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DEPARTMENT: MEDICINE AND SURGERY  
MATRIC NUMBER: 19/MHS01/337  
COURSE CODE:

1. Give the IUPAC names of the following compounds

(A)  $\text{HCOOH}$  - Methanoic acid

(B)  $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH}$  - Pentan-1,5-dioic acid

(C)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$  - Butanoic acid

(D)  $\text{HO}_2\text{C}-\text{CO}_2\text{H}$  - Ethanedioic acid

(E)  $\text{CH}_3(\text{CH}_2)_4\text{COOH}$  - Hexanoic acid

(F)  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{COOH}$  - Hex-4-eneoic 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 anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

**ii. Boiling points:** 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:** The solubility of carboxylic acids in water is similar to that of alcohols, aldehydes, and ketones. Acids with fewer than about five carbons dissolve in water; those with a higher molecular weight are insoluble owing to the larger hydrocarbon portion, which is hydrophobic.

3. Write two industrial preparations of carboxylic acids

**(A) 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>)

**(B) From ethanal**

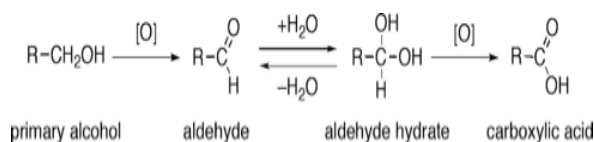
Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganite

(II) ethanoate catalyst. Ethanal itself is obtained from ethylene

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

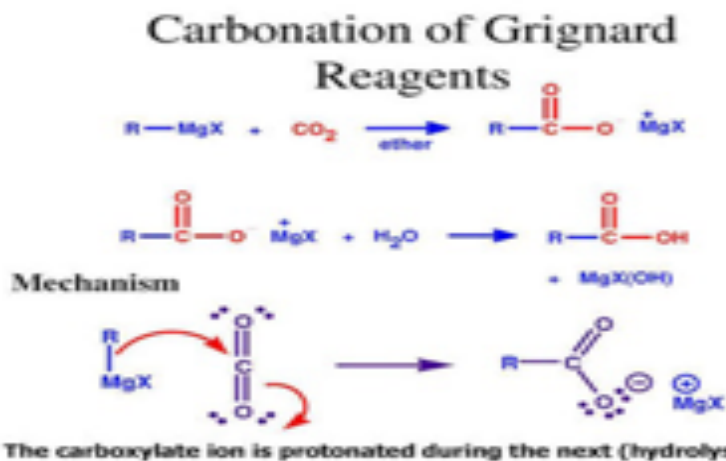
**1. Oxidation of primary alcohols and aldehydes**

Oxidation of primary alcohols and aldehydes can be used to prepare carboxylic acids using the usual oxidizing agents (i.e K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> or KMnO<sub>4</sub>) in acidic solution



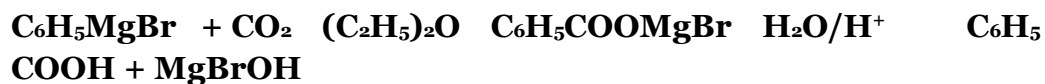
**2. Carbonation of Grignard reagent**

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



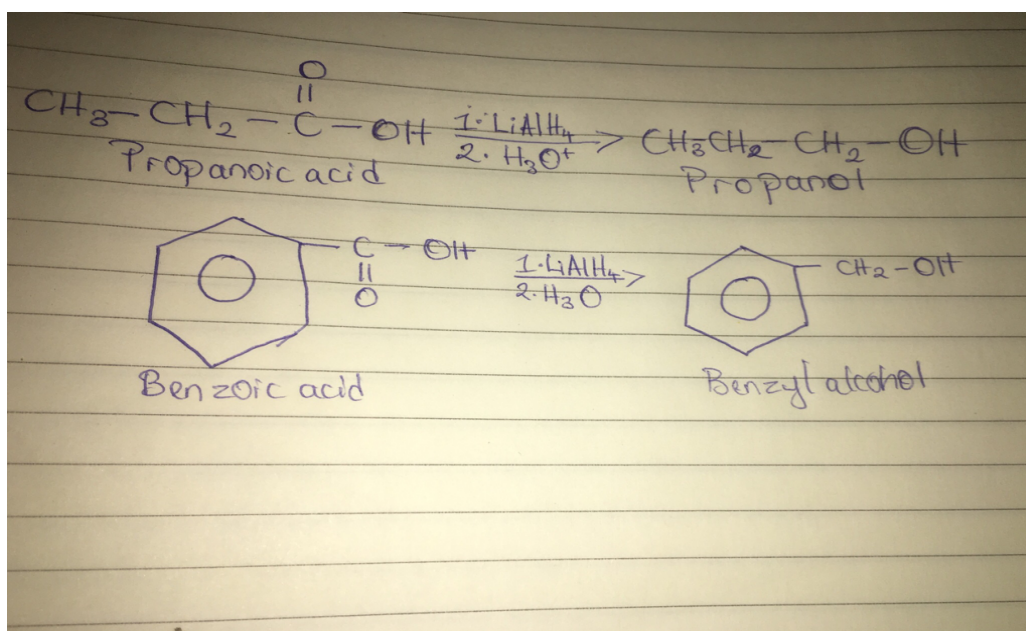
R may be 1°, 2°, 3° aliphatic alkyl or aryl radical

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

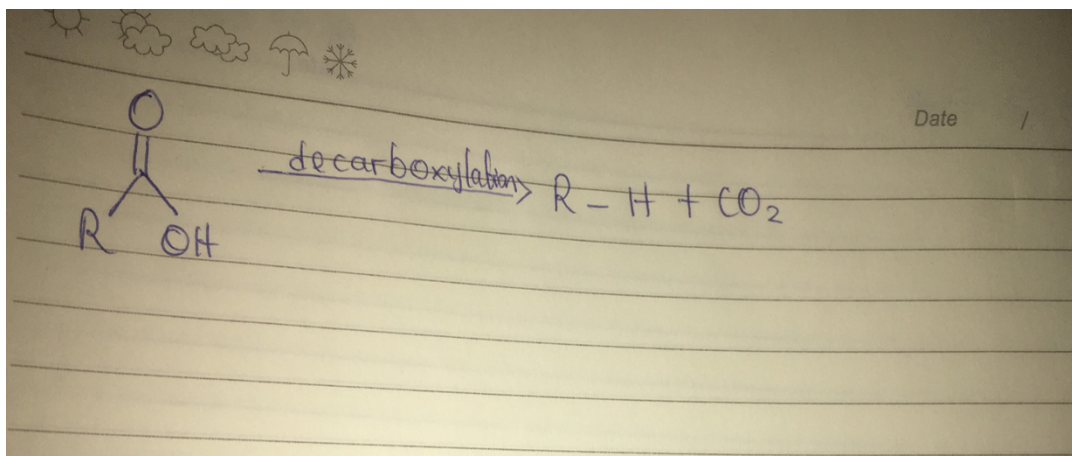


5. With chemical equation only, outline the reduction, decarboxylation and esterification of carboxylic acid

1. Reduction of carboxylic acid: Most reductions of carboxylic acids lead to the formation of primary alcohols. These reductions are normally carried out using a strong reducing agent, such as lithium aluminum hydride ( $\text{LiAlH}_4$ ).



2. Decarboxylation of carboxylic acid : This involves removal of the carboxyl group from the acid to give a hydrocarbon or its derivative.



**3. Esterification of carboxylic acid: In the presence of strong acid catalyst, carboxylic acids react with alcohols to form esters**

