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19/MHS01/001.
CHM 102.

1) $HCOOH$ ⟶ Methanoic acid
$HOOCCH_2CH_2CH_2COOH$ ⟶ Pentan-1,5-dioic acid.
$CH_3CH_2CH_2COOH$ ⟶ Butanoic acid.
HO_2C-CO_2H ⟶ ~~Ethan~~ Ethanedioic acid
$CH_3(CH_2)_4COOH$ ⟶ Hexanoic acid.
$CH_3CH=CHCH_2CH_2COOH$ ⟶ Hex-4-enoic acid.

2) a) Physical appearance:
All Simple aliphatic carboxylic acids up to C_{10} are liquid at room temperature. Most other Carboxylic acids ~~(acetic acid)~~ are Solid at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like Solid below the room temperature.

b) Boiling Point:
This increases with increasing relative molecular mass. Aromatic Carboxylic acids are Crystalline solids and have higher melting Points than their aliphatic counterparts of Comparable relative molecular mass.

c) Solubility:
Lower molecular mass; Carboxylic acids with up to four Carbon atom in their molecules are Soluble in water, this is largely due to their ability to form hydrogen bonds with water molecules. The water ~~sol~~ Solubility of the acids decreases as the relative molecular mass increases because the Structure becomes relatively more hydrocarbon in nature and hence covalent. All Carboxylic acids are soluble in Organic Solvents.

3) a) From ethanal: Ethanoic acid is obtained Commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganese (II) ethanoate Catalyst. Ethanal itself is obtained from ethylene.

$HC \equiv CH \xrightarrow{dil.\ H_2SO_4 / HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$

4) Hydrolysis of nitriles (cyanides) or esters.

$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+$

$RCOOR \xrightarrow{H_2O/H^+,\ reflux} RCOOH + R'OH$

$C_6H_5CH_2CN + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+$

$CH_3CH_2COOCH_3 \xrightarrow{H_2O/H^+\ reflux} CH_3CH_2COOH + CH_3OH$

} R = alkyl or aryl radical.

3b) From Petroleum: Liquid phase air oxidation of $C_5 - C_7$ alkanes, obtainable from petroleum of high temperature & pressure will give $C_5 - C_7$ carboxylic acids with methanoic, propanoic and butanedioic acids as by-products.

$C_5 - C_7 \xrightarrow{O_2/\text{High temperature and Pressure}} C_5 - C_7$ carboxylic acid

5 a) Reduction

$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + H_2$

$\downarrow 4H_2O$

$4RCH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid → Butanol.

b) Decarboxylation

$CH_3CH_2CH_2COONa + NaOH \xrightarrow{fux} CH_3CH_2CH_3 + Na_2CO_3$.

Kolbe Synthesis

$2CH_3CH_2COONa + 2H_2O \xrightarrow{electrolysis/aq.\ CH_3OH} CH_3(CH_2)CH_3 + CO_2 + 2NaOH + H_2$

(anode) (cathode)

c) Esterification

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xleftrightarrow{H^+} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$