Main Points

1 - Introduction to Alcohols

2 - Naming Alcohols

3 - Types of Alcohols

4 - Phenols

5 - Preparation of Alcohols

6 - Physical properties

7 - Chemical properties

8 - Applications of Alcohols

1

Introduction

Definition:

An ***alcohol*** is any organic compound in which a hydroxyl functional group (-**O**H) is bound to a carbon atom, usually connected to other carbon or hydrogen atoms.

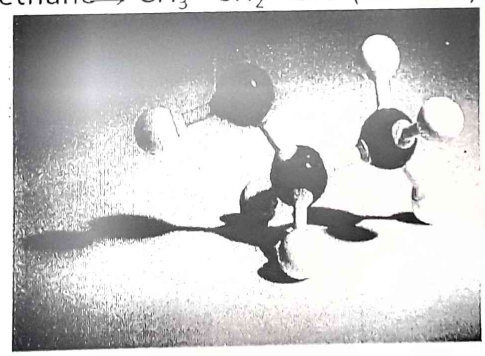
-Alcohols are organic derivatives of water H-O-H in which one of the hydrogen atoms (H) is replaced by an alkyl group (R) **R-O-H**

-The word ***alcohol*** appeared in English in the 16th century originating from the Arabic word الكحول

2 Naming Alcohols

- IUPAC name: We replace the -e in alkane name with -ol.
- Common name: As simple alcohols using the name of the alkyl group followed by *alcohol.*

- CH_4 methane $\rightarrow CH_3—OH$ (methanol)or(methyl alcohol)
- $CH_3—CH_3$ ethane $\rightarrow$ $CH_3—CH_2—OH$ (ethanol)or(ethyl alcohol)



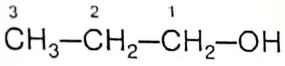
Naming Alcohols in Steps (IUPAC)

Step 1
Select the longest carbon chain that contains the -OH group.

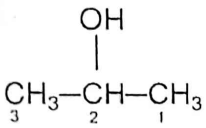
Step 3
Change the ending of parent alkane from -e to -ol. Use the number to show the location of -OH.

Step 4
Give the location and name of each substituent (alphabetical order) as a prefix to the name of the main chain.

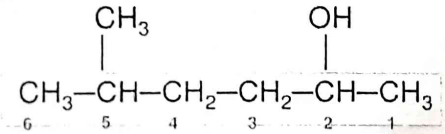
Naming Alcohols
Examples



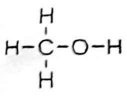
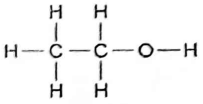
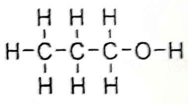
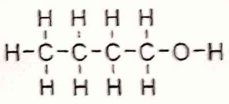
1-propanol



2-propanol



5-methyl-2-hexanol

Methanol	Ethanol	Propanol	Butanol
CH_3OH	C_2H_5OH	C_3H_7OH	C_4H_9OH
			

Common Name :

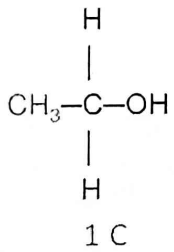
Wood alcohol Grain alcohol rubbing alcohol

3 Different Types of Alcohols

Depending on the **position** of **-OH** group:

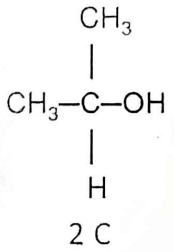
The -OH group of alkyl alcohols can be positioned on different carbon atoms of the carbon chain and are classified as

Primary (1º)



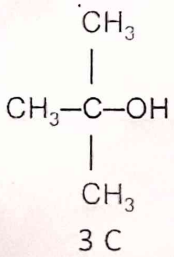
1 C attached to C-OH

Secondary (2º)



2 C attached to C-OH

Tertiary (3º)

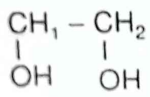


3 C attached to C-OH

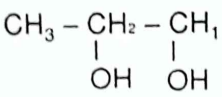
Diols & Triols

Depending on the **number** of **–OH** groups :

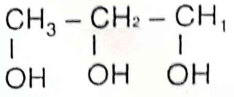
Diol: a compound containing two –OH (Hydroxyl groups).
Triol: a compound containing three –OH (Hydroxyl groups).



