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19/MHS01/393
MEDICINE AND SURGERY
CHM 102
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ASSIGNMENT ON CARBOXYLIC ACIDS

1. **Give the IUPAC names of the following compounds:**

   HCOOH ———> Methanoic acid
   $HOOCCH_2CH_2CH_2COOH$ ———> Pentan-1,5-dioic acid
   $CH_3CH_2CH_2COOH$———> Butanoic acid
   $HO_2C\text{-}CO_2H$ ———> Ethanedioic acid
   $CH_3(CH_2)_4COOH$ ———> Hexanoic acid
   $CH_3CH{=}CHCH_2CH_2COOH$ ———> Hex-4-eneoic acid

2. **Discuss briefly the physical properties of carboxylic acids under the following headings:**
   I. **Physical appearance:** All simple aliphatic carboxylic acids that are up to C_{10} are liquids at room temperature. Most of the other carboxylic acids are solid at room temperature but anhydrous carboxylic acid (acetic acid) which is also known as glacial ethanoic acid freezes to an ice-like solid when it is below the room temperature.
   II. **Boiling temperature:** The boiling point of carboxylic acids increases with increasing relative molecular mass. The aromatic carboxylic acids are crystalline solids and therefore have a higher melting points than their corresponding aliphatic counterparts of comparable relative molecular mass.
   III. **Solubility:** Lower molecular mass carboxylic acids which have up to four carbon atoms within their molecules are soluble in water. This is due to their ability to form hydrogen bonds with the water molecules.
   The solubility of carboxylic acids in water decades as the relative molecular mass increases, due to the fact that their structure becomes relatively more hydrocarbon in nature and therefore covalent. However, all carboxylic acids are soluble in organic solvents.

3. **Write two industrial preparations of carboxylic acids.**
   I. **From carbon(II) oxide**
   Methanoic acid also known as formic acid is manufactured through the addition of 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)

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

II. **From petroleum**

Liquid phase air oxidation of C_3-C_7 alkanes, which can obtained from petroleum at very high temperature and pressure which will give C_5-C_7 carboxylic acids with methanoic acids, propanoic acids and butanedioic acids as a by product.

4. **With equations and brief explanation discuss the synthetic preparation of carboxylic acid**

There are three synthetic preparation of carboxylic acids and they are :

- **Oxidation of primary alcohols and aldehydes:** The oxidation of primary alcohols and aldehydes can be used for the preparation of carboxylic acids by using the oxidation agents ($K_2Cr_2O_7$ or $KMnO_4$) in acidic solution.

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

- **Carbonation of Grignard reagent:** Aliphatic carboxylic acids can be obtained by bubbling Carbon(IV) oxide into the Grignard reagent and then hydrolyse the mixture with dilute acid.

$$RMgBr + CO_2 \xrightarrow[(C_2H_3)_2O]{} RCOOMgBr \xrightarrow[H_2O/\text{dil.acid}]{} RCOOH + MgBrOH$$

*R can be 1°,2°, 3° aliphatic alkyl or aryl radical.

- **Hydrolysis of nitriles (cyanides) or esters:**

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

*R can be alkyl or aryl radical

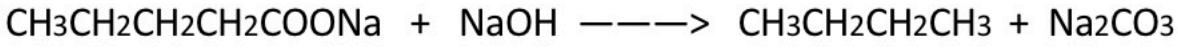
$$RCOOR' \xrightarrow[H_2O/H+\ \text{reflux}]{} RCOOH + R'OH$$

5. **With chemical equations only, outline the reduction, decarboxylation and esterification of carboxylic acids**

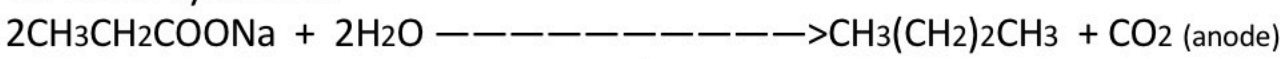
- **Reduction to primary alcohols**:

$$\underset{\text{Butanoic acid}}{CH_3CH_2CH_2COOH} \xrightarrow[(liAlH_4)]{} \underset{\text{Butanol}}{CH_3CH_2CH_2CH_2OH}$$

- **Decarboxylation**:



Or Kolbe synthesis:



- **Esterification**: