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DEPARTMENT: PHARMACY

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Assignment

1. Give the IUPAC names of the following compounds

HCOOH  - Methanoic acid

  HOOCCH2CH2CH2COOH – Pentanedioic acid

CH3CH2CH2COOH- Butanoic acid

 HO2C-CO2H – Ehanedioic acid

CH3(CH2)4COOH- Hexanoic acid

 CH3CH=CHCH2CH2COOH – Hex-4-enoic acid

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

I. 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.

ii. Boiling points

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.

1. 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

* 1. Write two industrial preparations of carboxylic acids
1. 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 NaOH HCOONa H2SO4 HCOOH + NaHSO4

1. 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 (i.e K2Cr2O7 or KMnO4) in acidic solution

RCH2OH [O], excess acid/KMnO4 RCHO [O] RCOOH

* 1. With chemical equation only, outline the reduction,decarboxylation and esterification of carboxylic acid.
1. Reduction

Carboxylic acids are very difficult to reduce by catalytic hydrogenation or dissolving metals but lithium tetrahydridoaluminate (III) and diborane form intermediate compounds with the acids which liberate the alcohol on hydrolysis

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

 4H2O

 4RCH2OH + Al(OH)3 + LiOH

CH3CH2CH2COOH LiAlH4 CH3CH2CH2CH2OH

Butanoic acid Butanol

1. Decarboxylation

This involves removal of the carboxyl group from the acid to give a hydrocarbon or its derivative.

Thermal decarboxylation

Carboxylic acids with a strong electron attracting group eg –COOH, -CN, NO2, C=O decarboxylate readily on heating to 100-150oC while others decarboxylate when their salts are heated with soda lime

CH3CH2CH2COONa + NaOH fuse CH3CH2CH3 + Na2CO3

1. Esterification

In the presence of strong acid catalyst, carboxylic acids react with alcohols to form esters

CH3CH2CH2COOH + CH3CH2CH2OH H+ CH3CH2CH2COO CH2CH2CH3 + H2O.