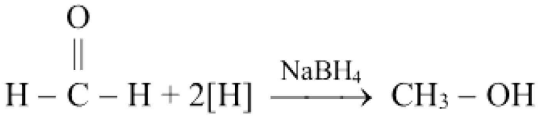
(iii) $NaHSO_3$:



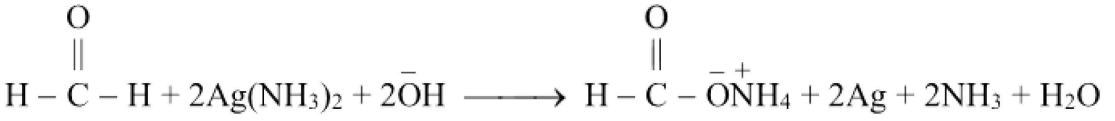
(iv) NaOH:



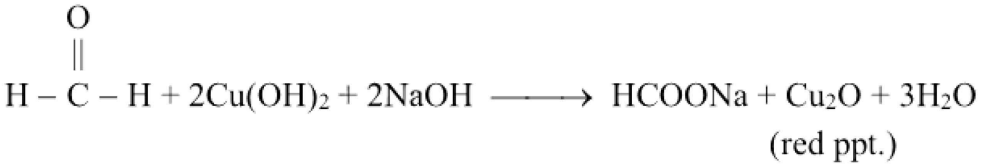
(v) Hydrogen:



(vi) Tollen's Reagent:



(vii) Fehling's Reagent:

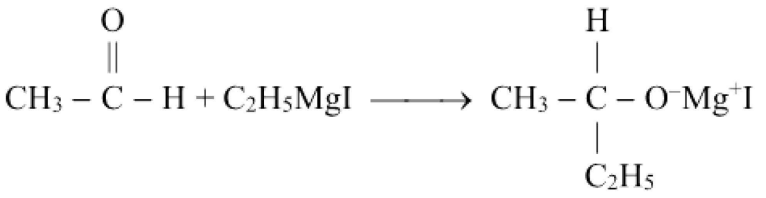


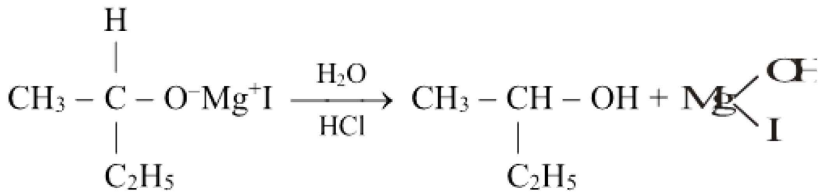
Q.7 How does acetaldehyde reacts with following?

(i) C_2H_5MgI **(ii) HCN** **(iii) $NaHSO_3$**
(iv) dil. NaOH **(v) I_2/NaOH** **(vi) $NaBH_4/H_2O$**
(vii) NH_2OH **(viii) $K_2Cr_2O_7$ / H_2SO_4**

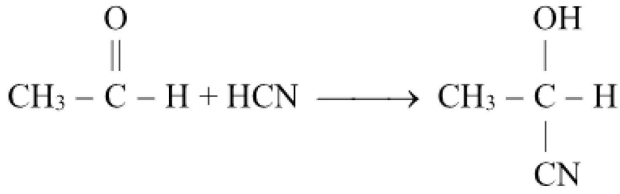
Ans.

(i) C_2H_5MgI:

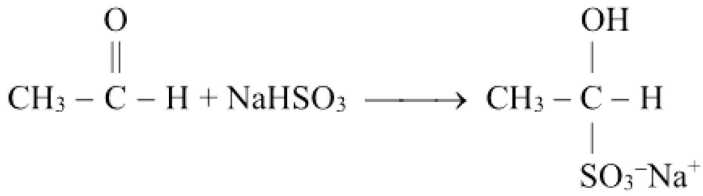




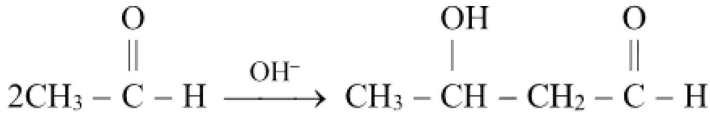
(ii) HCN:



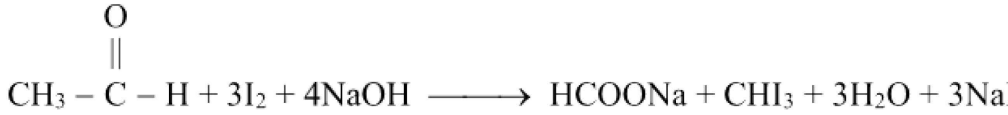
(iii) $NaHSO_3$:



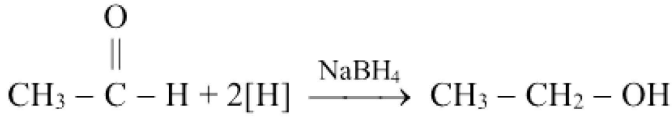
(iv) dil. NaOH:



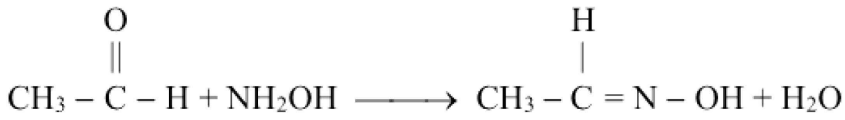
(v) I_2/NaOH:



(vi) $NaBH_4/H_2O$:



(vii) NH_2OH:



(oxime)

(viii) $K_2Cr_2O_7$ / H_2SO_4:

$$CH_3-\overset{\overset{O}{\|}}{C}-H + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3-\overset{\overset{O}{\|}}{C}-OH$$

Q.14 Using ethyne as starting material how would you get acetaldehyde, acetone and ethyl alcohol?

Ans.

(i) Acetaldehyde:

$$CH \equiv CH + H_2O \xrightarrow[10\%\ H_2SO_4]{HgSO_4} CH_2 = CH - OH$$

$$CH_2 = CH - OH \rightsquigarrow CH_3-\overset{\overset{O}{\|}}{C}-H$$

(ii) Acetone:

$$CH \equiv CH + NaNH_2 \longrightarrow CH \equiv \overset{-}{C}\overset{+}{Na} + NH_3$$

$$CH \equiv \overset{-}{C}\overset{+}{Na} + CH_3I \longrightarrow CH \equiv C - CH_3 + NaI$$

$$CH \equiv C - CH_3 + H_2O \longrightarrow CH_2 = \overset{\overset{OH}{|}}{C} - CH_3$$

$$CH_2 = \overset{\overset{OH}{|}}{C} - CH_3 \rightsquigarrow CH_3-\overset{\overset{O}{\|}}{C}-CH_3$$

(iii) Ethyl Alcohol:

$$CH \equiv CH + H_2O \longrightarrow CH_2 = CH - OH$$

$$CH_2 = CH - OH \rightsquigarrow CH_3-\overset{\overset{O}{\|}}{C}-H$$

$$CH_3-\overset{\overset{O}{\|}}{C}-H + H_2 \xrightarrow{Pd} CH_3 - CH_2 - OH$$

Q.16 How would you bring about the following conversions?

(i) Acetone into t-Butyl alcohol (ii) Propanal into 1-propanol

(iii) Propanone into 2-propanol (iv) Methanal into Ethanal

(v) Ethanal into propanone **(vi) Ethanal into 2-propanol**

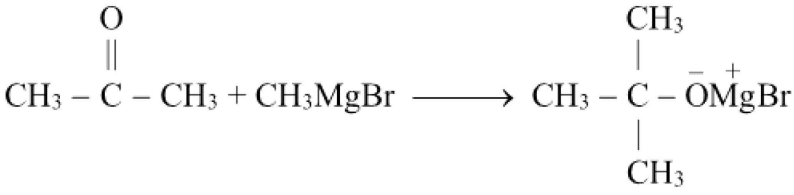
(vii) Ethene into Ethanal **(viii) Ethanal into Ethanol**

