

ALDEHYDES

KETONES

CARBOXYLIC ACIDS

Mrs. Janahi Vijayakumar

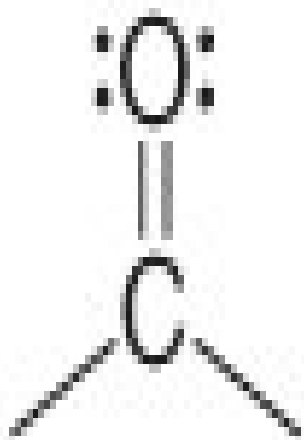
PGT Chemistry

Kendriya Vidyalaya Mankhurd Mumbai – 400 088

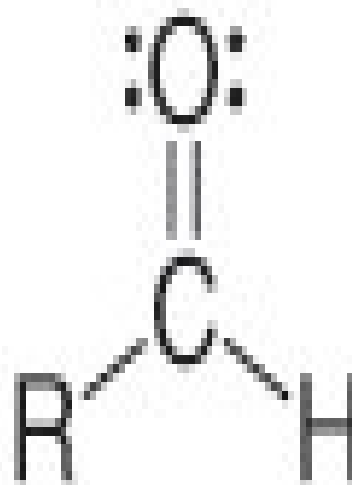
# Introduction (Aldehydes & Ketones)

Aldehydes and ketones contain a **carbonyl group**.

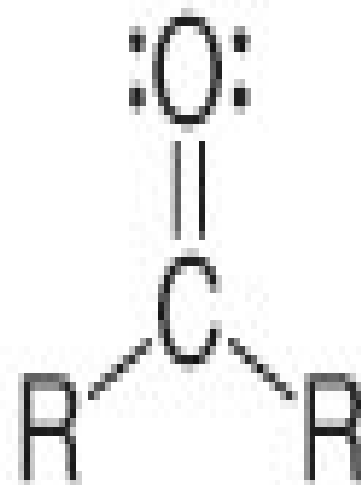
An aldehyde contains at least **one H atom** bonded to the carbonyl carbon, whereas the ketone has **two alkyl or aryl groups** bonded to it.



carbonyl group



aldehyde



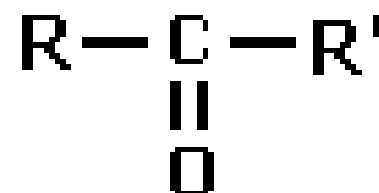
ketone

# Introduction (Aldehydes & Ketones)

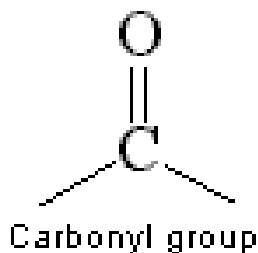


R = H, alkyl or aryl

Ketone



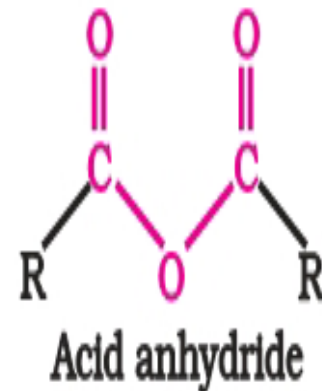
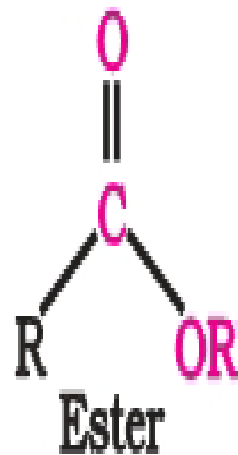
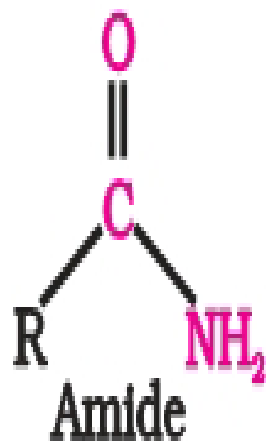
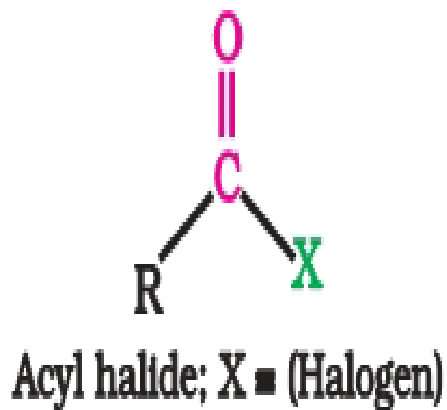
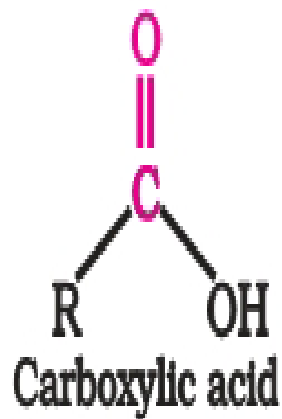
R and R' = alkyl or aryl



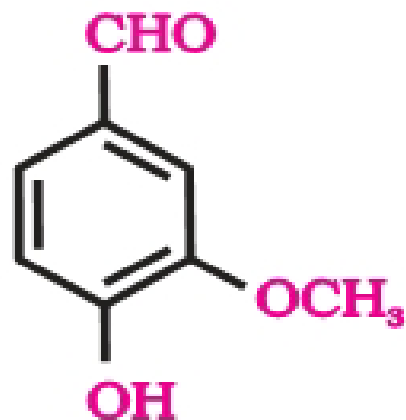
Carbonyl group

# Introduction (Carboxylic Acids)

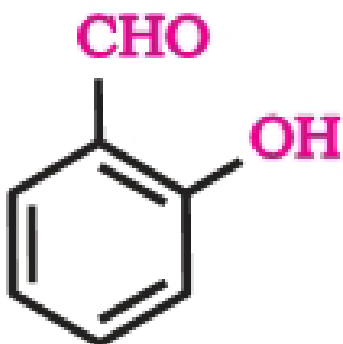
The carbonyl compounds in which **carbonyl group** is bonded to **oxygen** are known as **carboxylic acids**, and their derivatives (e.g. esters, anhydrides) while in compounds where carbon is attached to nitrogen and to halogens are called **amides** and **acyl halides** respectively.



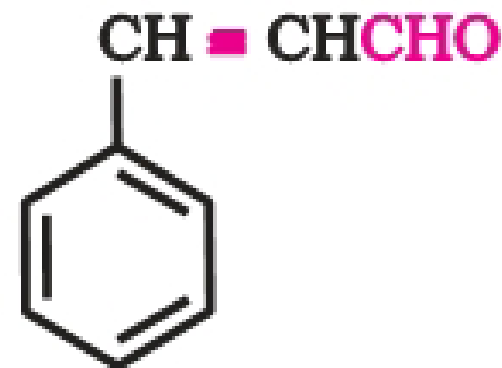
# Aromatic Aldehydes in plants



**Vanillin**



**Salicylaldehyde**

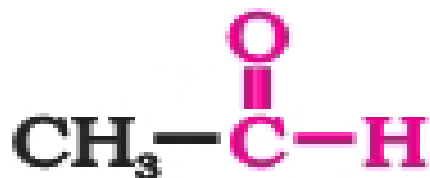


**Cinnamaldehyde**

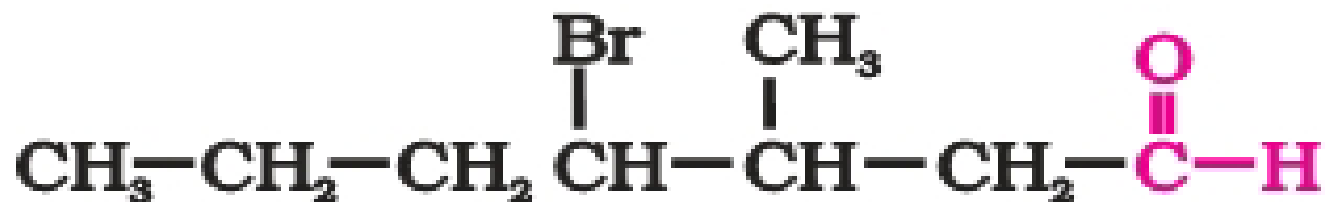
# Nomenclature

The IUPAC names of open chain aliphatic aldehydes and ketones are derived from the names of the corresponding alkanes by **replacing the ending -e with -al and -one respectively.**

In case of aldehydes the longest carbon chain is numbered starting from the carbon of the aldehyde group while in case of ketones the numbering begins from the end nearer to the carbonyl group.



Ethanal

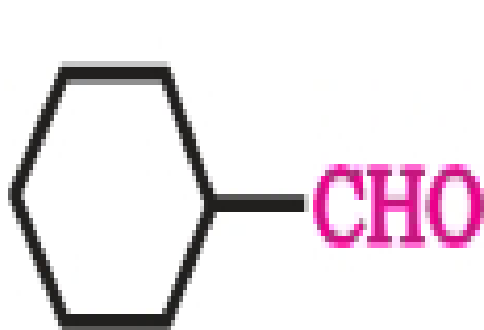


4-Bromo-3-methylheptanal

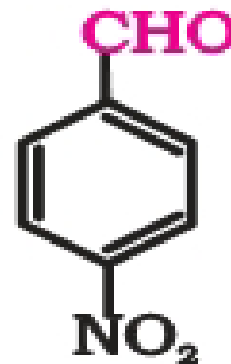
# Nomenclature (contd)

When the aldehyde group is attached to a ring, the suffix carbaldehyde is added after the full name of the cycloalkane.

The numbering of the ring carbon atoms start from the carbon atom attached to the aldehyde group.

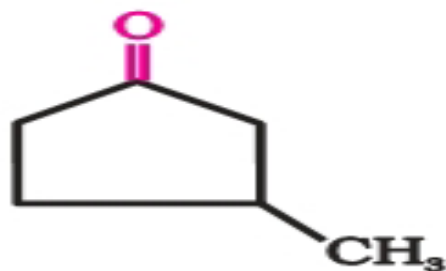


Cyclohexanecarbaldehyde

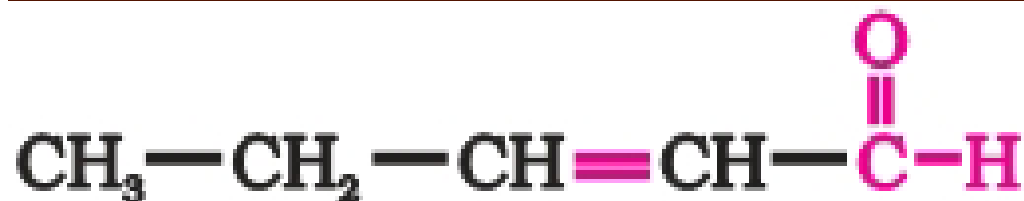


4-Nitrobenzenecarbaldehyde  
or  
4-Nitrobenzaldehyde

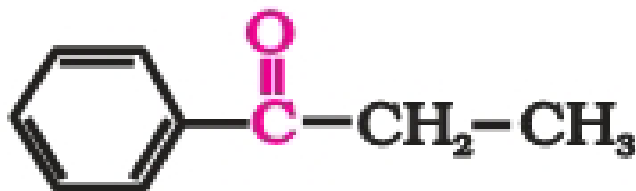
# Nomenclature (contd)



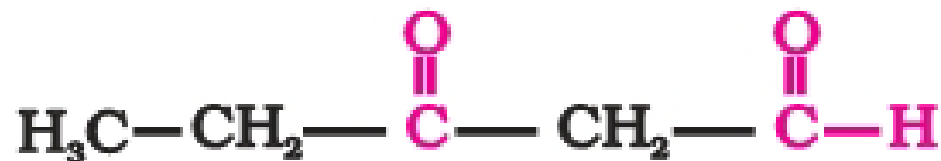
3-Methylcyclopentanone



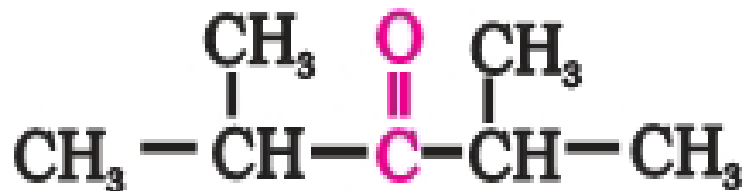
Pent-2-enal



1-Phenylpropan-1-one



3-Oxopentanal



2,4-Dimethylpentan-3-one



Propane-1,2,3-tricarbaldehyde



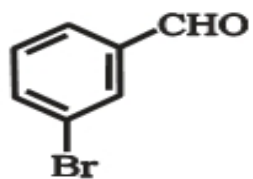
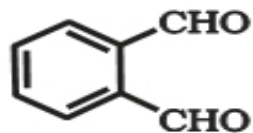
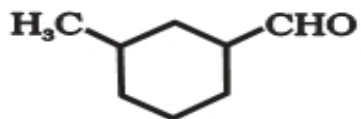
# Common & IUPAC names of some aldehydes & ketones

## Structure

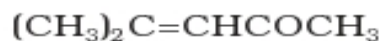
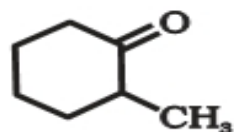
## Common name

## IUPAC name

### Aldehydes



### Ketones



Formaldehyde

Acetaldehyde

Isobutyraldehyde

$\gamma$ -Methylcyclohexane

$\alpha$ -Methoxypropionaldehyde

Valeraldehyde

Acrolein

Phthalaldehyde

*m*-Bromobenzaldehyde

Methyl *n*-propyl ketone

Diisopropyl ketone

$\alpha$ -Methylcyclohexanone

Mesityl oxide

Methanal

Ethanal

2-Methylpropanal

3-Methylcyclohexanecarbaldehyde

2-Methoxypropanal

Pentanal

Prop-2-enal

Benzene-1,2-dicarbaldehyde

3-Bromobenzenecarbaldehyde  
or

3-Bromobenzaldehyde

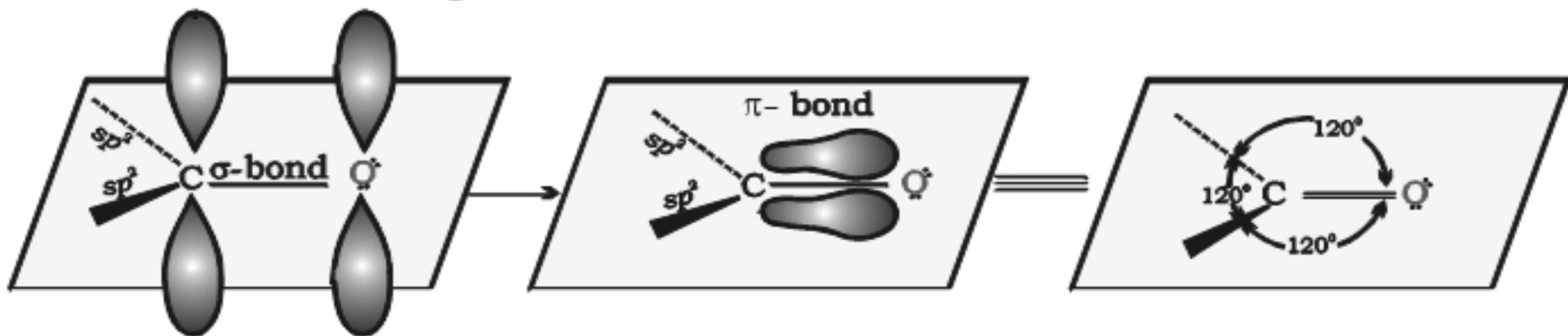
Pentan-2-one

2,4-Dimethylpentan-3-one

2-Methylcyclohexanone

4-Methylpent-3-en-2-one

# Structure of carbonyl group



**The carbonyl carbon atom is  $sp^2$ -hybridised and forms three sigma ( $\sigma$ ) bonds.**

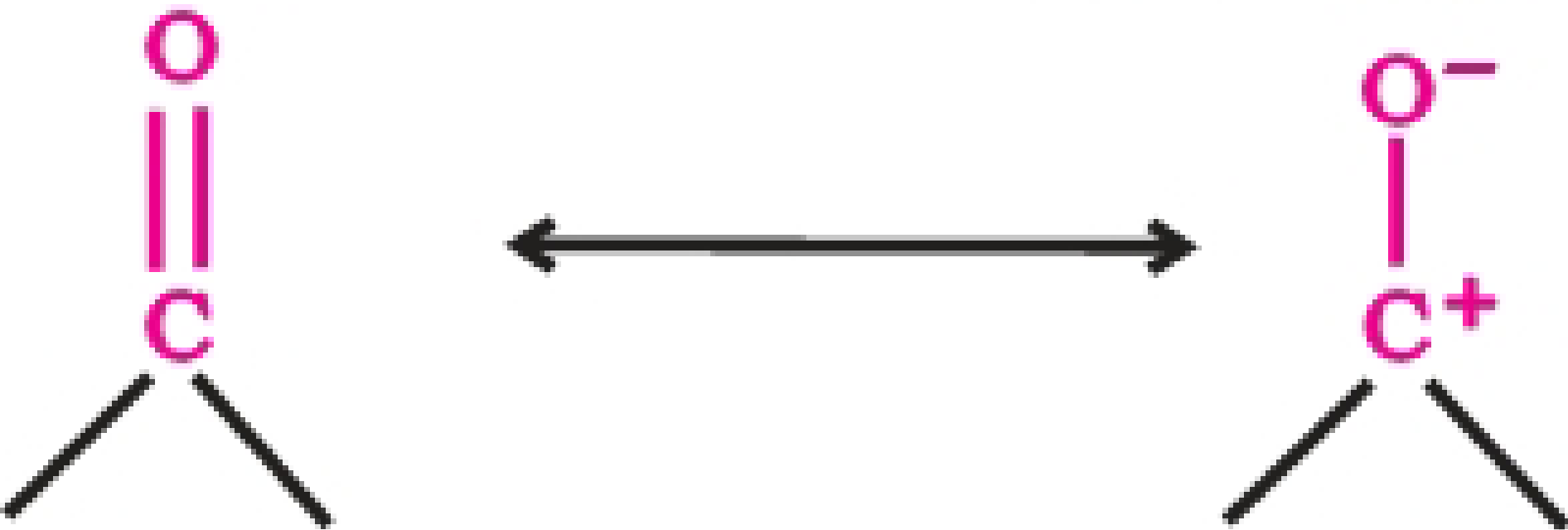
The fourth valence electron of carbon remains in its  $p$ -orbital and forms a  $\pi$ -bond with oxygen by overlap with  $p$ -orbital of an oxygen.

