NAME: Ike-Egbuonu Marvellous Chinelo
MATRIC NO: 19/SC109/003
DEPT: Industrial Chemistry
LECTURER: [redacted] Mr. Jonathan Johnson. 1002

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-CO_2H Ethan-1,2-dioic acid.
$CH_3CH=CHCH_2CH_2COOH$ - Hex-4-eneoic acid

2i Physical appearance: All simple aliphatic carboxylic acids up to C_{10} are liquids at room temperature. Most other carboxylic acids are solids at room temperature although acetic acid (glacial ethanoic acid) freezes to an ice-like solid below room temperature

ii Boiling point: It 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.

iii. Solubility: The water solubility of the acids decrease as the RMM increases because the structure becomes relatively more hydrocarbon in nature & hence covalent. All carboxylic acids are soluble in organic solvents.

3i) Preparation from Carbon (II) oxide: Methanoic acid can be prepared 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)

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

methanoic acid

ii) Preparation from petroleum: Liquid phase air oxidation of C_5-C_7 alkanes, obtainable from petroleum at high temperature & pressure will give C_5-C_7 carboxylic acids with methanoic, propanoic and butanedioic acids as by-products.

$$C_5-C_7 \xrightarrow{O_2/\text{High temperature and pressure}} C_5-C_7 \text{ carboxylic acids}$$

4i Oxidation of primary alcohols and aldehydes: Oxidation of primary alcohols & aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents (i.e. $K_2Cr_2O_7$ or $KMnO_4$) in acidic solution.

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

ii. Carbonation of Grignard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon (IV) oxide into the Grignard reagent & then hydrolyzed with dilute acids.

$$RMgBr + CO_2 \xrightarrow{(C_2H_5)_2O} RCOOMgBr \xrightarrow{H_2O/\text{dil. acid}} RCOOH + MgBrOH$$

iii Hydrolysis of nitriles (cyanides) or esters

$$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+ \quad (R = \text{alkyl or aryl radical})$$

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

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

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

Reduction to primary alcohol:

$$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$$

Butanoic acid — Butanol

ii. Decarboxylation:

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

iii. Esterification

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