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Chemistry Assignment

1.) IUPAC names:

(i) $HCOOH$ – methanoic acid

(ii) $HOOCCH_2CH_2CH_2COOH$ – pentan-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-enoic acid

2.) (i) Physical appearance:

All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most other carboxylic acids are solids 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.

(ii) Boiling point:

Boiling point 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.

(iii) Solubility:

Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water; this largely due to their ability to form hydrogen bonds with water molecules. The water 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.) Two industrial preparations of carboxylic acids are:

(i) From carbon(II)oxide: By adding carbon(II)oxide to hot aqeous solution of sodium hydroxide, after which the free carboxylic acid is is liberated by careful reaction with H_2SO_4 to produce methanoic acid

(ii) From petroleum: Liquid phase air oxidation of C5-C7 alkanes, obtainable from petroleum at high temperature and pressure will give C5-C7 carboxylic acids with methanoic, propanoic and butanedioic acis as by-product

4.) (i) Oxidation of primary alcohols and aldehydes: Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidising agents in acidic solution

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

(ii) By the hydrolysis of nitriles (cyanides) or esters

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

OR

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

5.) Reduction:

$$4RCOOH + 3LiALH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4ALLi + 2LiALO_2 + 4H_2$$

$$\downarrow 4H_2O$$

$$4RCH_2OH + AL(OH)_3 + 2LiOH$$

$$CH_3CH_2CH_2COOH \xrightarrow{LiALH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

Decarboxylation:

- Thermal decarboxylation:

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

• Kolbe synthesis:

$$2CH_3CH_2COONa + 2H_2O \xrightarrow[\text{aq. } CH_3OH]{\text{electrolysis}} CH_3(CH_2)_2CH_3 + \underset{\text{anode}}{CO_2} + 2NaOH + \underset{\text{cathode}}{H_2}$$

Esterification:

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