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1. A. $HCOOH$ Methanoic acid

   B. $HOOCCH_2CH_2CH_2COOH$ Pentan-1,5-dioic acid

   C. $CH_3CH_2CH_2COOH$ Butanoic acid

   D. $HO_2C\text{-}CO_2H$ Ethanedioic acid

   E. $CH_3(CH_2)_4COOH$ Hexanoic acid

   F. $CH_3CH=CHCH_2CH_2COOH$ Hex-4-eneoic acid

2. i. Physical appearances:

All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most other carboxylic acids are solid at room temperature although anhydrous carboxylic 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 due to their ability to form hydrogen bonds with water molecules. The water solubility of the acids decreases as the relative molecular mass increases they are soluble in organic solvents.

3. i. From Carbon(II) oxide:

Methanoic acid is manufactured by adding carbon monoxide under pressure to hot aqueous solution of NaOH. The free carboxylic acid is liberated by careful reaction with (H_2SO_4)

$$CO \xrightarrow{NaOH} HCOONa \xrightarrow{H_2SO_4} HCOOH + NaHSO_4$$

ii. 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

$$HC \equiv CH \xrightarrow{\text{dil. } H_2SO_4/HgSO_4} CH_3CHO \xrightarrow{O2/\ (CH3COO)2Mn} CH_3COOH$$

4. Synthetic preparation of carboxylic acid by 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 $K_2Cr_2O_7$ or $KMnO_4$) in acidic solution

   $$RCH_2OH \xrightarrow{[O],\ \text{excess acid/KMnO4}} RCHO \xrightarrow{[O]} RCOOH$$

5. A. REDUCTION OF CARBOXYLC ACID

   $$RCOOH + 4[H] \longrightarrow RCH_2OH + H_2O$$

   B. ESTERIFICATION OF CARBOXYLC ACID

   $$RCOOH + R`OH \longleftrightarrow RCOOR` + H_20$$