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100 LEVEL, MBBS

19/MHS01/200

CHM 102

1. Give the IUPAC names of the following compounds:

* HCOOH - Methanoic acid
* HOOCCH2CH2CH2COOH - Pentan-1,5-dioic acid
* CH3CH2CH2COOH - Butanoic acid
* HO2C-CO2H - Ethanedioic acid
* CH3(CH2)4COOH - Hexanoic acid
* CH3CH=CHCH2CH2COOH - Hex-4-eneoic acid

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

* Physical appearance:

Simple aliphatic carboxylic acids up to C10 are liquids at room temperature. Most other carboxylic acids are solid at room temperature though anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

* 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.

* Solubility:

Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water and this is mostly because of 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.

1. Write two industrial preparations of carboxylic acids

* 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(triple bond)-CH ––dil. H2SO4/HgSO4​––> CH3CHO ​–O2/ (CH3COO)2Mn––> CH3COOH

* 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

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

* Oxidation of primary alcohols and aldehydes

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents in acidic solution

RCH2OH [O], ——excess acid/KMnO4——> ​ RCHO ​[O]​​RCOOH

* 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 (C2H5)2O ​ ——RCOOMgBr​H2O/ dil. Acid——> ​RCOOH + MgBrOH

* Hydrolysis of nitriles (cyanides) or esters:

RCN + 2H2O —​—H+——> ​ RCOOH + NH4+ (R=alkyl or aryl radical)

RCOOR’​​ ——H2O/H+——> reflux​​​RCOOH + R’OH

C6H5CH2CN + 2H2O ——​H+​​——> C6H5CH2COOH + NH4+

CH3CH2COOCH3 ​ ——H2O/H+—> ​​reflux CH3CH2COOH + CH3OH

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

* Reduction to primary alkanol:

4RCOOH + 3LiAlH4 ​​ ––(C2H5)2O––> ​(RCH2O)4AlLi + 2LiAlO2 + 4H2

​​​​​​​​ | 4H2O

​​​​​​ 4RCH2OH + Al(OH)3 + LiOH

CH3CH2CH2COOH ​​ ––LiAlH4––> ​​CH3CH2CH2CH2OH

Butanoic acid ​​​​​Butanol

* Decarboxylation:

CH3CH2CH2COONa + NaOH ​ –––fuse–––> ​​​CH3CH2CH3 + Na2CO3

Kolbe synthesis

2CH3CH2COONa + 2H2O​ –––electrolysis/aq. CH3OH––> ​CH3(CH2)2CH3 +CO2 (anode) + 2NaOH + H2(cathode)

* Esterification:

CH3CH2CH2COOH + CH3CH2CH2OH​ <–––H+​–––> CH3CH2CH2COO CH2CH2CH3 + H2O.