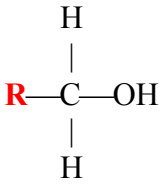
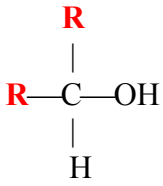
ALCOHOLS

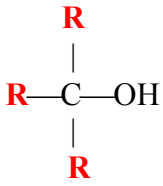
- Organic molecules that possess a **hydroxyl** group (—OH) are classified as **alcohols**.
- Alcohols are classified as primary (1°), secondary (2°) or tertiary (3°) depending on whether the carbon atom to which the —OH is attached is directly bonded to 1, 2, or 3 other carbon atoms, respectively.



Primary alcohol

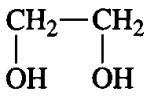


Secondary alcohol

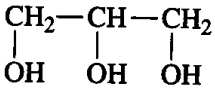


Tertiary alcohol

- Compounds that possess more than one alcohol group are called polyhydroxy alcohols. These compounds are important molecules in living cells and include carbohydrates.
- Two simple and important polyhydroxy alcohols are ethylene glycol and glycerol.



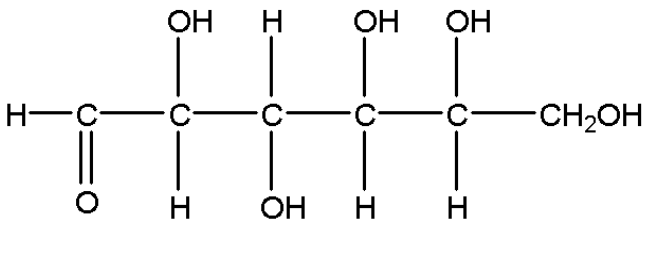
1,2-Ethanediol
(Ethylene glycol)



1,2,3-Propanetriol
(Glycerol, Glycerin)

Examples:

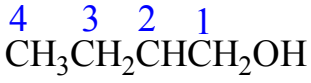
Blood sugar is a polyhydroxy compound with 5 alcohol groups. Identify each as primary, secondary or tertiary.



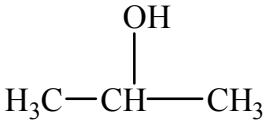
NAMING OF ALCOHOLS

- The IUPAC system for naming alcohols is the following:

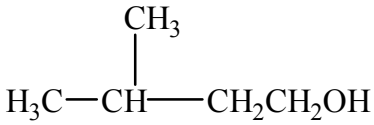
  1. Select the longest continuous chain of carbon atoms containing the hydroxyl group.
  2. Number the carbon atoms in the chain so that the one bearing the hydroxyl group has the lowest possible number.
  3. Name the parent chain as an alkane, with the end changing from ***–e*** to ***–ol***
  4. Name the alkyl side chains and designate their position by number.



1-butanol

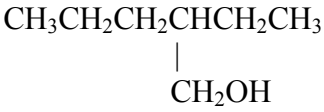


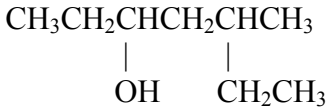
2-propanol

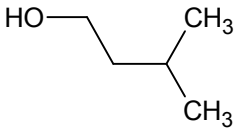


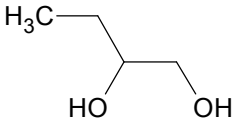
3-methyl-1-butanol

Examples:
Name each alcohol shown below:

1) 

2) 

3) 

4) 

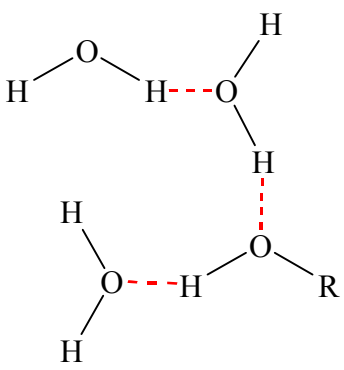
PHYSICAL ROPERTIES OF ALCOHOLS

- The physical properties of alcohols are related to those of both water and alkanes. This results from the similarity of alcohol molecules to both water and alkanes.

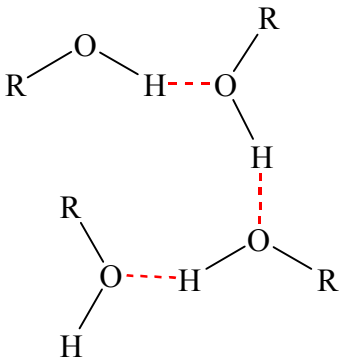
H—O—H	R—O—H	R—H
Water	Alcohol	Alkane

- Similar to water, alcohols are polar molecules. As a result, many alcohols are quite soluble in water. This is in contrast to alkanes which are non-polar and therefore insoluble in water.

