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MATRIC NUMBER: 19/ENG03/003

CHEMISTRY 102 ASSIGNMENT

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① Give the IUPAC names of the following compounds

a) $HCOOH$ (Methanoic acid)

b) $HOOC[H_2CH_2CH_2COOH$ (Pentan-1,5, dioic acid)

c) $CH_3CH_2CH_2COOH$ (Butanoic acid)

d) HO_2C-CO_2H (Ethanedioic acid)

e) $CH_3(CH_2)_4COOH$ (Hexanoic acid)

f) $CH_3CH=CHCH_2CH_2COOH$ (Hex-4-enoic acid)

② Discuss briefly the physical properties of carboxylic acid under the following headings: Physical appearance, boiling point and solubility.

a) Physical appearance: All simple aliphatic carboxylic acids up to C_{10} are liquid at room temprature. Most other carboxylic acids 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 masses. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative mas

c) Solubility: Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water: this largely due to the ability to form hydrogen bonds with water molecules.

The water solubility of the acids decreases as the relative molecul mass increases because the structure becomes relatively more hydrocar in nature and hence covalent. All carboxylic acids are soluble in organic solvents.

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③ Write 2 industrial preparations of carboxylic acids

a) 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 butanoic acids as by-products

$$C_5-C_7 \xrightarrow{O_2 \text{ / high temperature and pressure}} C_5-C_7 \text{ carboxylic acid}$$

b) From ethanal: ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganite(II) ethanoate catalyst. Ethanal itself is obtained from ethylene

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

④ With equations and brief explanation, discuss the synthetic production of carboxylic acid.

Sol: Hydrolysis of nitriles (cyanides) or esters

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

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

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

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

R = alkyl or aryl radical

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5) With chemical equation only outlining the reduction, decarboxylation and esterification of carboxylic acid

a) Reduction

$$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + H_2$$
$$4H_2O$$

$$\downarrow$$

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

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

b) Decarboxylation

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

Kolbe synthesis

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

(anode) (cathode)

c) Esterification

$$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \overset{H^+}{\rightleftharpoons} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$$