Chemistry Study Materials for Class 12

(NCERT Based Notes of Chapter - 11)

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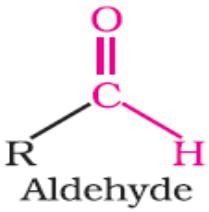
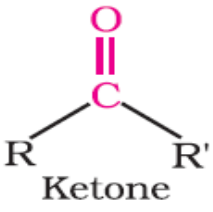
Aldehyde, Ketones and Carboxylic Acid

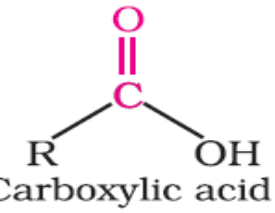
These are compounds containing carbon-oxygen double bond (>C=O) called carbonyl group. In aldehydes, the carbonyl group is bonded to a carbon and hydrogen while in ketones; it is bonded to two carbon atoms. The carbonyl compounds in which carbonyl group is bonded to oxygen are known as carboxylic acids, 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. The general formulas of these compounds are:



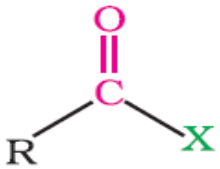
Aldehyde



Ketone

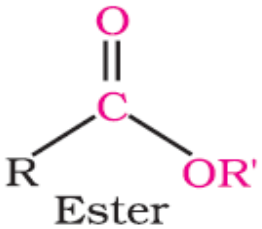


Carboxylic acid

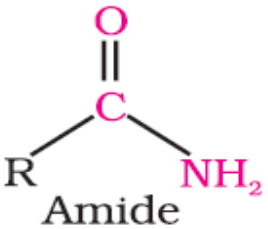


Acyl halide; X = (Halogen)

Acid anhydride



Ester



Amide

Aldehydes and Ketones

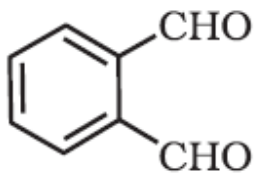
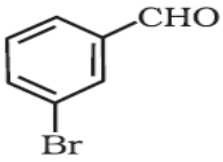
Nomenclature:

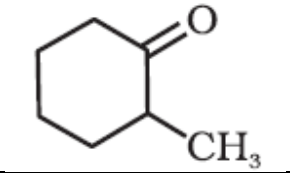
The common names of most aldehydes are derived from the common names of the corresponding carboxylic acids by replacing the ending –ic acid with aldehyde. The position of the substituent in the carbon chain is indicated by Greek letters α, β, γ, δ, etc.

The common names of ketones are derived by naming two alkyl or aryl groups bonded to the carbonyl group and by suffixing ketone. The positions of the substituents are indicated by Greek letters, α α′, β β′ and so on.

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.

Some examples are:

Compound	**Common name**	**IUPAC name**
ALDEHYDES		
HCHO	Formaldehyde	Methanal
CH_3CHO	Acetaldehyde	Ethanal
$(CH_3)_2CHCHO$	Isobutyraldehyde	2-Methylpropanal
$CH_3CH(OCH_3)CHO$	α-Methoxy propionaldehyde	2-Methoxypropanal
$CH_3CH_2CH_2CH_2CHO$	Valeraldehyde	Pentanal
$CH_2=CHCHO$	Acrolein	Prop-2-enal
	Phthaldehyde	Benzene-1,2-dicarbaldehyde
	m-Bromobenzaldehyde	3-Bromobenzene carbaldehyde Or 3-Bromobenzaldehyde

KETONES		
Compound	**Common name**	**IUPAC name**
CH_3COCH_3	Acetone	Propanone
$CH_3COCH_2CH_3$	Ethyl methyl ketone	Butanone
$CH_3COCH_2CH_2CH_3$	Methyl n-propyl ketone	Pentan-2-one
$CH_3CH_2COCH_2CH_3$	Diethyl ketone	Pentan-3-one
$(CH_3)_2CHCOCH(CH_3)_2$	Diisopropyl ketone	2,4-Dimethylpentan-3-one
$(CH_3)_2C=CHCOCH_3$	Mesityl oxide	4-Methylpent-3-en-2-one
	α-Methylcyclohexanone	2-Methylcyclohexanone

Preparation of Aldehydes and Ketones

1. **By oxidation of alcohols**: Primary alcohols on oxidation with mild oxidising agents like CrO_3 to give aldehydes while secondary alcohols give ketones.

$$R\text{-}CH_2OH \xrightarrow{[O]} R\text{-}CHO$$

Primary alcohol — Aldehyde

$$R_2CHOH \xrightarrow{[O]} R_2CO$$

Secondary alcohol — Ketones

2. **By dehydrogenation of alcohols**: Alcohols when heated with Cu or Silver catalyst at 573K, we get carbonyl compounds. Primary alcohols give aldehydes, while secondary alcohols give ketones.

