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Matric No: 19/ENG05/056

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(i) $\text{HCOOH} \rightarrow$ hydronium carbonoxide / methanoic acid

(ii) $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH} \rightarrow$ ^{Pentan} Propan - 1,3 - dioic acid

(iii) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} \rightarrow$ ~~propionic acid~~ butyric acid

(iv) $\text{HO}_2\text{CCO}_2\text{H} \rightarrow$ Oxalic acid.

(v) $\text{CH}_3(\text{CH}_2)_4\text{COOH} \rightarrow$ Hexanoic acid / caproic acid

(vi) $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{COOH} \rightarrow$ Hex - 2 - ene - 1 - oic acid.

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2.)

Physical appearance (Odour)

Carboxylic acids tend to have strong odours, especially those that are volatile. Common odours can be found in vinegar, which contains ethanoic acid, and rancid butter, which contains butanoic acid. Esters of carboxylic acids tend to have pleasant odours, so they are usually used to make perfumes.

Solubility in water

Carboxylic acids are soluble in water. Carboxylic acids do not dimerise in water, but forms hydrogen bonds with water. Carboxylic acids are polar and due to the presence of the hydroxyl in the carboxyl group, they are able to form hydrogen bonds with water molecules. Smaller carboxylic acids (C1 to C5) are soluble in water, whereas larger carboxylic acids (C6 and above) are less soluble due to the increasing hydrophobic nature of the hydrocarbon chains.

Boiling point

Formula	Common Name	Source	IUPAC Name	Melting Point	Boiling Point
HCO_2H	formic acid	ants (L. Formica)	methanoic acid	8.4 °C	101 °C
$\text{CH}_3\text{CO}_2\text{H}$	acetic acid	vinegar (L. acetum)	ethanoic acid	16.6 °C	118 °C
$\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$	propionic acid	milk (Gk. protus prion)	propanoic acid	-20.8 °C	141 °C
$\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{H}$	butyric acid	butter (L. butyrum)	butanoic acid	-5.5 °C	164 °C
$\text{CH}_3(\text{CH}_2)_3\text{CO}_2\text{H}$	valeric acid	valerian root	pentanoic acid	-34.5 °C	186 °C
$\text{CH}_3(\text{CH}_2)_4\text{CO}_2\text{H}$	caproic acid	goats (L. caper)	hexanoic acid	-4.0 °C	205 °C
$\text{CH}_3(\text{CH}_2)_5\text{CO}_2\text{H}$	enanthic acid	vines (Gk. oenanthe)	heptanoic acid	-7.5 °C	223 °C
$\text{CH}_3(\text{CH}_2)_6\text{CO}_2\text{H}$	caprylic acid	goats (L. caper)	octanoic acid	16.3 °C	239 °C
$\text{CH}_3(\text{CH}_2)_7\text{CO}_2\text{H}$	pelargonic acid	pelargonium (an herb)	nonanoic acid	12.0 °C	253 °C
$\text{CH}_3(\text{CH}_2)_8\text{CO}_2\text{H}$	capric acid	goats (L. caper)	decanoic acid	31.0 °C	219 °C

The boiling points of carboxylic acids increases as the

molecules get bigger. Carboxylic acids have even higher boiling points than alkanes and alcohols. Carboxylic acids, similar to alcohols, can form hydrogen bonds with each other as well as van der Waals dispersion forces and dipole-dipole interactions. However, unique to carboxylic acids, hydrogen bonding can occur between two molecules to produce a dimer.

The presence of dimers increases the strength of the van der Waals dispersion forces, resulting in the high boiling points of carboxylic acids.

3.)

Preparation from Primary Alcohols.

Primary alcohols, as well as aldehydes, can undergo oxidation reaction to form corresponding carboxylic acids with the help of oxidizing agents such as potassium permanganate (KMnO_4 for neutral or acidic or alkaline media), chromium trioxide (CrO_3 – H_2SO_4 – Jones reagent), and potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$ – acidic media).