**In addition, the oxygen atom also has two non bonding electron pairs.**

Thus, the carbonyl carbon and the three atoms attached to it lie in the same plane and the  $\pi$ -electron cloud is above and below this plane.

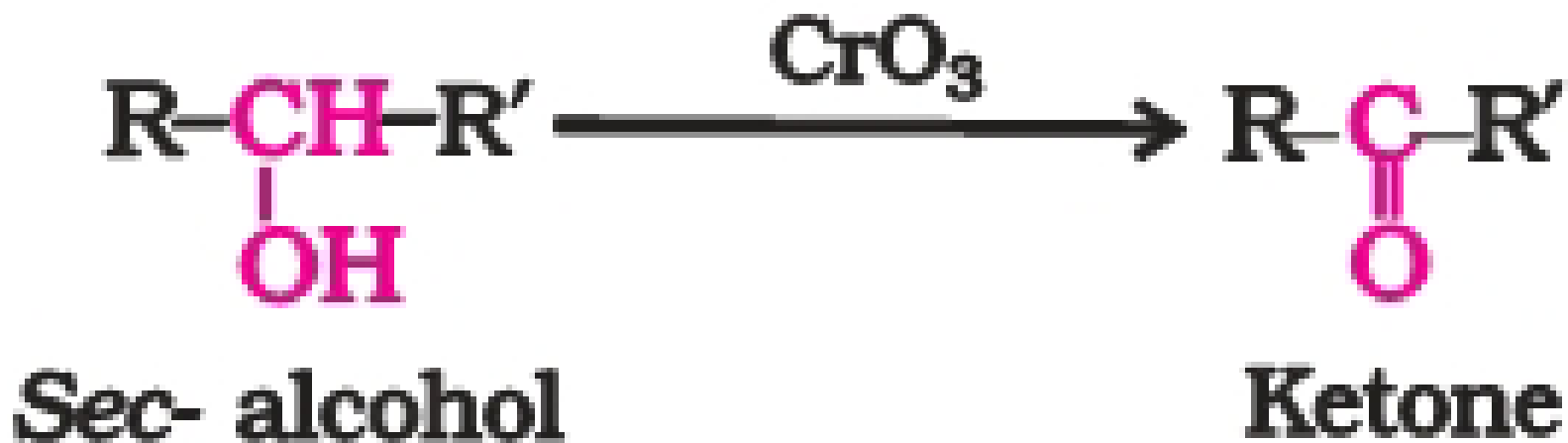
## Structure of carbonyl group (contd)

The carbon-oxygen double bond is polarised due to higher electronegativity of oxygen relative to carbon. Hence, the carbonyl carbon is an **electrophilic (Lewis acid)**, and carbonyl oxygen, a **nucleophilic (Lewis base)** centre.



# Preparation of aldehydes & ketones

## By oxidation of alcohol



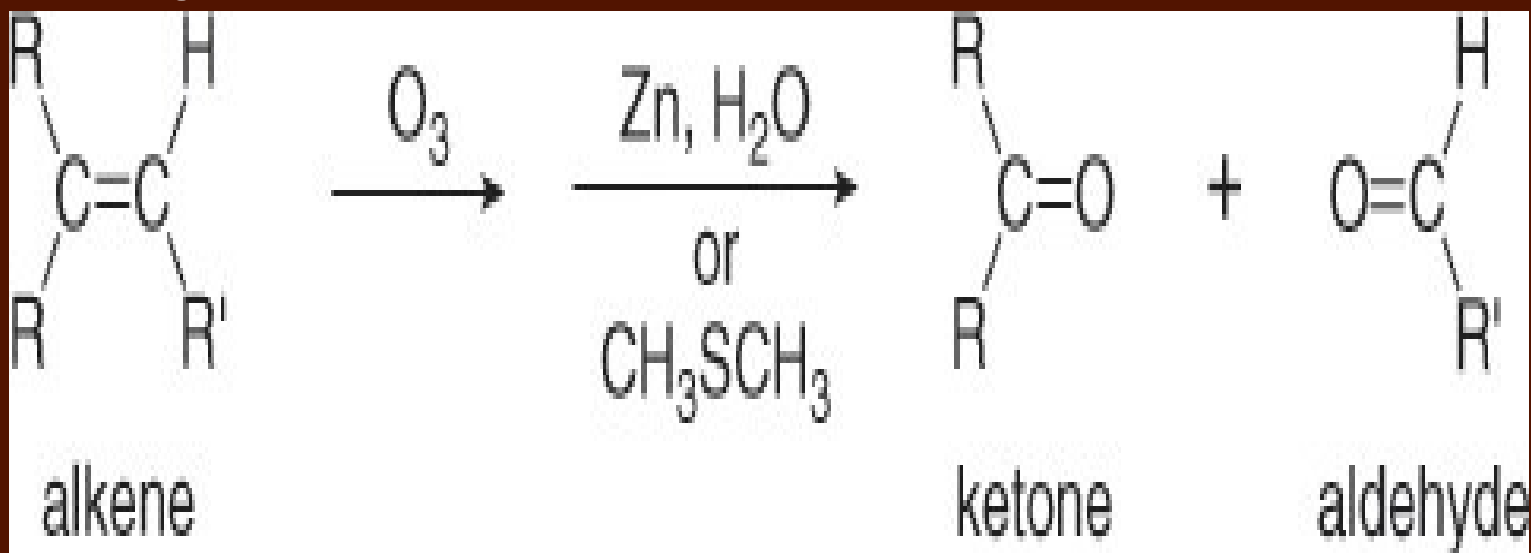
# Preparation of aldehydes & ketones

## By dehydrogenation of alcohols



## From hydrocarbons

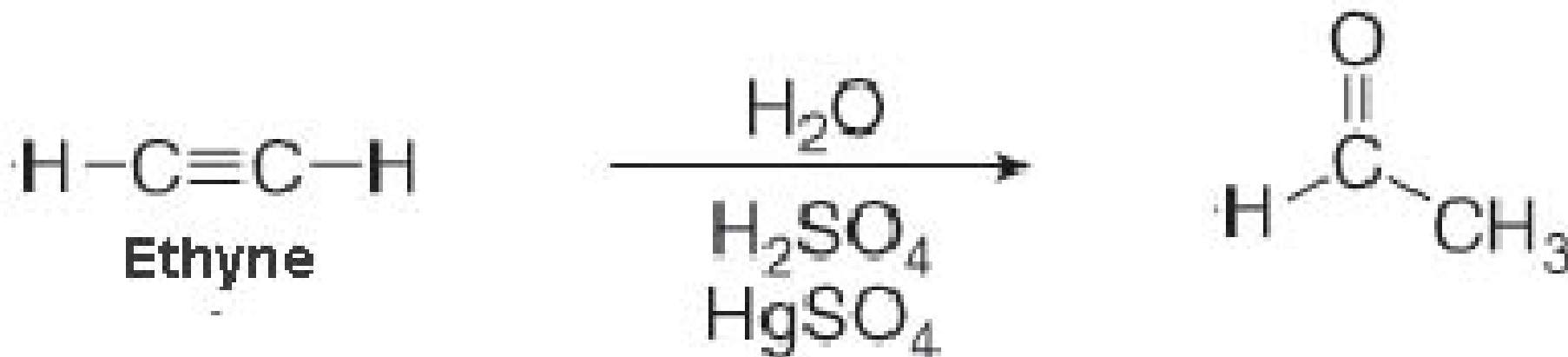
### (1) By ozonolysis of alkenes:



# Preparation of aldehydes & ketones

## From hydrocarbons (contd)

(2) By hydration of alkynes:



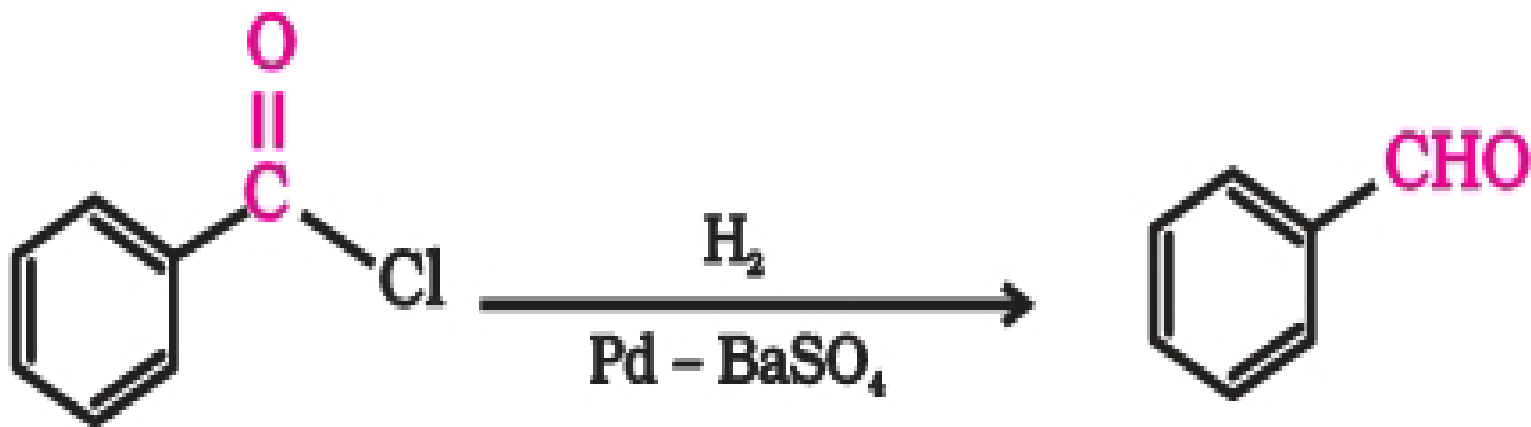
Addition of water to ethyne gives **acetaldehyde**.

All other alkynes give **ketones**.

# Preparation of aldehydes only

From acyl chloride (acid chloride)

## *Rosenmund reduction*



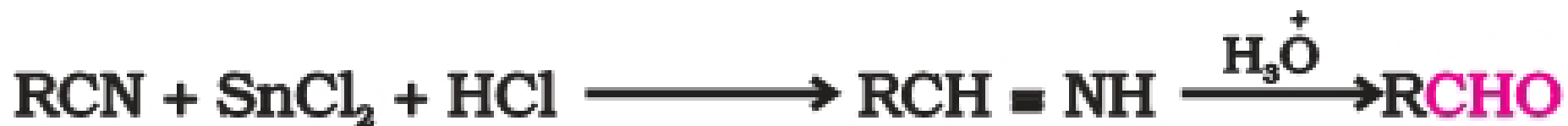
Benzoyl chloride

Benzaldehyde

# Preparation of aldehydes only

## From nitriles and esters

Nitriles are reduced to corresponding imine with stannous chloride in the presence of hydrochloric acid, which on hydrolysis give corresponding aldehyde.

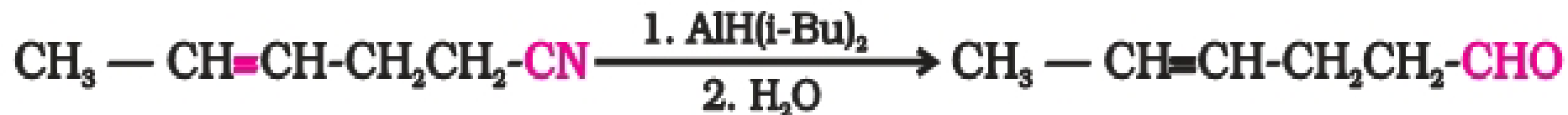
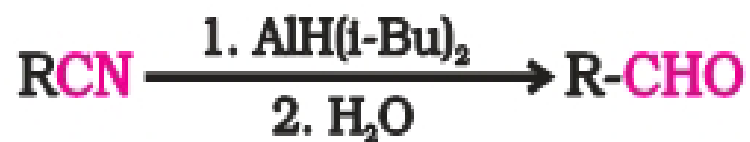


This reaction is called **Stephen reaction**.



# Preparation of aldehydes only (contd)

Nitriles are selectively reduced by diisobutylaluminium hydride, (DIBAL-H) to imines followed by hydrolysis to aldehydes:



Esters are also reduced to aldehydes with DIBAL-H.

# Preparation of aromatic aldehydes

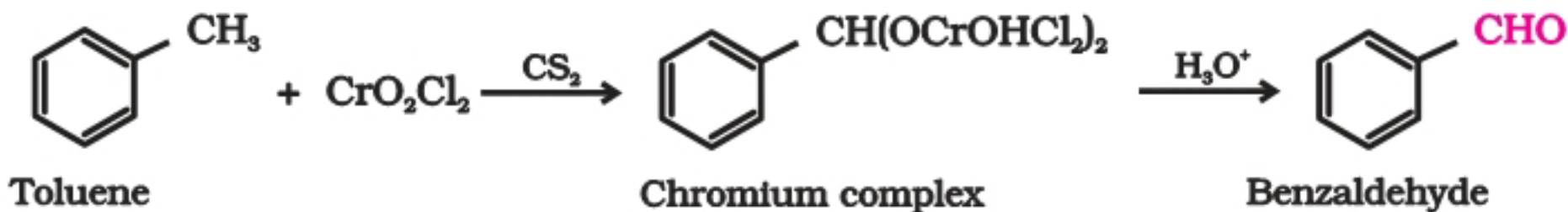
From hydrocarbons

By oxidation of methylbenzene

Strong oxidising agents oxidise toluene and its derivatives to benzoic acids.

