

**CBSE Class 12 Chemistry Notes Chapter 12:** The important organic molecules aldehydes, ketones, and carboxylic acids are covered in Chapter 12 of CBSE Class 12 Chemistry. Ketones have the carbonyl group ( $\text{C}=\text{O}$ ) joined to two alkyl groups, whereas aldehydes have the carbonyl group ( $\text{C}=\text{O}$ ) bonded to a hydrogen atom. A carboxyl group ( $-\text{COOH}$ ) is present in carboxylic acids.

Their structure, nomenclature, and physical characteristics, such as solubility and boiling points, are examined in this chapter. It also covers key reactions like nucleophilic addition and oxidation and preparation techniques like the oxidation of alcohols. Additionally highlighted are the uses of these chemicals in the pharmaceutical, solvent, and perfume industries.

## CBSE Class 12 Chemistry Notes Chapter 12 Overview

Aldehydes, ketones, and carboxylic acids are the three main groups of organic compounds with the carbonyl group ( $\text{C}=\text{O}$ ) that are covered in Chapter 12 of CBSE Class 12 Chemistry. Ketones have the carbonyl group connected to two alkyl or aryl groups, while aldehydes have it attached to a hydrogen atom and one of these groups. On the other hand, carboxylic acids have a carboxyl group ( $-\text{COOH}$ ) made composed of a hydroxyl and a carbonyl group.

The chapter explores these compounds' structure and nomenclature, outlining IUPAC and accepted naming practices. It looks at the physical characteristics that come from being polar, like boiling temperatures, solubility, and dipole moments. Oxidation of alcohols and ozonolysis of alkenes are important procedures for preparing aldehydes and ketones, whereas carboxylic acids are frequently made by oxidising aldehydes and primary alcohols.

Among the reactions discussed are decarboxylation, esterification, and reactions with bases, as well as nucleophilic addition in aldehydes and ketones. A thorough discussion of these compounds' chemical reactivity is included, highlighting their industrial importance in the manufacturing of solvents, fragrances, dyes, and medications.

## CBSE Class 12 Chemistry Notes Chapter 12 Aldehydes, Ketones and Carboxylic Acids

Here we have provided CBSE Class 12 Chemistry Notes Chapter 12 Aldehydes, Ketones and Carboxylic Acids -

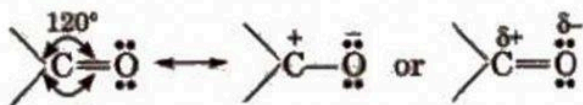
The carbonyl group ( $\text{C}=\text{O}$ ) is bound to two carbon atoms in ketones and to carbon and hydrogen in aldehydes.

**Haloform reaction** - When sodium hypohalite is added to aldehydes and ketones with at least one methyl group [ $3-\alpha$  hydrogen] attached to the carbonyl carbon atom, it oxidises the

compounds to sodium salts of the corresponding carboxylic acids, which have one carbon atom less than the carbonyl compound. Haloform is produced by converting the methyl group.

### Nature of Carbonyl Group

The carbon and oxygen of the carbonyl group are  $sp^2$  hybridised and the carbonyl double bond contains one  $\sigma$ -bond and one  $\pi$ -bond.



The electronegativity of oxygen is much higher than that of the carbon, so there electron cloud is shifted towards the oxygen. Therefore, C-O bond is polar in nature.

### Nomenclature

Nomenclature in organic chemistry refers to the systematic naming of compounds based on their structure, following the rules established by the International Union of Pure and Applied Chemistry (IUPAC).

(i) **Nomenclature of aldehydes** In IUPAC system, the suffix “e” of alkane is replaced by the suffix “al”. e.g.,

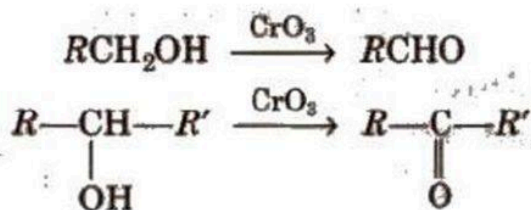
Compound	Common name	IUPAC name
HCHO	Formaldehyde	Methanal
CH <sub>3</sub> CHO	Acetaldehyde	Ethanal

(ii) **Nomenclature of ketones** In IUPAC system, the suffix “e” of alkane is replaced by “one”. e.g.,

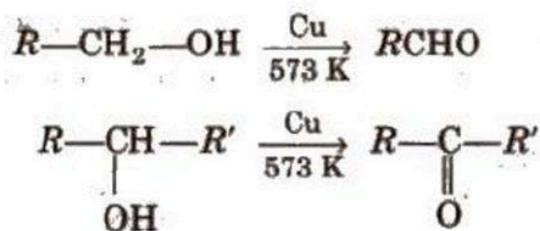
Compound	Common name	IUPAC name
H <sub>3</sub> C · COCH <sub>3</sub>	Dimethyl ketone (acetone)	Propanone
H <sub>3</sub> C · COC <sub>2</sub> H <sub>5</sub>	Ethyl methyl ketone	Butanone

