

Al-Mustaqbal University

College of Science

Forensic Evidence Department



جامعة المستقبل  
AL MUSTAQBAL UNIVERSITY

## كلية العلوم قسم الادلة الجنائية

### المحاضرة السابعة

### Alcohols and Phenols

المادة : عضوية

المرحلة : الثانية

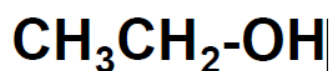
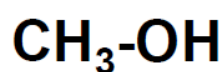
اسم الاستاذ: م.د. كرار مجيد عبيد

## Introduction

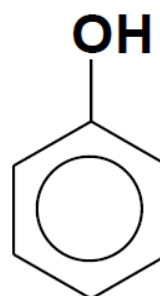
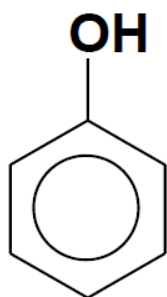
- ✓ Alcohol – organic compound that contains a hydroxyl (-OH) group attached to an alkyl group
- ✓ Phenol – organic compound that contains a hydroxyl (-OH) group attached to an aryl group

## Examples

**Alcohols -OH hydroxyl**

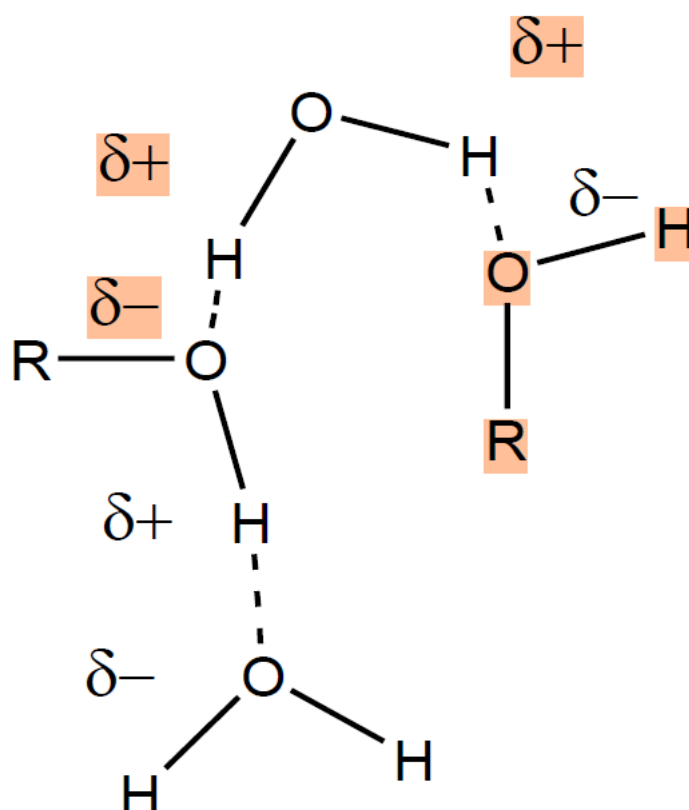


**Phenols**



## Structure and Properties

- ✓ R-O-H portion of alcohol is similar to the structure of water.
  - a. The oxygen and two atoms bonded to it lie in the same plane
  - b. The bond angle is  $104^\circ$
- ✓ Hydroxyl groups are very polar because of significantly different electronegativities.
- ✓ Hydrogen bonding can form between alcohol molecules.

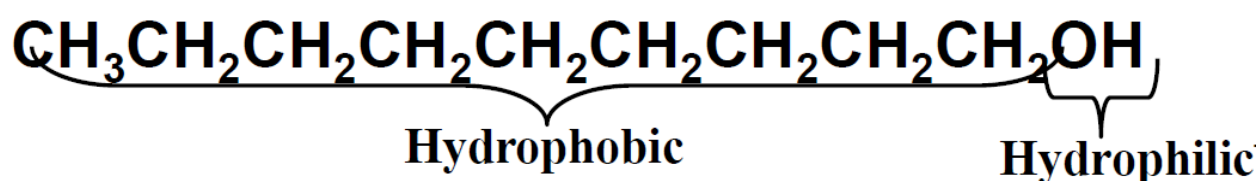


### Results of Hydrogen Bonding

1. Alcohols boil at much higher temperatures than hydrocarbons of similar molecular weight.
2. Alcohols with fewer than five carbons are very soluble in water.
3. Alcohols with five to eight carbons are moderately soluble in water.
4. As the nonpolar (R) portion of the alcohol gets larger, the water solubility decreases.

