

**WORKSHEET 17**School: Ba Sangam CollegeSubject: ChemistryYear: 13

Name: _____

Strand	4 - Materials
Sub strand	4.2- Organic Chemistry
Content Learning Outcome	<p>-Classify alcohols into primary, secondary and tertiary alcohols and recognise their general formulas.</p> <p>-Explain the physical properties of alcohols.</p> <p>-Describe and compare the effect of oxidising agents on primary, secondary and tertiary alcohols.</p> <p>-Describe the various reactions of alcohols and write balanced equation for the reactions.</p>

Alcohols

Alcohols are represented as: R-OH, where R is the alkyl group and OH is the hydroxyl group.

IUPAC Naming of alcohols

-Naming alcohols is similar to alkenes and alkynes with some exceptions.

-Alcohols are named by replacing the terminal "e" of the corresponding alkane by "ol". Wherever necessary, a number is written in front of "ol" to indicate the position of the -OH functional group.

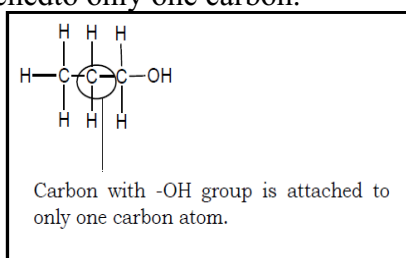
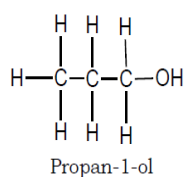
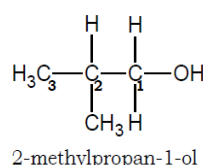
-While numbering the carbon atoms, priority should be given to the hydroxy group over the alkyl group.

Steps

1. Select the longest carbon chain containing the functional group -OH.
2. Number the chain with the -OH group getting the lowest possible number.
3. Replace the "e" at the end of the suffix of the alkyl chain with -ol.
4. If necessary, add a prefix number to indicate which carbon the -OH group is bonded to.

Types of Alcohol**Primary alcohols**

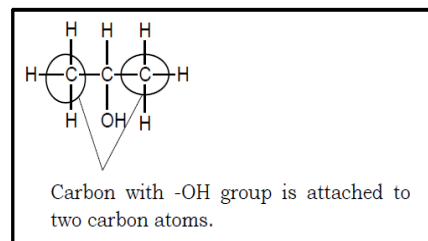
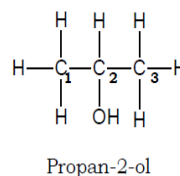
In a primary (1°) alcohol, the carbon which carries the -OH group is attached to only one carbon.

Example 1**Example 2****Naming**

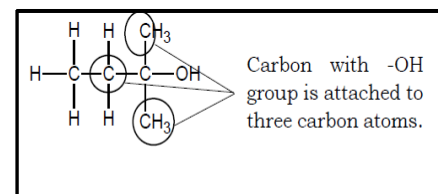
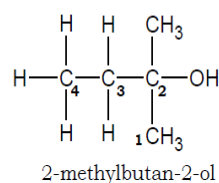
- a. Parent Chain - Longest chain with the -OH functional group contains 3 carbon atoms and the -OH is placed at the first carbon atom, thus propan-1-ol.
- b. Substituent - Carbon number 2 has a methyl side branch; thus, 2-methyl.
- c. Therefore, the name is 2-methylpropan-1-ol.

Secondary alcohols

In a secondary (2°) alcohol, the carbon which carries the -OH group is attached to two carbon atoms.

Example**Tertiary alcohols**

In a tertiary (3°) alcohol, the carbon atom which carries the -OH group is attached to three carbon atoms.

Example**Naming**

- a. Parent Chain - As shown in the diagram above, the longest chain with the -OH functional group contains 4 carbon atoms and the -OH is placed at the second carbon, thus butan-2-ol.
- b. Substituent - Carbon number 2 has a methyl side branch; thus, 2-methyl.
- c. Therefore, the name is 2-methylbutan-2-ol.