Primary alcohol undergoes oxidation to produce carboxylic acid on the addition of the oxidizing agents. Therefore, the oxidation of primary alcohols produces aldehydes which further repeat the oxidation to produce carboxylic acids. The strong oxidizing agents including potassium dichromate, potassium permanganate, and chromium trioxide can readily oxidize the aldehyde to form carboxylic acids.

However, mild oxidizing agents can only undergo one step and convert the primary alcohols into aldehydes. Example of mild oxidizing agents includes manganese dioxide (MnO_2) and Tollen's reagent [$\text{Ag}(\text{NH}_3)_2^+ \text{OH}^-$]. Hence, they are not strong enough to undergo oxidation twice. Therefore, the mild oxidizing agents are used for converting aldehydes into carboxylic acids.

It is important to remember that acidified oxidizing agents like potassium dichromate and Jones reagent lead to the formation of esters in a small amount. Therefore, it is preferable to use neutral or alkaline agents such as potassium permanganate for this preparation method.



Preparation from Aldehydes.

As discussed in the above topic, Preparation of carboxylic acid is possible from the usual strong oxidizing agents. Carboxylic acids formation is possible with mild oxidizing agents such as Tollen's reagents [$\text{Ag}(\text{NH}_3)_2^+ \text{OH}^-$] and manganese dioxide (MnO_2).

Reaction:



4.)

Synthesis Of Carboxylic Acids

Most of the methods for the synthesis of carboxylic acids can be put into one of two categories: (1) hydrolysis of acid derivatives and (2) oxidation of various compounds.

Hydrolysis of acid derivatives

All acid derivatives can be hydrolyzed (cleaved by water) to yield carboxylic acids; the conditions required range from mild to severe, depending on the compound involved.

Chemical Compounds. Carboxylic acids and their derivatives. Synthesis of Carboxylic Acids. Hydrolysis of acid derivatives. [All acid derivatives can be hydrolyzed to yield carboxylic acids; the conditions required range from mild to severe.

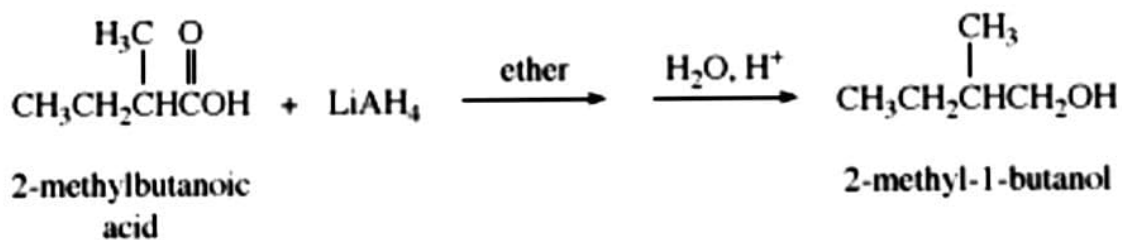
The easiest acid derivatives to hydrolyze are acyl chlorides, which require only the addition of water. Carboxylic acid salts are converted to the corresponding acids instantaneously at room temperature simply on treatment with water and a strong acid such as hydrochloric acid (shown as H^+ in the equations above). Carboxylic esters, nitriles, and amides are less reactive and typically must be heated with water and a strong acid or base to give the corresponding carboxylic acid. If a base is used, a salt is formed instead of the carboxylic acid, but the salt is easily converted to the acid by treatment with hydrochloric acid. Of these three types of acid derivatives, amides are the least reactive and require the most vigorous treatment (i.e., higher temperatures and more prolonged heating). Under milder conditions, nitriles can also be partially hydrolyzed, yielding amides: $RCN \rightarrow RCONH_2$.

