



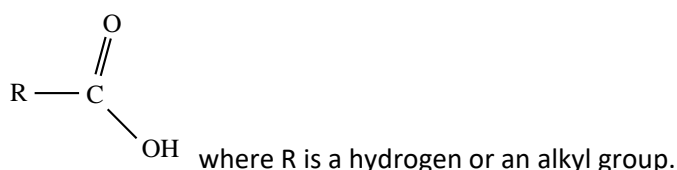
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Carboxylic acid or alkanonic acids

These are compounds with the formula



The carboxylic group is a combination of carbonyl group and an hydroxyl group(OH): the name carboxylic group.

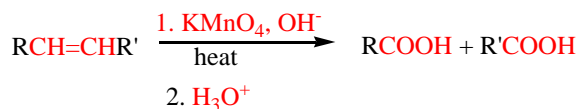
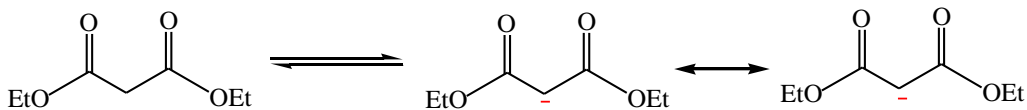
Nomenclature

1. Their names end with suffix "oic" followed by the word acid.
2. The carboxylic group must always be at the end of the chain and therefore its position need not to be specified. Take longest chain that contain the carboxylic group and start numbering from the carboxylic carbon

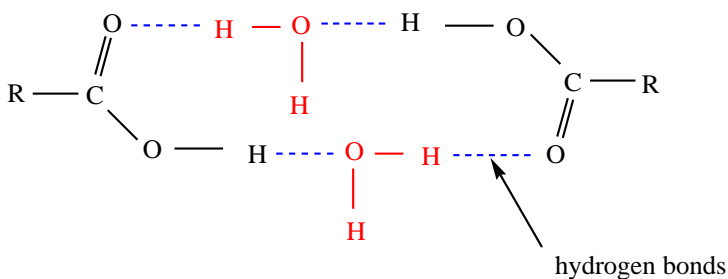
Examples	Systematic name	Common name
HCOOH	Methanoic acid	Formic acid
CH ₃ COOH	Ethanoic	Acetic acid
CH ₃ CH ₂ COOH	Propanoic acid	Propionic acid
CH ₂ CH ₂ CH ₂ COOH	Butanoic acid	Butyric acid
CH ₃ CH(CH ₃)COOH	2-methylpropanoic acid	Isobutyric acid

Physical properties

1. Lower members are liquids and higher members are waxy solids. With boiling points which are higher than expected, this because, their molecules are associated by hydrogen bonds.



2. Lower members are soluble in water but the solubility decreases with the increasing molecular mass of carboxylic acid. This is because carboxylic acids are capable of formation of hydrogen bonds with water



3. Melting points

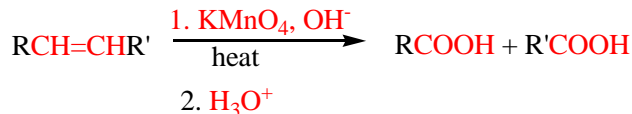
Compounds	Mpt ($^{\circ}\text{C}$)	Bpt ($^{\circ}\text{C}$)	Ka
HCOOH	8	100.5	1.7×10^{-4}
CH_3COOH	16.6	118	1.77×10^{-5}
$\text{CH}_3\text{CH}_2\text{COOH}$	21	141	1.34×10^{-5}
$\text{CH}_3(\text{CH}_2)_2\text{COOH}$	-6	164	1.54×10^{-5}
$\text{CH}_3(\text{CH}_2)_3\text{COOH}$	-34	187	1.52×10^{-5}
$\text{CH}_3(\text{CH}_2)_4\text{COOH}$	-3	205	
$\text{CH}_3(\text{CH}_2)_5\text{COOH}$	16	259	

Generally the melting point increase with the molecular mass. However, the melting points of lower carboxylic acids are relatively higher than those of higher carboxylic acids because they form stronger hydrogen bonds.

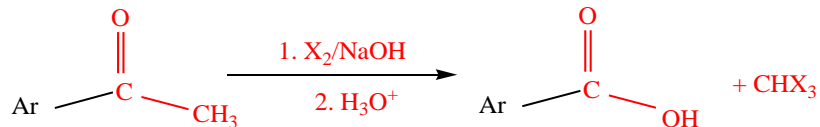
4. The acidity of carboxylic acids decrease with the increase in molecular mass due to positive inductive effect of alkyl group. Electron withdrawing groups make carboxylic acid more acidic. For example CCl_3COOH is more acidic than CH_3COOH .

