NAME: NARIBO AWAJIGBANAM A.
DEPARTMENT: AGRICULTURAL SCIENCE
MATRIC NO.: 19/SC107/009
LEVEL: 100 LEVEL
COURSE TITLE: GENERAL CHEMISTRY II
CHM102 ASSIGNMENT

1. a $HCOOH$ Methanoic acid.
b. $HOOCCH_2CH_2CH_2COOH$ Pentan-1,5,dioicacid
c. $CH_3CH_2CH_2COOH$ Butanoic acid.
d HO_2C-CO_2H Ethanedioic acid.
e $CH_3(CH_2)_4COOH$ Hexanoic acid.
f $CH_3CH=CHCH_2CH_2COOH$ Hex-4-enoic acid

2. Discuss briefly the physical properties of carboxylic acids under the following headings.
a. Physical appearances: All simple aliphatic Carboxylic acids up to C_{10} and liquids at room temperature. Most other carboxylic acids are solid at room temperature although anhydrous carboxylic acid (aceticacid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

b. Boiling point: Boiling point increasing with relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass.

c. 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 solvents.

3a. 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).

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

b. From Ethanol:

Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganese(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 Synthetic Preparation of Carboxylic acid

a. Oxidation of Primary alcohols and aldehydes:

This process can be used to prepare carboxylic acids using the usual oxidizing agent (i.e. $K_2Cr_2O_7$ or $KMnO_4$) in acidic solution.

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

b. Carbonation of Grignard reagent:

Aliphatic carboxylic acids are obtained by

bubbling Carbon (IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid.

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

R may be 1°, 2°, 3° aliphatic aryl or aryl radical.

In the preparation of benzoic acid, the reagent is added to solid Carbon (IV) oxide (dry ice) which also serves as coolant to the reaction mixture.

$C_6H_5MgBr + CO_2 \xrightarrow{(C_2H_5)_2O} C_6H_5COOMgBr \xrightarrow{H_2O/H^+}$

$C_6H_5COOH + MgBrOH$

C. Hydrolysis of nitriles (cyanides) or esters

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

(R = alkyl or aryl radical)

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

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

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

5a Reduction;

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

$(RCH_2O)_4AlLi \xrightarrow{4H_2O} 4RCH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid — Butanol

Decarboxylation:

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

Kolbe Synthesis

$2\,CH_3CH_2COONa + 2H_2O \xrightarrow{electrolysis\ aq\ CH_3OH} CH_3(CH_2)_2CH_3 + CO_2\,(anode) + 2NaOH + H_2\,(cathode)$

Esterification:

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