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1. Alcohols are very important Organic Compounds. Discuss (briefly) their Classifications and give one example reaction regarding each of them.  
→ Classifications of alcohols is based on the number of alkyl groups. The general formula is  $R-OH$  where  $R$  is alkyl group. There are three types of alcohols based on this classification.

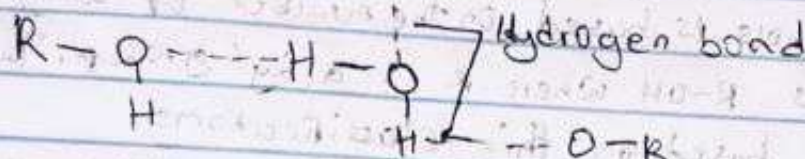
a) Primary alcohol: It has only one alkyl group attached to the Carbon atom that carries the hydroxyl group and two hydrogen atoms attached to the carbon atom bearing the  $-OH$  group.  
e.g.  $\begin{array}{c} H \\ | \\ C - C - OH \\ | \quad | \\ H \quad H \end{array}$   
Ethanol (primary alcohol)

b) Secondary alcohol: It has two alkyl groups attached to the Carbon atom that carries the hydroxyl group and one hydrogen atom attached to the carbon atom bearing the  $-OH$  group.  
e.g.  $\begin{array}{c} H & H & H \\ | & | & | \\ H-C & -C & -C-H \\ & | & | \\ & H & OH \end{array}$   
Propan-2-ol (Secondary alcohol)

c) Tertiary alcohol: It has three alkyl groups attached to the Carbon atom that carries the hydroxyl group and none hydrogen atom attached to the carbon atom bearing the  $-OH$  group.  
e.g.  $\begin{array}{c} H & H & OH & H & H \\ | & | & | & | & | \\ H-C & -C & -C & -C & -C-H \\ & | & | & | & | \\ & H & H & H & H \end{array}$   
3-Methyl pentan-3-ol (Tertiary alcohol)



2. Discuss the solubility of alcohols in water, organic solvents  
 → Generally hydrocarbons are not soluble in water, but alkanol are soluble because the hydroxyl groups in their molecules can form hydrogen bond with water.

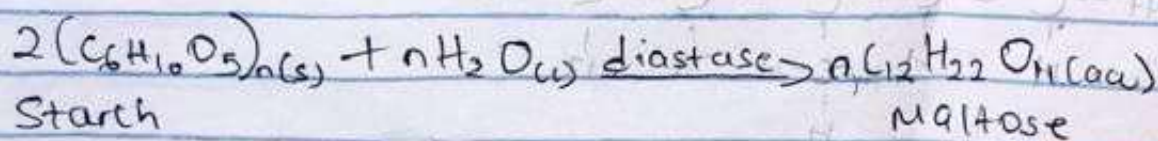


Solubility and volatility decrease as the number of carbon atoms increases in alkanols because the molecules are stuck together due to hydrogen bonding. They are difficult to separate and driven off into the vapour phase. Primary alkanols with more than five carbon atoms are insoluble in water.

3. Show the three steps in the industrial manufacture of ethanol. Equations of reaction are mandatory.

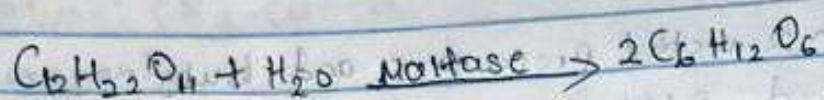
→ Industrial manufacture of ethanol by fermentation. Fermentation is the slow decomposition of large organic molecule (starch) by micro-organism [e.g. yeast and bacterial] into smaller molecules. (ethanol). In fermentation process, enzymes which are secreted by these microorganism act as catalyst for the breakdown of sugar molecules.

a) From potatoes, cassava and cereals: The starchy food is crushed and treated with steam to extract the starch granules.