1,2-Ethanediol
(Ethylene **glycol**)



1,2-Propanediol
(Propylene **glycol**)



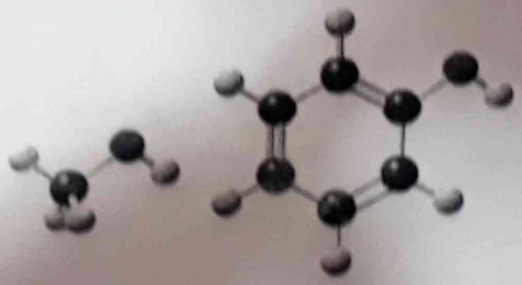
1,2,3-Propanetriol
(**glycerol, glycerin**)

Note: that the -OH groups *must* be placed in neighboring carbon atoms to name them glycols & glycerols

4

Phenol

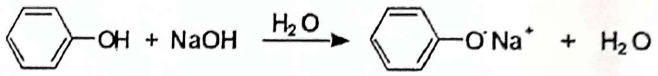
- Phenol is the **IUPAC** name for benzene with a hydroxyl group.
- Phenols are a special type of alcohols with an **6**-carbon benzene ring attached to -OH group



Methanol Phenol

- Many are used as antiseptics & disinfectants.

- Phenols are **weak acids** because they can transfer a proton to water to a very small extent.

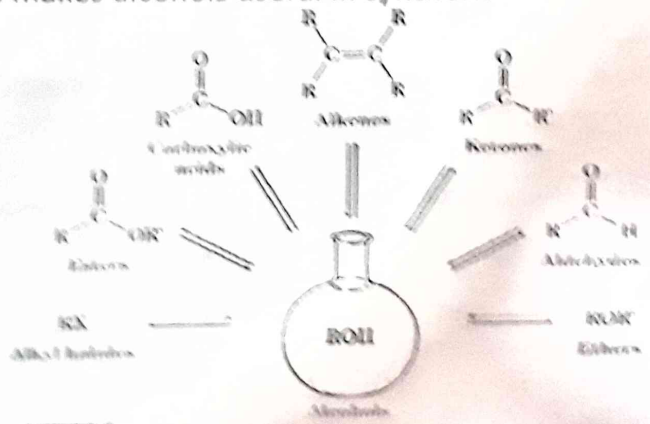


Phenol

Sodium phenoxide
(a water-soluble salt)

5 Preparation of Alcohols

- Alcohols are derived from many types of compounds
- The alcohol hydroxyl can be converted to many other functional groups
- This makes alcohols useful in synthesis



Preparation of Alcohol

Primary (1º) Alcohol	Secondary (2º) Alcohols	Tertiary (3º) Alcohols
-S_N2	-S_N1	-S_N1
-Reduction	-S_N2	-Grignard
-Grignard	-Reduction	
	-Grignard	

1) **Reduction** of an aldehyde, ketone, or carboxylic acid with the appropriate reducing agent.

2) **Substitution** The **S_N1 & S_N2 reactions** are substitution reactions . "S_N" stands for nucleophilic substitution and "1" stands for unimolecular & "2" for bimolecular S_N1 has two steps & S_N2 has one step for reaction

3) **Grignard** is an organometallic chemical reaction in which alkyl or aryl magnesium halide **RMgX** is used

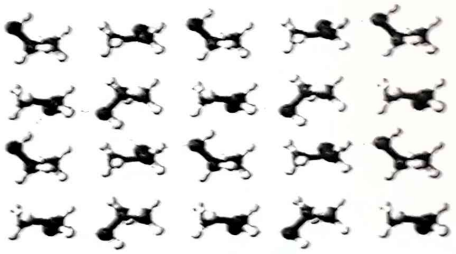
Reactions That Give Alcohols

Primary (1º) Alcohols

Reagents	Reaction Type	Product
RCH_2Br (1° halide) $\xrightarrow{HO^-}$ RCH_2OH	S_N2	RCH_2OH 1° alcohol
$R-\overset{O}{\overset{\|}{C}}-H$ (aldehyde) $\xrightarrow{NaBH_4;\ LiAlH_4;\ \text{or } H_2, Pd}$ RCH_2OH	reduction	
$H-\overset{O}{\overset{\|}{C}}-H$ (formaldehyde) $\xrightarrow{1\ RMgX;\ 2\ H^+, H_2O}$ RCH_2OH	Grignard	

6 Physical Properties of Alcohols

1. Alcohols are polar molecules (because of O-H and C-O)
   Electro-negativity: C-O: (3.5 – 2.5 = 1.0)
   O-H : (3.5 – 2.1 = 1.4)
2. Hydrogen bonding occurs between alcohols molecules.