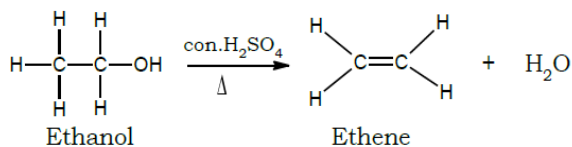
-Alcohols can be dehydrated to alkenes upon heating in the presence of a strong acid, such as sulphuric acid. In this reaction, there is loss of a water molecule which leaves behind a carbon-carbon double bond.

-Tertiary alcohols are easier to dehydrate than secondary alcohols.

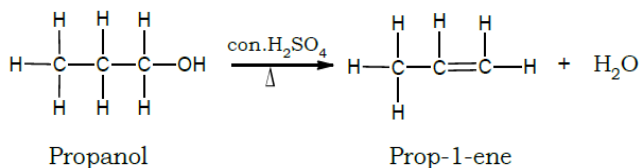
-Secondary alcohols are easier to dehydrate than primary alcohols.

Examples

a.



b.

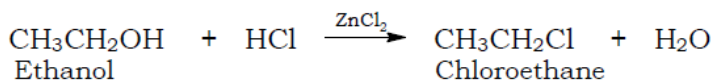


3. Substitution Reactions of Alcohols

a. Substitution by chlorine

-The reaction of alcohol with dry hydrogen chloride gas is catalysed by zinc chloride. The alcohol is boiled under reflux as the gas is bubbled through.

Example

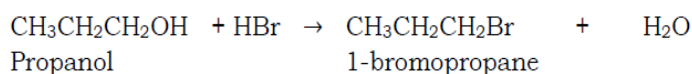


b. Substitution by bromine or iodine

Formation of bromoalkanes

Example

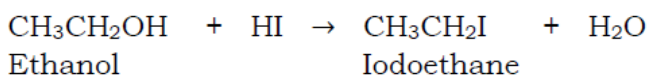
HBr reacts with propanol to give 1-bromopropane.



Formation of iodoalkanes

Example

HI reacts with ethanol to give iodoethane.



Test to distinguish between alcohols

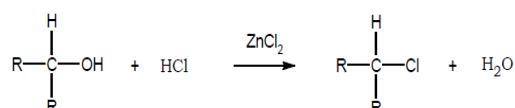
1. Warm with acidified dichromate ($\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$)

- **Primary and secondary alcohol** - There will be a change in colour from orange to green.
- **Tertiary alcohol** - There will be no colour change. Orange dichromate remains orange.

2. Lucas Reagent (Anhydrous ZnCl_2 / conc. HCl)

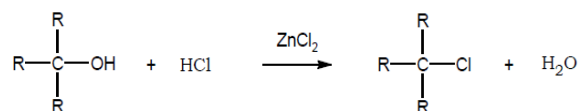
- **Primary alcohol** - There will be no change. In fact, primary alcohols react very slowly and their cloudiness come after more than 45 minutes. This is why it is assumed that there is no change in the reaction.
- **Secondary alcohol** - The mixture gets cloudy after 10 minutes.

Reaction Equation



Tertiary alcohol - The mixture gets cloudy immediately (within 2-5 minutes).

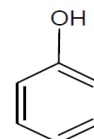
Reaction Equation



Note: The cloudiness is due to the formation of insoluble alkyl halide.

Aromatic Alcohol - Phenols

-Phenols are compounds with one or more -OH groups attached to the benzene ring. The simplest phenol is shown below.



Phenol

Properties of phenol

- Phenol is a solid made up of crystals.
- Its melting point is low (43 °C), but higher than that of benzene (6 °C).
- Hydrogen bonding in phenol accounts for the difference in the melting point.
- Phenol is slightly acidic and will react with a strong alkali.
- Phenol is moderately soluble in water.

Functional Group Isomers of Alcohols – Ethers

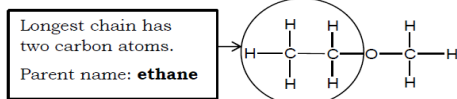
-Molecules of ethers contain two alkyl (R) groups joined to one oxygen, the two R groups being alike or different.

-The general formula for ethers is 'R-O-R'.

IUPAC Nomenclature of Ethers

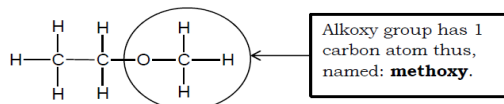
1. Identify the longest alkyl chain. That becomes the parent name.

