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19/MHS01/344

Medicine and Surgery

Carboxylic acid assignment

1. Give the IUPAC names of the following compounds

HCOOH - Methanoic acid

HOOCCH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>COOH. - pentan-1,5-dioic acid

CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH . . - butanoic acid

HO<sub>2</sub>C-CO<sub>2</sub>H. -. Ethanedioic acid

CH<sub>3</sub>(CH<sub>2</sub>)<sub>4</sub>COOH . -. Hexanoic acid

CH<sub>3</sub>CH=CHCH<sub>2</sub>CH<sub>2</sub>COOH. - Hex-4-eneoic acid.

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

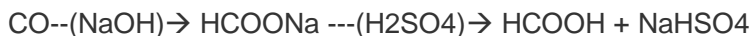
- i. Physical appearance. Simple aliphatic carboxylic acids up to C<sub>10</sub> are liquids at room temperature. Most are colourless liquids with disagreeable odours. The acids with higher than 10 carbon atoms are wax-like solids at room temperature although anhydrous carboxylic acid (acetic acid) freezes to an ice-like solid below room temperature. Their odours decrease with increasing molar mass.
- ii. Boiling point boiling points increases in carboxylic acids with increasing molar mass as they exhibit strong hydrogen bonding between molecules and therefore have high boiling points compared to other organic compounds of relative molecular mass. Aromatic carboxylic acids are crystalline solids with higher melting points than their aliphatic counterparts of relative molecular mass.
- iii. Solubility. Carboxylic acids with atoms up to four carbon atoms are completely soluble in water this is because they form hydrogen bonds with water molecules. Solubility from here on decreases with increasing number of carbon atoms because the structure becomes more hydrocarbon in nature and hence covalent making it insoluble in water. But a carboxylic acids are soluble in organic solvents.

3. Write two industrial preparations of carboxylic acids

- I. From ethanol. Ethanoic acid is produced from Ethanol through oxidation. Commercially it is produced by the liquid air phase oxidation of 5% solution of ethanal which is gotten from the oxidation of ethanol a catalyst of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> can be used.



- II. 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<sub>2</sub>SO<sub>4</sub>)



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

- a. Oxidation of primary alcohols and aldehydes. Oxidation of primary alcohols and 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



- b. Carbonation of grignard reagent. Carbonation is the addition of  $CO_2$  aliphatic carboxylic acids are obtained by bubbling  $CO_2$  into the grignard reagent and then hydrolyzed with dilute acid



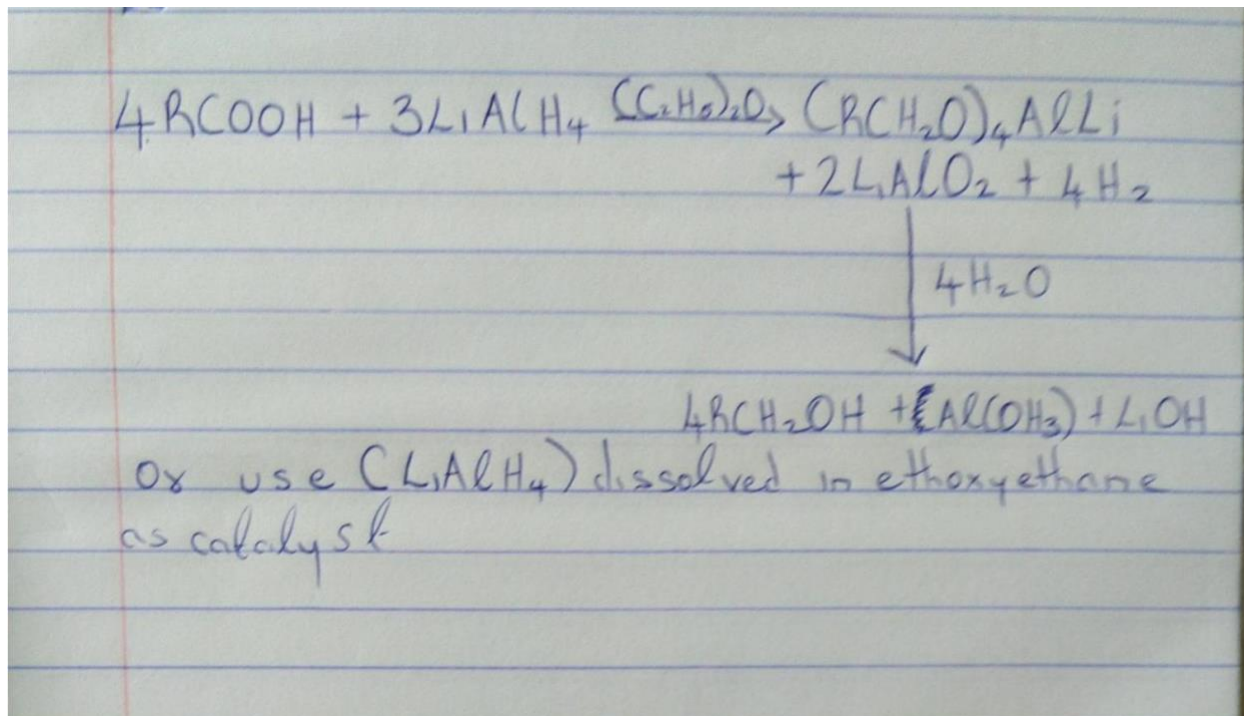
Where R may be  $1^\circ$ ,  $2^\circ$ , or  $3^\circ$  aliphatic alkyl or aryl radical.

In preparation of benzoic acid, the reagent is added to solid  $CO_2$  (dry ice) which serves also as a coolant to the reaction mixture.



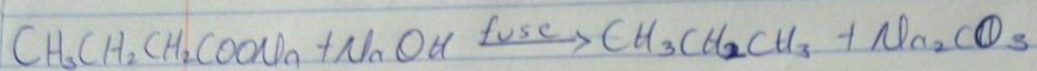
5. With chemical equation only, outline the reduction, decarboxylation and esterification of carboxylic acid

- i. Reduction to primary alcohol. Carboxylic Acids are very difficult to reduce by catalytic hydrogenation or dissolving metals but lithium tetrahydroaluminate (III) and diborane form intermediate compounds with the acids which liberate the alcohol on hydrolysis.

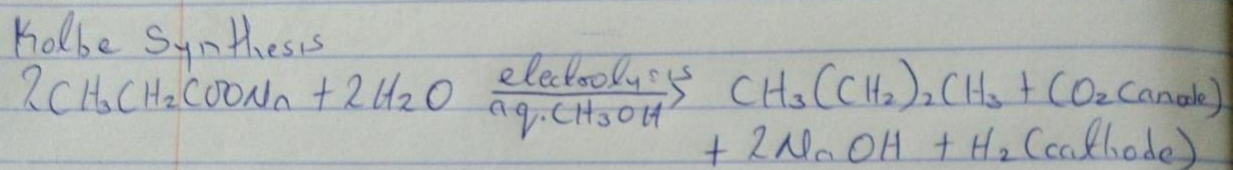


- ii. Decarboxylation of carboxylic acids

Thermal decarboxylation



Hofbe Synthesis



iii. Esterification of carboxylic Acids