Methods of preparation

1. By oxidation of primary alcohols using $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$, $\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}^+$, or KMnO_4/H^+



8. Oxidation of methyl ketone



Chemical properties

1. Carboxylic acid react with base to form salts and even liberate carbon dioxide from carbonates.

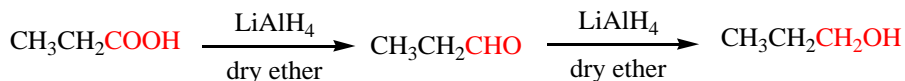
Examples



2. Reduction of carboxylic acid

Carboxylic acids are resistant to reduction by mild reducing agents. However, they can be reduced through aldehydes to primary alcohols by LiAlH_4 in presence of dry ether.

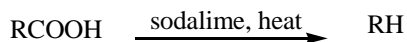
Example



3. Decarboxylation

This is a reaction in which a molecule of CO_2 is removed from carboxylic acids.

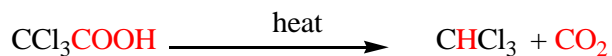
- (i) Simple carboxylic acids are not easily decarboxylated but their salts are easily decarboxylated in presence of soda lime.



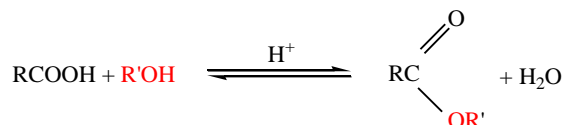
- (ii) $\text{CH}_3\text{CH}_2\text{COOH} \xrightarrow{\text{sodalime, heat}} \text{CH}_3\text{CH}_3$

- (iii) Acids with electron withdrawing groups on α -carbon are easily decarboxylated on heating.

Example



- (iv) Esterification: Carboxylic acids react with alcohol in presence of mineral acids to form ester

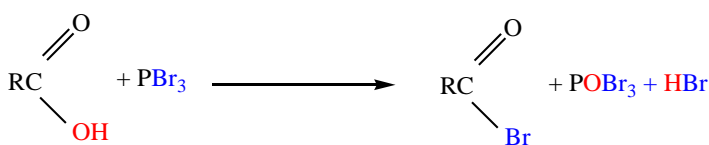
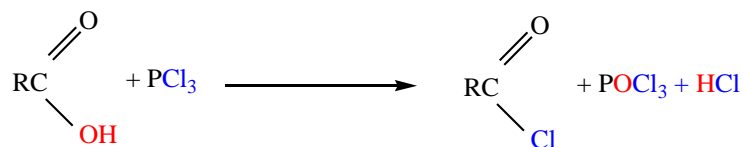


Esters have got sweet smell; this is why this reaction is used in identification of carboxylic acids

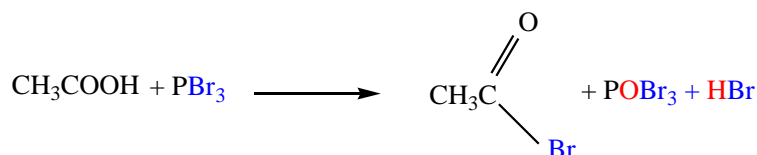
Reactivity of alcohols is in order $1^\circ > 2^\circ > 3^\circ$, and the reactivity of carboxylic acids is in order $\text{HCOOH} > \text{CH}_3\text{COOH} > \text{RCH}_2\text{COOH} > \text{R}_2\text{CHCOOH} > \text{R}_3\text{CCOOH}$, due to steric hindrance. i.e. the presence of bulky groups near the site of reaction, whether in the alcohol or in acid slows esterification.

4. Formation of acid halides

Carboxylic acids (except methanoic acid) react with phosphorus halides to form acid halides



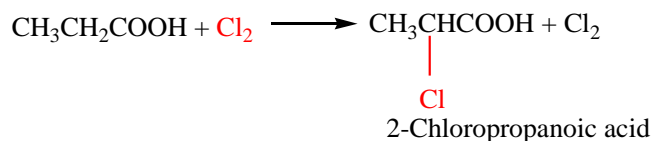
Example



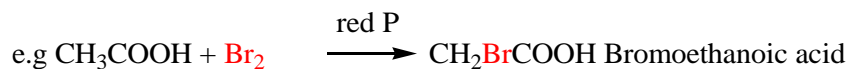
5. Halogenation of aliphatic acids

(a) Carboxylic acids (except methanoic acid) react with chlorine in presence of sunlight or u.v light, thereby a chlorine atom replacing an α -hydrogen.

e.g $\text{CH}_3\text{COOH} + \text{Cl}_2 \longrightarrow \text{CH}_2\text{ClCOOH}$ chloroethanoic acid



(b) Bromine replaces an α -hydrogen in presence of red phosphorous (hell-vohlard zelensky reaction)



Dr. Bbosa Science