### Solubility of Alcohols

- Very large alcohols are not soluble in water.
- Hydrophobic – “water fearing”; used to describe nonpolar region of molecule
- Hydrophilic – “water loving”; used to describe polar region of molecule



- An increase in the number of hydroxyl groups will increase the influence of the polar hydroxyl group.
- Diols and triols are more water soluble than alcohols with only a single hydroxyl group.

### Nomenclature of Alcohols

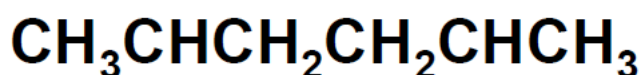
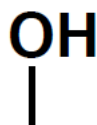
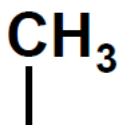
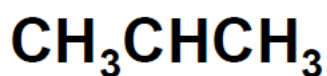
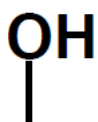
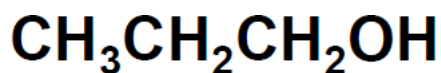
- A carbon compound that contain -OH(hydroxyl) group
- In IUPAC name, the -e in alkane name is replaced with -ol.

### Comparison Between Alkanes and Alcohols

This table compares the homologous series of alkanes and their corresponding alcohols, showing molecular and structural formulas along with naming differences according to the IUPAC system.

No. of Carbons	Alkane (Formula & Name)	Alcohol (Formula & Name)
1	CH <sub>4</sub> → Methane	CH <sub>3</sub> OH → Methanol
2	C <sub>2</sub> H <sub>6</sub> → Ethane	C <sub>2</sub> H <sub>5</sub> OH → Ethanol
3	C <sub>3</sub> H <sub>8</sub> → Propane	C <sub>3</sub> H <sub>7</sub> OH → Propanol
4	C <sub>4</sub> H <sub>10</sub> → Butane	C <sub>4</sub> H <sub>9</sub> OH → Butanol
5	C <sub>5</sub> H <sub>12</sub> → Pentane	C <sub>5</sub> H <sub>11</sub> OH → Pentanol
6	C <sub>6</sub> H <sub>14</sub> → Hexane	C <sub>6</sub> H <sub>13</sub> OH → Hexanol
7	C <sub>7</sub> H <sub>16</sub> → Heptane	C <sub>7</sub> H <sub>15</sub> OH → Heptanol
8	C <sub>8</sub> H <sub>18</sub> → Octane	C <sub>8</sub> H <sub>17</sub> OH → Octanol
9	C <sub>9</sub> H <sub>20</sub> → Nonane	C <sub>9</sub> H <sub>19</sub> OH → Nonanol
10	C <sub>10</sub> H <sub>22</sub> → Decane	C <sub>10</sub> H <sub>21</sub> OH → Decanol

**IUPAC names for longer chains number the chain from the end nearest the -OH group.**

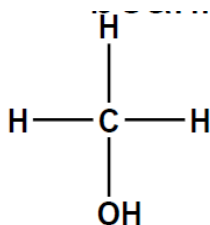


**Alcohols that contain more than one hydroxyl group**

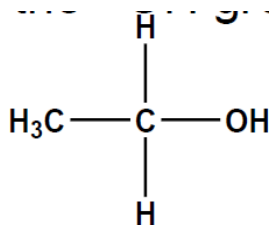
- 1) Alcohols containing two hydroxyl groups are named –diols.
- 2) Alcohols containing three hydroxyl groups are named –triols.
- 3) A number giving the position of each of the hydroxyl groups is needed in these cases.

### Classification of Alcohols

Alcohols can be classified as primary ( $1^\circ$ ), secondary ( $2^\circ$ ), or tertiary ( $3^\circ$ ) depending on the number of alkyl groups attached to the carbon bearing the –OH group.

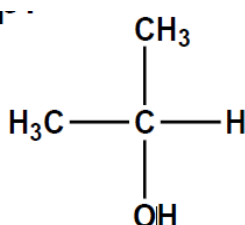


Methanol



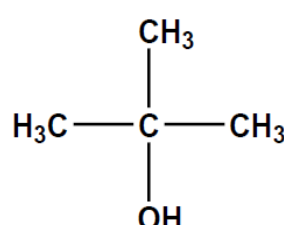
$1^\circ$  alcohol

ethanol



$2^\circ$  alcohol

2-propanol

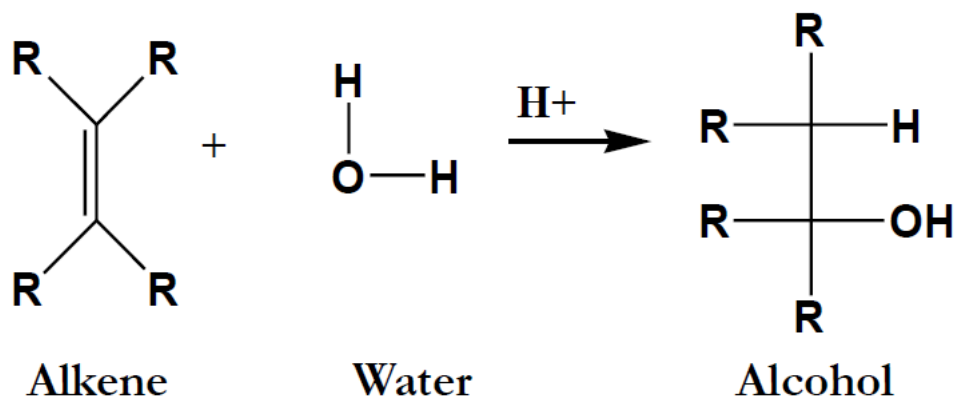


$3^\circ$  alcohol

2-methyl-2-propanol

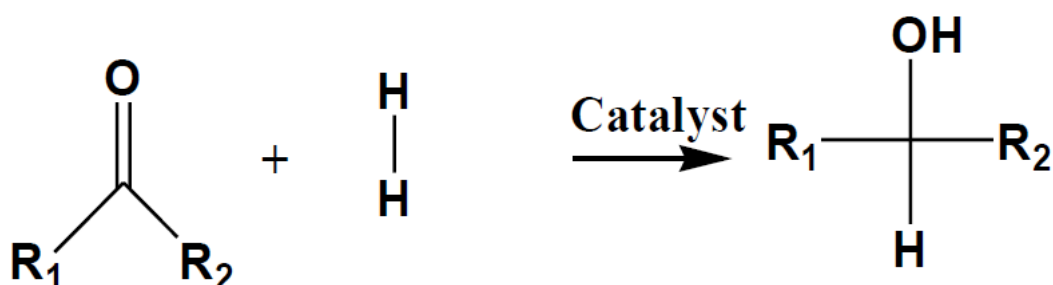
## Preparation of Alcohols

Review: Hydration – an addition reaction in which a water molecule is added to an alkene; requires acid as catalyst



\*Markovnikov's rule applies!!

## Hydrogenation of aldehydes and ketones

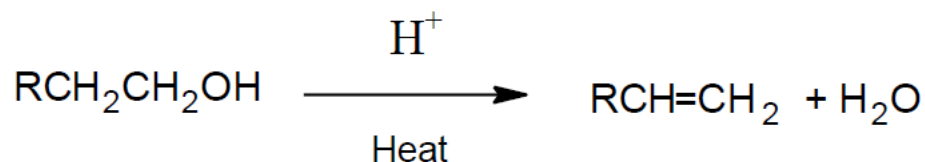


In an aldehyde, R1 and R2 may be either alkyl groups or H. In a ketone, R1 and R2 are both alkyl groups.

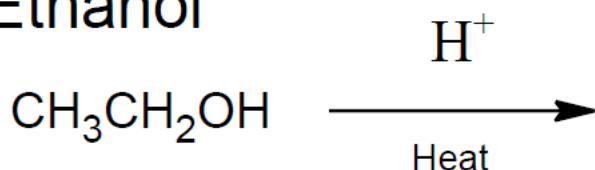
## Dehydration of Alcohols

- Alcohols undergo dehydration (lose water) when heating with concentrated sulfuric or phosphoric acid.
- Dehydration is an example of an elimination reaction.
- Elimination reaction – a reaction in which a molecule loses atoms or ions from its structure.
- Dehydration is opposite of hydration!