Oxidation

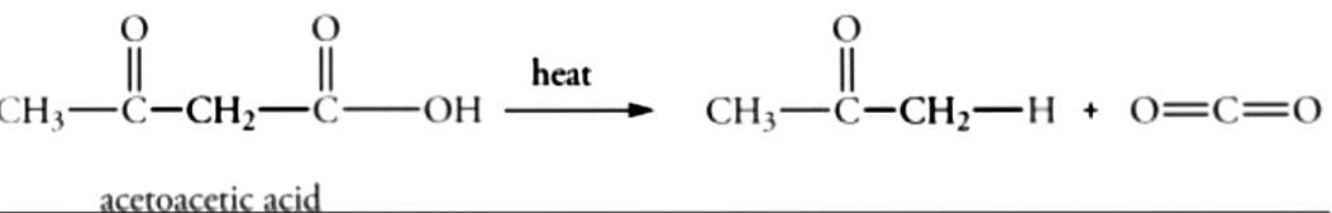
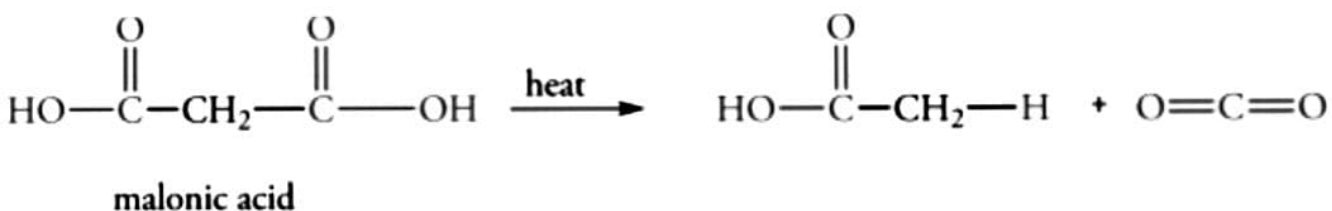
The oxidation of primary alcohols is a common method for the synthesis of carboxylic acids: $RCH_2OH \rightarrow RCOOH$. This requires a strong oxidizing agent, the most common being chromic acid (H_2CrO_4), potassium permanganate ($KMnO_4$), and nitric acid (HNO_3). Aldehydes are oxidized to carboxylic acids more easily (by many oxidizing agents), but this is not often useful, because the aldehydes are usually less available than the corresponding acids. Also important is the oxidation of alkyl side chains of aromatic rings by strong oxidizing agents such as chromic acid, potassium permanganate, and nitric acid to yield aromatic carboxylic acids. Regardless of the number of carbon atoms in the side chain or the presence of any groups attached to them, if the first carbon in the alkyl chain is bonded to at least one hydrogen (and not to another aromatic ring), all but one of the carbons are removed, and only a $COOH$ group remains bonded to the aromatic ring. Examples are the oxidations of toluene and 1-chloro-3-phenylpropane. Terephthalic acid for the production of the polymer poly(ethylene terephthalate), abbreviated PET, is made by the catalyzed air oxidation of 1,4-dimethylbenzene (p-xylene). Treatment of this dicarboxylic acid or its dimethyl ester with ethylene glycol gives PET. PET can be fabricated into textile fibres (Dacron polyester), into film (Mylar), and into recyclable beverage containers.

5.)

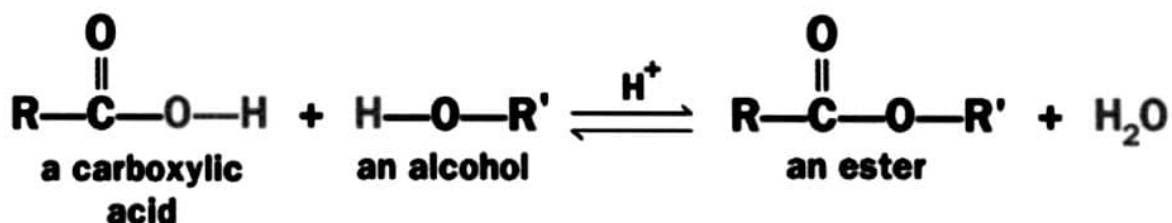
Reduction



Decarboxylation



Esterification



(Where R and R' are general hydrocarbon groups)