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

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

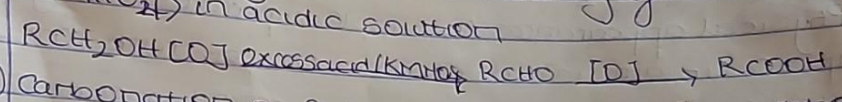
Boiling points: Boiling points increase with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have highest melting points than their aliphatic counterparts of comparable relative molecular mass.

Solubility: Lower molecular mass carboxylic acids with up to four carbon atoms 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.

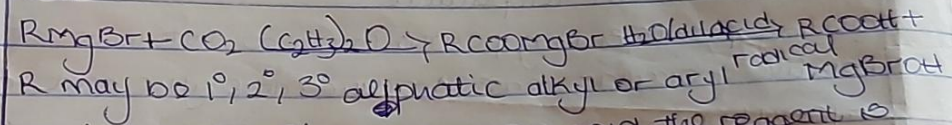
3) From ethanol: Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanol to ethanoic acid using manganese(II) ethanoate catalyst. Ethanol itself is obtained from ethylene.

$\text{HC}\equiv\text{CH} \xrightarrow{\text{dil. H}_2\text{SO}_4/\text{HgSO}_4} \text{CH}_3\text{CHO} \xrightarrow{\text{O}_2/\text{C}_6\text{H}_5\text{COOH}} \text{CH}_3\text{COOH}$
 2) 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)

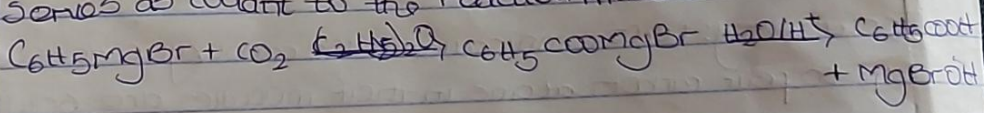
$\text{CO} + \text{NaOH} \rightarrow \text{HCOONa} \xrightarrow{\text{H}_2\text{SO}_4} \text{HCOOH} + \text{NaHSO}_4$
 Oxidation of primary alcohols and aldehydes: Oxidation of primary alcohols and aldehydes can lead to carboxylic acid using the usual oxidizing agents ($\text{K}_2\text{Cr}_2\text{O}_7$ or KMnO_4) in acidic solution



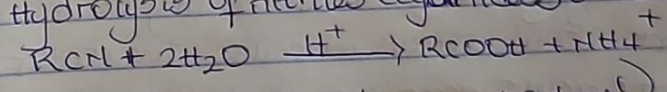
2) Carbonation of Grignard reagent: Aliphatic carboxylic acids are obtained by bubbling carbon(IV) oxide into the Grignard reagent and then hydrolyzed with dilute acid.



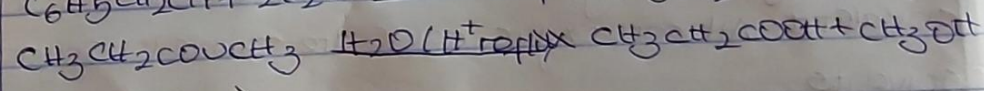
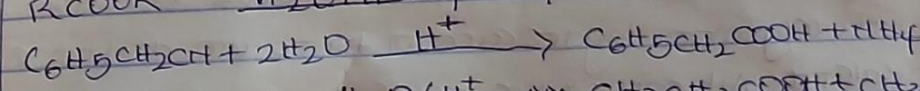
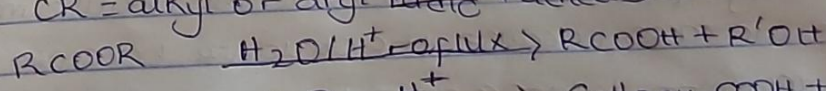
In the preparation of benzoic acid, the reagent is added to solid carbon(IV) oxide (dry ice) which also serves as solvent to the reaction mixture



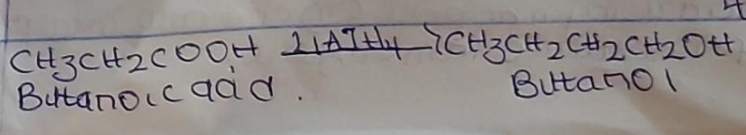
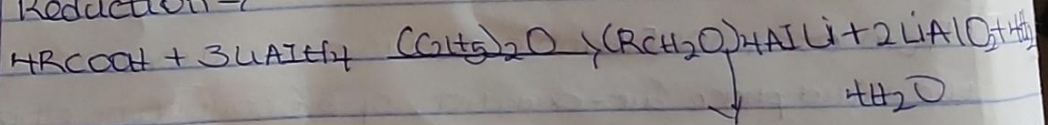
3) Hydrolysis of nitriles (cyanides) or esters



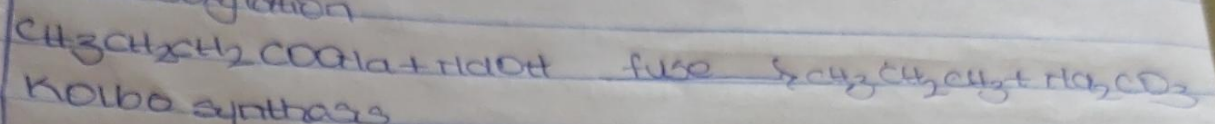
CR = alkyl or aryl radical



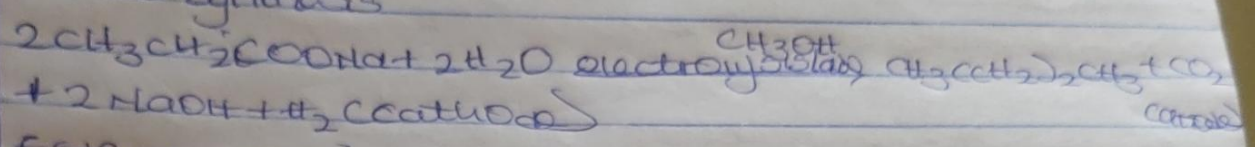
5) Reduction \rightarrow



2) Decarboxylation



Kolbe synthesis



3) Esterification

