Name: Ometan Precious Efe

Course: CHEM102

Martic no:19/mhs11/109

Department:Pharmacy

College:MHS

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 Assignment answer

1.a)HCOOH----Methanoic acid

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

 c)CH3CH2CH2COOH----Butanoic acid

 d)HO2C-CO2H----Ethanoic acid

 e)CH3 (CH2)4COOH----Hexanoic acid

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

2. Physical properties of carboxylic acids

 a)Physical appearance:All simple sliphatic carboxylic acid 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 sn ice-like solid below the room temperature.

b) Boiling point:Boiling point increases with increasing relative molecular mass.

c) Solubility:Lower molecular mass of carboxylic scid with up to four carbon atoms in their molecules are soluble in water due to their ability to form hydrogen bond with water molecules. All carboxylic acids are soluble in organic solvent.

3. Industrial preparation of carboxylic acid

a) From carbon (ll) oxide:Methanoic acid (formic acid) is manufuctured by adding carbon (ll) oxide under pressure to hot aqueous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with tetraoxosulphate (lV) acid(H2SO4).

CO(NaOH)➡HCOONa(H2SO4)➡HCOOH+NaHSO4

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

HC=CH(dil.H2SO4/HgSO4)➡CH3CHO (O2/(CH3COO)2Mn)➡CH3COOH

4.a)Oxidation of primary alcohols and aldehydes:This can be used to prepare carboxylic acid using the usual oxidizing agents (that is K2Cr2O7 or KMnO4) in acidic solution.

RCH2OH (O,excess acid/KMnO4)➡RCHO (O)➡RCOOH

b)Carbonation of Grignard reagenent:Aliphatic carboxylic acids are obtained by bubbling carbon (lV)oxide into the Grignard reagnent and then hydrolyzed with dilute acid.

RMgBr+Co2( (C2H5)2O)➡RCOOMgBr (H2O/dil.acid)➡RCOOH+MgBrOH

c)Hydrolysis of nitriles (cyanide) or esters.

C6H5CH2CN+2H2O (H+)➡C6H5CH2COOH +NH4+

CH3CH2COOCH3 (H2O/H+ reflux)➡CH3CH2COOH +CH3OH

5. Chemical reaction of carboxylic acid

a)Reduction to primary alcohol

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

 (4H2O)⬇

 4RCH2OH+Al (OH)3+LiOH

b)Decarboxylation

CH3CH2CH2COONa+NaOH (fuse)➡CH3CH2CH3+Na2CO3

Kolbe synthesis

2CH3CH2COONa+2H2O(electrolysis/aq.CH3OH)➡CH3(CH2)2CH3+CO2(anode)+2NaO H+H2(cathode)

c)Esterification

CH3CH2CH2COOH+CH3CH2CH2OH (H+)↔CH3CH2CH2COOCH2CH2CH3+H2O