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Course code: CHM102

1. Name the IUPAC names present in each of the following molecules compounds.

- i.  $\text{HCOOH}$  (ii)  $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH}$   
iii.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$  (iv)  $\text{HO}_2\text{C}-\text{CO}_2\text{H}$   
v.  $\text{CH}_3(\text{CH}_2)_4\text{COOH}$  (vi)  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{COOH}$

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

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

i. Physical appearance (ii) Boiling point (iii) solubility

i. Physical appearance: All simple aliphatic carboxylic acids up to  $\text{C}_{10}$  are liquids at room temperature. Most other carboxylic acids are solid at room temperature although acetic acid (also known as glacial ethanoic acid) freezes to an ice-like solid below the room temperature.

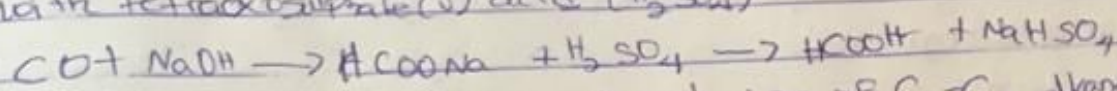
ii. Boiling point: Boiling point increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular mass.



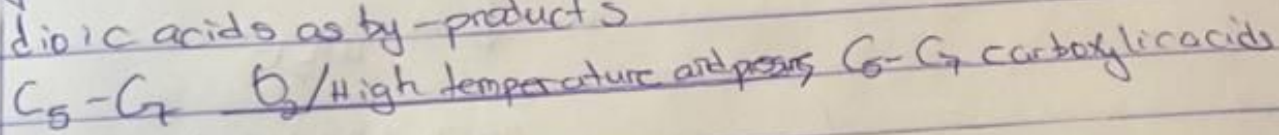
iii solubility: Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water, this is largely due to their ability to form hydrogen bonds with water molecules. The water solubility of the acids decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in organic solvents.

3. Write two industrial preparations of carboxylic acids

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

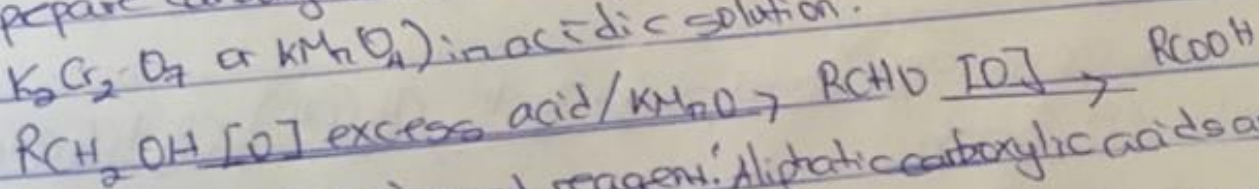


ii. From petroleum: Liquid phase air oxidation of  $C_5-C_7$  alkanes, obtainable from petroleum at high temperature and pressure will give  $C_5-C_7$  carboxylic acids with methanoic, propanoic and butane dioic acids as by-products

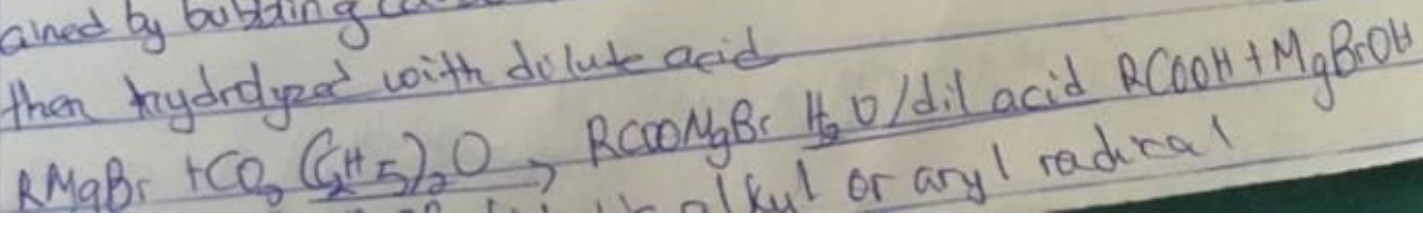


4. With equations and brief explanation discuss the synthetic preparation of carboxylic acid

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

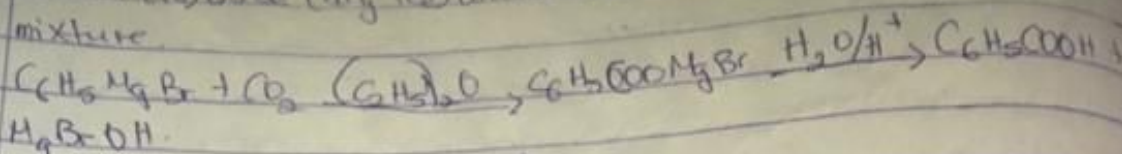


ii. Carbonation of Grignard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon (IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid

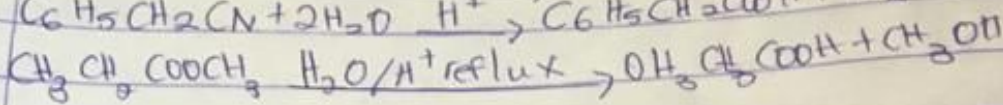
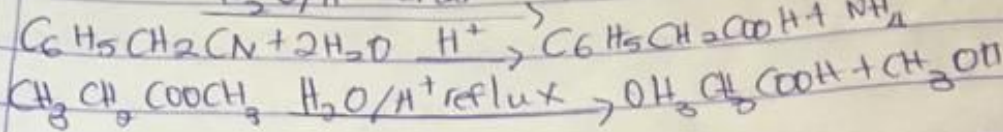
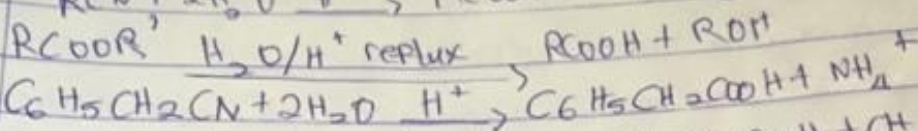
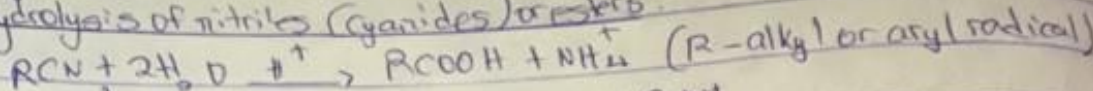




In the preparation of benzoic acid, the reagent added to ethyl carbon (iv) oxide (dry ice) which also serves as a catalyst to the reaction mixture.

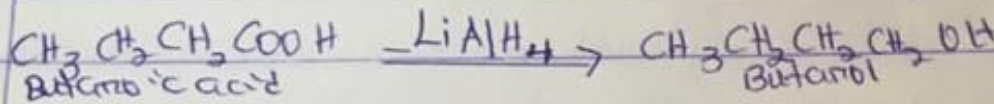
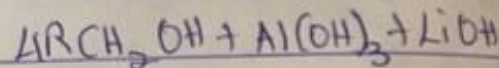
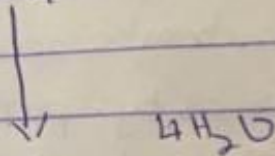
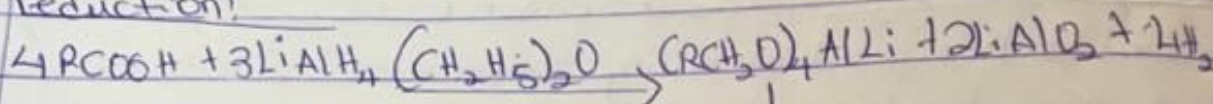


ii: Hydrolysis of nitriles (cyanides) or esters:

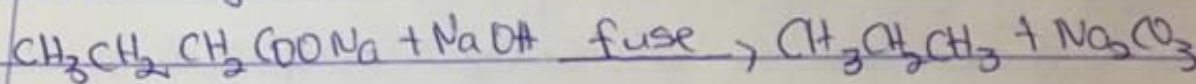


5. With chemical equation only outline the reduction, decarboxylation and esterification of carboxylic acid

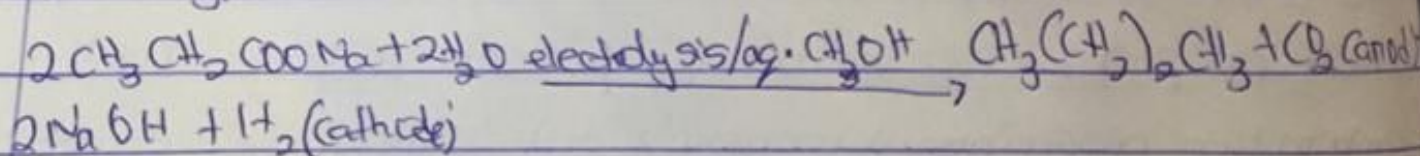
i: reduction!



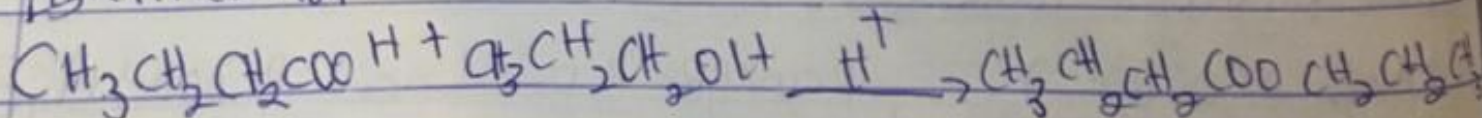
ii: Decarboxylation!



Kolbe synthesis



iii: Esterification



H<sub>2</sub>O