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**1.**

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.**

**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.

**iii. 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.

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

**2. 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.

**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

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 (C2H5)2O C6H5COOMgBr H2O/H+ C6H5COOH + MgBrOH

5.

**reduction**

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.