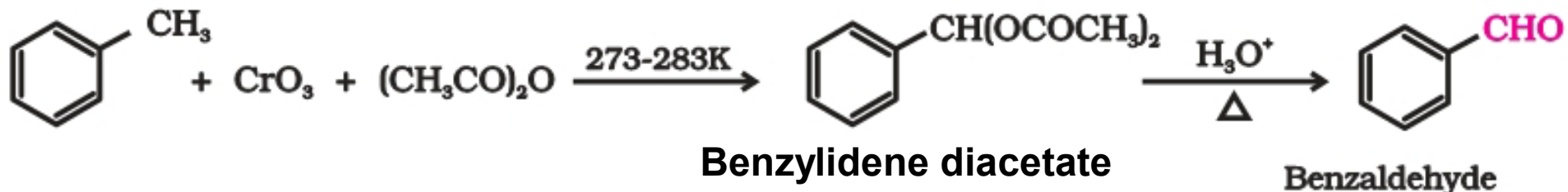
It is possible to stop the oxidation at the aldehyde stage with suitable reagents

(a) Use of chromyl chloride ( $\text{CrO}_2\text{Cl}_2$ ) (Etard reaction) :

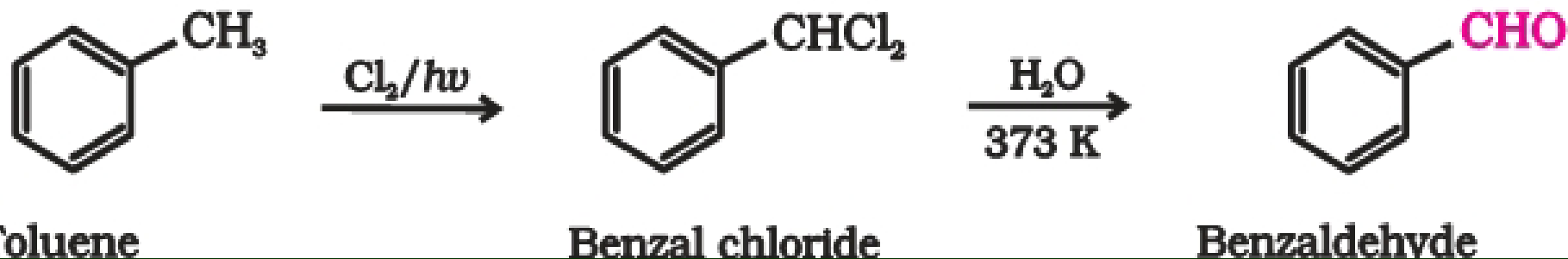


# Preparation of aromatic aldehydes (contd)

## (b) Use of chromic oxide ( $\text{CrO}_3$ ):



## By side chain chlorination

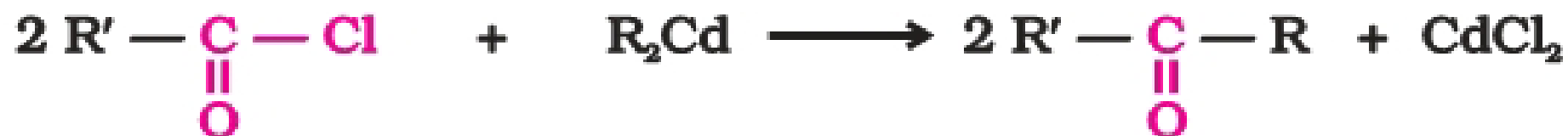


## By Gatterman - Koch reaction

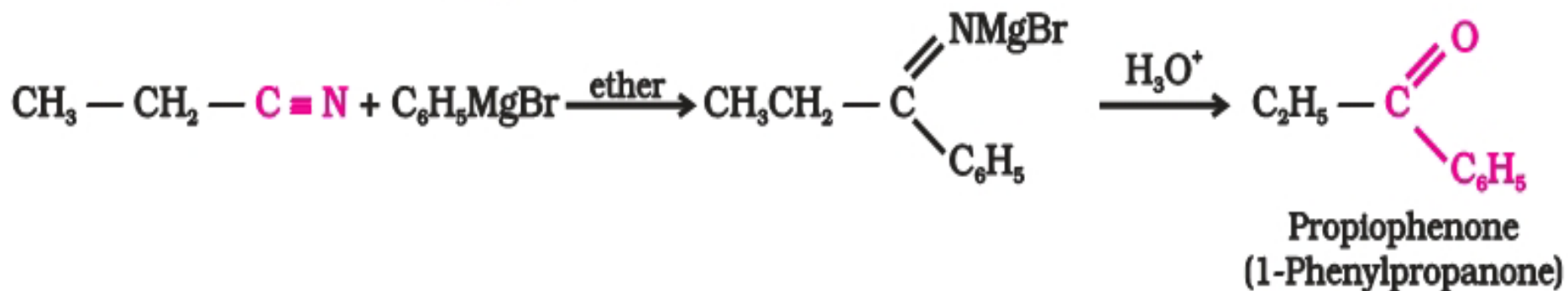


# Preparation of ketones only

## From acyl chlorides

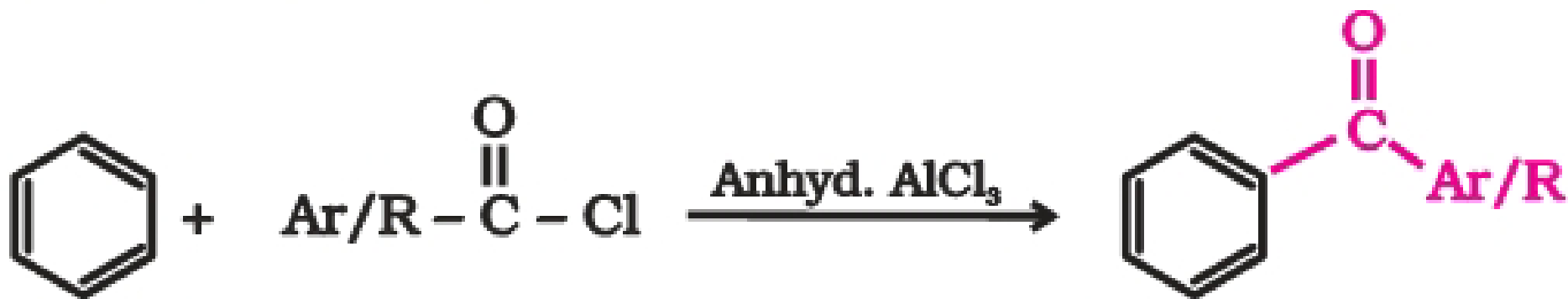


## From nitriles



# Preparation of ketones only (contd)

From benzene or substituted benzenes  
( Friedel-Crafts acylation reaction )



# Physical properties of aldehydes & ketones

## Boiling point

*The boiling points of aldehydes and ketones are higher than hydrocarbons and ethers of comparable molecular masses.*

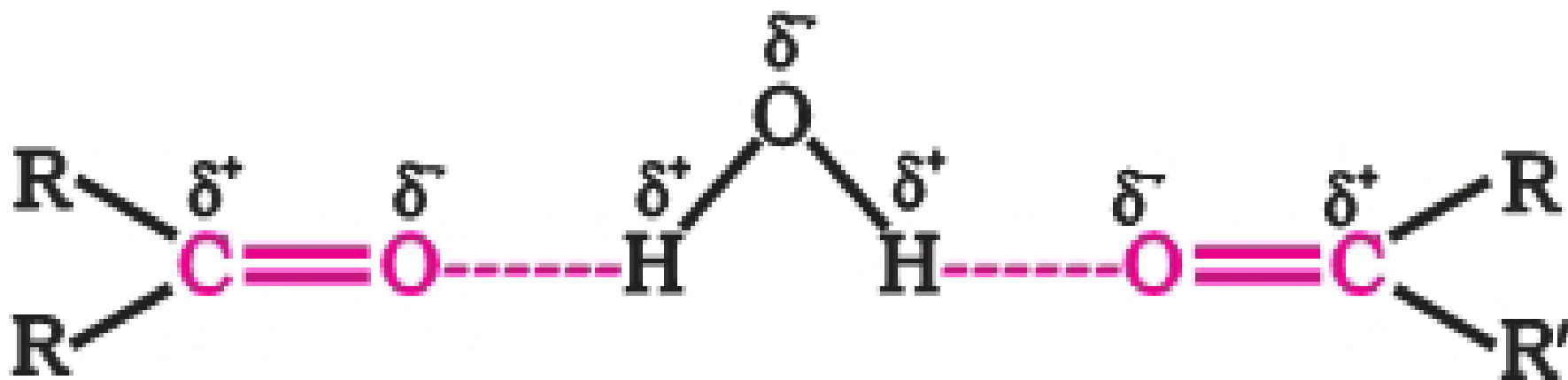
It is due to weak molecular association in aldehydes and ketones arising out of the dipole-dipole interactions.

**Also, their boiling points are lower than those of alcohols of similar molecular masses due to absence of intermolecular hydrogen bonding.**

# Physical properties of aldehydes & ketones

## Solubility

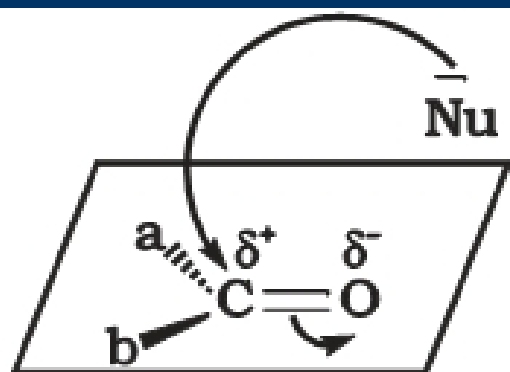
The lower members of aldehydes and ketones such as methanal, ethanal and propanone are miscible with water in all proportions, because they form hydrogen bond with water.



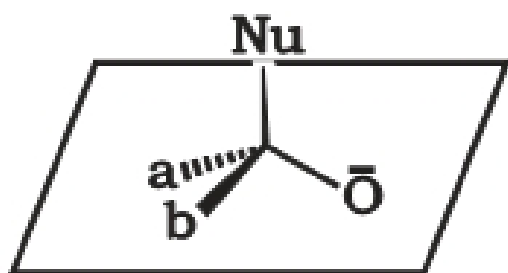
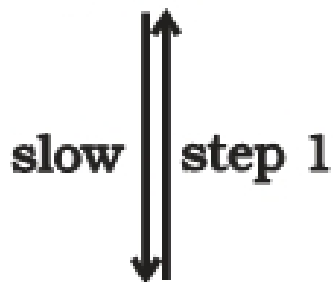
However, the solubility of aldehydes and ketones decreases rapidly on increasing the length of alkyl chain.

# Chemical Reactions of aldehydes & ketones

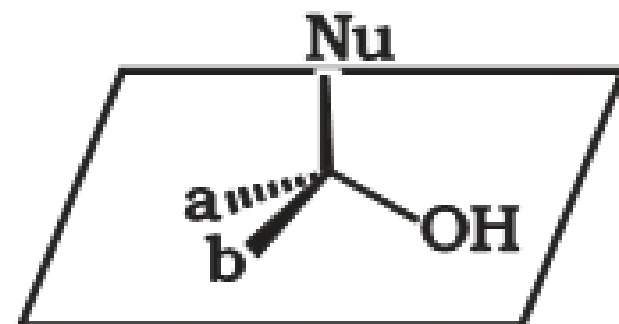
## Nucleophilic addition reactions



Planar



Tetrahedral intermediate



Addition product

Nucleophilic attack on carbonyl carbon

Mechanism



# Chemical Reactions of aldehydes & ketones

## Reactivity

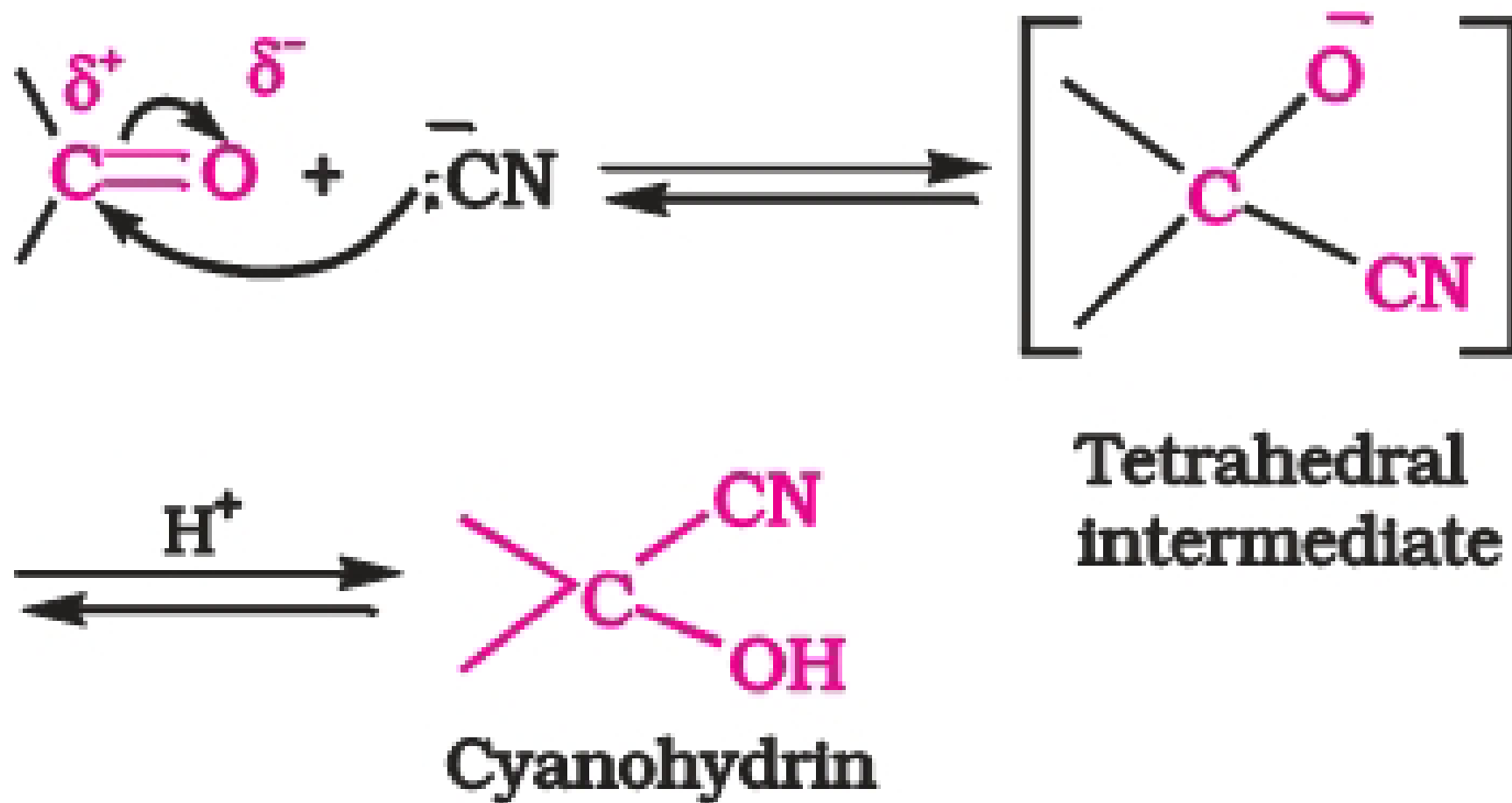
Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons.

**Sterically, the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbon than in aldehydes having only one such substituent.**

Electronically, aldehydes are more reactive than ketones because two alkyl groups reduce the electrophilicity of the carbonyl more effectively than in aldehydes.

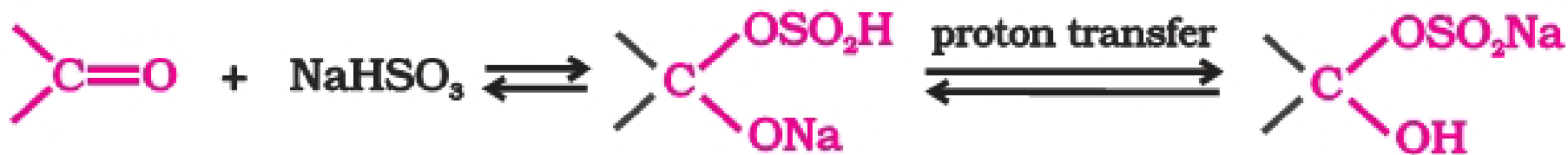
# Examples of nucleophilic addition and nucleophilic addition-elimination reactions

## (a) Addition of hydrogen cyanide (HCN):



## Examples of nucleophilic addition and nucleophilic addition-elimination reactions (contd)

### (b) Addition of sodium hydrogensulphite:

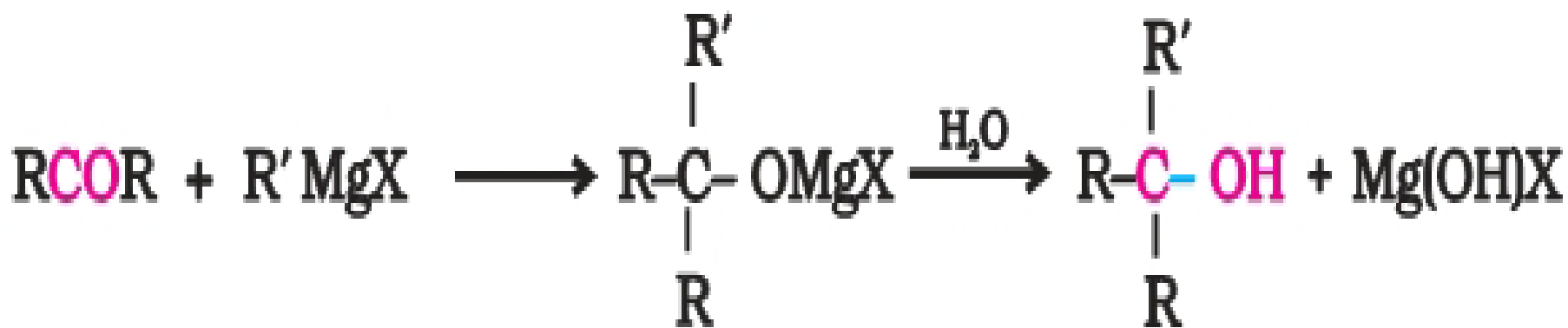


The hydrogensulphite addition compound is water soluble and can be converted back to the original carbonyl compound by treating it with dilute mineral acid or alkali.

Therefore, these are useful for separation and purification of aldehydes.

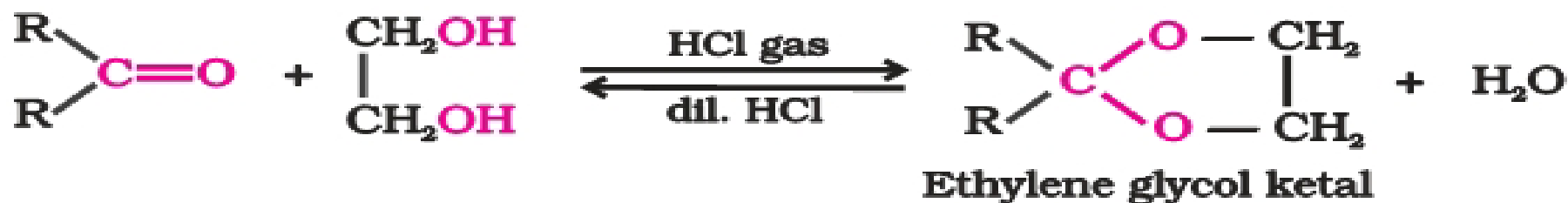
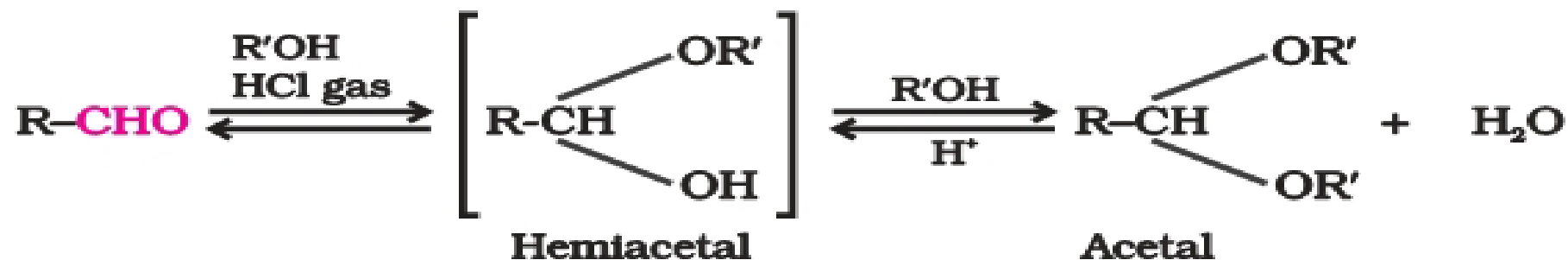
# Examples of nucleophilic addition and nucleophilic addition-elimination reactions (contd)

## (c) Addition of Grignard reagents:



# Examples of nucleophilic addition and nucleophilic addition-elimination reactions (contd)

## (d) Addition of alcohols:

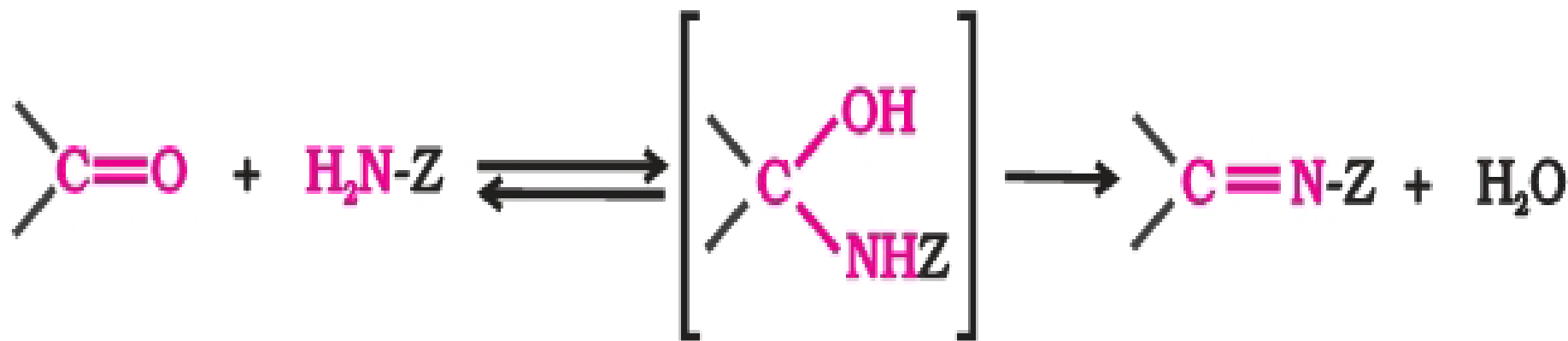


Acetals and ketals are hydrolysed with aqueous mineral acids to yield corresponding aldehydes and ketones respectively.

# Examples of nucleophilic addition and nucleophilic addition-elimination reactions

H<sup>+</sup>



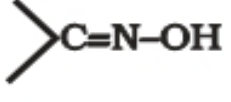
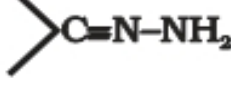
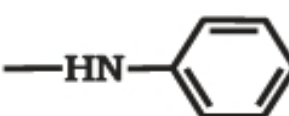
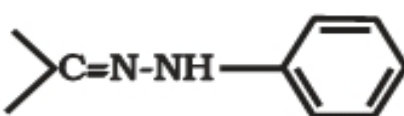
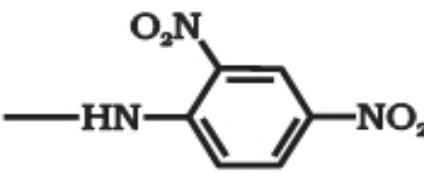
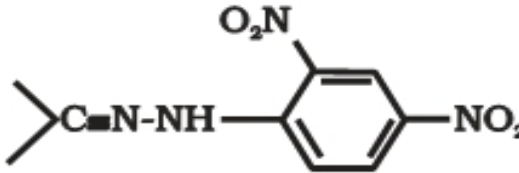
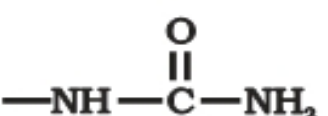
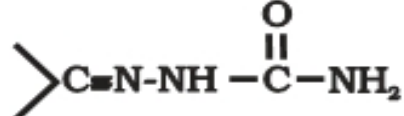
## (e) Addition of ammonia and its derivatives:



Z = Alkyl, aryl, OH, NH<sub>2</sub>, C<sub>6</sub>H<sub>5</sub>NH, NHCONH<sub>2</sub>,

# Examples of nucleophilic addition and nucleophilic addition-elimination reactions (contd)

## (e) Addition of ammonia and its derivatives: (contd)

Z	Reagent name	Carbonyl derivative	Product name
-H	Ammonia		Imine
-R	Amine		Substituted imine (Schiff's base)
-OH	Hydroxylamine		Oxime
-NH <sub>2</sub>	Hydrazine		Hydrazone
	Phenylhydrazine		Phenylhydrazone
	2,4-Dinitrophenylhydrazine		2,4 Dinitrophenylhydrazone
	Semicarbazide		Semicarbazone

# Reduction of aldehydes and ketones

## (i) Reduction to alcohols:

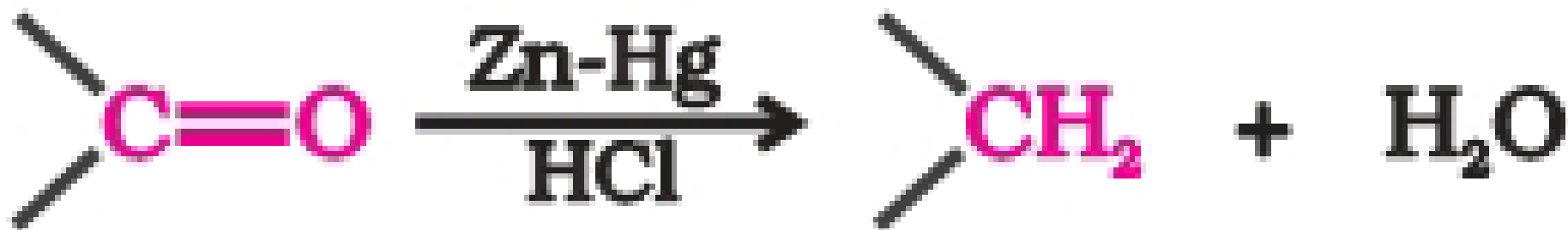




# Reduction of aldehyde and ketones

## (ii) Reduction to hydrocarbons :

### Clemmensen reduction



### Wolff-Kishner reduction



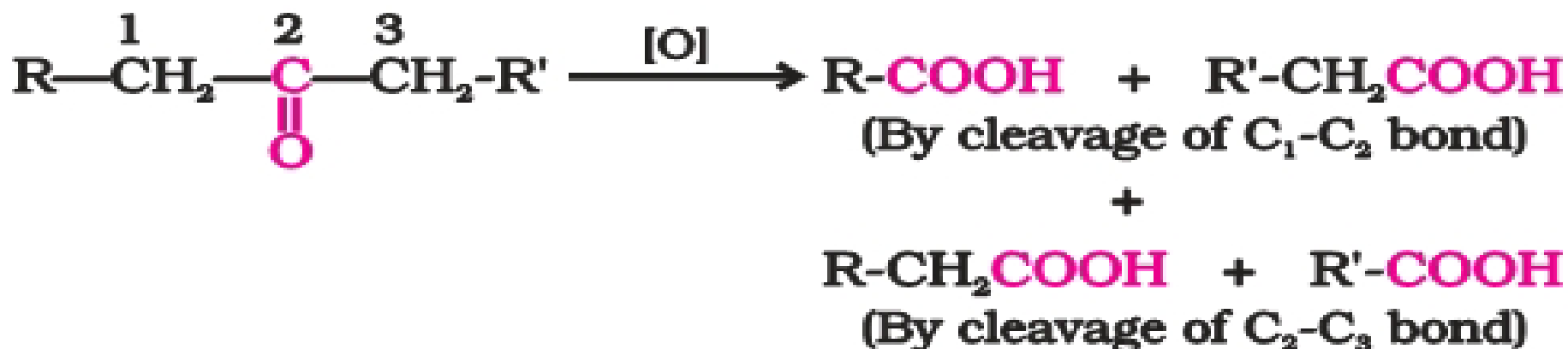
# Oxidation of aldehydes and ketones

Aldehydes are easily oxidised to carboxylic acids on treatment with common oxidising agents like nitric acid, potassium permanganate, potassium dichromate, etc.

Even mild oxidising agents, mainly Tollens' reagent and Fehlings' reagent also oxidise aldehydes.

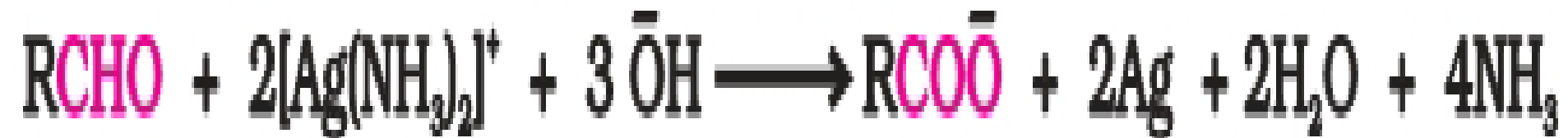


Ketones are generally oxidised under vigorous conditions, i.e., strong oxidising agents and at elevated temperatures.



# The mild oxidising agents are used to distinguish aldehydes from ketones

## (i) Tollens' test:



The mild oxidising agents are used to distinguish aldehydes from ketones

## (ii) Fehling's test:

Fehling reagent comprises of two solutions, Fehling solution A and Fehling solution B.

**Fehling solution A is aqueous copper sulphate and Fehling solution B is alkaline sodium potassium tartarate (Rochelle salt).**

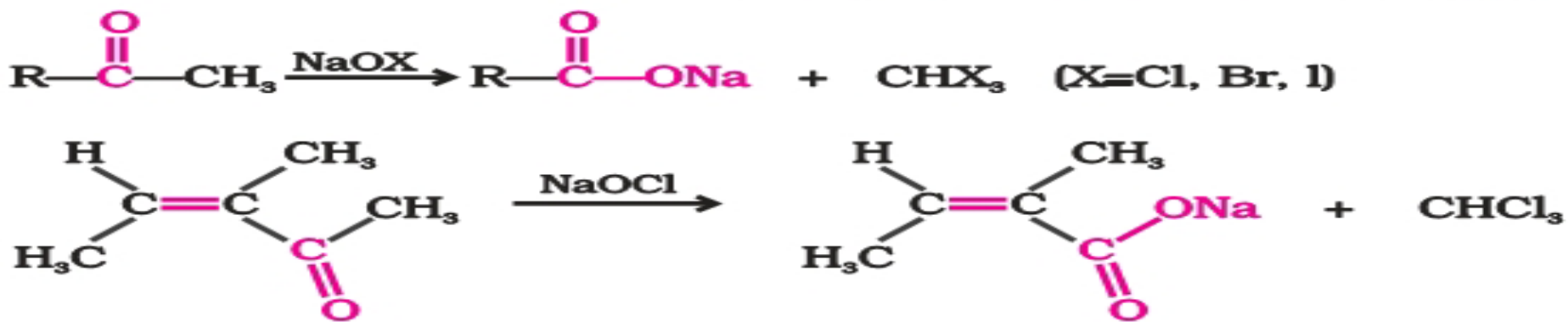


Aromatic aldehydes do not respond to this test.

The mild oxidising agents are used to distinguish aldehydes from ketones

(iii) Oxidation of methyl ketones by **haloform** reaction :

Aldehydes and ketones having at least one methyl group linked to the carbonyl carbon atom (methyl ketones) are oxidised by sodium hypohalite to sodium salts of corresponding carboxylic acids having one carbon atom less than that of carbonyl compound. The methyl group is converted to **haloform**.

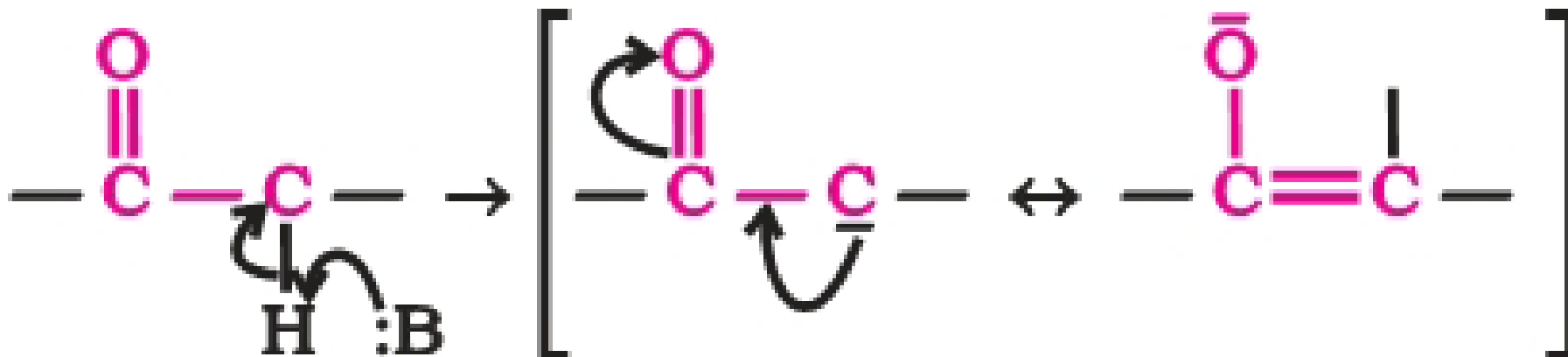


Iodoform reaction with sodium hypoiodite is also used for detection of  $\text{CH}_3\text{CO}$  group or  $\text{CH}_3\text{CH}(\text{OH})$  group which produces  $\text{CH}_3\text{CO}$  group on oxidation.