### Preparation of Aldehydes and Ketones

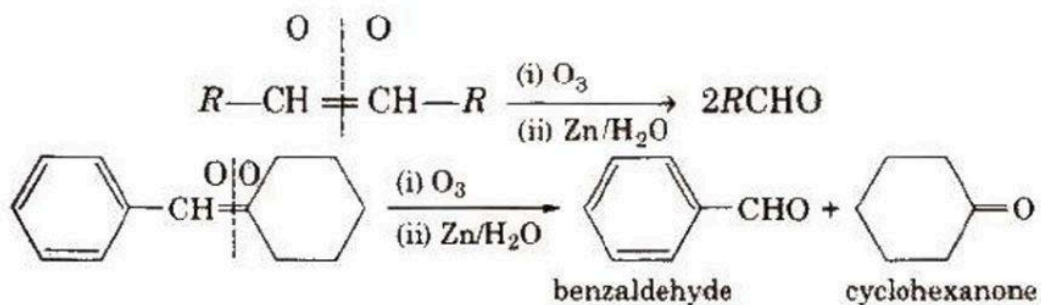
i) By alcohols oxidising Typically, primary and secondary alcohols are oxidised to produce aldehydes and ketones, respectively.



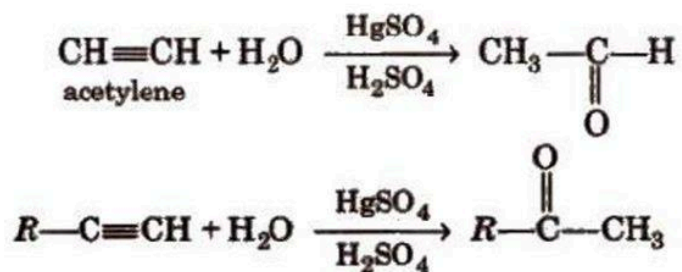
(ii) **By dehydrogenation of alcohols** In this method, alcohol vapours are passed over heavy metal catalysts (Ag or Cu). Primary and secondary alcohols give aldehydes and ketones.



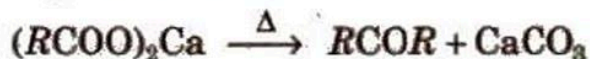
**By ozonolysis of alkenes**



(iv) **By hydration of alkynes** Acetylene on hydration gives acetaldehyde and other alkynes on hydration give ketones.



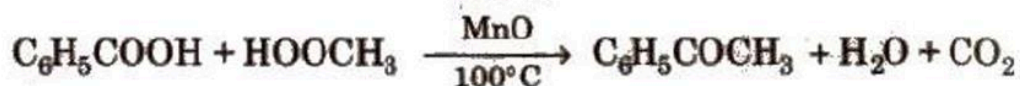
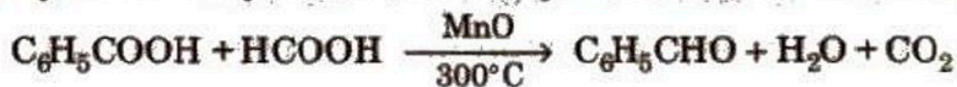
(v) **By heating Ca salt of acid**



To obtain aldehyde, calcium formate and any other Ca salt of acid are heated.

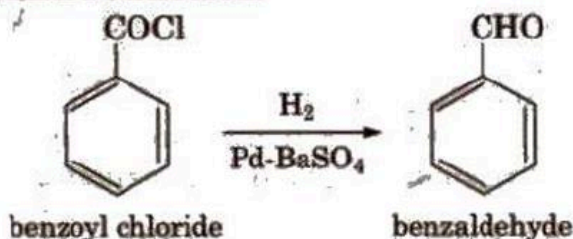


(vi) **By decarboxylation and dehydration of aromatic acids**



**Preparation of Aldehydes**

(i) **Rosenmund reduction**



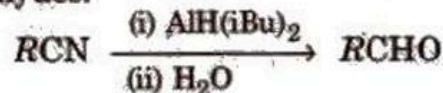
Formaldehyde cannot be prepared by this method as  $HCOCl$  is highly unstable.

(ii) **From nitriles**

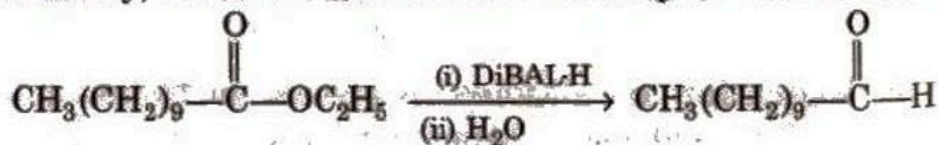


This reaction is called **Stephen reaction**.