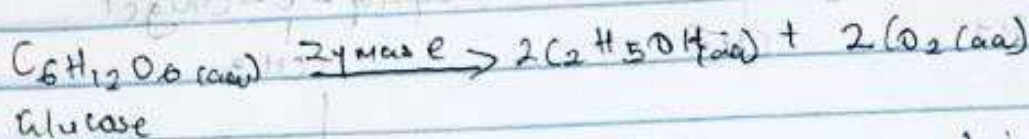


Yeast is then added at room temperature to release ~~Maltase~~ <sup>Maltase</sup>, which converts maltose into glucose.

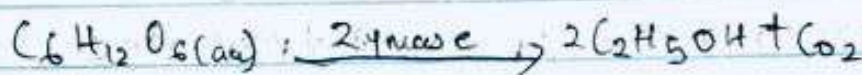
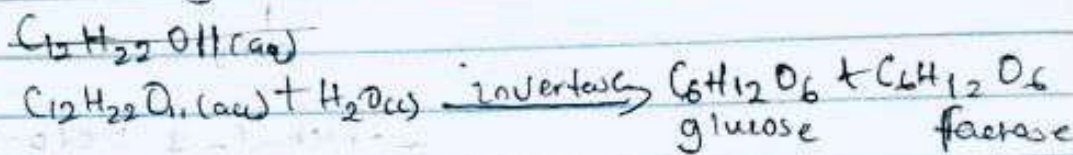




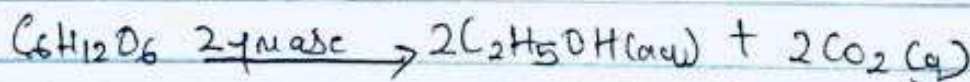
enzymes zymase which is also present in yeast convert the glucose into ethanol and carbon IV oxide.



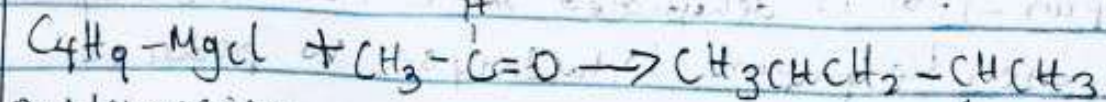
b) From sugar cane: The part of sugar cane used is called molasses, a liquid that remains after crystallization of sugar from sugar cane.



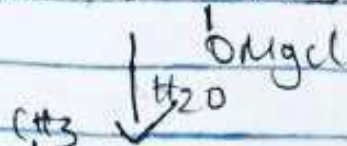
c) From Cellulose: Cellulose and Cellulose wastes are good and cheap sources of ethanol. They are hydrolysed with dilute acids e.g.  $H_2SO_4$  to obtain sugar. The sugar is separated and converted into ethanol by fermentation using yeast as a source of enzyme.



10) Show the reaction between 2-methylpropanal and butylmagnesium chloride Hint: Grignard synthesis



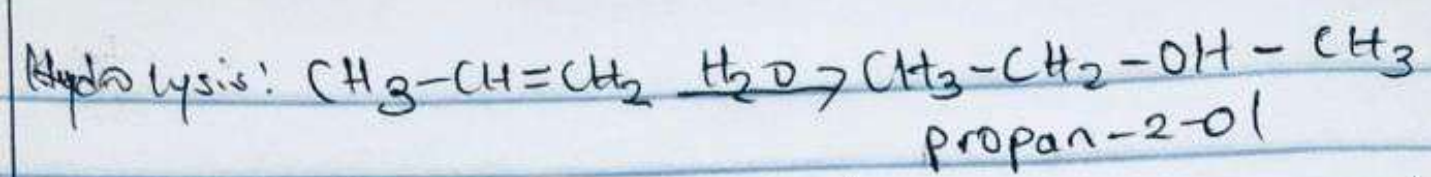
Butylmagnesium chloride.



4-methyl-2-pentanol







The mechanism is called Markovnikov's addition.