# Reactions due to $\alpha$ -hydrogen

## Acidity of $\alpha$ -hydrogens of aldehydes and ketones:

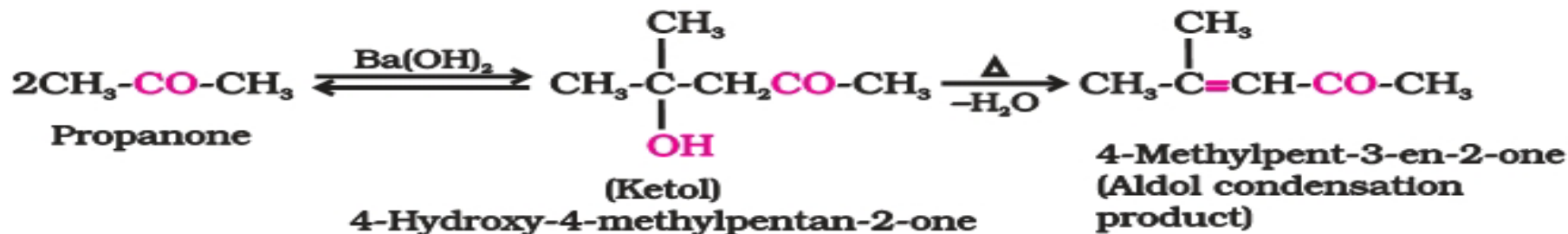
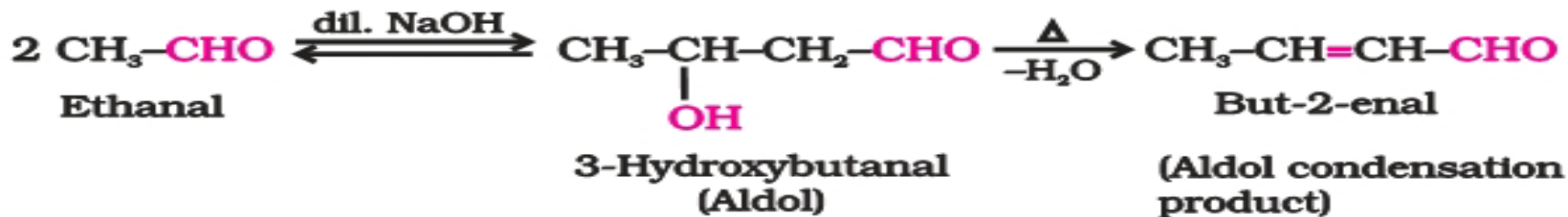
The acidity of  $\alpha$ -hydrogen atoms of carbonyl compounds is due to the strong electron withdrawing effect of the carbonyl group and resonance stabilisation of the conjugate base.



# Reactions due to $\alpha$ -hydrogen

## (i) Aldol condensation:

Aldehydes and ketones **having at least one  $\alpha$ -hydrogen** undergo a reaction in the presence of dilute alkali as catalyst to form  $\beta$ -hydroxy aldehydes (aldol) or  $\beta$ -hydroxy ketones (ketol), respectively. This is known as **Aldol reaction**.

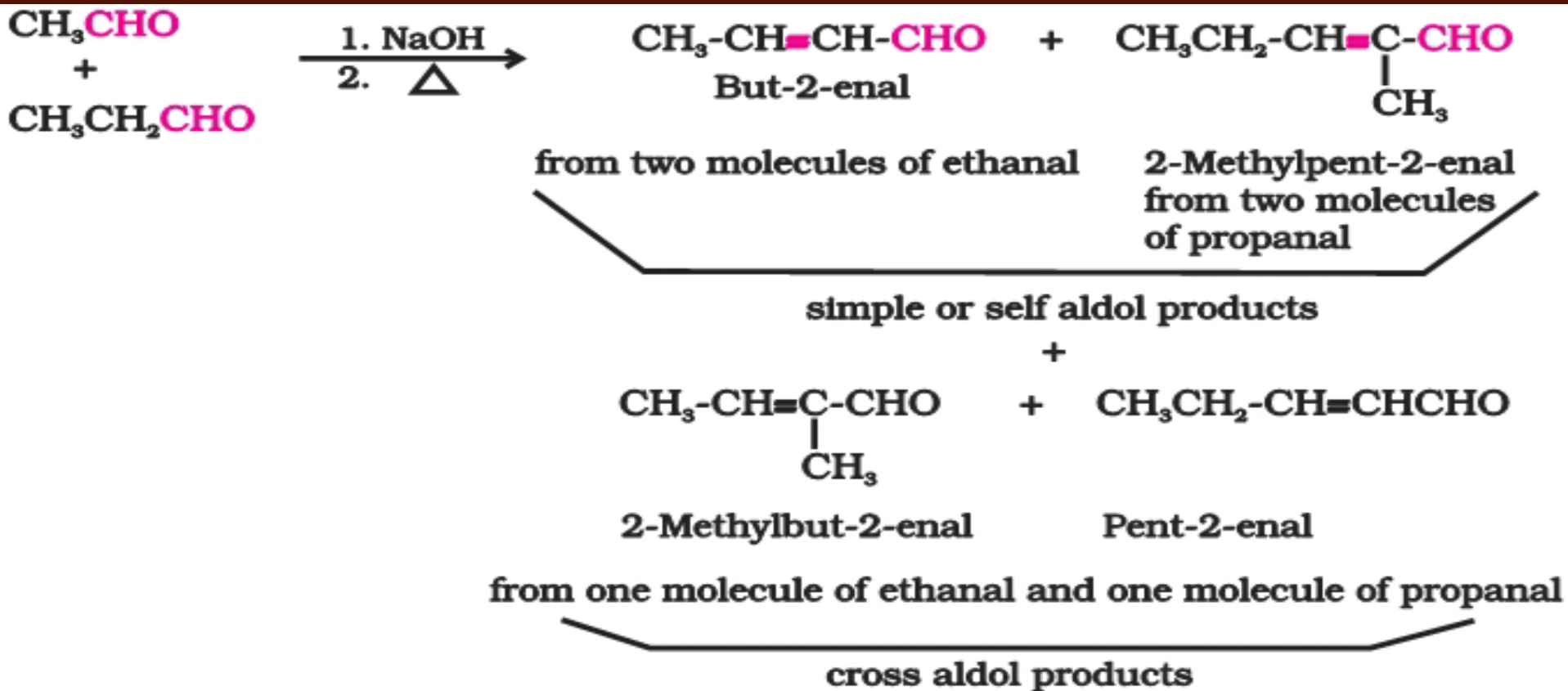


The aldol and ketol readily lose water to give  $\alpha,\beta$ -unsaturated carbonyl compounds which are aldol condensation products and the reaction is called **Aldol condensation**.

# Reactions due to $\alpha$ -hydrogen

## (ii) Cross aldol condensation:

When aldol condensation is carried out between two different aldehydes and / or ketones, it is called cross aldol condensation. If both of them contain  $\alpha$ -hydrogen atoms, it gives a mixture of four products.

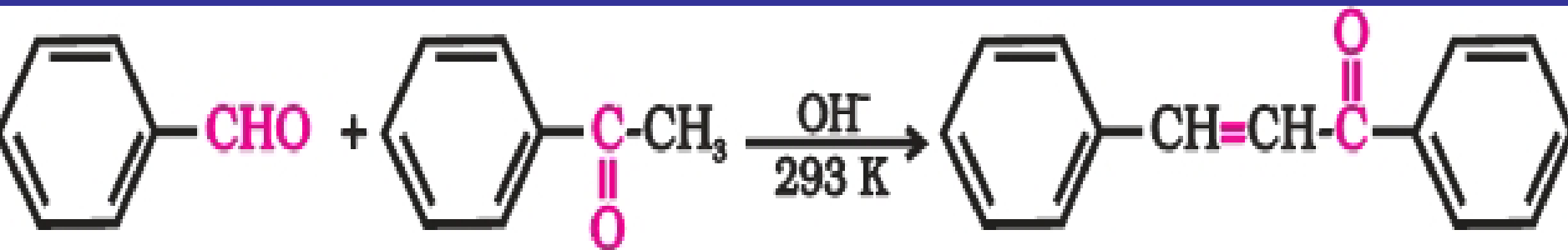




# Reactions due to $\alpha$ -hydrogen

## (ii) Cross aldol condensation: (contd)

Ketones can also be used as one component in the cross aldol reactions.



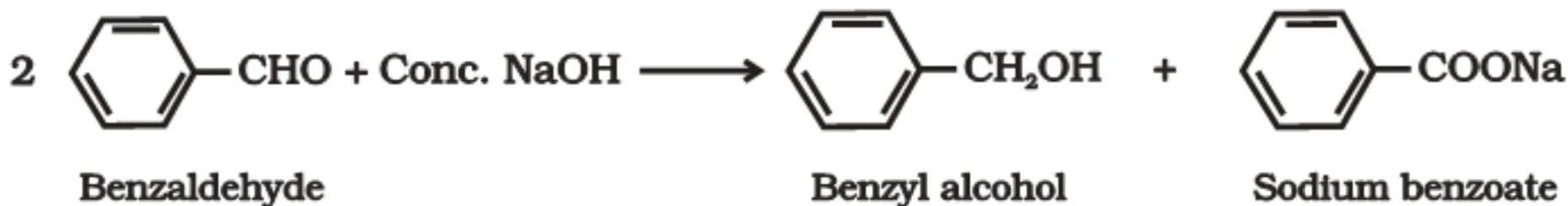
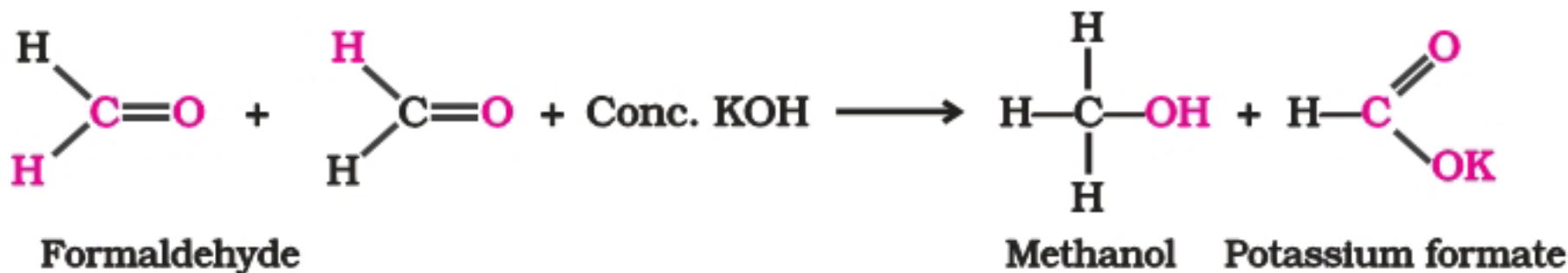
1, 3-Diphenylprop-2-en-1-one  
(Benzalacetophenone)  
(Major product)

# Other reactions

## (i) Cannizzaro reaction:

Aldehydes which **do not have an  $\alpha$ -hydrogen atom**, undergo self oxidation and reduction (disproportionation) reaction on treatment with concentrated alkali.

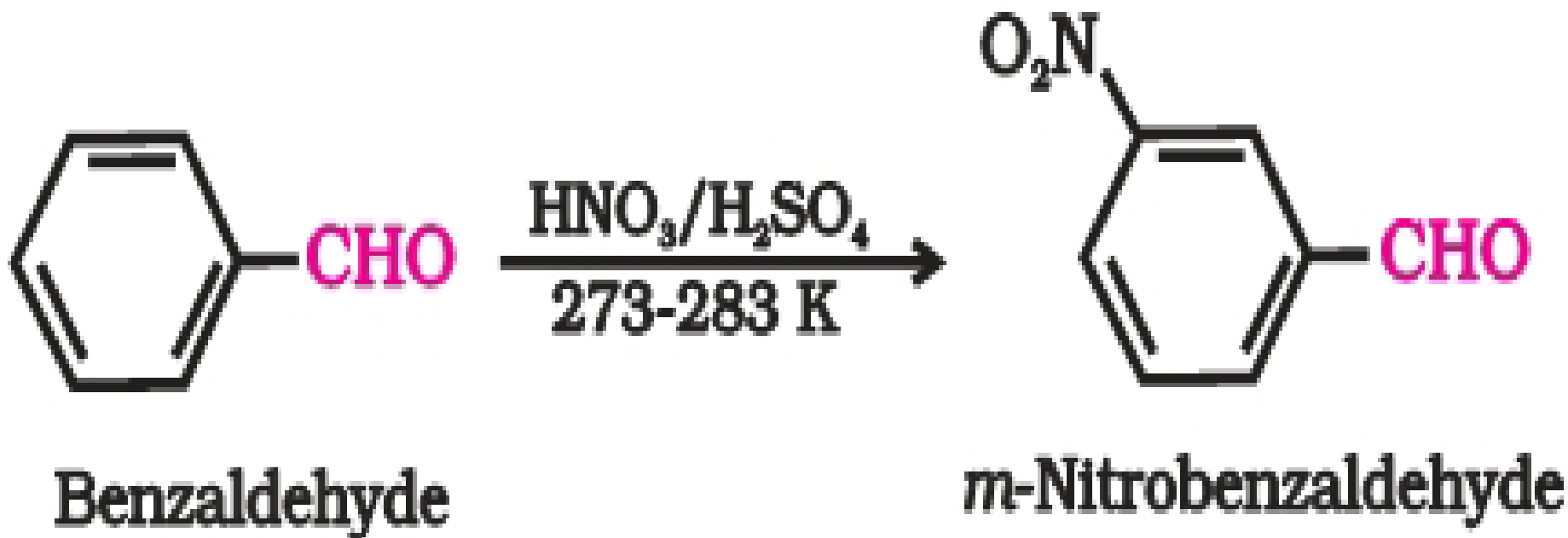
In this reaction, one molecule of the aldehyde is reduced to alcohol while another is oxidised to carboxylic acid salt.



# Other reactions

## (ii) Electrophilic substitution reaction:

Aromatic aldehydes and ketones undergo electrophilic substitution at the ring in which the carbonyl group acts as a deactivating and meta-directing group.



# Uses of aldehydes & ketones

Formaldehyde is well known as **formalin** (40%) solution used to preserve biological specimens and to prepare bakelite (a phenol-formaldehyderesin), urea-formaldehyde glues and other polymeric products.

Benzaldehyde is used in perfumery and in dye industries. Acetone and ethyl methyl ketone are common industrial solvents.

# Carboxylic Acids

Carbon compounds containing a carboxyl functional group,  $-\text{COOH}$  are called **carboxylic acids**.

The carboxyl group, consists of a carbonyl group attached to a hydroxyl group, hence its name **carboxyl**.

Carboxylic acids may be **aliphatic** ( $\text{RCOOH}$ ) or **aromatic** ( $\text{ArCOOH}$ ) depending on the group, **alkyl** or **aryl**, attached to carboxylic carbon.

Some higher members of aliphatic carboxylic acids ( $\text{C}_{12} - \text{C}_{18}$ ) known as **fatty acids**, occur in natural fats as esters of glycerol.

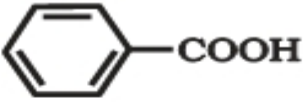
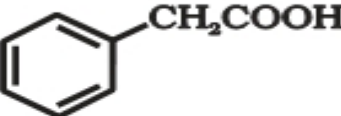
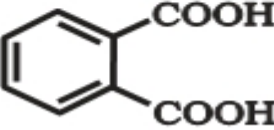
# Nomenclature of Carboxylic Acids

In the IUPAC system, aliphatic carboxylic acids are named by replacing the ending **-e** in the name of the corresponding alkane with **-oic acid**.