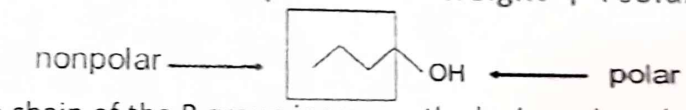
relatively weak bond
(represented by dots)
O has a partially negative charge δ-
& H has a partially positive charge δ+.

3. Have higher boiling point than Alkanes, Alkenes & Alkynes & Alkyl-Halides :
   (due to the Oxygen presence forming polar bonding between C-O & O-H.)

4. They are weak acids (alkyl alcohols weaker than Phenol):

Although alkyl alcohols have an -OH group, they do not ionize in water, whereas phenols ionize like acids (donating a proton to water).

5. Solubility in water (Molecular weight ↑ : solubility ↓)



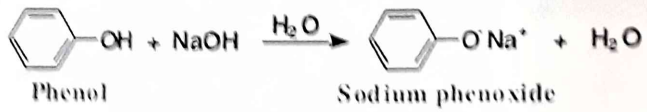
-As the chain of the R group increases the hydrocarbon **(non- polar)** character of the compound [illegible] the **(polar)** character of the OH group. Consequently, the **solubility** and **boiling point** of an alcohol are affected by the 1) length of the carbon chain and 2) the shape of the molecule .

-The short chain alcohols are **soluble** in water, whereas the longer chain alcohols are insoluble in water.

-In general a molecule which is [illegible] (i.e., more branched) will be [illegible] in water and will have [illegible] than the straight chain isomer.

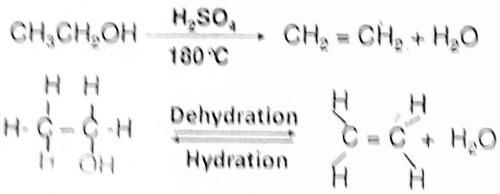
7 Chemical Properties of Alcohols

1. Acidity of Alcohols:



Phenol — Sodium phenoxide

2. Acid-Catalyzed Dehydration:



3. Oxidation of Alcohols: (1^{o}), (2^{o}) &(3^{o})

Using Potassium Dichromate $K_2Cr_2O_7$ & Sulfuric Acid H_2SO_4 as catalysts

7 Chemical Properties of Alcohols

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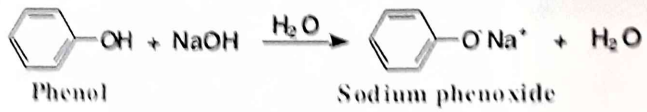

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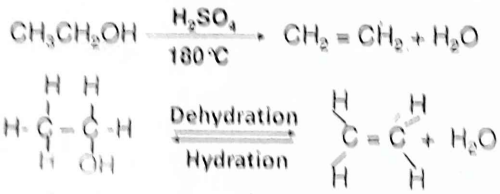

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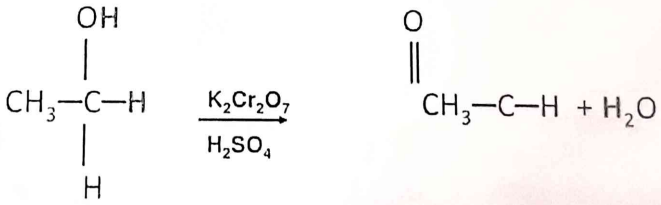
Oxidation of 1° Alcohols