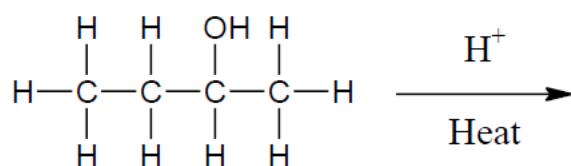
## General Reaction



## Ethanol



## 2-butanol



Zaitsev's rule – in an elimination reaction, the alkene with the greatest number of alkyl groups on the double bonded carbon (more highly substituted alkene) is the major product of the reaction

### Oxidation Reactions

- oxidation – loss of electrons; add O and/or lose H
- Reduction – gain of electrons; add H and/or lose O

Common oxidizing agents:

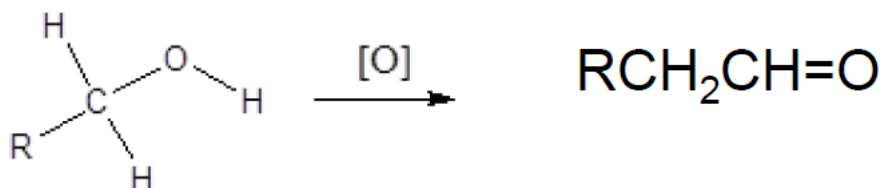
- Basic potassium permanganate ( $\text{KMnO}_4/\text{OH}^-$ )
- Chromic Acid ( $\text{H}_2\text{CrO}_4$ )

[O] Any general oxidizing agent

## Oxidation of Primary Alcohols

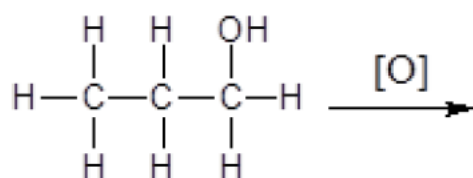
General equation:

– Primary alcohol  $\xrightarrow{[O]}$  aldehyde



EXAMPLE:

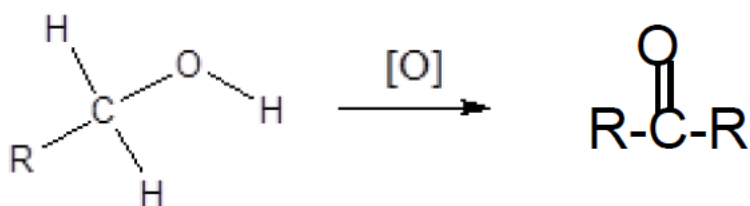
1-propanol



## Oxidation of Secondary Alcohols

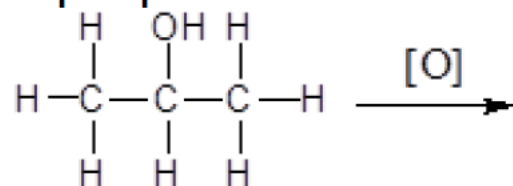
General equation:

– Secondary alcohol  $\xrightarrow{[O]}$  ketone



EXAMPLE:

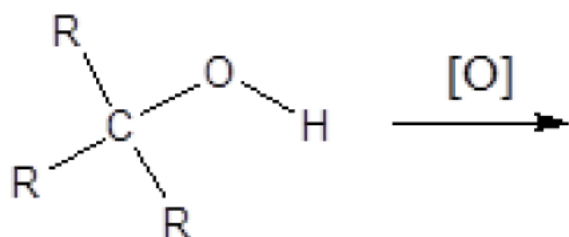
2-propanol





## Oxidation of Tertiary Alcohols

General equation:

– Tertiary alcohol  $\xrightarrow{[O]}$  NO REACTION!!!

## Phenols

Phenols – compounds in which the hydroxyl group is attached to a benzene ring

- They are polar compounds because of the polar hydroxyl group.
- Smaller phenols are somewhat soluble in water.
- They are found in fragrances and flavorings and are also used as preservatives and germicides

Common Phenols and their Uses