In numbering the carbon chain, the carboxylic carbon is numbered one.

For naming compounds containing more than one carboxyl group, the ending **-e** of the alkane is retained.

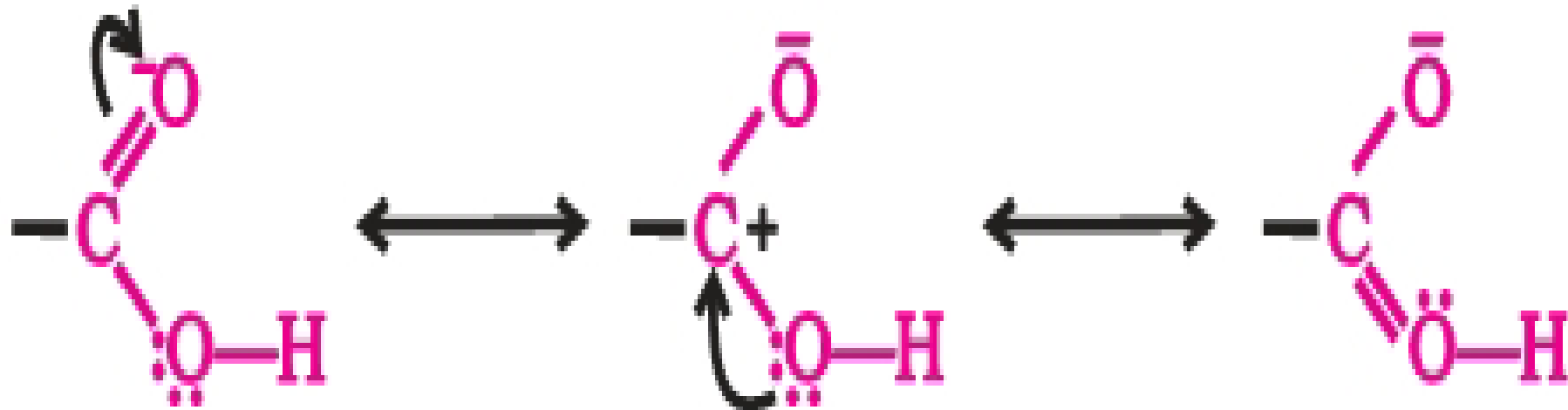
# Nomenclature of Carboxyl Group (contd)

Structure	Common name	IUPAC name
HCOOH	Formic acid	Methanoic acid
CH <sub>3</sub> COOH	Acetic acid	Ethanoic acid
CH <sub>3</sub> CH <sub>2</sub> COOH	Propionic acid	Propanoic acid
CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> COOH	Butyric acid	Butanoic acid
(CH <sub>3</sub> ) <sub>2</sub> CHCOOH	Isobutyric acid	2-Methylpropanoic acid
HOOC-COOH	Oxalic acid	Ethanedioic acid
HOOC-CH <sub>2</sub> -COOH	Malonic acid	Propanedioic acid
HOOC-(CH <sub>2</sub> ) <sub>2</sub> -COOH	Succinic acid	Butanedioic acid
HOOC-(CH <sub>2</sub> ) <sub>3</sub> -COOH	Glutaric acid	Pentanedioic acid
HOOC-(CH <sub>2</sub> ) <sub>4</sub> -COOH	Adipic acid	Hexanedioic acid
HOOC-CH <sub>2</sub> -CH(COOH)-CH <sub>2</sub> -COOH	-	Propane-1, 2, 3-tricarboxylic acid
	Benzoic acid	Benzenecarboxylic acid (Benzoic acid)
	Phenylacetic acid	2-Phenylethanoic acid
	Phthalic acid	Benzene-1, 2-dicarboxylic acid

# Structure of Carboxyl Group

In carboxylic acids, the bonds to the carboxyl carbon lie in one plane and are separated by about  $120^\circ$ .

The carboxylic carbon is less electrophilic than carbonyl carbon because of the possible resonance structure.





# Preparation of Carboxylic Acids

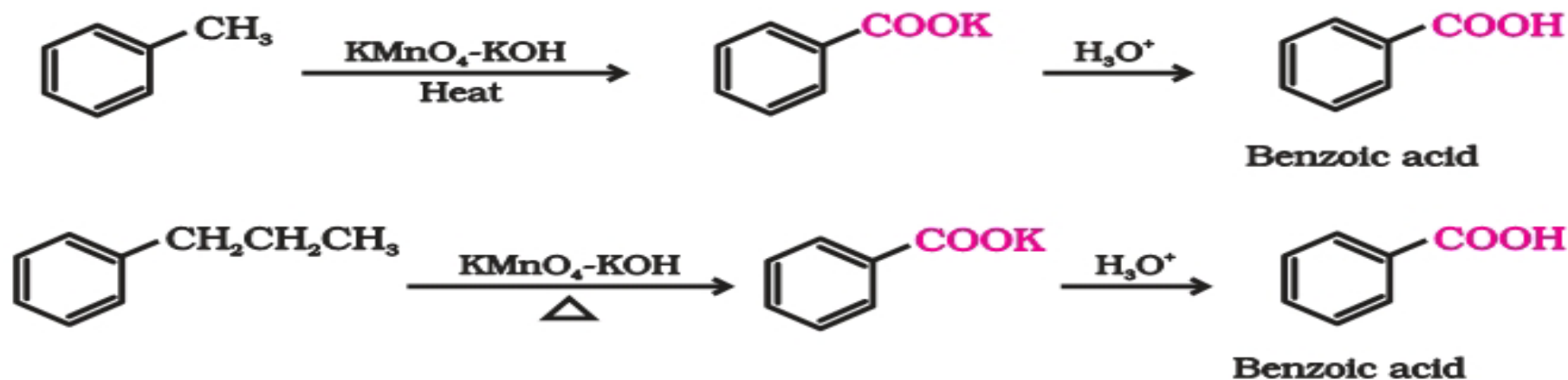
## 1. From primary alcohols and aldehydes



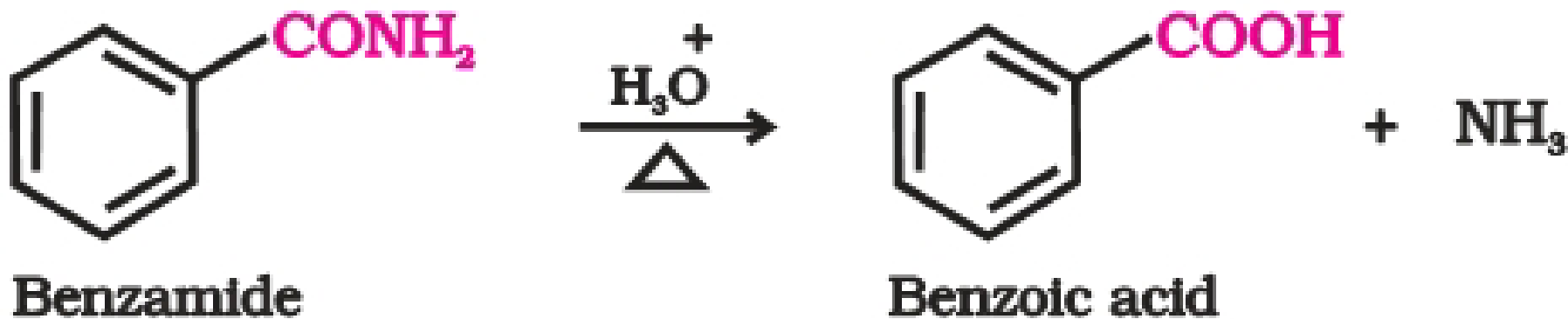
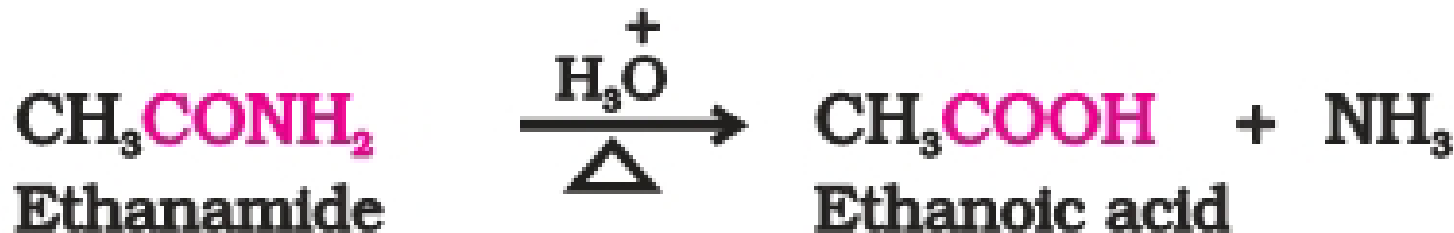
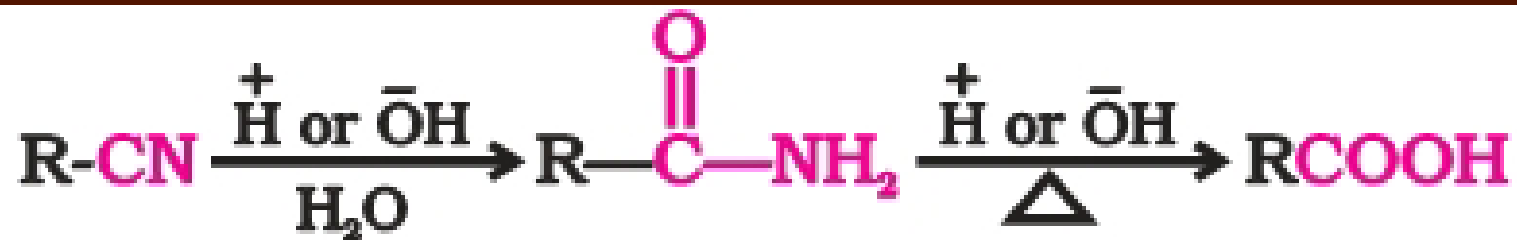
## 2. From alkylbenzenes

Aromatic carboxylic acids can be prepared by vigorous oxidation of alkyl benzenes with chromic acid or acidic or alkaline potassium permanganate.

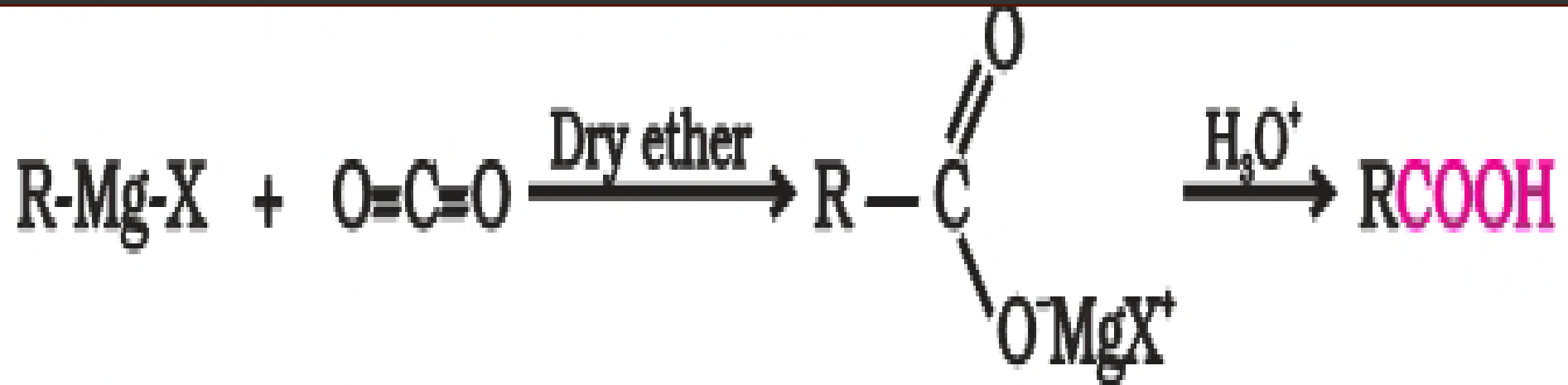
The entire side chain is oxidised to the carboxyl group irrespective of length of the side chain. Primary and secondary alkyl groups are oxidised in this manner while tertiary group is not affected.



## 3. From nitriles and amides

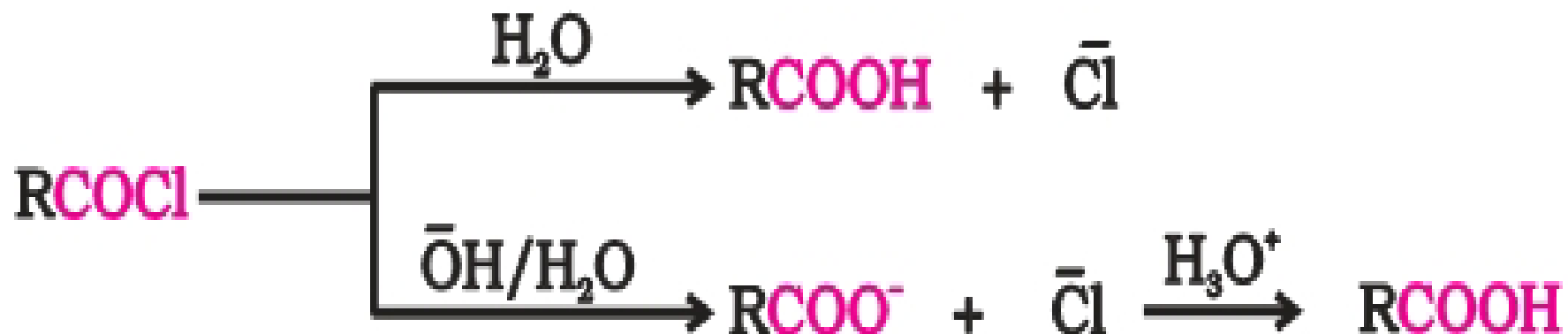


## 4. From Grignard reagents



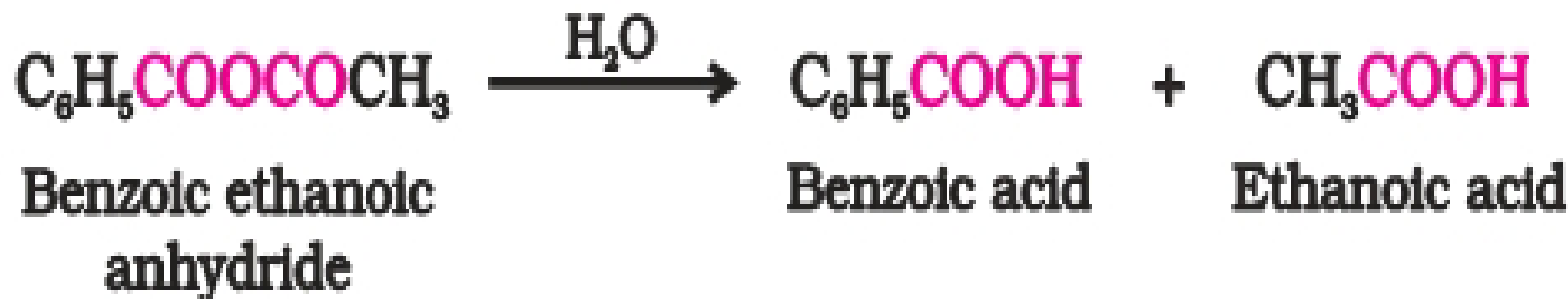
Useful for converting alkyl halides into corresponding carboxylic acids having one carbon atom more than that present in alkyl halides (ascending the series).

## 5. From acyl halides and anhydrides



Benzoic anhydride

Benzoic acid

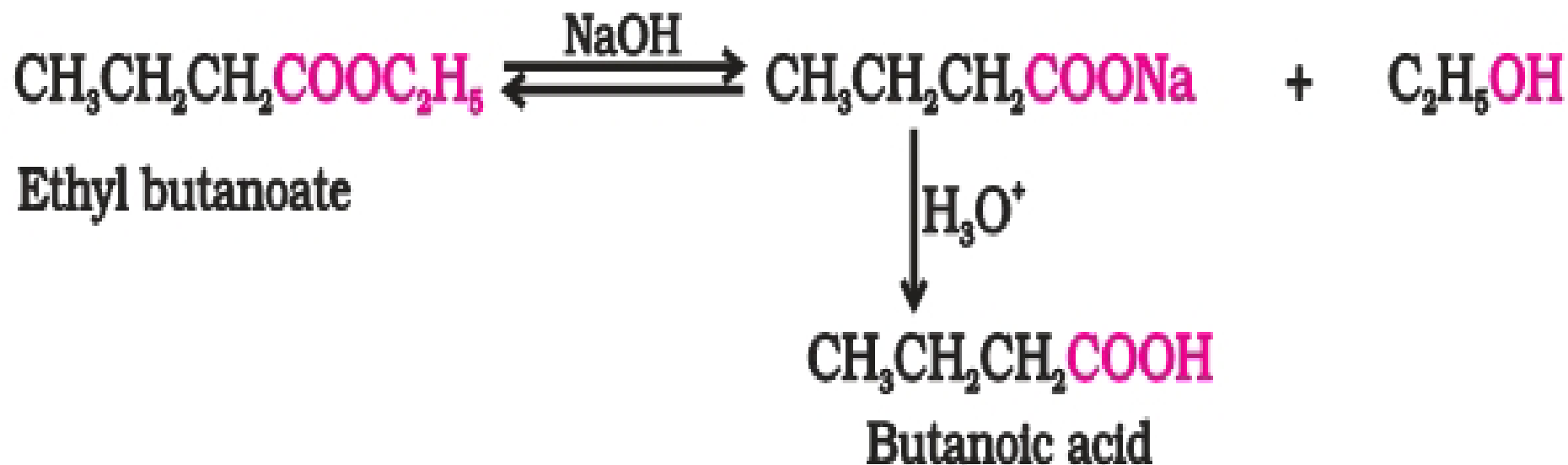
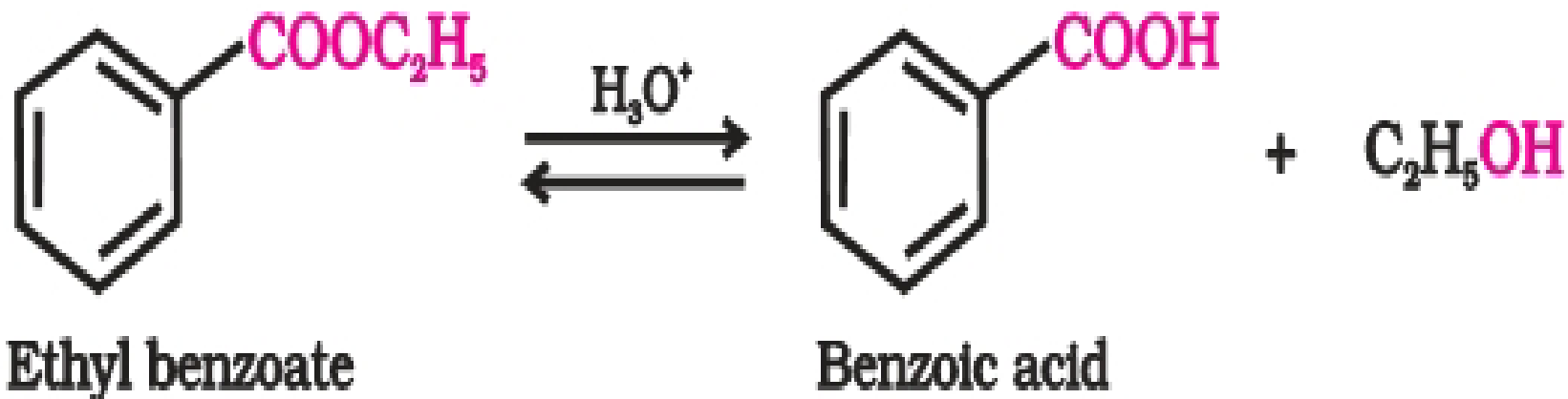


Benzoic ethanoic  
anhydride

Benzoic acid

Ethanoic acid

## 6. From esters



# Physical Properties of carboxylic acids

## Boiling Point

Carboxylic acids are higher boiling liquids than aldehydes, ketones and even alcohols of comparable molecular masses. This is due to more extensive association of carboxylic acid molecules through intermolecular hydrogen bonding.

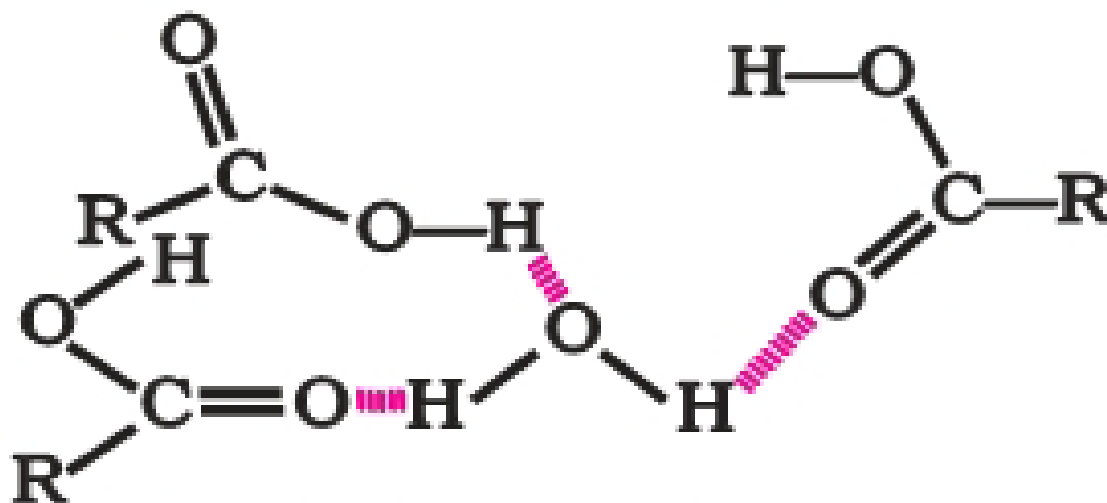


*In vapour state or in aprotic solvent*

# Physical Properties of carboxylic acid

## Solubility

Simple aliphatic carboxylic acids having upto four carbon atoms are miscible in water due to the formation of hydrogen bonds with water. **The solubility decreases with increasing number of carbon atoms** . Higher carboxylic acids are practically insoluble in water due to the increased hydrophobic interaction of hydrocarbon part.



*Hydrogen bonding of  
RCOOH with H<sub>2</sub>O*

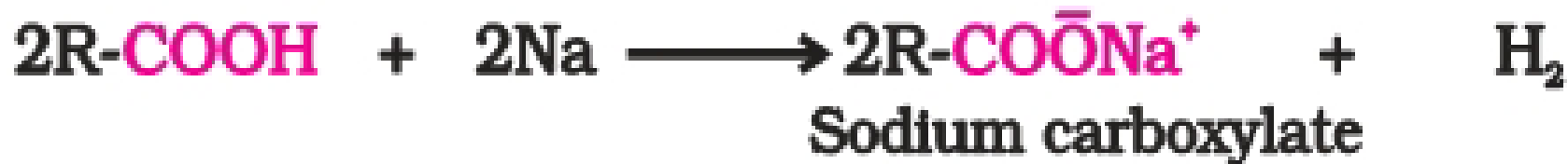


# Chemical reactions of carboxylic acid

## Reactions Involving Cleavage of O-H Bond

### Acidity

#### Reactions with metals and alkalies

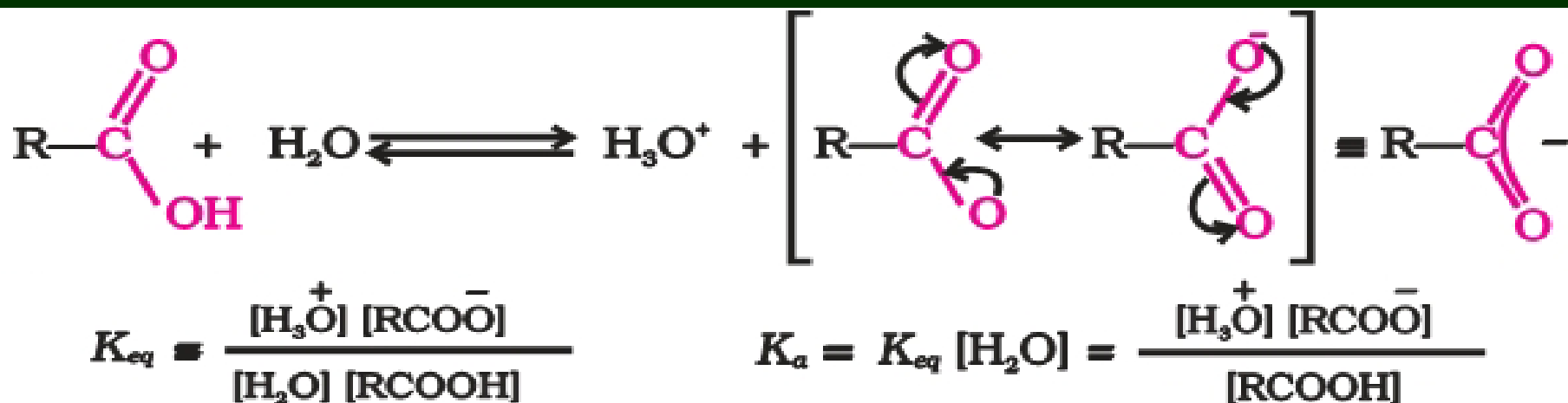


This reaction is used to detect the presence of carboxyl group in an organic compound.

# Chemical reactions of carboxylic acid

## Reactions Involving Cleavage of O-H Bond (Contd)

Carboxylic acids dissociate in water to give resonance stabilised carboxylate anions and hydronium ion.



where  $K_{\text{eq}}$  is equilibrium constant and  $K_{\text{a}}$  is the acid dissociation constant.

For convenience, the strength of an acid is generally indicated by its  $\text{p}K_{\text{a}}$  value rather than its  $K_{\text{a}}$  value.

$$\text{p}K_{\text{a}} = -\log K_{\text{a}}$$

Smaller the  $\text{p}K_{\text{a}}$ , the stronger the acid (the better it is as a proton donor). **Strong acids have  $\text{p}K_{\text{a}}$  values  $< 1$ , the acids with  $\text{p}K_{\text{a}}$  values between 1 and 5 are considered to be moderately strong acids, weak acids have  $\text{p}K_{\text{a}}$  values between 5 and 15, and extremely weak acids have  $\text{p}K_{\text{a}}$  values  $> 15$ .**

***Carboxylic acids are weaker than mineral acids, but they are stronger acids than alcohols and phenols.***

**The higher acidity of carboxylic acids as compared to phenols is due to the following reason.**

**The conjugate base of carboxylic acid, a carboxylate ion, is stabilised by two equivalent resonance structures in which the negative charge is at the more electronegative oxygen atom.**

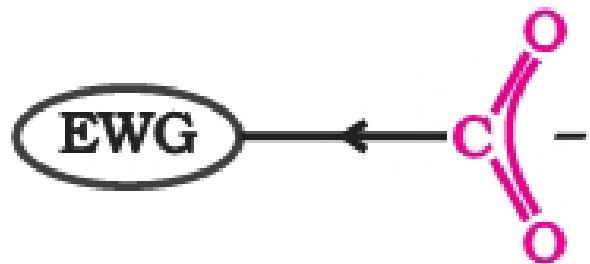
**The conjugate base of phenol, a phenoxide ion, has non-equivalent resonance structures in which the negative charge is at the less electronegative carbon atom.**

**The negative charge is delocalised over two electronegative oxygen atoms in carboxylate ion whereas it is less effectively delocalised over one oxygen atom and less electronegative carbon atoms in phenoxide ion**

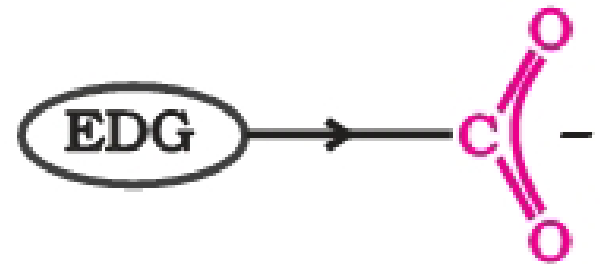
**Thus, the carboxylate ion is more stabilised than phenoxide ion, so carboxylic acids are more acidic than phenols.**

# Effect of substituents on the acidity of carboxylic acids

Electron withdrawing groups increase the acidity of carboxylic acids by stabilising the conjugate base through delocalisation of the negative charge by inductive and/or resonance effects. Conversely, electron donating groups decrease the acidity by destabilising the conjugate base.



Electron withdrawing group (EWG) stabilises the carboxylate anion and strengthens the acid



Electron donating group (EDG) destabilises the carboxylate anion and weakens the acid

# Effect of substituents on the acidity of carboxylic acids

The effect of the following groups in increasing acidity order is

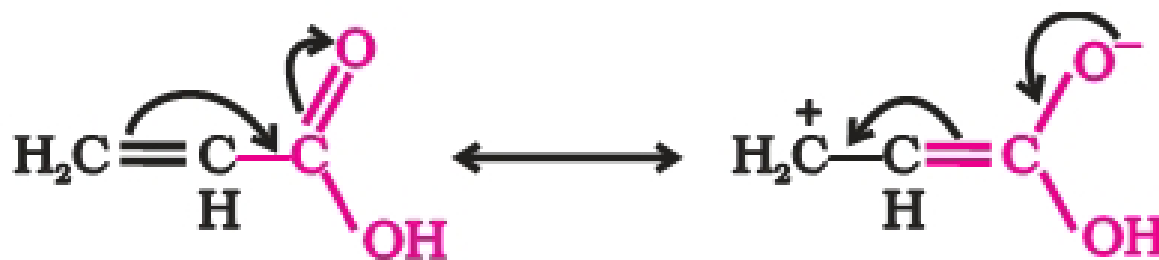


Thus, the following acids are arranged in order of decreasing acidity (based on pKa values):

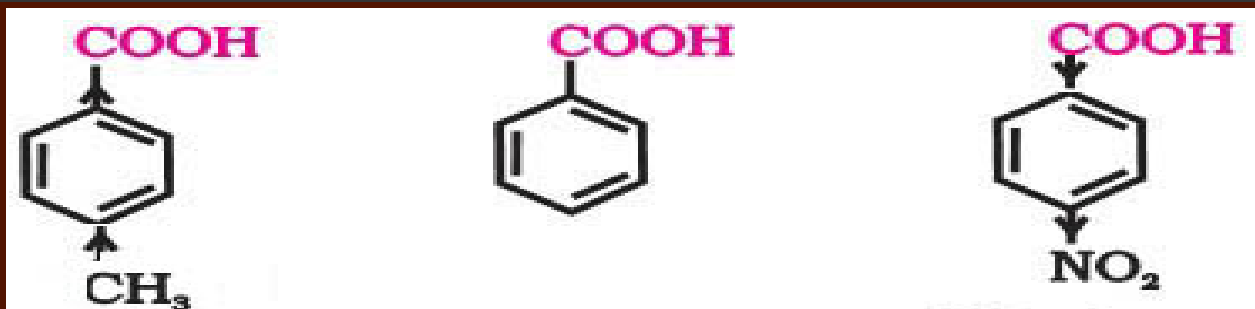


# Effect of substituents on the acidity of carboxylic acids

Direct attachment of groups such as phenyl or vinyl to the carboxylic acid, increases the acidity of corresponding carboxylic acid, contrary to the decrease expected due to resonance effect.



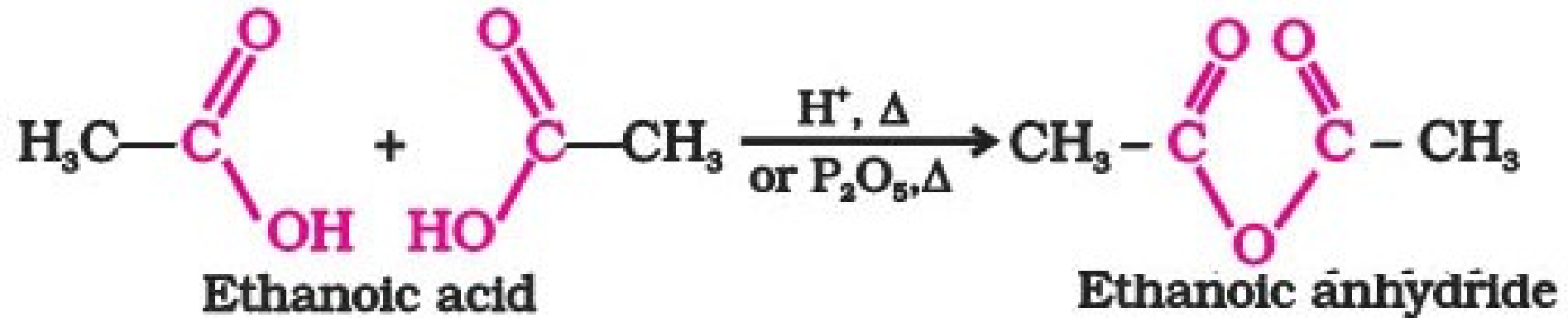
This is because of greater electronegativity of  $\text{sp}^2$  hybridised carbon to which carboxyl carbon is attached.



