# CARBOXYLIC ACIDS : ORGANIC CHEMISTRY

↳ General Formula : $C_nH_{2n+1}COOH$

: $R-\overset{\overset{O}{\|}}{C}-OH$

## Physical Properties :

1st Acid Methanoic Acid $H-\overset{\overset{O}{\|}}{C}-OH$

2nd Acid Ethanoic Acid $CH_3-\overset{\overset{O}{\|}}{C}-OH$

$CH_3COOH$ or $CH_3CO_2H$

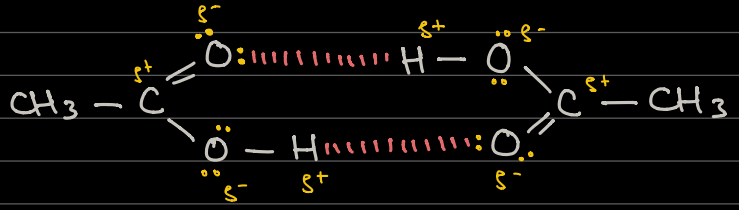
States at RTP :

1 carbon — 9 carbon acids → liquids

> 9 carbon acids → white crystalline solids

↳ They show strong intermolecular H bonds

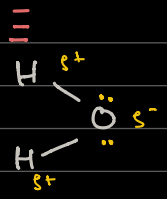
- Ethanoic Acid exists as a dimer due to H-bonding between 2 ethanoic acid molecules :



Ethanoic Acid Dimer, Mr = 120
aka. Glacial Acetic Acid
↳ fine, ice like crystals

Solubility :

- lower acids are very soluble in water as they can form H-bonds with water
- Solubility decreases as number of carbons increases (VDW forces start to dominate)



## Preparation of Carboxylic Acids:

1. Oxidation of 1° alcohols

$$CH_3CH_2OH \xrightarrow[\text{heat under reflux}]{K_2Cr_2O_7 / H^+(aq)} CH_3COOH$$

Note: $KMnO_4 / H^+(aq)$ could also be used as the OA instead of $K_2Cr_2O_7$

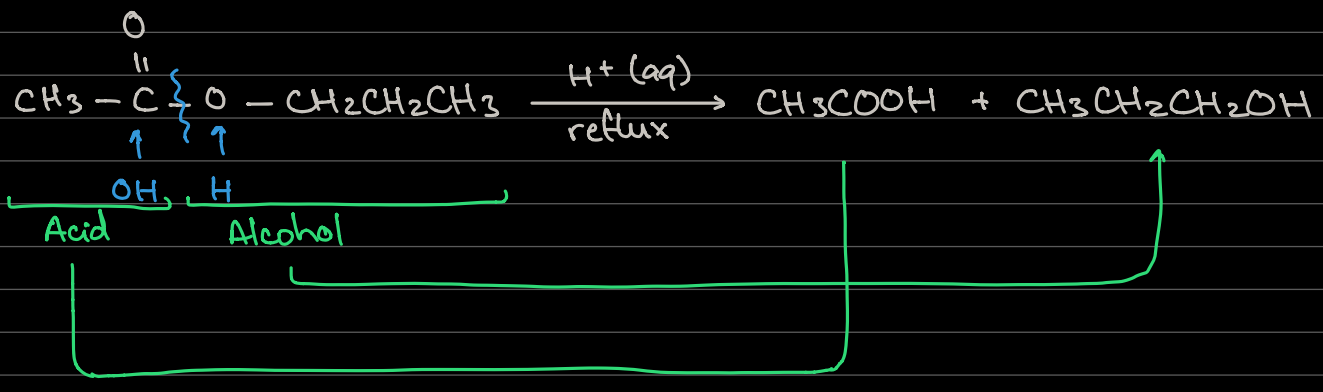
2. Oxidation of Aldehydes

$$CH_3CHO \xrightarrow[\text{heat under reflux}]{K_2Cr_2O_7 / H^+(aq)} CH_3COOH$$

3. Hydrolysis of Nitriles

$$CH_3CN \xrightarrow[\text{heat under reflux}]{\text{dilute } H^+(aq)} CH_3COOH$$

4. Hydrolysis of Esters (Acid Hydrolysis)

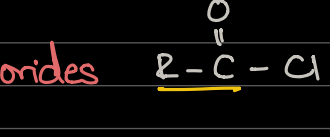


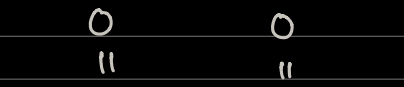

## ACID DERIVATIVES

↳ substances prepared from carboxylic acids

AS Esters $R-\overset{\overset{O}{\|}}{C}-O-R'$

A2 Amides $R-\overset{\overset{O}{\|}}{C}-\overset{\overset{H}{|}}{N}-H$

Mostly A2 **Acyl Chlorides** 

Not in Syllabus **Acid Anhydrides**  → two acids joined together by eliminating a water molecule.