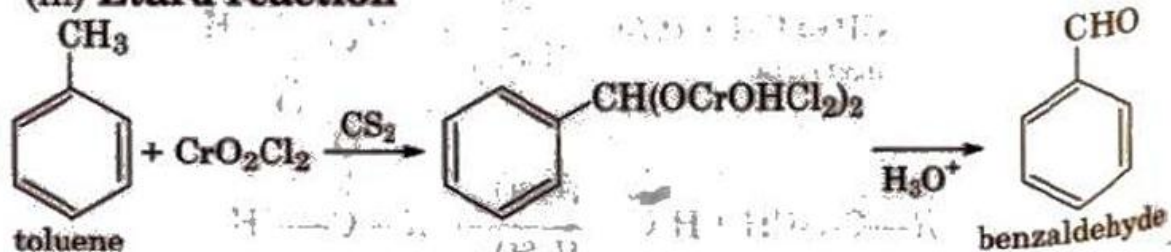
Alternatively, nitriles are selectively reduced by diisobutylaluminium hydride,  $[DiBAL-H]$  to imines which on hydrolysis give aldehydes.



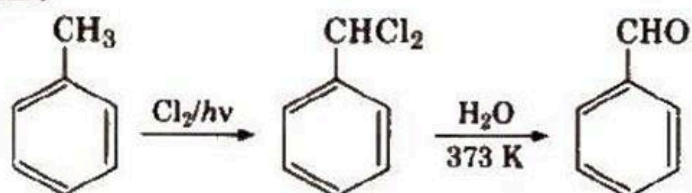
Similarly, esters can also be reduced to aldehydes with  $DiBAL-H$ .



