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CHEM 102 ASSIGNMENT (CARBOXYLIC ACIDS)

(1) Give the IUPAC names of the following

→ HCOOH - Methanoic acid

→ $HOOCCH_2CH_2CH_2COOH$ = Pentan-1,5-dioic acid

→ $CH_3CH_2CH_2COOH$ - Butanoic acid

→ HO_2C-CO_2H - Ethanedioic acid

→ $CH_3(CH_2)_4COOH$ - Hexanoic acid

→ $CH_3CH=CHCH_2CH_2COOH$ = Hex-4-enoic acid

(2) Discuss briefly the physical properties of Carboxylic acids under the following headings

→ Physical appearances: All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. most other Carboxylic acids are Solid at room temp. although anhydrous Carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like Solid below the room temperature.

→ Boiling Points: This increases with increasing relative Molecular Mass. Aromatic Carboxylic acids are Crystalline Solids and have higher Melting points than their aliphatic Counterparts of Compareable 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 Solvent.

③ Write 2 Industrial preparations of Carboxylic acids

Ans: → 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 (H_2SO_4)

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

→ From ethanol

Ethanoic acid is obtained Comercially by the liquid phase air-Oxidation of 5% Solution of ethanol to ethanoic acid using Manganese (II) ethanoate Catalyst. Ethanol itself is Obtained from ethylene

$$HC \equiv CH \xrightarrow{dil.\ H_2SO_4/HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$$

④ With equations and brief explanation discuss the Synthetic prep. of Carboxylic acid

Ans → Oxidation of Primary alcohol and aldehydes: The oxidation of Primary alcohols and aldehydes can be used to prepare Carboxylic acids using Oxidizing agents ($K_2Cr_2O_7$ or $KMnO_4$) in acidic Solution

$$RCH_2OH \xrightarrow{[O]\ excess\ acid/KMnO_4} RCHO \xrightarrow{[O]} RCOOH$$

⑤ With Chemical equation Only, Outline the reduction, decarboxylation and esterification of Carboxylic acid.

Ans: Reduction:

$$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + 4H_2$$

$$\downarrow 4H_2O$$

$$4RCH_2OH + Al(OH)_3 + LiOH$$

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

⇒ Decarboxylation:

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

Kolbe Synthesis

$2CH_3CH_2COONa + 2H_2O \xrightarrow{\text{electrolysis aq. } CH_3OH} CH_3(CH_2)_2CH_3 +$

CO_2 (anode) +

$2NaOH + H_2$ (cathode)

⇒ Esterification

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xleftrightarrow{H^+} CH_3CH_2CH_2COOCH_2CH_3 + H_2O$