- The hydroxyl group in alcohol molecule is responsible for both the solubility and the relatively high boiling point of alcohol. The hydroxyl groups can hydrogen bond between water and alcohol molecules.



water-alcohol

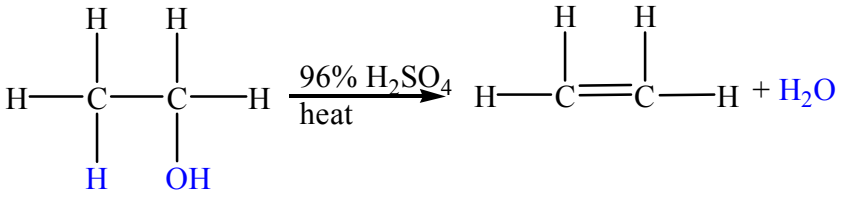


alcohol-alcohol

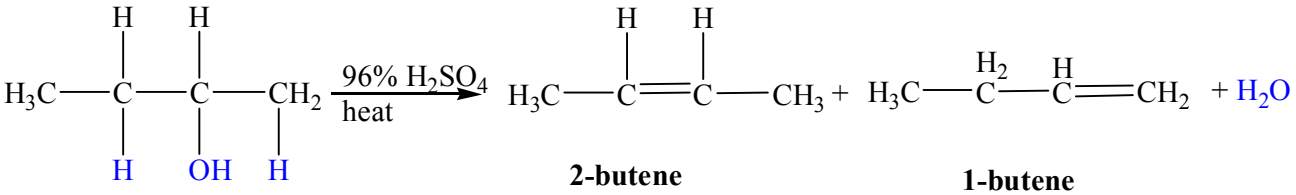
- Hydrogen bonding between water and alcohol leads to increased solubility, while hydrogen bonding between alcohol and alcohol molecules accounts for the high boiling point.

REACTIONS OF ALCOHOLS

- The main reactions of alcohols are dehydration and oxidation.
- Dehydration reactions occur when a water molecule is lost from an alcohol and an alkene is produced.



- For many alcohols, there is more than one way to remove water. Therefore the double bond can be located in different positions.
- The major product in such cases is the alkene in which the C=C bond has the greatest number of alkyl substituents on it (or the least number of hydrogens).



2-butanol

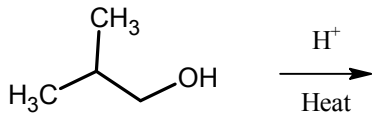
2-butene (major product)

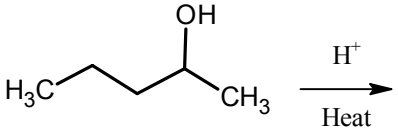
1-butene

- This rule is summarized as **Saytzeff's rule**, which states that during intramolecular dehydration, if there is a choice of positions for the carbon-carbon double bond, the preferred location is the one that generally gives the **more highly substituted alkene** – that is, the alkene with the most alkyl groups attached to the double-bond carbons.

Examples:

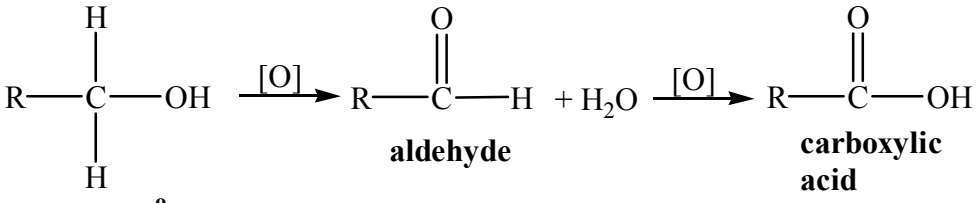
Predict and name the major product formed by the dehydration of each of the following alcohols:

1. 

2. 

REACTIONS OF ALCOHOLS

- Oxidation of alcohols can yield to aldehydes, ketones and carboxylic acids.
- Mild oxidation of primary alcohols yields aldehydes. Further oxidation of these compounds yields carboxylic acids.

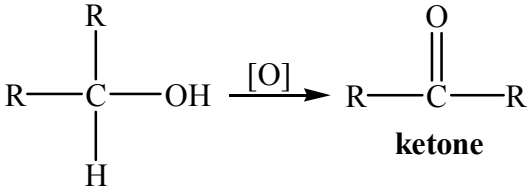


aldehyde

carboxylic acid

primary (1^o) alcohol

- Oxidation of secondary alcohols yields ketones.



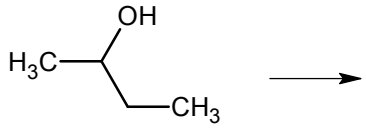
ketone

secondary (2^o) alcohol

- Tertiary alcohols do not undergo oxidation.

Examples:

Predict the major product formed by the oxidation of each of the following alcohols:

1. 

2.