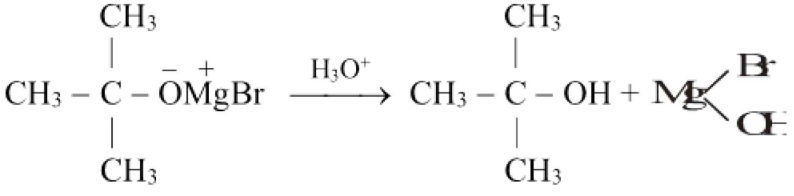
(ix) Ethanol into 2-butanone **(x) Methanol into Ethanal**

(xi) Ethanal into Ethanoic acid

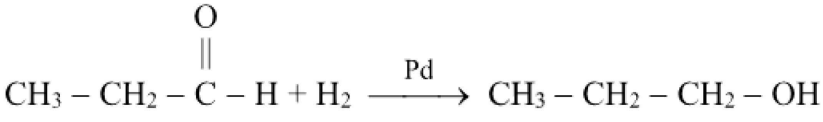
Ans.

(i) Acetone ⟶ t-Butyl alcohol

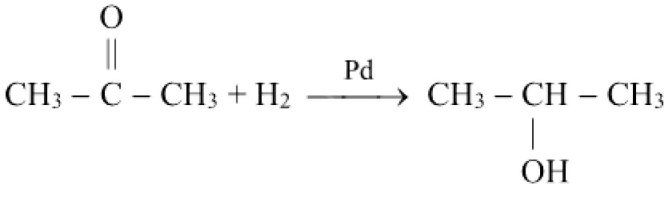




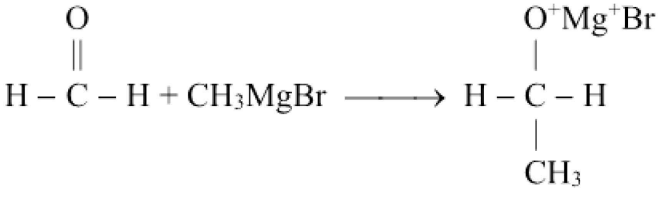
(ii) Propanal ⟶ 1-propanol:

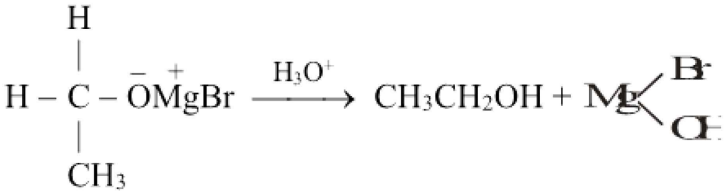


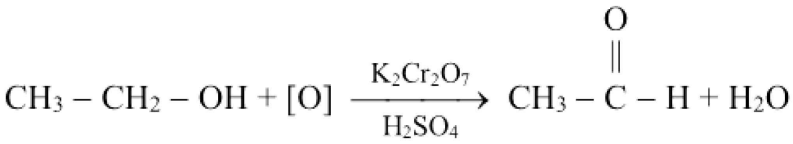
(iii) Propanone ⟶ 2-propanol:



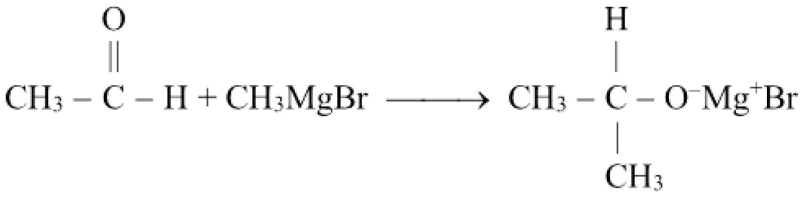
(iv) Methanal ⟶ Ethanal:

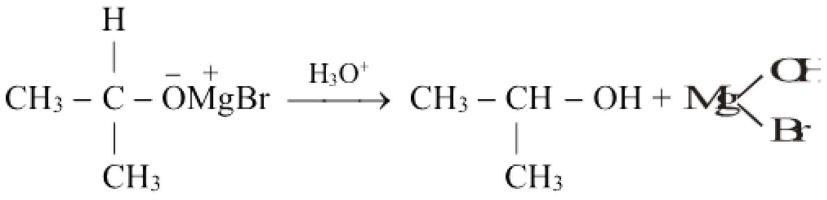


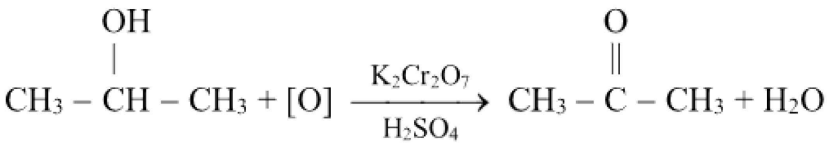




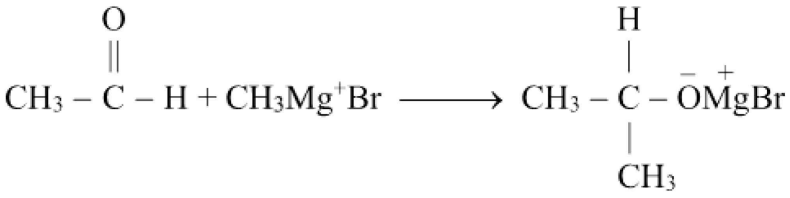
(v) Ethanal ⟶ propanone:

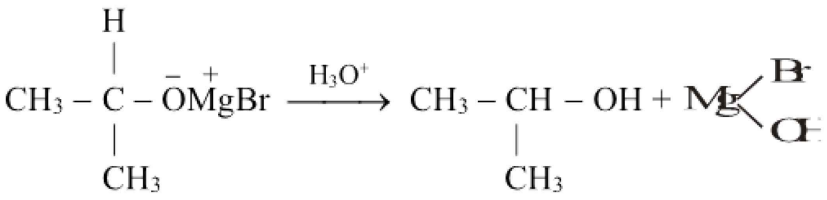






(vi) Ethanal ⟶ 2-propanol:





(vii) Ethene ⟶ Ethanal:



$$CH_3 - CH_2 - OH + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - H + H_2O$$

(viii) Ethanal ⟶ Ethanol:

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + H_2 \xrightarrow{Pd} CH_3 - CH_2 - OH$$

(ix) Ethanol ⟶ 2-butanone:

$$CH_3 - CH_2OH + HBr \longrightarrow CH_3CH_2Br + H_2O$$

$$CH_3CH_2Br + Mg \longrightarrow CH_3CH_2MgBr$$

$$CH_3CH_2MgBr + CH_3 - \overset{\overset{O}{\|}}{C} - H \longrightarrow CH_3 - \overset{\overset{OMgBr}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3$$

$$CH_3 - \overset{\overset{OMgBr}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + H_2O \longrightarrow CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + MgBrCl$$

$$CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{H}{|}}{C}} - CH_2 - CH_3 + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - CH_2 - CH_3 + H_2O$$

(x) Methanol ⟶ Ethanal:

$$CH_3OH + [O] \longrightarrow H - \overset{\overset{O}{\|}}{C} - H + H_2O$$

$$H - \overset{\overset{O}{\|}}{C} - H + CH_3MgBr \longrightarrow CH_3 - CH_2 - O^-Mg^+Br$$

$$CH_3 - CH_2OMgBr + H_2O \xrightarrow{H_3O^+} CH_3CH_2OH + MgBrCl$$

$$CH_3CH_2OH + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - H + H_2O$$

(xi) Ethanal ⟶ Ethanoic Acid:

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + [O] \xrightarrow[H_2SO_4]{K_2Cr_2O_7} CH_3 - \overset{\overset{O}{\|}}{C} - OH$$

Q.17 How will you distinguish between:

(i) Methanal and ethanal **(ii) Ethanal and propanone**

(iii) Ethanal and propanal **(iv) Acetone and ethyl alcohol**

(v) Butanone and 3-pentanone **(vi) Acetaldehyde and benzaldehyde**

(vii) 2-pentanone and 3-pentanone

Ans.

