Name: Alanza Ijeoma Shalom
Department: Computer Engineering
Matric No: 18/SCI01/1016
Course Title: Chemistry 102

1. Give the IUPAC names of the following compounds.

Answers

a. $HCOOH$ ⟶ Methanoic acid

b. $HOOCCH_2CH_2CH_2COOH$ ⟶ 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-eneoic acid

2. Discuss briefly the physical properties of carboxylic acids under the following headings. Physical appearance, Boiling point & Solubility

Answer

a. Physical appearance:

All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most other 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 maecular mass carboxylic acids with up to four carbon atoms in their molecule 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

increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvents

3 Write two industrial preparations of carboxylic acids

Answer

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 butanedioic acids as by-products

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

b From ethanol

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 preparation of carboxylic acid.

Answer

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

5 With chemical equation only outline the reduction, decarboxylation and esterification of carboxylic acid.

Answer.

a. Reduction

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

$$\downarrow + 4H_2O$$

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

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

b. Decarboxylation

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

Kolbe synthesis

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

c Esterification

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