# TYPICAL ACID-LIKE REACTIONS OF CARBOXYLIC ACIDS

Example:

$$2CH_3COOH + Mg \longrightarrow (CH_3COO)_2Mg + H_2(g)$$

2. Reaction with Alkalis → Salt + Water

$$CH_3COOH + NaOH \xrightarrow{rtp} CH_3COONa + H_2O$$

sodium ethanoate

3. Reaction with carbonates → salt + water + $CO_2$

$$2CH_3COOH + Na_2CO_3 \xrightarrow{rtp} 2CH_3COONa + H_2O + CO_2$$

Observation:
Effervescence of a colorless gas which turns lime water milky or cloudy

$$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O$$

limewater → milky or cloudy white ppt.

4. Reaction with $NaHCO_3$ → salt + $H_2O$ + $CO_2$

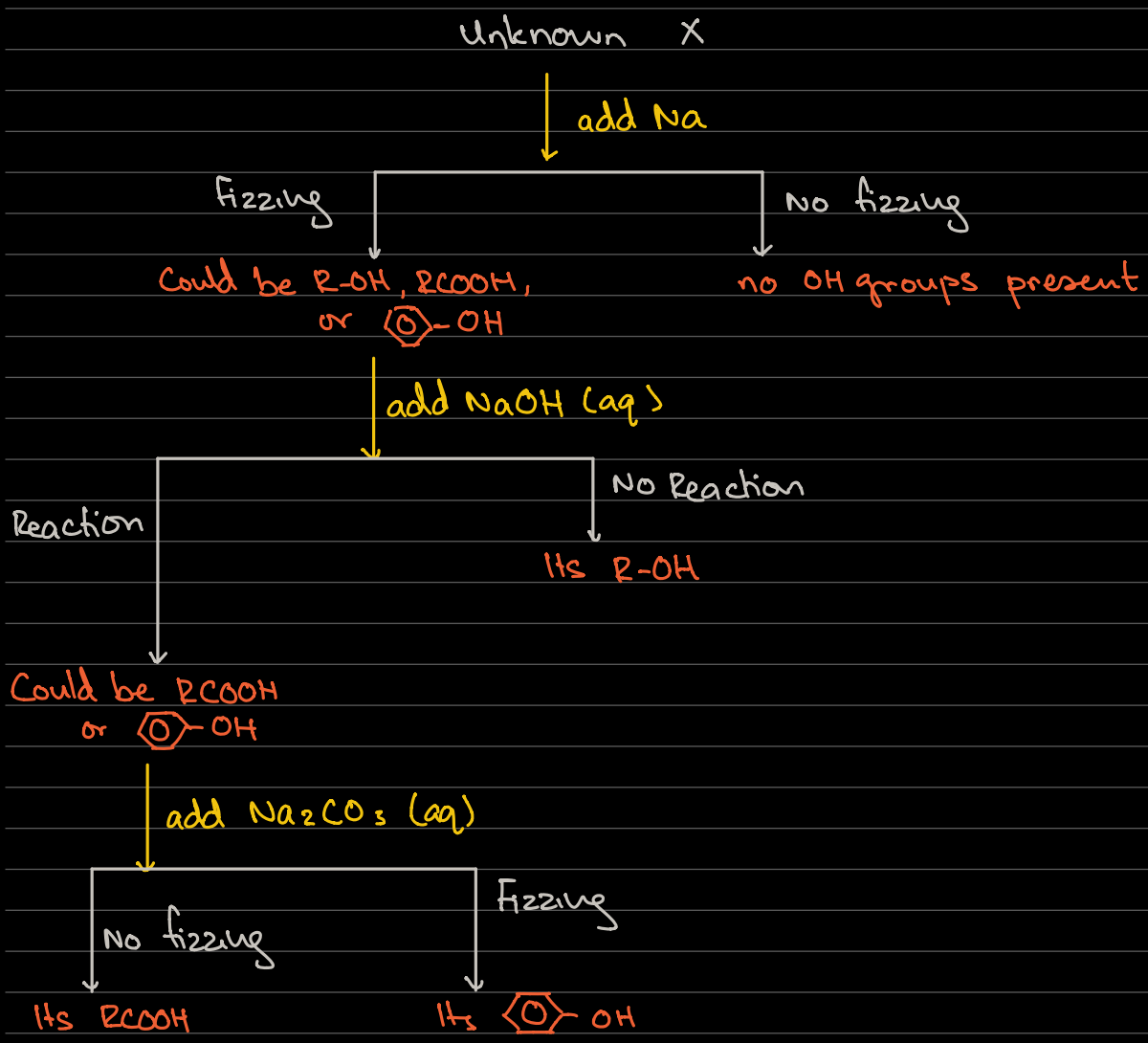
$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$$

Distinguishing between alcohols, phenols, and carboxylic acids

alcohols: R-OH

phenols: 

carboxylic acids: $R-\overset{O}{\overset{\|}{C}}-OH$




Note: The best identification for a carboxylic acid is the reaction with sodium carbonates

| | | Na | NaOH | $Na_2CO_3$ |
|---|---|---|---|---|
| Acid | $CH_3COOH$ | ✓ | ✓ | ✓ |
| Alcohol | $CH_3OH$ | ✓ | ✗ | ✗ |
| Phenol | $C_6H_5OH$ | ✓ | ✓ | ✗ |

# ESTERIFICATION : ALCOHOLS + ACIDS