

CARBOXYLIC ACIDS

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COURSE: CHM 102

Assignment: Carboxylic Acids

1) Give the IUPAC names of the following compounds

- i) 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.

Answer

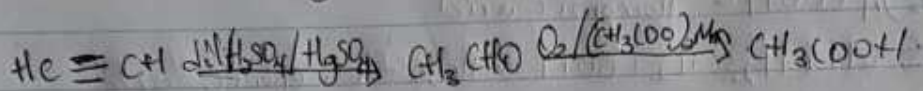
i. Physical appearance: All simple aliphatic acids up to C_{10} are liquids at room temperature. Most other carboxylic acids are solids at room temperature, although, anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to a ice-like solid below the room temperature.

ii. Boiling points: This 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.

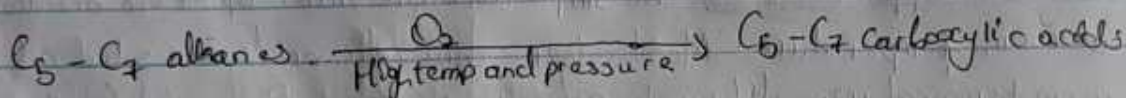
iii. Solubility: Lower molecular mass carboxylic acids with up to four carbon atoms in their molecules are soluble in water, this is largely due to their ability to form hydrogen bonds with water molecules. The water solubility of acids decreases as the relative molecular mass increases because the structure 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 ethanol: Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanol to ethanoic acid using manganese(II) ethanoate catalyst. Ethanol itself is obtained from ethylene.



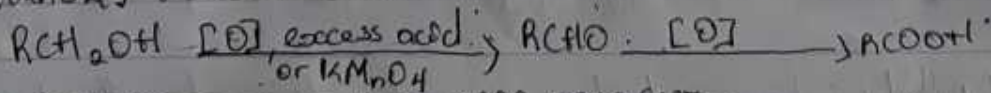
ii) From petroleum: Liquid phase air oxidation of C₅-C₇ alkanes, obtainable from petroleum at high temperature and pressure will give C₅-C₇ carboxylic acids with methanoic, propanoic and butanoic acids as by-products.



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

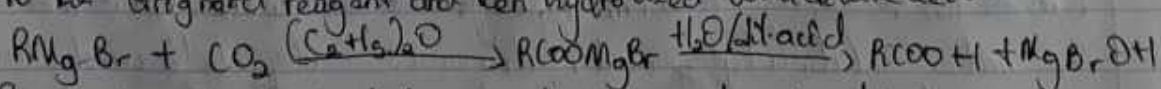
i) Oxidation of primary alcohols and aldehydes

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the oxidizing agents (i.e. K₂Cr₂O₇ or KMnO₄) in acidic solution.



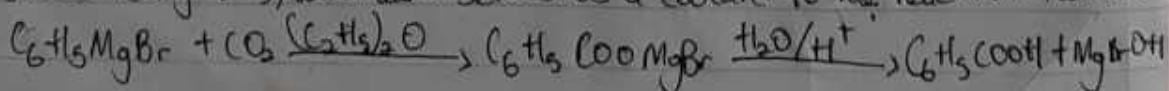
ii) CARBONYLATION OF GRIGNARD REAGENT

A) Aliphatic carboxylic acids are obtained by bubbling carbon (I) oxide into the Grignard reagent and then hydrolyzed with dilute acid.

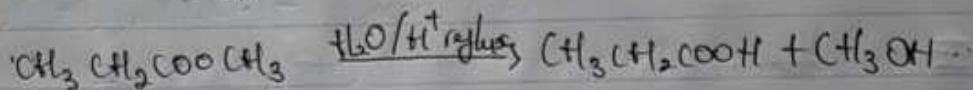
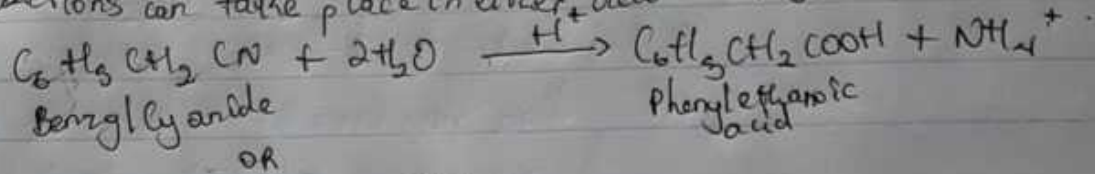


R may be 1°, 2°, 3° aliphatic alkyl or aryl radical.

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

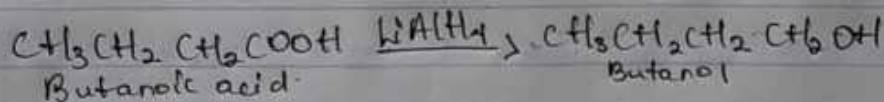
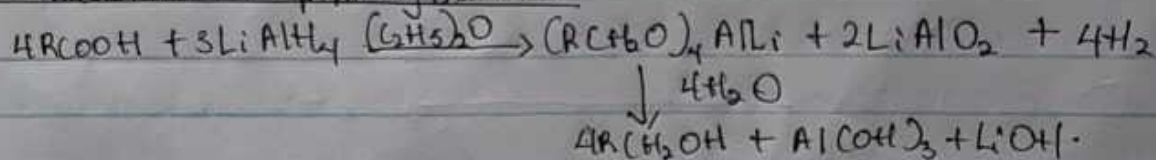


31) Hydrolysis of nitriles (cyanides) or esters
 Hydrolysis of nitriles which are organic ^{molecules} compounds containing a cyano group, leads to carboxylic acid formation. These hydrolysis reactions can take place in either acidic or basic solutions!



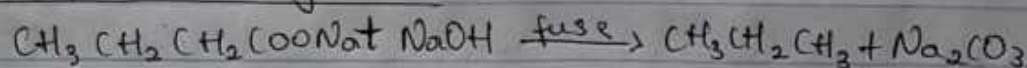
B) With chemical equations only, outline the reduction, decarboxylation and esterification of carboxylic acid.

i) Reduction to primary alcohols

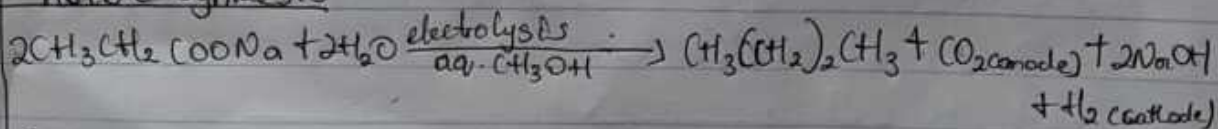


ii) Decarboxylation

i) Thermal decarboxylation



ii) Kolbe synthesis



3)

3) Esterification