In the oxidation [O] of a primary alcohol 1°, one H is removed from the –OH group and another H from the C bonded to the –OH and aldehyde is produced

primary alcohol $\xrightarrow{[O]}$ aldehyde



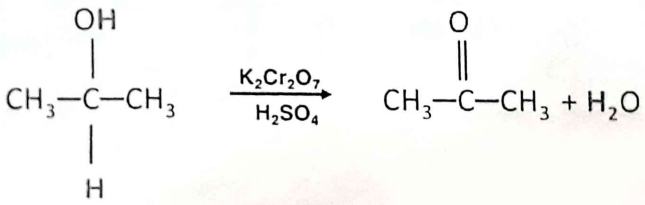
ethanol
(ethyl alcohol)

ethanal
(acetaldehyde)

Oxidation of 2° Alcohols

The oxidation of 2° alcohols is similar to 1 , except that a ketone is formed.

secondary alcohol $\xrightarrow{[O]}$ ketone

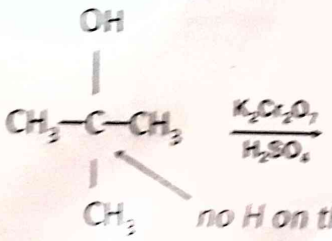


2-propanol 2-propanone

Oxidation of 3° Alcohols

Tertiary 3° alcohols do not oxidize.

Tertiary alcohol $\xrightarrow{[O]}$ No reaction



2-methyl-2-propanol

Oxidation of Alcohols in our body

In the body:

- Enzymes in the liver oxidize ethanol.
- Blood alcohol concentration over 0.4% can be fatal.

$$\underset{\text{ethanol}}{CH_3CH_2OH} \xrightarrow{[O]} \underset{\text{ethanal}}{CH_3\overset{\overset{O}{\|}}{C}H} \xrightarrow{[O]} \underset{\text{acetic acid}}{CH_3\overset{\overset{O}{\|}}{C}OH} \xrightarrow{[O]} 2CO_2 + H_2O + \text{Energy}$$

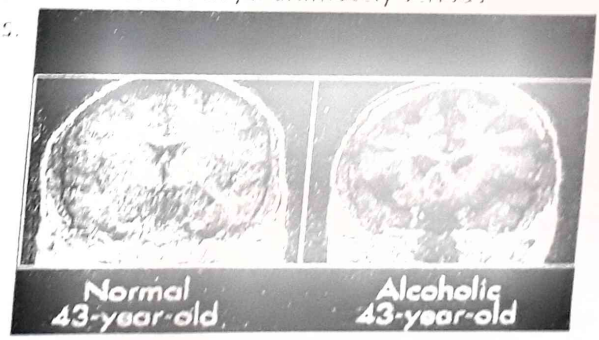
Oxidation: adding one oxygen atom or removing two hydrogen atoms
Reduction: adding two hydrogen atoms or removing one oxygen atom

8 Applications

Alcohols can be used for many scientific ,medical & industrial Utilities.

As a beverage:

Alcohols can be used as a **beverage** (***ethanol*** only, when fermented from sugar), Ethanol in the form of alcoholic beverages has been consumed by humans since pre-historic times. Alcohol usage especially at a young age may lead to: depression & addiction, serious liver problems such as fatty liver which is basically the liver falling apart, illnesses also in the brain(atrophy), heart, pancreas & stomach ,& ultimately serious malformation of embryos.



Read again

As a fuel:

Some alcohols, mainly ***ethanol*** and ***methanol***, can be used as an alcohol Fuel. Performance can be increased in forced induction internal combustion engines by injecting alcohol into the air intake after the turbocharger or supercharger has pressurized the air. This cools the pressurized air, providing a denser air charge, which allows for more fuel, and therefore more power.

In industry:

Alcohols have applications in industry and science as reagents or solvents. Because of its low toxicity and ability to dissolve non-polar substances, ethanol can be used as a solvent in medical drugs, perfumes, and vegetable essences such as vanilla. In organic synthesis, alcohols serve as versatile intermediates.

In pharmacy

can be used as an antiseptic to dis-infect the skin before injections are given, often along with iodine. Ethanol-based soaps are becoming common in restaurants and are convenient because they do not require drying due to volatility of the compound. Alcohol is also used as a preservative for specimens. Alcohol gels have become common as

END OF PRESENTATION

Thank you for your attention