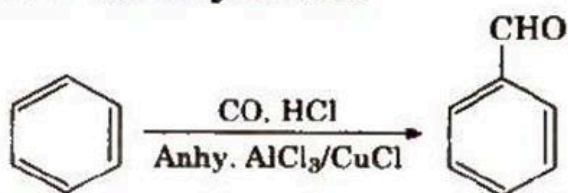
**(iii) Etard reaction**



**(iv) Side chain halogenation followed by hydrolysis of toluene**



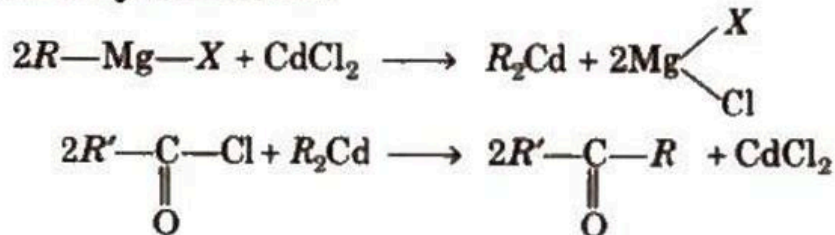
**(v) Gattermann-Koch synthesis**



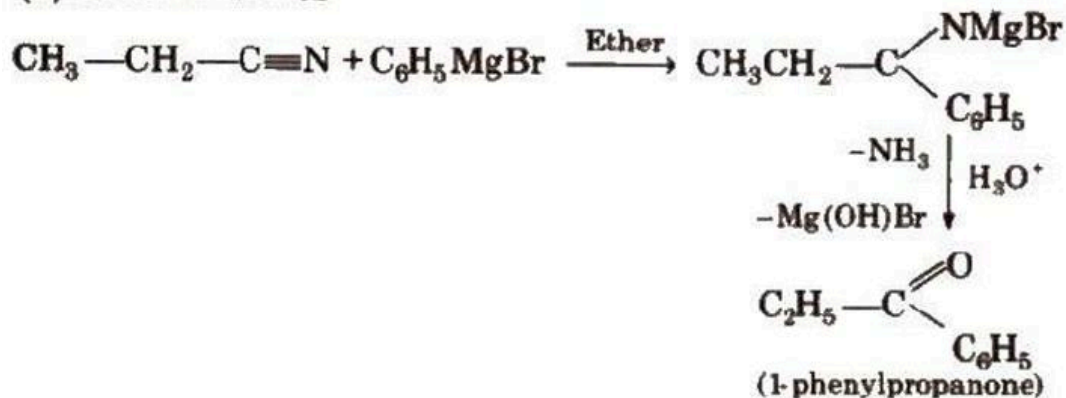
**Preparation of Ketones**



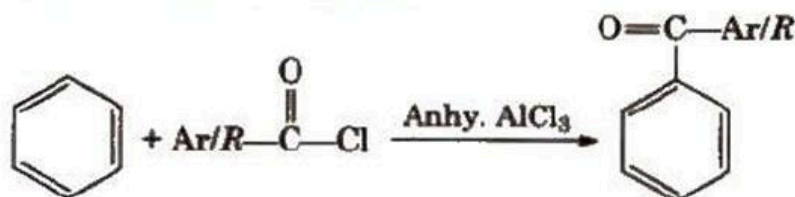
**(i) From acyl chlorides**



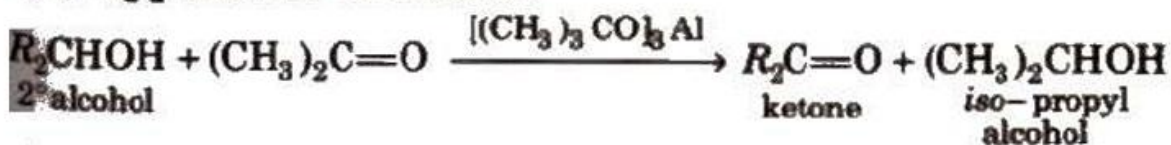
**(ii) From nitriles**



**(iii) Friedel-Crafts acylation**



**(iv) Oppenauer oxidation**



## Physical Properties of Aldehydes and Ketones

1. It is a gas at room temperature, methanal (HCHO). and formalin is the name given to its 40% aqueous solution. It works as a reducing agent to remove colour from vat dyes and silver mirrors.
2. The liquid ethanol (CH<sub>3</sub>CHO) is volatile. At room temperature, other aldehydes and ketones are either liquid or solid.
3. Because of the strong dipole-dipole interactions, aldehydes and ketones have higher boiling

points than ethers and hydrocarbons with similar molecular masses.

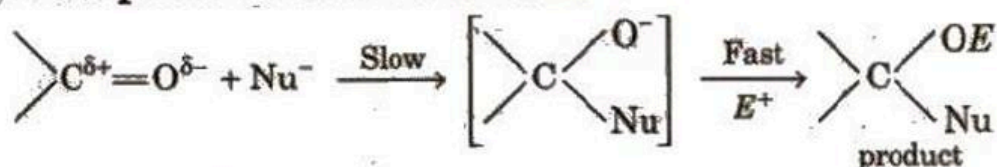
4. The boiling points of aldehydes and ketones are lower than those of alcohols with comparable molecular masses because there are no hydrogen bonds between the molecules.

5. Because a hydrogen bond forms with water, the lower members of aldehydes and ketones are miscible with it. However, as the alkyl chain lengthens, the solubility diminishes.

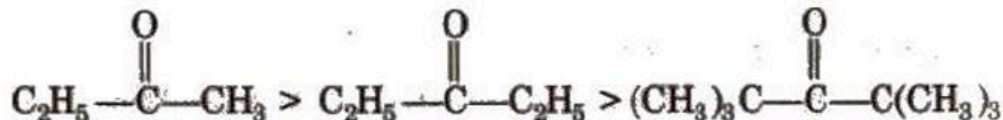
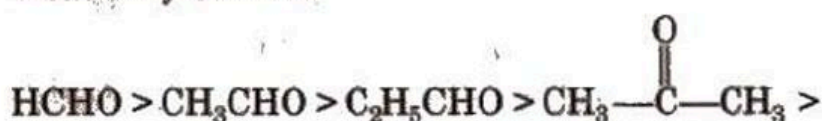
6. Acetophenone is a hypnotic (drug that induces sleep), so it is marketed as hyponine in medicine.

## Chemical Reactions of Aldehydes and Ketones

### (i) Nucleophilic addition reactions



Reactivity order is

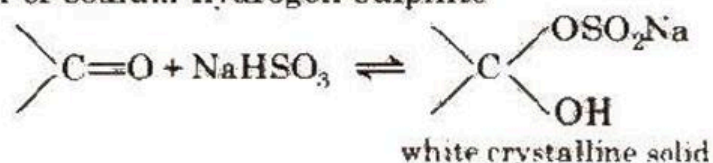


It is due to +I effect of alkyl groups which decreases the positive charge on carbonyl carbon and steric hinderance (The bulky alkyl group hinder the approach of nucleophile).

