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Course code: Chem 102.

* Assignment:

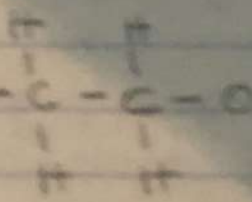
1. Discuss the two major classification of alkanols. Give two examples each for each class.
2. In the Grignard Synthesis of alkanols, react a named Grignard reagent with $CH_3CH_2CH_2CH_2C=OCH_2CH_2CH_3$. Show the reaction steps.
3. Discuss the industrial manufacture of ethanol showing all reactions equations and necessary enzymes and temperature of reaction.
4. Determine the product obtained in the reduction of Alkanon and Alkanal. Use specific example for each and show the equation of reaction.

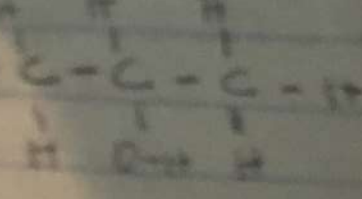
Answers:

1a) Classification based on the number of hydrogen atoms attached to the carbon atom containing the hydroxyl group:

If the number of hydrogen atoms attached to the carbon atom bearing the hydroxyl group are three or two, it is called a "Primary alkanol (1°)" [In a primary alkanol, the hydroxyl group is attached to a primary carbon atom in the molecule $C-CH_2OH$]. If it is one hydrogen atom attached to the carbon atom bearing the hydroxyl group is called "Secondary alkanol (2°)". [In a secondary alkanol, the -OH group is on a secondary carbon atom. It is characterized by $>CH(OH)$] and if no hydrogen atom is attached to the carbon atom bearing the hydroxyl group, it is called a "tertiary alkanol (3°)". [In a tertiary alkanol, the -OH is on a tertiary carbon. It is characterized by $>C-OH$].

→ Examples:

i) CH_3CH_2OH - Ethanol (1°) → 

ii) $CH_3CH(OH)CH_3$ - Propan-2-ol (2°) → 

B) Classification based on the number of hydroxyl groups they have

Monohydric alcohols, have only one hydroxyl group per molecule present in the alcohol structure.

Dihydric alcohols are also called "Glycols" have two hydroxyl group present in the alcohol structure.

Trihydric alcohols or triols, have three hydroxyl groups present in the structure of the alcohol.

Polyhydric alcohols or polyols have more than three hydroxyl groups.

→ Examples;

i. $CH_3CH_2CH_2OH$ – Propanol (monohydric alcohol).

ii. $CH_3CH(OH)CH_2CH(OH)CH_2CH_3$ – Hexane – 2,4 – diol (Dihydric alcohol).

2. Grignard reagent: CH_3CH_2MgCl = ethyl magnesium chloride).

$$CH_3CH_2MgCl + CH_3CH_2CH_2CH_2C=OCH_2CH_2CH_3$$

$$\downarrow$$

$$CH_3CH_2CH_2-\underset{\underset{CH_2CH_2CH_3}{|}}{\overset{\overset{CH_3CH_2}{|}}{C}}-OMgCl \xrightarrow[\text{dil. acid}]{H^+OH^-} CH_3CH_2CH_2CH_2-\underset{\underset{CH_2CH_2CH_3}{|}}{\overset{\overset{CH_3CH_2}{|}}{C}}-OH + Mg(OH)Cl$$

3. Industrial Manufacture of Ethanol;

Carbohydrates such as ~~star~~ starch are major groups of natural compounds that can be made to yield ethanol by the biological process of fermentation. The biological catalysts, enzymes found in yeast breaks down the carbohydrates molecules into ethanol to give an yield of 90%.

1. The starch containing materials include molasses, potatoes, cereals, rice and on warming with malt to 60°C for a specific period of time are converted into maltose by the enzyme "diastase" contained in the malt.

$$2(C_6H_{10}O_5)_n + nH_2O \xrightarrow[\text{diastase}]{60°C} nC_{12}H_{22}O_{11}$$

Carbohydrate → maltose

2. The maltose is broken down into glucose on addition of yeast which contains the enzyme "maltase"

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow[\text{maltase}]{18^\circ C} 2C_6H_{12}O_6$$

maltose → glucose

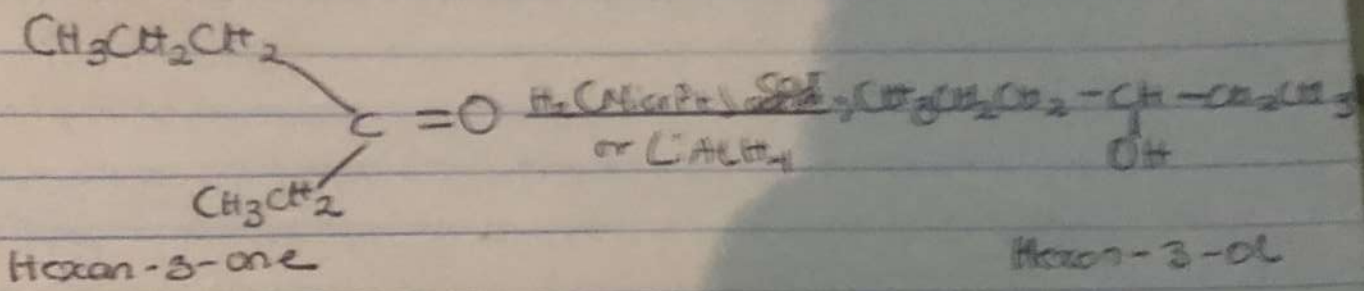
3. The glucose at constant temperature of 18°C is then converted into alcohol by the enzyme "zymase" contained also in yeast.

$$C_6H_{12}O_6 \xrightarrow[\text{zymase}]{18^\circ C} 2CH_3CH_2OH + 2CO_2 \uparrow$$

Glucose → ethanol + carbon(iv) oxide

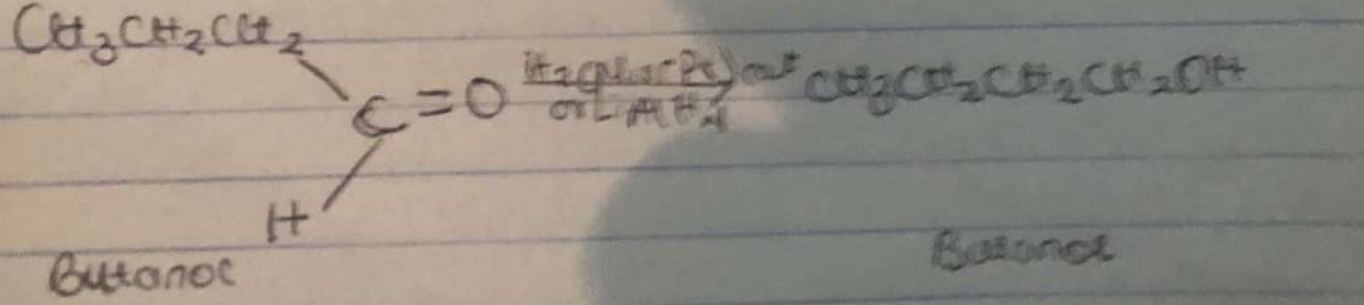
4. <u>The Reduction of Alkanone and Alkanal using MEERWEIN - PONNDORF Reaction.</u>

1. <u>Alkanone;</u>



The reaction above shows the reduction of an alkanone, <u>example</u>, Hexan-3-one to an alkanol eg Hexan-3-ol.

2. Alkanal;



The reaction above shows the reduction of an alkanal (e.g Butanal) to an alkanol (e.g Butanol).