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(1) Give the IUPAC name of the following compounds

Answers

a. $HCOOH$ → Methanoic acid

b. $HOOC[CH_2CH_2CH_2COOH]$ → Pentan-1,5-dioic acid

c. $CH_3CH_2CH_2COOH$ → Butanoic acid

d. HO_2C-CO_2H → Ethan-dioic 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 acids under the following headings i. Physical appearance, Boiling point and solubility.

Answer -

(i) Physical appearance: All simple aliphatic carboxylic acids up to C10 are liquids at room temperature although aphydrous carboxylic acid (acetic acid) also known as glacial ethanoic

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 molecular mass carboxylic acids (up to four carbon atom 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) 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 like methanoic, propanoic and butenedioic acids as by products.
C_5/C_7 $\xrightarrow{O_2/\text{high temperature and pressure}}$ C_5/C_7 carboxylic acid

(b) From ethanol:
Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanol to ethanoic acid using manganese (II) ethanoate catalyst. Ethanol itself is obtained from ethyne

$HC \equiv CH \xrightarrow{dil.\ H_2SO_4,\ HgSO_4} CH_3CHO \xrightarrow{[O]} CH_3COOH$

(a) With equations and brief explanation, discuss the synthetic preparation of carboxylic acids.

Answer.

⇒ Hydrolysis of nitriles (cyanides) or esters

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

$RCOOR \xrightarrow{H_2O/H^+ \text{ Reflux}} RCOOH + ROH$

$C_6H_5CH_2Cl + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+Cl^-$

$CH_3CH_2COOCH_3 \longrightarrow CH_3CH_2COOH + CH_3OH$

(R = alkyl, aryl, cyclo, ...)

(b) With chemical equation only outline the reduction decarboxylation and esterification of carboxylic acid

Answer.

(i) Reduction

$RCOOH + 3[AlH_4^-] \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4Al + 4OH^-$

$(RCH_2O)_4Al + 4H_2O \longrightarrow RCH_2OH + Al(OH)_3$

$CH_3CH_2CH(COOH) \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanol

(ii) Decarboxylation

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

Kolbe Synthesis

$2CH_3CH_2COONa + 2H_2O \xrightarrow{\text{electrolysis/eg } CH_3OH} CH_3(CH_2)CH_3$

$+ CO_2 + 2NaOH + H_2$

anode (cathode)

(c) Esterification

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