Addition of hydrogen cyanide

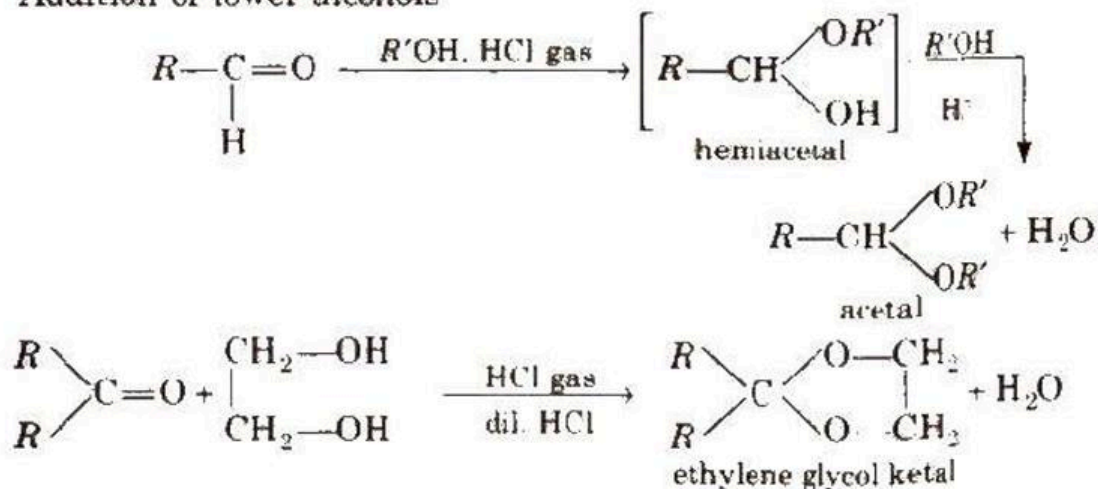


Addition of sodium hydrogen sulphite



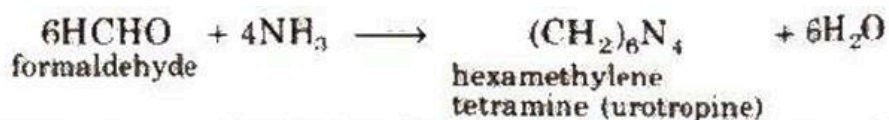
This reaction is used for the separation and purification of aldehydes and ketones. This is because the addition compound formed, is water soluble and can be converted back to the original carbonyl compound by treating with dilute mineral acid or alkali.

Addition of lower alcohols

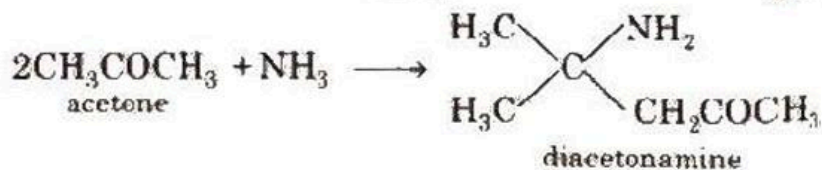
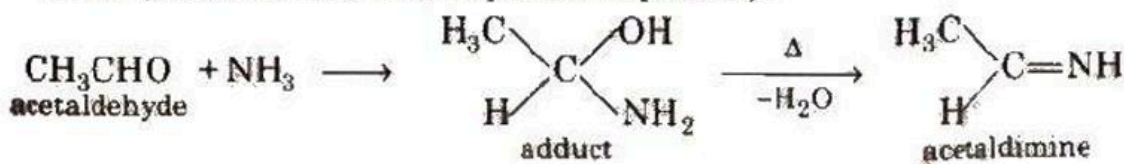


(ii) **Addition of ammonia and its derivatives** Reaction with ammonia

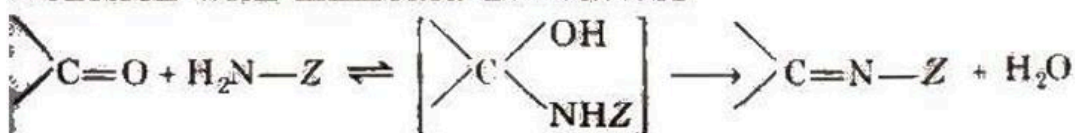




Urotropine on controlled nitration gives the well known explosive RDX (Research and Development explosive).

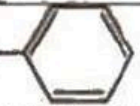

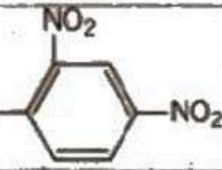
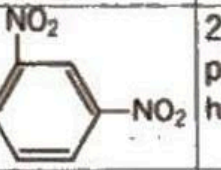
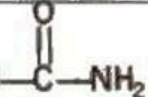
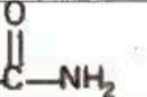


### Reaction with ammonia derivatives



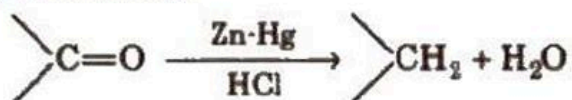
where, Z = alkyl, aryl, —OH, —NH<sub>2</sub>, —C<sub>6</sub>H<sub>5</sub>NH, —NHCONH<sub>2</sub> etc.

### Some N-substituted Derivatives of Aldehydes and Ketones

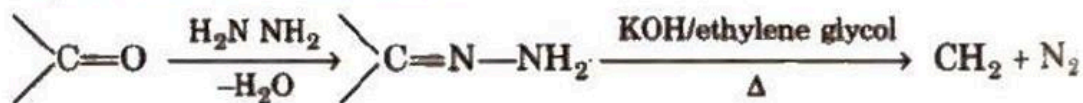
Z	Reagent name	Carbonyl derivative	Product name
—R	Amine	$\text{>C=N—R}$	Substituted imine (Schiff's base)
—OH	Hydroxyl amine	$\text{>C=N—OH}$	oxime
—NH <sub>2</sub>	Hydrazine	$\text{>C=N—NH}_2$	Hydrazone
—NH— 	Phenyl-hydrazine	$\text{>C=N—NH—}$ 	Phenylhydrazone
—NH— 	2,4-dinitro-phenyl hydrazine	$\text{>C=N—NH—}$ 	2,4-dinitro-phenyl hydrazone
—NH— 	Semi-carbazide	$\text{>C=N—NH—}$ 	Semi-carbazone

(iii) **Reduction** Aldehydes and ketones are reduced to primary and secondary alcohols respectively by sodium borohydride ( $\text{NaBH}_4$ ) or lithium aluminium hydride [ $\text{LiAlH}_4$ ].

