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 ANSWERS

1) IUPAC names of the following compounds

* 1. HCOOH – Methanoic acid
	2. HOOCCH2CH2CH2COOH – Penta-1,5-doic acid
	3. CH3CH2CH2COOH – Benzoic acid
	4. HO2C-CO2H- Ethanedioic acid
	5. CH3(CH2)4COOH –Hexanoic acid
	6. CH3CH=CHCH2CH2COOH - Hexan-4- noic acid
1. Physical properties of carboxylic acid

Physical appearance

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) 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; 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.Industrial preparation**

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

**4 SYNTHETIC PREPARATIONS OF CARBOXYLIC ACIDS**

There are a lot of ways to prepare the carboxylic acid synthetically, but I will just state two briefly with the respective equations.

 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

 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.**

 **Reduction to primary alcohol**

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

**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

Kolbe synthesis

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

**Esterification**

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

CH3CH2CH2COOH + CH3CH2CH2OH H+ CH3CH2CH2COO CH2CH2CH3 + H2O.