

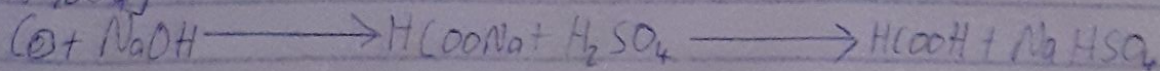
1. HCOOH - Methanoic acid
 $\text{HOOCCH}_2\text{CH}_2\text{COOH}$ - Pentan-1,5-dioic acid
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ - Butanoic acid
 $\text{HO}_2\text{C}-\text{CO}_2\text{H}$ - Ethanedioic acid
 $\text{CH}_3(\text{CH}_2)_4\text{COOH}$ - Hexanoic acid
 $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{COOH}$ - Hex-4-enoic acid

2. Physical properties of Carboxylic acid

- i. Physical appearances: All simple aliphatic carboxylic acid to C_{10} are in liquid state at room temperature. Most other carboxylic acids are in solid state at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.
- ii. Boiling point: Boiling point increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass.
- iii. Solubility: Lower molecular mass carboxylic acids with up to four carbon atom 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.

3. Two industrial preparations of carboxylic acids:

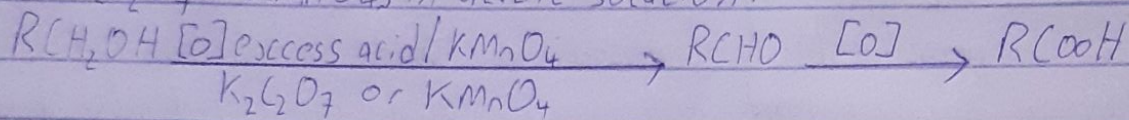
- i. From carbon(II) oxide: Methanoic acid (formic acid) is manufactured by adding carbon(II) oxide under pressure to hot aqueous solution of sodium hydroxide. The free carboxylic acid is liberated by careful reaction with tetraoxosulphate(VI) acid (H_2SO_4)



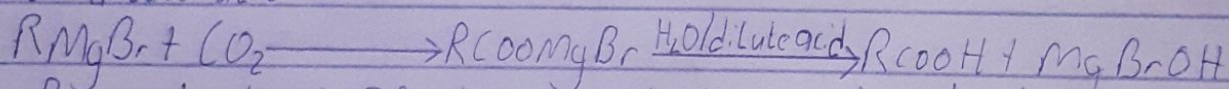
- i) From petroleum: Liquid phase air oxidation of C₅-C₇ alkanes, obtainable from petroleum at high temperature and pressure will give C₅-C₇ carboxylic acids with methanoic, propanoic and butanedioic acids as by-products.
- $$C_5-C_7 \xrightarrow{O_2 / \text{High Temperature and Pressure}} C_5-C_7 \text{ carboxylic acids}$$

4 Explanation of the synthetic preparation of carboxylic acid

- i) Oxidation of primary alcohols and aldehydes: It can be used to prepare carboxylic acids using the usual oxidizing agents (i.e. ~~K₂C₂O₇~~ or KMnO₄) in acidic solution.

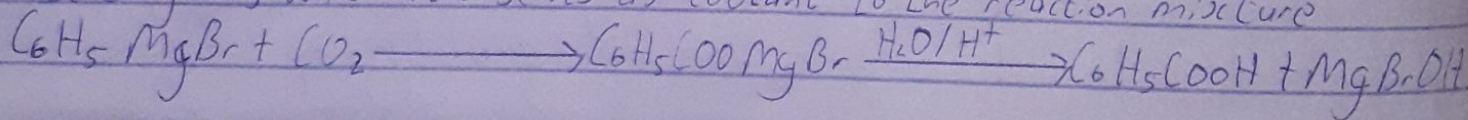


- ii) Carboxylation of Grignard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon(IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid.

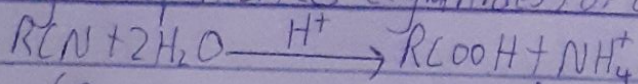


R may be 1°, 2°, 3° aliphatic alkyl or aryl radical

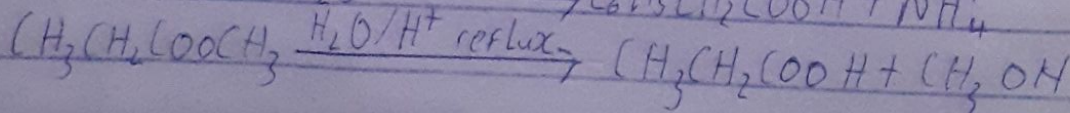
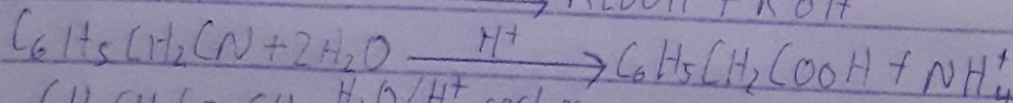
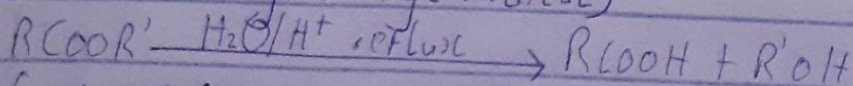
In the preparation of benzoic acid, the reagent is added to solid carbon(IV) oxide (dry ice) which also serves as coolant to the reaction mixture



- iii) Hydrolysis of nitriles (cyanides) or esters

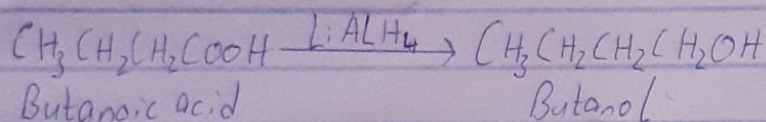
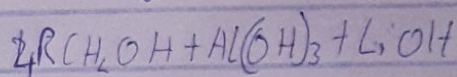
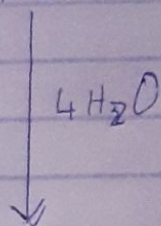
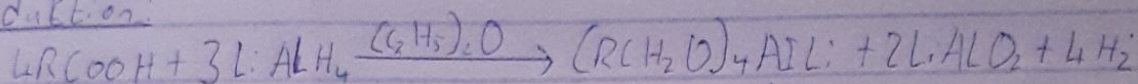


(R = alkyl or aryl radical)



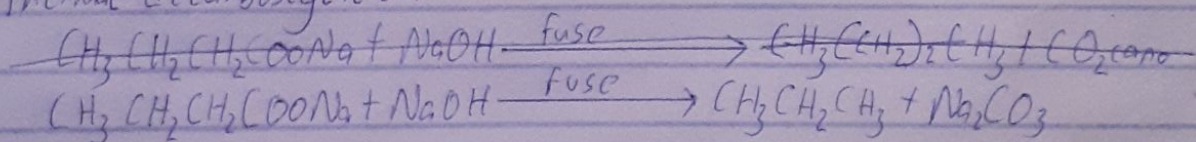
5) Outline the reduction, decarboxylation and esterification of carboxylic acid with their chemical equations

i) Reduction:

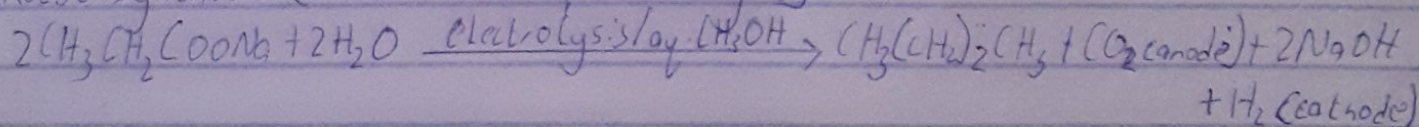


ii) Decarboxylation: They are two derivative of decarboxylation which are:

Thermal decarboxylation



Kolbe synthesis (involvement of electrolysis)



iii) Esterification

