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ELECT/ELECT ENGINEERING
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CHM 102 ASSIGNMENT

1(i) HCOOH - Methanoic acid
(ii) $HOOCCH_2CH_2CH_2COOH$ - Pent-1,5-dioic acid
(iii) $CH_3CH_2CH_2COOH$ - Butanoic acid
(iv) HO_2C-CO_2H - Ethanedioic acid
(v) $CH_3(CH_2)_4COOH$ - Hexanoic acid
(vi) $CH_3CH=CHCH_2CH_2COOH$ - Hex-4-eneoic acid

2 Physical Appearance
All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most ~~are~~ other carboxylic acids are solid at room temperature although acetic acid or glacial ethanoic acid freezes to an ice-like solid below room temperature.

(ii) Boiling Point
Boiling point increases with relative molecular mass. Aromatic carboxylic acids have higher melting points than their aliphatic counterparts of comparable relative molecular mass

(iii) Solubility
Carboxylic acids with up to four carbon atoms are soluble in water due to ~~their~~ their ability to form hydrogen bonds with water molecules. Their water solubility decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence

~~more~~ covalent. All carboxylic acids are soluble in organic solvents

3(i) From Carbon (II) oxide

Methanoic acid (Formic acid) is manufactured by adding carbon (II) oxide under pressure to hot aqeous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with tetraoxosulphate (vi) acid (H_2SO_4)

$$CO + NaOH \longrightarrow HCOONa \xrightarrow{H_2SO_4} HCOOH + NaHSO_4$$

(ii) From petroleum

Liquid phase air oxidation of C_5 - C_7 alkanes, obtainable from petroleum at high temperature and pressure will give C_5 - C_7 carboxylic acids with methanoic, propanoic and butanedioic acids as by-products

$$C_5 - C_7 \text{ alkanes} \xrightarrow{O_2 / \text{High temperature \& pressure}} C_5 - C_7 \text{ carboxylic acids}$$

4 Oxidation of primary alcohols and aldehydes

Carboxylic acids can be prepared by oxidation of primary alcohols and aldehydes using usual oxidizing agents ($K_2Cr_2O_7$ or $KMnO_4$) in acidic solution

$$RCH_2OH \xrightarrow{[O], \text{excess acid/} KMnO_4} RCHO \xrightarrow{[O]} RCOOH$$

(ii) Carbonation of Grignard reagent

Aliphatic carboxylic acids are obtained by bubbling carbon (IV) oxide into grignard reagent and then hydrolyzed with dilute acid

$RMgBr + CO_2 (C_2H_5)_2O \longrightarrow RCOOMgBr \xrightarrow{H_2O/dil.\ acid} RCOOH + MgBrOH$

R may be 1°, 2°, 3° aliphatic alkyl or aryl radical

In preparing benzoic acid, the reagent is added to solid Carbon(IV) oxide also serving as a coolant

$C_6H_5MgBr + CO_2 \xrightarrow{(C_2H_5)_2O} C_6H_5COOMgBr \xrightarrow{H_2O/H^+} C_6H_5COOH + MgBrOH$

(iii) Hydrolysis of nitriles (cyanides) or esters

$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+$ (R = alkyl or aryl radical)

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

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

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

5 Reduction of Carboxylic acid to primary alcohol

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

$(RCH_2O)_4AlLi \xrightarrow{4H_2O} 4RCH_2OH + Al(OH)_3 + LiOH$

(ii) Decarboxylation

$CH_3CH_2CH_2COONa + NaOH \xrightarrow{Fuse} CH_3CH_2CH_3 + Na_2CO_3$

(iii) Esterification

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