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DEPARTMENT: NURSING

ASSIGNMENT TITLE: ASSIGNMENT ON CARBOXYLIC ACID

COURSE CODE: CHM 102

1. Give the IUPAC names of the following compounds.

- HCOOH- Methanoic acid
- HOOCCH2CH2CH2COOH- Pentan-1,5-dioic acid
- CH3CH2CHCOOH- Butanoic acid
- HO2C-CO2H- Ethanedioic acid
- CH3(CH2)4COOH-Hexanoic acid
- CH3CH=CHCH2CH2COOH- Hex-4-eneoic acid

2. Discuss briefly the physical properties of carboxylic acids under the following headings

- Physical apperance: All simples aliphatic carboxylic acids up to C10 are liquids at room temperarure. Most other carboxylic acids are solid at room temperature although annhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice like solid below the room temperature.

- Boiling points: Boiling points increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids have higher melting points than their aliphatic counterparts of comparable 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 from 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 solvents.

3. Write two industrial preparations of carboxylic acids.

- From carbon(ii) oxide: Methanoic 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 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.

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

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

- Oxidation of primary alcohols and aldehydes: oxidation of primary alohols and aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents (i.e k2cr2O7 or KmnO4) in acidic solution

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

- Carbonation of Gringard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon(IV) oxide into the Gringnard reagent and then hydrolyzed with dilute acid.

$$RMgBr + CO_2 \xrightarrow{(C_2H_3)_2O} RCOOMgBr \xrightarrow{H_2O/Dil.\ acid} RCOOH + MgBrOH$$

- Hydrolysis of nitriles(cyanides) or esters

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

H_2O/H^+ reflux

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

$C_6H_5CH_2CN + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+$

$CH_3CH_2COOCH_3 \xrightarrow{H_2O/H^+ \text{reflux}} CH_3CH_2COOH + CH_3OH$

5. With chemical equation only, outline the reduction, decarboxylation and esterification of carboxylic acid.

$4RCOOH + 3LiAlH_4 \rightarrow (RCH_2O)_4AlLi + 2LiAlO_2 + 4H_2$

$(RCH_2O)_4AlLi + 4H_2O \rightarrow 4RCH_2OH + Al(OH) + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid butanol

- Decarboxylation

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

Kolbe synthesis

$$2CH_3CH_2COONa + 2H_2O \xrightarrow[\text{Electrolysis/aq. } CH_3OH]{} CH_3(CH_2)_2CH_3 + CO_{2(Anode)} + 2NaOH + H_{2(cathode)}$$

- Estherification

$$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xleftrightarrow{H^+} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$$