Example



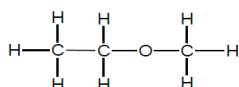
2. The other alkyl group with the oxygen atom is known as the alkoxy group. The name of this group begins with the respective alkane and ends with 'oxy'.

Example



3. Name the ether by writing the alkoxy group first followed by the parent name, with no space.

Example



Name: **Methoxyethane**

Ethers are known more commonly by their common names rather than the IUPAC names. Ethers can be named commonly by naming each of the two carbon groups as a separate word (in alphabetical order) followed by a space and the word 'ether'.

The table below shows some common ethers

Ether	Common Name	IUPAC Name
 CH_3OCH_3	Dimethyl ether	Methoxymethane
 $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$	Diethyl ether	Ethoxyethane
 $\text{CH}_3\text{CH}_2\text{OCH}_3$	Ethyl methyl ether	Methoxyethane

Note:

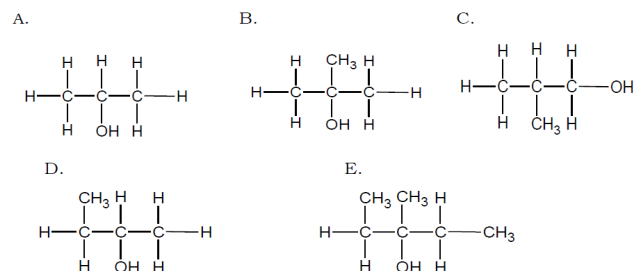
- Ethers have low boiling points when compared to alcohols.
- Hydrogen bonds cannot exist between molecules of ethers, thus, the simple ethers have very low boiling points, lower than those alcohols of comparable molecular masses.

Example

The boiling point of butan-1-ol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$) is 117°C and the boiling point of diethyl ether ($\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$) is 34.5°C .

Exercises

1. Classify the following alcohols as primary, secondary or tertiary. (5 marks)



2. What type of alcohol is 2-methylpentan-2-ol?

- A. Primary B. Secondary
C. Tertiary D. cannot be told (1 mark)

3. Which of the following statements show that phenol can be a solid at room temperature while benzene is a liquid. (1 mark)

- A. Phenol demonstrates hydrogen bonding.
B. Benzene demonstrates hydrogen bonding.
C. Benzene has greater van der Waals forces than phenol.
D. Phenol has greater van der Waals forces than benzene.

4. Explain the following statements.

- a. Alcohols have high boiling points. (1 mark)

- b. Phenol is able to dissolve in water, even if it is to a small extent. (1 mark)

5. Illustrate hydrogen bonding in propanol. (1 mark)

5.

respectively. (4 marks)

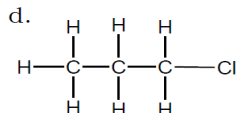
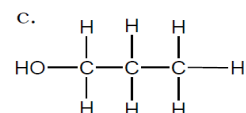
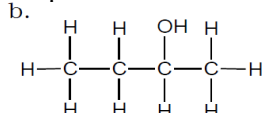
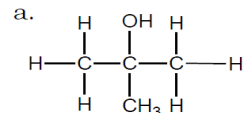
b. Name the products of each reaction as represented by A, B, C and D, respectively.

6. Name the following ethers. (2 marks)

a. $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_3$ - _____

b. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_3$ - _____

7. Consider some organic compounds shown below.



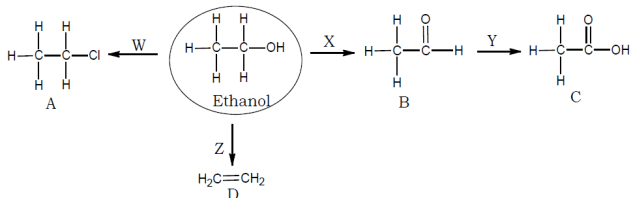
From the above organic compounds, identify a compound that would react with acidified potassium dichromate to: (2 marks)

i. Produce a ketone - _____

ii. Produce an aldehyde - _____

Also draw the structural formula of the aldehyde and ketone that are produced and name them. (2 marks)

8. Consider the reactions which ethanol undergoes as shown below and answer the questions that follow.



a. State the reagents and conditions necessary for the reactions to occur as represented by W, X, Y and Z