(i) Methanal and Ethanal: Both can be distinguish by iodoform test.

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + 4NaOH + 3I_2 \longrightarrow CHI_3 + 3NaI + 3H_2O + HCOONa$$

$$H - \overset{\overset{O}{\|}}{C} - H + 4NaOH + 3I_2 \longrightarrow \text{No iodoform test}$$

(ii) Ethanal and Propanal: Both can be distinguished by iodoform test.

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + 4NaOH + 3I_2 \longrightarrow CHI_3 + 3NaI + 3H_2O + HCOONa$$

$$CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - H + NaOH + I_2 \longrightarrow \text{No reaction}$$

(iii) Ethanal and Propanone: Both can be distinguish by mild oxidizing agent. e.g., Benedict's, Fehling's.

$$CH_3 - \overset{\overset{O}{\|}}{C} - H + 2Cu(OH)_2 + 2NaOH \longrightarrow CH_3COONa + Cu_2O + 3H_2O$$

(red ppt.)

$$CH_3 - \overset{\overset{O}{\|}}{C} - CH_3 + \text{Benedict's solution} \longrightarrow \text{No reaction}$$

(iv) **Acetone and Ethyl Alcohol:** Both can be distinguished by reacting with phenylhydrazine.

$$CH_3 - \overset{\overset{O}{\|}}{C} - CH_3 + NH_2 - NHC_6H_5 \longrightarrow$$



$$CH_3CH_2OH + NH_2 - NHC_6H_5 \longrightarrow \text{No reaction}$$

(v) **Butanone and 3-pentanone:** Both can be distinguished by iodoform test.

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3+4NaOH+3I_2 \longrightarrow CH_3-CH_2COONa+3NaI+CHI_3+3H_2O$$

$$CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - CH_2 - CH_3 + NaOH + I_2 \longrightarrow \text{No reaction}$$

(vi) **Acetaldehyde and Benzaldehyde:**

1. Acetaldehyde give iodoform test while benzaldehyde give no iodoform test.
2. Benzaldehyde give cannizzaro reaction while acetaldehyde gives aldol product.

(vii) **2-pentanone and 3-pentanone:** Both can be distinguished by iodoform test.

$$CH_3 - CH_2 - CH_2 - \overset{\overset{O}{\|}}{C} - CH_3 + 4NaOH + 3I_2 \longrightarrow CH_3 - CH_2 - CH_2COONa + CHI_3 + 3NaI + 3H_2O$$

$$CH_3 - CH_2 - \overset{\overset{O}{\|}}{C} - CH_2 - CH_3 + NaOH + I_2 \longrightarrow \text{No reaction}$$

DO YOU KNOW?

1. Aldehydes and ketones are called carbonyl compounds.
2. Formaline contains 40% formaldehyde 8% methyl alcohol and 52% water.
3. Formaline is used as preservative for biological specimens.
4. Calcium acetate on heating forms acetone.
5. Acetone is used as nail polish remover.
6. Aldehydes and Ketones having no α-hydrogen atom do not undergo aldol condensation.
7. Formaldehyde reacts with NH_3 to form hexa methylene tetramine which is used as urinary antiseptic. Its trade name is urotropine.
8. Formaldehyde is also used to prepare antipolio vaccine.
9. ($AgNO_3$ + NH_4OH) is called Tollen's reagent.
10. Ketones produce orange red colour with sodium nitro prusside after addition of NaOH. Aldehydes do not give this reaction.
11. Aldehydes are strong reducing agents.
12. Acetaldehyde is used for silvering of mirrors.
13. Formaldehyde + Lactose (Formamint) is used as throat lozenges.
14. Formaldehyde is used in the preparation of Bakelite (plastic).
15. Ethyne on hydration with 10% H_2SO_4 and $HgSO_4$ forms acetaldehyde while propyne on hydration forms acetone.

SHORT QUESTIONS

Q.1 How will you distinguish between propanal and propanone?