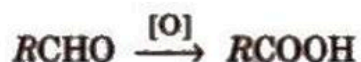
#### Clemmensen reduction



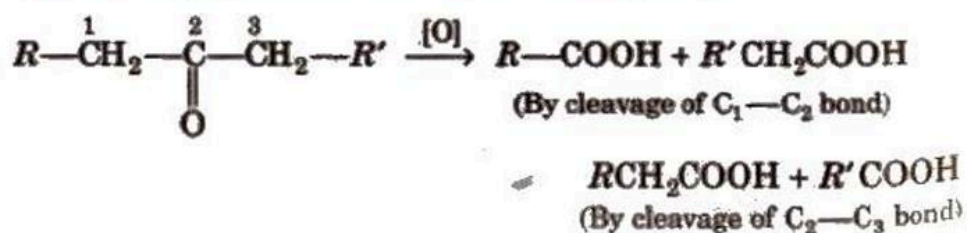
#### Wolff-Kishner reduction



(iv) **Oxidation** Aldehydes get easily oxidised to carboxylic acids by  $\text{HNO}_3$ ,  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$ , etc., or even by mild oxidising agent.

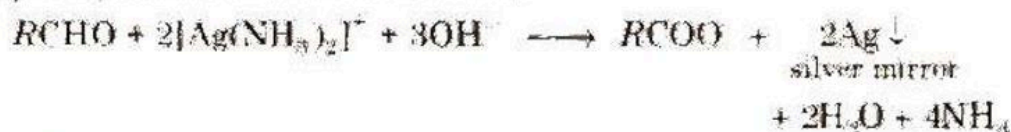


Ketones are generally oxidised under vigorous conditions, i.e., strong oxidising agents and at elevated temperature.



During oxidation of unsymmetrical ketones the point of cleavage is such that keto group stays preferentially with the smaller alkyl group (Popoff's rule).

(a) **Tollen's test** Aldehydes give bright silver mirror with Tollen's reagent (ammoniacal silver nitrate).



(b) **Fehling's test** Fehling solution gives a reddish brown precipitate with aldehydes (except benzaldehyde).



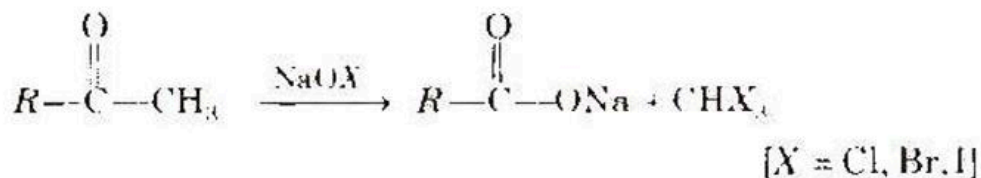
Fehling solution is made up of a 1:1 mixture of Fehling solutions A and B.

Aqueous copper sulphate is Fehling solution A, while alkaline sodium potassium tartrate, sometimes known as Rochelle salt, is Fehling solution B.

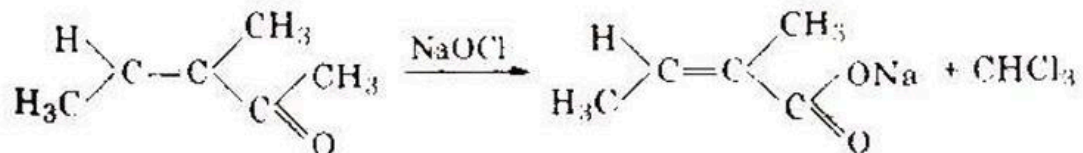
(c) **Benedict's resolution** It also produces red ppt. of Cu<sub>2</sub>O in aldehydes, with the exception of benzaldehyde.

**Schiff's reagent** - This is an aqueous solution of magenta or pink-colored rosaniline hydrochloride that has been decolorized by passing SO<sub>2</sub>. Ketones do not react with this reagent.

to produce a pink hue, but aldehydes do.



This oxidation does not affect a carbon-carbon double bond, if present in the molecule.



Iodoform reaction with sodium hypiodite is also used for the detection of  $\text{CH}_3-$  group or  $\text{CH}_3\text{CH}(\text{OH})-$  group by producing yellow solid  $\text{CHI}_3$ .

## Carboxylic Acids

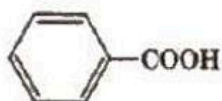
Carboxylic acids are organic compounds that contain a carboxyl group ( $-\text{COOH}$ ), which is made up of a carbonyl group ( $\text{C}=\text{O}$ ) attached to a hydroxyl group ( $\text{OH}$ ). The general formula is  $\text{R}-\text{COOH}$ , where "R" is an alkyl or aryl group.



