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Answers

1(i) HCOOH – Methanoic acid
1.(ii) $HOOCCH_2CH_2CH_2COOH$ – Pentane-1,2-dioic acid
1.(iii) $CH_3CH_2CH_2COOH$ – butanoic acid
1.(iv) HO_2C-CO_2H – ethane-1,2,-dioic acid
1(v) $CH_3(CH_2)_4COOH$ – Hexanoic acid
1(vi) $CH_3CH=CHCH_2CH_2COOH$ – Hex-4-enedioic acid

2.(i) Physical appearance: Simple aliphatic carboxylic acids up to carbon atom up to 10 are liquids at room temperature. Most other carboxylic acids are solid at room temperature. Although acetic acid (anhydrous carboxylic acid) freezes to ice-like solid below room temperature.

(ii) Boiling points: The higher the number of carbon atom and relative molecular weight. The higher the boiling point. Aromatic carboxylic acid are crystalline solids and have higher boiling point than their counterpart aliphatic counterpart comparable to the relative molecular mass.

(iii) Solubility: Carboxylic acid with ~~dpcar~~ up to 4 carbon atoms are soluble in water due to the ability of forming hydrogen bond. Solubility generally decreases with increasing molecular weight. All organic carboxylic acid are soluble in organic solvent.

3. Industrial Preparations include.

i) From Carbon (II) oxide

Methanic acid (formic acid) is manufactured by adding CO under pressure to hot aqueous solution of sodium hydroxide. 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 Petroleum

Liquid phase air oxidation of C_5-C_7 alkanes, obtainable from petroleum at high temperature and pressure would give C_5-C_7 carboxylic acid with methanoic acid, butanoic acid and propanoic acid as by products

$$C_5 \rightarrow C_7 \text{ alkanes} \xrightarrow{O_2/\text{high pressure \& temperature}} C_5\text{-}C_7 \text{ carboxylic acid}$$

4. Synthetic preparations

1. Oxidation of primary alcohols and aldehydes using oxidising agents like $KMnO_4$ or $K_2Cr_2O_7$ in acidic solution

Example:

$$CH_3CH_2OH \xrightarrow{[O], KMnO_4/\text{(excess) acid}} CH_3CHO \xrightarrow{[O]} CH_3COOH.$$

2. Carbonation of Grignard reagent

Aliphatic carboxylic acid are obtained by bubbling carbon (IV) oxide into the grignard reagent reagent and then hydrolyzed with dilute acid

Example

$$CO_2 + CH_3MgBr \xrightarrow{(C_2H_5)_2O} CH_3CO\text{-}OMgBr \xrightarrow{H_2O/\text{dilacid}} CH_3COOH + MgBrOH$$

Question 4

3. Hydrolysis of nitriles (cyanides) or esters

(i) Hydrolysis of nitrile

$$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+$$

Example: $CH_3CN + 2H_2O \rightarrow CH_3COOH + NH_4^+$

(ii) Hydrolysis of esters

$$RCOOR' + H_2O \xrightarrow{H^+/reflux} RCOOH + R'OH$$

Example: $CH_3COOCH_3 \xrightarrow{H^+/reflux} CH_3COOH + CH_3OH$

5.

(i) Reduction of carboxylic acid to primary alcohols

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

(ii) Decarboxylation

$$CH_3CH_2CH_2COONa + NaOH \xrightarrow{fuse} CH_3CH_2CH_3 + Na_2CO_3$$

(iii) Esterification

$$CH_3CH_2CH_2COOH + CH_3OH \xrightarrow{H_2SO_4} CH_3CH_2CH_2COOCH_3 + H_2O$$