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19/MHS01/810.

1) Give the IUPAC names of the following compounds:
$HCOOH$ → Methanoic acid
$HOOCCH_2CH_2CH_2COOH$ → Pentan-1,5-dioic acid.
$CH_3CH_2CH_2COOH$ → Butanoic acid
HO_2C-CO_2H → Ethanedioic acid
$CH_3(CH_2)_4COOH$ → Hexanoic acid
$CH_3CH=CHCH_2CH_2COOH$ → Hex-4-eneoic acid.

2) Discuss briefly the physical properties of carboxylic acids under the following headings:

i) Physical appearance: Simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most other carboxylic are solid at room temp. although anhydrous carboxylic acid (Acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

ii) Boiling points: B_{pt} 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 become relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvents.

3) Write two industrial preparations of carboxylic acids.

i) 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.

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

ii) From Carbon(II) oxide:

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

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

4 With equation and brief explanation discuss the synthetic preparation of carboxylic acid.

- Hydrolysis of nitrates (cyanides) or esters.
- $RCN + 2H_2O \rightarrow RCOOH + NH_3$
- $RCOOR' \rightarrow RCOOH + R'OH$
- $C_6H_5CH_2CN + 2H_2O \rightarrow C_6H_5CH_2COOH + NH_3$
- $CH_3CH_2COOCH_3 \rightarrow CH_3CH_2COOH + CH_3OH$

∴ R = alkyl or aryl radical.

5) With chemical equations only outline the reduction of carboxylic and esterification of carboxylic acid.

- Reduction.

$4RCOOH + 3LiAlH_4 \rightarrow (RCH_2O)_4Al + 2LiAlO_2 + H_2$

$4H_2O$

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

$CH_3CH_2CH_2COOH \rightarrow CH_3CH_2CH_2CH_2OH$

Butanoic acid → Butanol

- Of carboxylic acid

$CH_3CH_2CH_2COONa + NaOH \rightarrow CH_3CH_2CH_3 + Na_2CO_3$

Kallora synthesis:

$2CH_3CH_2CH_2COONa + 2H_2O$ | $CH_3(CH_2)CH_3 + CO_2 + 2NaOH + H_2$

(anode) (cathode)

- Esterification:

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \rightarrow CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$