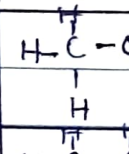
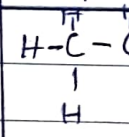
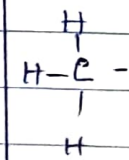
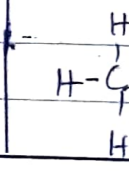
# ALCOHOLS

Alcohols or Alkanols are organic compounds with an $-OH$ functional group

Functional group is a group of atoms which is bonded to a carbon atom in an organic compound and which give distinct chemical properties to the compound.

– The general formula of alcohols (alkyl alcohols) is $C_nH_{2n+1}OH$. where $n \geq 1$. Their names end up with suffix -ol.

| | IUPAC name | Molecular formula | structural formula | Condensed formula | Common name |
|---|---|---|---|---|---|
| 1 | Methanol | $CH_3OH$ |  | $CH_3OH$ | Methyl alcohol |
| 2 | Ethanol | $C_2H_5OH$ |  | $CH_3CH_2OH$ | Ethyl alcohol |
| 3 | Propanol | $C_3H_7OH$ |  | $CH_3CH_2CH_2OH$ | Propyl alcohol |
| 4 | Butanol | $C_4H_9OH$ |  | $CH_3CH_2CH_2CH_2OH$ | Butyl alcohol |

Nomenclature of Alcohols

1 Select the longest continous carbon chain containing hydroxyl group. (OH group)

2 Number the carbon atoms in this longest chain beginning at the end nearer to the $-OH$ group.

3 Name this longest chain by substituting the ending -ol for the ~~-ane~~ "-e" of the corresponding alkane.

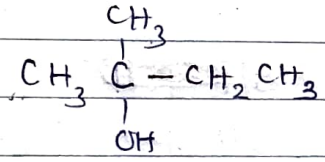
4 Identify the position of the -OH group by writing the number of the carbon atom to which it is attached in front of the ending -ol.

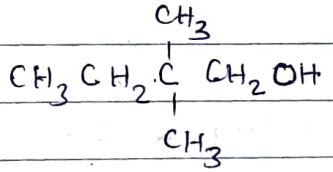
Note The position of the -OH group needs to be indicated only for chains of three or more carbon atoms.

5 If substituent is present, give the first priority to the functional group (-OH) than the substituent group eg. $CH_3$, Cl, Br

6 other alkanes rules should be applied.

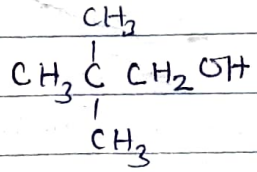
EXAMPLES

(i) 
2-methylbutan-2-ol

(ii) 
2, 2-dimethylbutan-2-ol.

(iii) $CH_3OH$ Methanol

(iv) $CH_3CH_2OH$ Ethanol

(v) 
2, 2-dimethylpropan-1-ol.

(vi)

# Isomerism in Alcohols

Isomerism in alcohols is caused by

(i) the branching of the carbon chain

(ii) The different locations of the -OH group.

1 Butanol $C_4H_9OH$

(i) $CH_3CH_2CH_2CH_2OH$ Butan-1-ol

(ii) $CH_3CH(CH_3)CH_2OH$ 2-methylpropan-1-ol

(iii) $CH_3C(CH_3)(OH)CH_3$ 2-methylpropan-2-ol.

(iv) $CH_3CH(OH)CH_2CH_3$ Butan-2-ol.

2 Pentanol $C_5H_{11}OH$

(i) $CH_3CH_2CH_2CH_2CH_2OH$ Pentan-1-ol.

(ii) $CH_3CH_2CH(CH_3)CH_2OH$ 2-methylbutan-1-ol.

(iii) $CH_3C(CH_3)_2CH_2OH$ 2, 2-dimethylpropan-1-ol.

(iv) $CH_3CH_2C(OH)(CH_3)CH_3$ 2-methylbutan-2-ol.

(v) $CH_3CH(OH)CH(CH_3)CH_3$ 3-methylbutan-2-ol.

# Classification of Alcohol.

The alcohols are classified into three groups

(a) Primary alcohols ($1^{\circ}$ - alcohols)

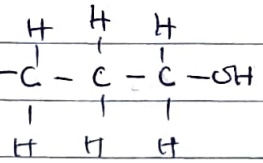
(b) Secondary alcohols ($2^{\circ}$ - alcohols)

(c) Tertiary alcohols ($3^{\circ}$ - alcohols)

## (i) PRimary Alcohols

These are the ones in which the carbon to which the -OH group is attached is bonded to another one carbon atom.

$CH_3CH_2CH_2OH$ OR



## (ii) Secondary Alcohols

These are the ones which the carbon to which the -OH group is attached is bonded to the other two carbon atoms

(i) $CH_3\underset{\underset{OH}{|}}{CH}CH_3$ - Propan-2-ol.

(ii) $CH_3CH_2\underset{\underset{OH}{|}}{CH}CH_2CH_3$ Pentan-3-ol

## (iii) Tertiary Alcohols

These are the ones in which the carbon to which the -OH group is attached is bonded to the other three carbon atoms.

(i) $CH_3\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}CH_3$

(ii) $CH_3CH_2\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}CH_3$.

# PREPARATION OF ALCOHOLS.

Ethanol is produced through the fermentation of carbohydrates.

Fermentation is the process in which large organic molecules are broken down into smaller molecules with the help of living organisms, examples yeasts.

Fermentation is the reaction where sugar is converted to alcohol / alkanol using biological catalyst / enzymes in yeast.

- It involves three processes.

(i) Conversion of starch to maltose using the enzyme diastase

$$C_6H_{10}O_{5(s)} + H_2O_{(l)} \xrightarrow{\text{diastase}} C_{12}H_{22}O_{11(aq)}$$

(starch)

(ii) Hydrolysis of maltose to glucose to glucose using the enzyme maltase

$$C_{12}H_{22}O_{11(aq)} + H_2O_{(l)} \xrightarrow{\text{maltase}} 2C_6H_{12}O_{6(aq)}$$

Maltase (glucose)

(iii) Conversion of glucose to ethanol and carbon dioxide gas using the enzyme zymase.

$$C_6H_{12}O_{6(aq)} \xrightarrow{\text{Zymase}} 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$$

(glucose) ethanol

- All enzymes involved are produced by yeast.
- The optimum temperature for yeast to catalyse the process is 37°C.
- If the ethanol content in the mixture rises to around 15%, the yeast is killed. If a more concentrated solution of ethanol is required the mixture is fractionally distilled.

# PROPERTIES OF ETHANOL / ALCOHOL.

(a) physical properties

1 Lower members of alcohol are liquid at room temperature eg. methanol, ethanol and propanol

2 The solubility of alcohols in water decreases with increase carbon chain.

3 They are colourless and volatile.

4 They are characterised with smell.

5 The MP and BP increase with increase in molecular mass.

(b) .

(b) Chemical properties

1 Reaction with sodium

$C_2H_5OH_{(aq)} + 2Na_{(s)} \rightarrow H_{2(g)} + C_2H_5ONa_{(aq)}$

sodium ethoxide

$CH_3OH_{(aq)} + 2Na_{(s)} \rightarrow 2CH_3ONa_{(aq)} + H_2(g)$

2 Dehydration by concentrated $H_2SO_4$

$C_2H_5OH_{(l)} \xrightarrow[\text{excess}]{H_2SO_4} C_2H_4 + H_2O$ (170°C)

3 Oxidation reaction

$CH_3CH_2OH_{(aq)} + [O] \rightarrow CH_3CHO + H_2O_{(l)}$

ethanol → ethanal

In excess of [O], the aldehyde is oxidized to carboxylic acid

$CH_3CH_2OH_{(aq)} + 2[O] \rightarrow CH_3COOH + H_2O$

excess → ethanoic acid.

[O] – represents the oxygen from the oxidizing agent.

eg. $K_2Cr_2O_7$ / $KMnO_4$ – acidified.

4 Combustion of alcohol

$CH_3CH_2OH_{(aq)} + 3O_2 \rightarrow 2CO_{2(g)} + 3H_2O$

5 Reaction with carboxylic acid

Esterification reaction $\rightarrow$ R-COO-R

An alcohol reacts with organic acids to form sweet smelling compounds called esters.

$$CH_3COOH + CH_3OH \overset{H^+}{\rightleftharpoons} CH_3COOCH_3 + H_2O$$

ester.

(methylethanoate)

$$C_2H_5COOH + C_2H_5OH \overset{H^+}{\rightleftharpoons} C_2H_5COOC_2H_5 + H_2O$$

ethyl propanoate.

Uses of ethanol

- It is used in alcoholic drinks
- It is used as fuel
- Ethanol is a good solvent for gums and resins.
- It is used in the manufature of other organic chemicals like acetaldehyde, chloroform. etc.

HARMFUL EFFECTS OF ALCOHOL

Excessive consumption of alcohol leads to addiction.

ADDICTION is a situation whereby some one become dependent on alcohol.

A person who is addicted to alcohol cannot stay for long time without drinking.

- A person who is addicted to alcohol is known as ALCOHOLIC.

The following are some of the negative effects of alcoholism in the society.

(i) Neglecting families and other relationships. The neglected family suffers financial difficulties which could leaf to divorce.

(ii) Children from neglected families can also get involved in criminal activities.

(iii) Alcoholics are sometimes violent and may cause injuries to other people.

## Health Problems Associated with Alcoholism.

1. Damage of the liver.
2. Damage of the brain cells.
3. Damage to the heart due to destruction of heart muscles
4. Alcohol is a diuretic, that is, it stimulates production of urine
5. Excessive consumption of alcohol by pregnant women may lead to defects in an unborn baby
6. The alcoholic may develop anaemia if he or she does not feed well.

## Important summary

General formula $C_nH_{2n+1}OH$

The formula can be represented as R-OH where R stands for alkyl group.