Ans. Fehling solution, Benedict solution or Tollen's reagent oxidises propanal but not propanone e.g.,

$$CH_3CH_2CHO + 2[Ag(NH_3)_2]^+ + H_2O \longrightarrow CH_3CH_2COOH + 2Ag + 2NH_4^+$$

$$CH_3\text{-}COH_3 + 2Ag(NH_3)_2^+ + H_2O \longrightarrow \text{No reaction}$$

Q.2 Give the name and formula of two substance which undergo cannizzaro reaction.

Ans. The compounds which have no α-carbon or no hydrogen at α-carbon undergo cannizzaro reaction. e.g.,

HCHO (Formaldehyde)

C_6H_5CHO (Benzaldehyde)

Q.3 What is disproportionation reactions?

Ans. The reactions in which same compound is oxidised and reduced are called self oxidation reduction reaction or disproportionation reaction. e.g.,

$$2HCHO + NaOH \longrightarrow CH_3OH + HCOONa$$

$$2C_6H_5CHO + NaOH \longrightarrow C_6H_5CH_2OH + C_6H_5\text{–}\overset{\overset{O}{\|}}{C}\text{–}\overset{-\ +}{O}Na$$

Q.4 How will you distinguish between ethanal and propanal?

Ans. Ethanal give positive iodoform test while propanal does not:

$$CH_3CHO + 4NaOH + 3I_2 \longrightarrow CHI_3 + HCOONa + 3NaI + 3H_2O$$

$$CH_3CH_2CHO + NaOH + I_2 \longrightarrow \text{No reaction}$$

Q.5 What is aldol?

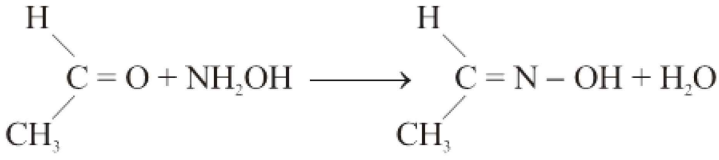
Ans. The compound which contain one aldehydic and one hydroxyl group in it is called aldol. e.g.,

$$CH_3 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_2 - CHO$$

3-hydroxy butanal

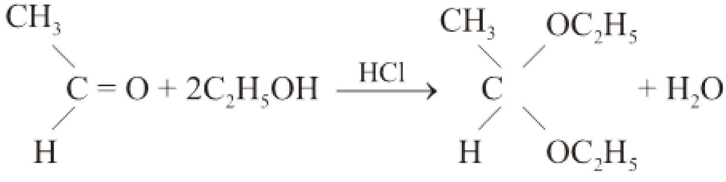
Q.6 What is oxime and how it is prepared?

Ans. When an aldehyde or ketone reacts with hydroxylamine, the addition product is called oxime. e.g.,



Q.7 What is acetal? What is its use?

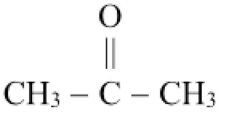
Ans. Aldehydes react with alcohols in the presence of dry hydrogen chloride gas to form acetal.



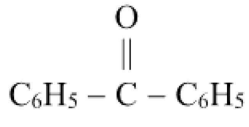
The reaction may be used to protect aldehyde group against alkaline oxidising agent. To regenerate aldehyde, the acetal is hydrolysed in the presence of an acid.

Q.8 What is difference between symmetrical and unsymmetrical ketones?

Ans. The ketone having similar alkyl or aryl group on both side of carboxyl group is called symmetrical ketone e.g.,

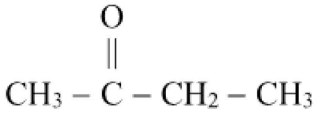


(Di-methyl ketone)

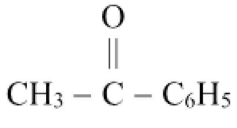


(Diphenyl ketone)

The ketone in which two different alkyl or aryl groups are attached with carbonyl group is called unsymmetrical ketone.



(Ethyl methyl ketone)



(Methyl-phenyl ketone)