

- ① Methanoic acid  
 Pentan-1,5-dioic acid  
 Butanoic acid  
 Ethanedioic acid  
 Hexanoic acid  
 Hex-4-enedioic acid

② a) Physical appearance: All simple aliphatic carboxylic acids up to C<sub>10</sub> are liquid at room temperature. Most other carboxylic acids are solids at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes an ice-like solid below room temperature.

i) Boiling point: This increases with increasing relative molecular masses. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative mass.

ii) Solubility: Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water. This is largely due to their ability to form hydrogen bonds with water molecules.

③ a) <sup>Petroleum</sup> C<sub>5</sub>-C<sub>7</sub>  $\xrightarrow{\text{O}_2/\text{high temperature and pressure}}$  C<sub>5</sub>-C<sub>7</sub> carboxylic acid

b)  $\text{HC}\equiv\text{CH} \xrightarrow{\text{dil. H}_2\text{SO}_4/\text{HgSO}_4} \text{CH}_3\text{CHO} \xrightarrow{\text{O}_2/\text{[C}_4\text{H}_7\text{(COO)]}_2\text{Mn}}$   $\text{CH}_3\text{COOH}$

