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DEPARTMENT: NURSING SCIENCE

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1. Give the IUPAC names of the following compounds

a. HCOOH - Methanoic acid

b.HOOCCH2CH2CH2COOH - Pentan-1,5-dioic acid

c.CH3CH2CH2COOH -Butanoic acid

d.HO2C-CO2H - Ethanedioic acid

e.CH3(CH2)4COOH - Hexanoic acid

f.CH3CH=CHCH2CH2COOH - Hex-4-eneoic acid

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

Physical appearance ii. Boiling point iii. Solubility

ANSWER

a.Physical appearances

All simple aliphatic carboxylic acids up to C10 are liquids at room temperature. 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

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.

c.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. Write two industrial preparations of carboxylic acids

ANSWER

a.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 (H2SO4)

CO ------------->HCOONa --------------->HCOOH + NaHSO4

 NaOH H2SO4

b.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 acids as by-products.

C5-C7------------------>O2/ High temperature and pressure C5-C7 carboxylic acids

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

ANSWER

 a.Oxidation of primary alcohols and aldehydes

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents (i.e K2Cr2O7 or KMnO4) in acidic solution

RCH2OH----------->excess acid/KMnO4 RCHO------------>RCOOH

 [O] [O]

b.Carbonation of Grignard reagent

Aliphatic carboxylic acids are obtained by bubbling carbon (IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid

RMgBr + CO2 --------------->RCOOMgBr-------------------->RCOOH + MgBrOH

 (C2H5)2O H2O/ dil. acid

R may be 1o, 2o , 3o aliphatic alkyl or aryl radical

In the preparation of benzoic acid, the reagent is added to solid carbon (IV) oxide (dry ice) which also serves as coolant to the reaction mixture

C6H5MgBr + CO2------------>C6H5COOMgBr---------------->C6H5COOH + MgBrOH

 (C2H5)2O H2O/H+

c.Hydrolysis of nitriles (cyanides) or esters

RCN + 2H2O------------->RCOOH + NH4+

H+

(R=alkyl or aryl radical)

RCOOR’---------------------->RCOOH + R’OH

 H2O/H+ reflux

C6H5CH2CN + 2H2O--------------->C6H5CH2COOH + NH4+

H+

CH3CH2COOCH3---------------------->CH3CH2COOH + CH3OH

 H2O/H+ reflux

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

ANSWER

REDUCTION

4RCOOH + 3LiAlH4 ----------------->(RCH2O)4AlLi + 2LiAlO2 + 4H2

(C2H5)2O ↓

4H2O

 4RCH2OH + Al(OH)3 + LiOH

CH3CH2CH2COOH -------------------------> CH3CH2CH2CH2OH

Butanoic acid LiAlH4 Butanol

DECARBOXYLATION

CH3CH2CH2COONa + NaOH--------------->CH3CH2CH3 + Na2CO3

fuse

Kolbe synthesis

2CH3CH2COONa + 2H2O------->CH3(CH2)2CH3 +CO2 (anode) + 2NaOH + H2(cathode)

ESTERIFICATION

CH3CH2CH2COOH + CH3CH2CH2O----------->HCH3CH2CH2COO CH2CH2CH3 + H2O.