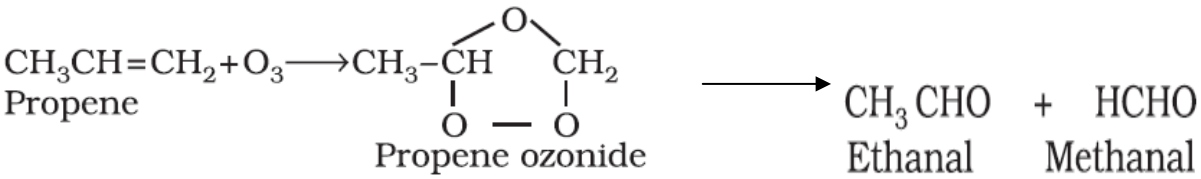
$$R\text{-}CH_2OH \xrightarrow{Cu/573\ K} R\text{-}CHO$$

Primary alcohol — Aldehyde

$$R_2CHOH \xrightarrow{Cu/573\ K} R_2CO$$

Secondary alcohol — Ketones

3. **By ozonolysis of alkenes**: Alkenes add ozone followed by hydrolysis with zinc dust and water, we get aldehydes or ketones.



4. **By hydration of alkynes**: Alkynes add water in the presence of H_2SO_4 and $HgSO_4$ to give carbonyl compounds. Ethyne (acetylene) gives acetaldehyde and all other alkynes give ketones.

$$CH \equiv CH + H_2O \xrightarrow{H2SO4/HgSO4} CH_3\text{-}CHO$$

Ethyne — Acetaldehyde

$$CH_3\text{-}C \equiv CH + H_2O \xrightarrow{H2SO4/HgSO4} CH_3\text{-}CO\text{-}CH_3$$

Propyne — Acetone

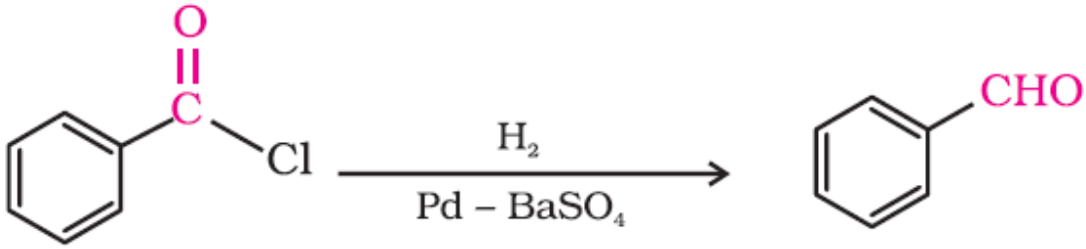
Preparation of Aldehydes

1. **From acyl chloride (Acid chloride) [*Rosenmund's Reduction*]:**

Acid chlorides react with hydrogen in presence of Pd supported on $BaSO_4$, we get aldehydes. This reaction is called Rosenmund's reduction.

$$R\text{-}COCl + H_2 \xrightarrow{Pd/BaSO4} R\text{-}CHO + HCl$$

Acid chloride — Aldehyde



Benzoyl chloride — Benzaldehyde

2. **From nitriles and esters**: ***(Stephen reaction)***

Nitriles when reduced with stannous chloride in the presence of hydrochloric acid, we get imines, which on hydrolysis give corresponding aldehyde. This reaction is called ***Stephen reaction***.

$$RCN + SnCl_2 + HCl \longrightarrow R\text{-}CH{=}NH \xrightarrow{H3O+} R\text{-}CHO$$

Nitrile — Imines — Aldehyde

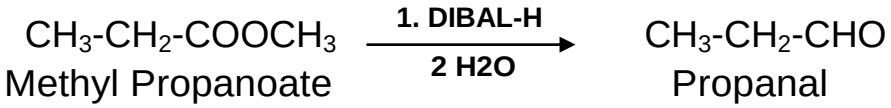
Nitriles can also be selectively reduced by *diisobutylaluminium hydride* (DIBAL-H) to imines followed by hydrolysis to aldehydes. DIBAL-H does not affect other reducable groups like double bonds.

$$R\text{-}CN \xrightarrow[2.\ H2O]{1.AlH\ (i\text{-}Bu)2} R\text{-}CHO$$

Nitrile — Aldehyde

$$CH_3\text{-}CH{=}CH\text{-}CH_2\text{-}CN \xrightarrow[2\ H2O]{1.\ DIBAL\text{-}H} CH_3\text{-}CH{=}CH\text{-}CH_2\text{-}CHO$$

Esters are also reduced to aldehydes with DIBAL-H.



Methyl Propanoate Propanal

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