The presence of electron withdrawing group on the phenyl of aromatic carboxylic acid increases their acidity while electron donating groups decrease their acidity.

# Reactions involving Cleavage of C-OH bond

## 1. Formation of anhydride

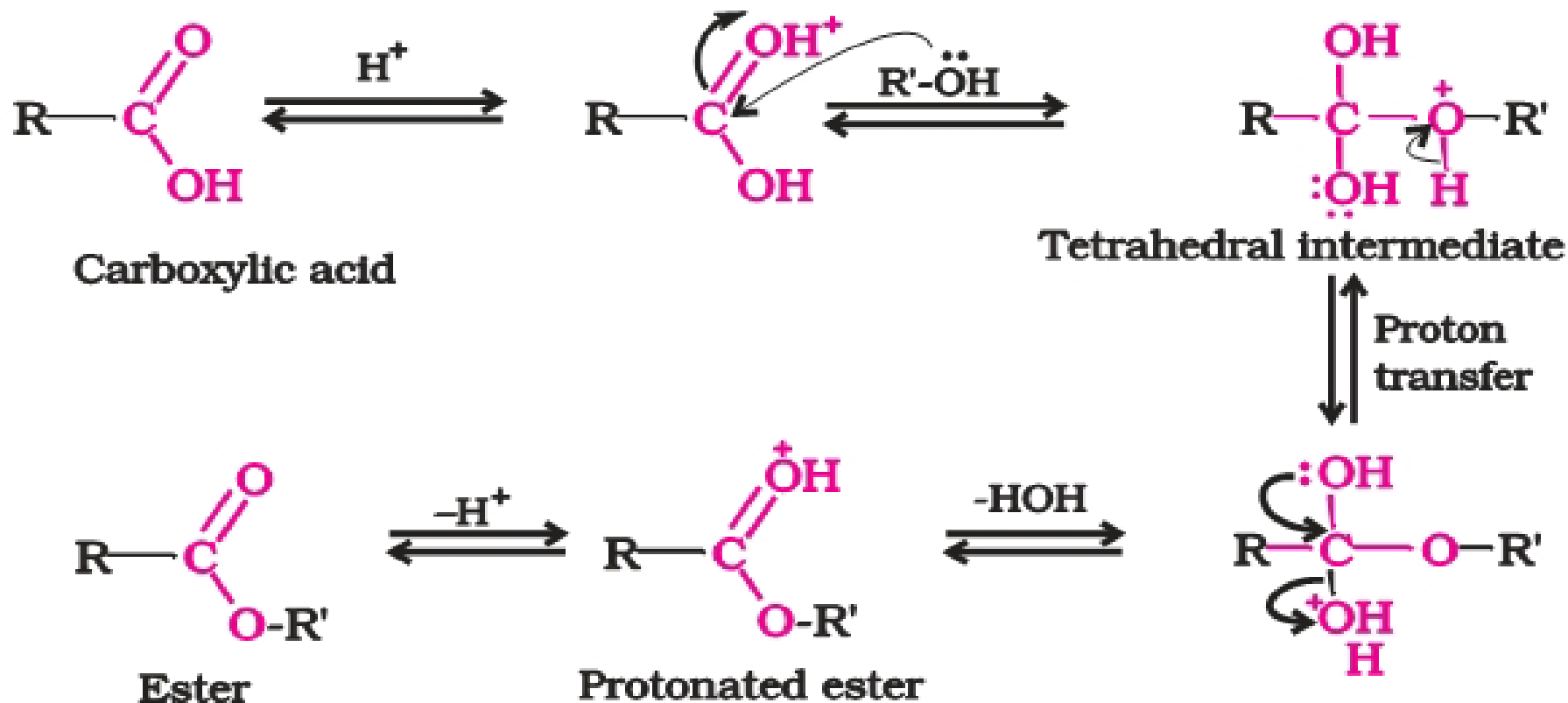


# Reactions involving Cleavage of C-OH bond (contd)

## 2. Esterification



### Mechanism of esterification of carboxylic acids:





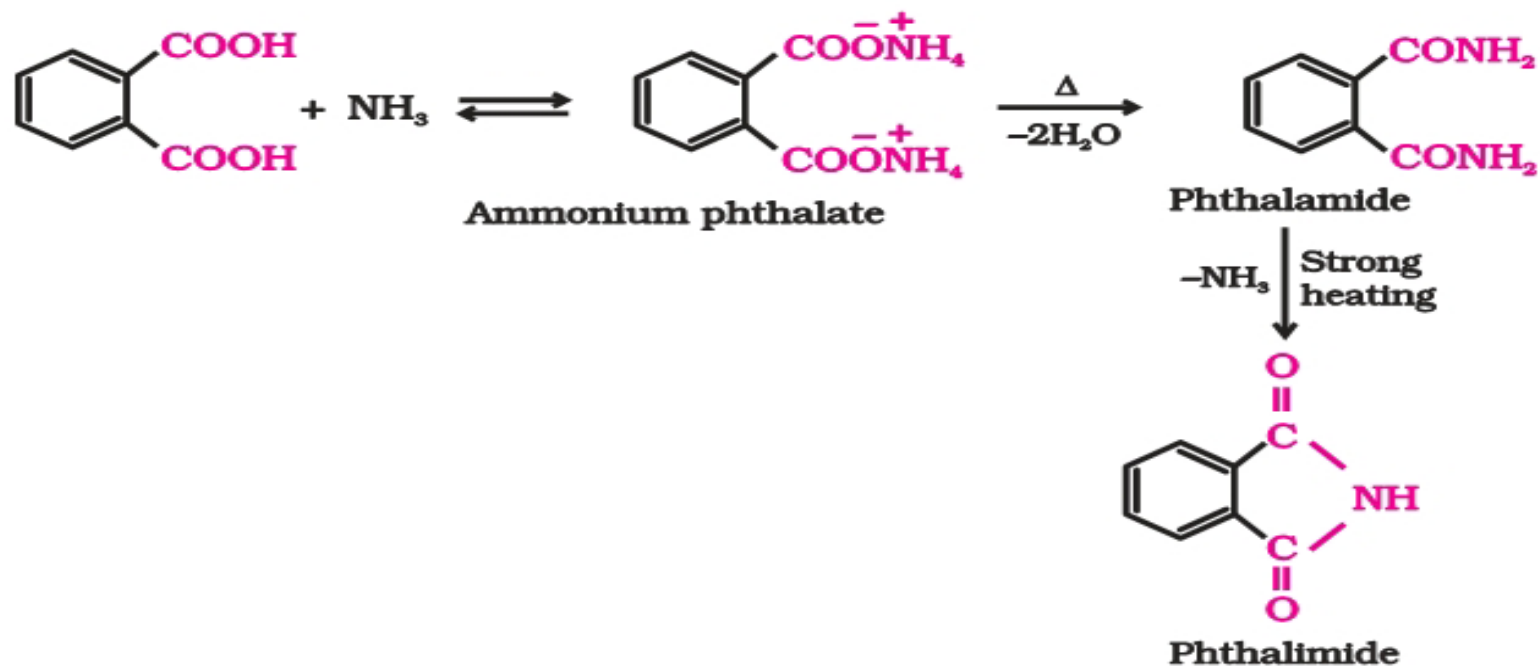
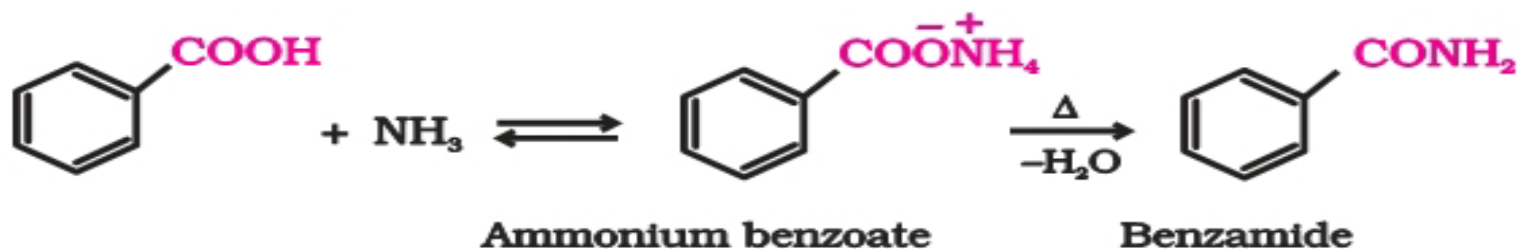
# Reactions involving Cleavage of C-OH bond (contd)

## 3. Reactions with $\text{PCl}_5$ , $\text{PCl}_3$ and $\text{SOCl}_2$



# Reactions involving Cleavage of C-OH bond (contd)

## 4. Reaction with ammonia



# Reactions Involving –COOH Group

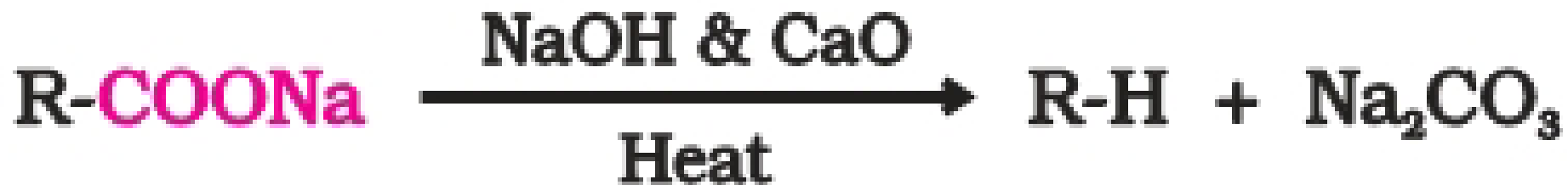
## 1. Reduction



Sodium borohydride does not reduce the carboxyl group.

# Reactions Involving –COOH Group (contd)

## 2. Decarboxylation



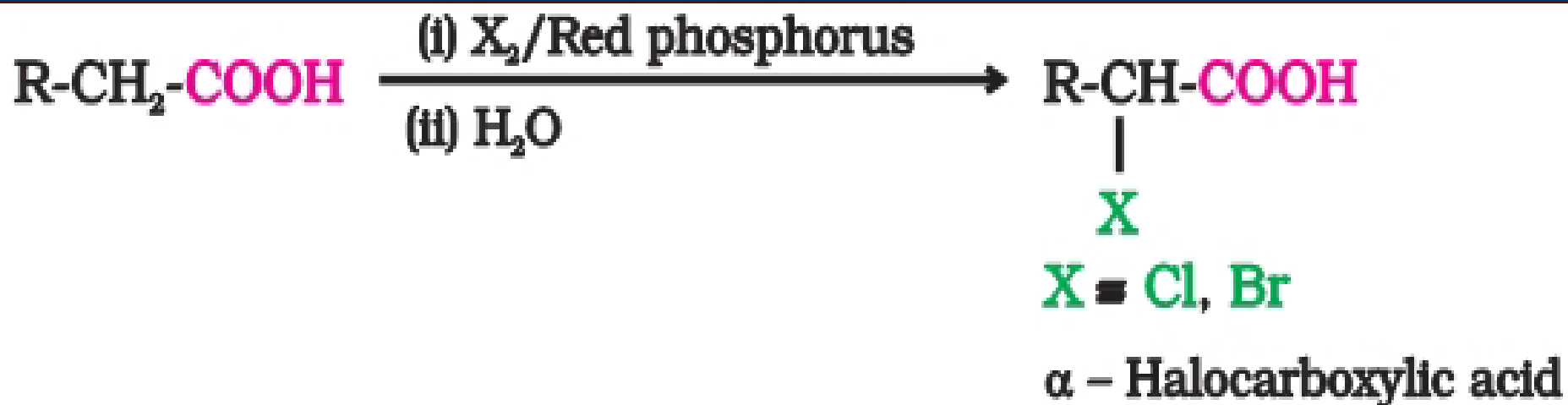
## Kolbe electrolysis

Alkali metal salts of carboxylic acids also undergo decarboxylation on electrolysis of their aqueous solutions and form hydrocarbons having twice the number of carbon atoms present in the alkyl group of the acid. The reaction is known as **Kolbe electrolysis**.

# Substitution Reactions in the Hydrocarbon Part

## 1. Halogenation (Hell-Volhard-Zelinsky reaction)

Carboxylic acids having an  $\alpha$ -hydrogen are halogenated at the  $\alpha$ -position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give  $\alpha$ -halocarboxylic acids. The reaction is known as **Hell-Volhard-Zelinsky reaction**.

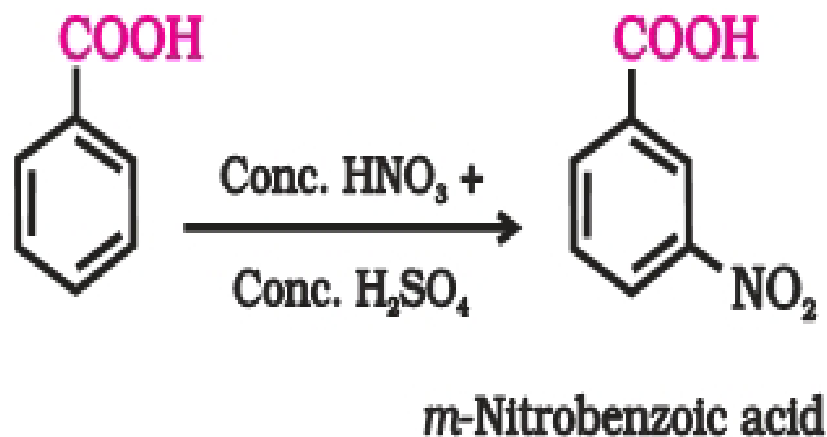


# Substitution Reactions in the Hydrocarbon Part

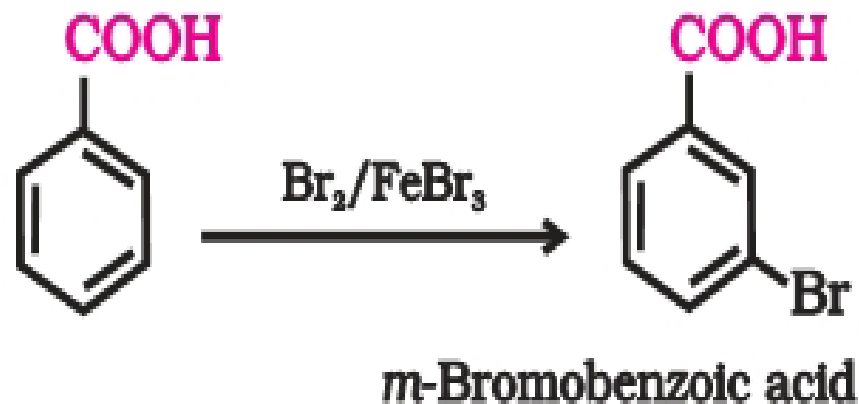
## 2. Ring substitution

Aromatic carboxylic acids undergo electrophilic substitution reactions in which the carboxyl group acts as a deactivating and meta-directing group.

### Nitration



### Halogenation



They **do not** undergo **Friedel-Crafts Reaction** because carboxyl group is deactivating and the catalyst AlCl<sub>3</sub> (Lewis acid) gets bonded to the carboxyl group.

# Uses of Carboxylic Acids

**Methanoic acid is used in rubber, textile, dyeing, leather and electroplating industries.**

**Ethanoic acid is used as solvent and as vinegar in food industry.**

**Hexanedioic acid is used in the manufacture of nylon-6, 6. Esters of benzoic acid are used in perfumery.**

**Sodium benzoate is used as a food preservative.**

**Higher fatty acids are used for the manufacture of soaps and detergents.**



Thanks