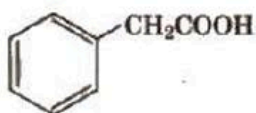
Formula	Common name	Source
HCOOH	Formic acid	Red ant (formica)
CH <sub>3</sub> COOH	Acetic acid	Vineger (acetum)
C <sub>3</sub> H <sub>7</sub> COOH	Butyric acid	Butter (butyrum)

### Nomenclature

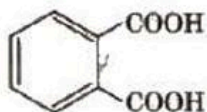
Their IUPAC names have been derived from the corresponding alkanes by replacing the letter 'li' of the alkane with 'oic' and adding suffix 'acid' at the end, Thus, monocarboxylic acids are called alkanolic acids.



Benzoic acid  
(Benzoic acid)



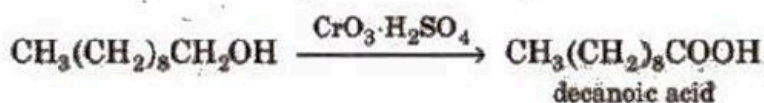
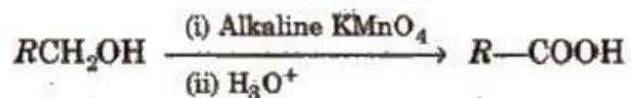
2-phenylethanoic acid



Benzoic acid-1, 2-dicarboxylic acid (phthalic acid)

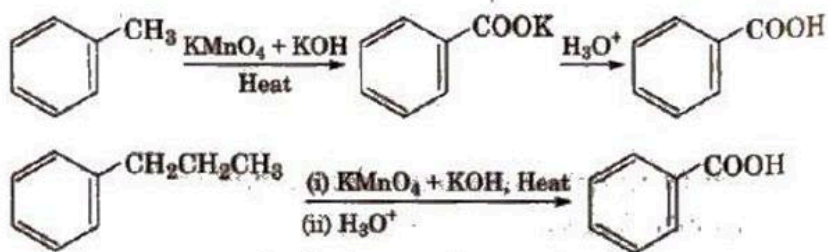
### Methods of Preparation of Monocarboxylic Acids

#### (i) From primary alcohols and aldehydes

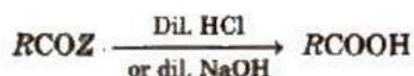


(ii) **From alkyl benzenes** Alkyl benzene when treated with strong oxidising agent like H<sub>2</sub>CrO<sub>4</sub> (chromic acid), acidic or alkaline KMnO<sub>4</sub> gives benzoic acid.





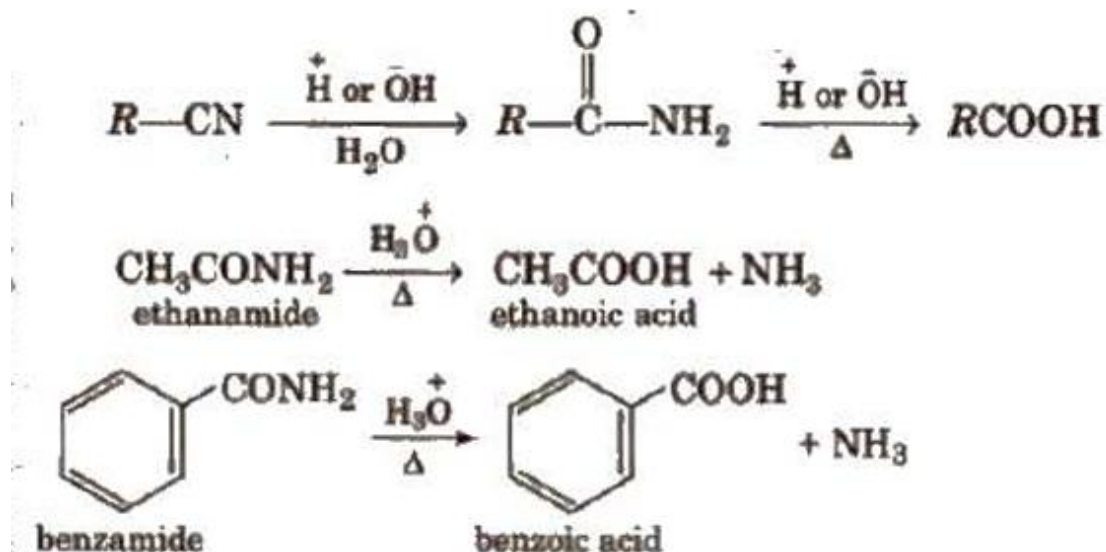
(iii) **From acid derivatives** All acid derivatives like amides ( $\text{RCONH}_2$ ), acid halides ( $\text{RCOCl}$ ), esters ( $\text{RCOOR}'$ ), acid anhydrides ( $\text{RCO-O-COR}$ ) on hydrolysis give carboxylic acids. All acid derivatives break from  $\text{RCO}^+$ .



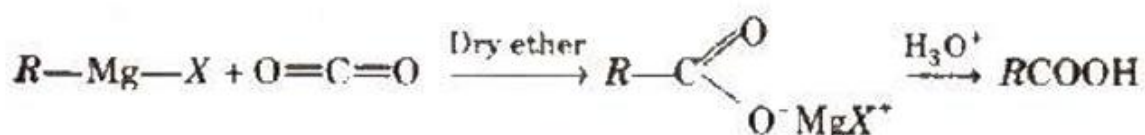
$\text{Z} = -\text{NH}_2, -\text{X} (\text{X} = \text{Cl, Br, I}), \text{OR}', \text{RCOO}-$  etc.

Ease of hydrolysis :  $\text{RCOCl} > (\text{RCO})_2\text{O} > \text{RCOOR}' > \text{RCONH}_2$

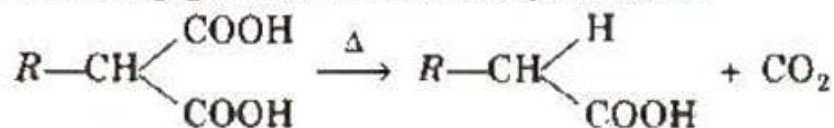
(iv) **From nitriles and amides** Nitriles are hydrolysed to amides and then to acids in the presence of  $\text{H}^+$  or  $\text{OH}^-$  as catalyst. Mild reaction conditions are used to stop the reaction at the amide stage.



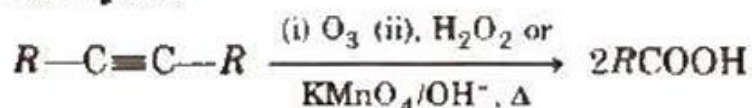
Using Grignard reagents (v) Grignard reagents react with carbon dioxide (dry ice) to produce carboxylic acid salts, which are then acidified with mineral acid to produce matching carboxylic acids.



(vi) **By heating geminal dicarboxylic acids**

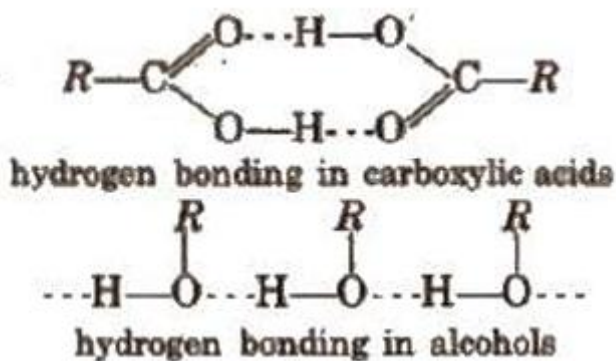


(vii) **From alkynes**



## Physical Properties of Carboxylic Acids

1. At normal temperature, aliphatic carboxylic acids with up to nine carbon atoms are colourless liquids with disagreeable odours. Higher acids resemble solid wax.
2. Due to intermolecular hydrogen bonding with H<sub>2</sub>O molecules, the lower carboxylic acids are easily miscible with water. However, when the alkyl group's size increases, the solubility in water gradually diminishes.
3. Because of their greater intermolecular hydrogen bonding than alcohols with similar molecular weights, monocarboxylic acids have higher boiling temperatures, as the following illustration illustrates.



4. Aliphatic monocarboxylic acids' melting points exhibit an oscillation or alternation effect; that is, an acid with an even number of carbon atoms has a greater melting point than its next lower and higher homologue, which has an odd number of carbon atoms. This is due to the fact that the terminal -CH<sub>3</sub> and -COOH groups of acids with an even number of carbon atoms are located on opposing sides of the zigzag chain. They consequently become densely packed within the crystal lattice.

5. Glacial acetic acid is the solid form of acetic acid and is entirely pure acetic acid. Glacial acetic acid is the name given to pure acetic acid that has turned into an ice-like solid below  $16.6^{\circ}\text{C}$  in temperature.

## Benefits of CBSE Class 12 Chemistry Notes Chapter 12

The CBSE Class 12 Chemistry Notes for Chapter 12 on Aldehydes, Ketones, and Carboxylic Acids offer several benefits for students:

**Concise and Organized Content:** The notes provide well-structured summaries of key concepts, helping students quickly grasp important topics like nomenclature, structure, and reactions of aldehydes, ketones, and carboxylic acids.

**Simplified Explanations:** Complex chemical reactions, mechanisms, and properties are explained in a simplified manner, making it easier for students to understand and retain information.

**Exam-Focused:** These notes highlight important topics frequently asked in exams, such as nucleophilic addition reactions, preparation methods, and industrial applications, helping students focus on exam-relevant material.

**Time-Saving:** By providing concise summaries of lengthy textbook content, the notes save time during revision and help students cover the entire chapter quickly before exams.

**Clarifies Doubts:** The notes clear common doubts related to reaction mechanisms, functional groups, and the behavior of these compounds, enabling better concept clarity.