

Objectives: Chap 7: Alcohols, Phenols, & Thiols (Chapter 7 and pages 283-285 & 296-297, A-1 & A-2 in lab manual)

- Identify molecules as an alcohol, phenol, glycol, glycerol, quinone, aldehyde, ketone, carboxylic acid, ether, ester, thiol, and thiophenol
 - Uses, dangers, common names/nicknames, biological significance from notes, reading assignments, class discussions
- Determine the IUPAC name of alcohols, phenols, thiols, thiophenols, carboxylic acids, esters, or their structures, including ene-ol, yne-ol, diol.
- Classify alcohols as 1°, 2°, 3°
- Explain the properties of acidity & boiling point as relates to alcohols & phenols.
- Rank given molecules according to acidity
- Define and identify acids and bases according to their charge, H⁺ transfer or e⁻ transfer (Lewis acid/base).
- Identify conjugate acid-base pairs, acid strength using pK_a
- Determine equations, reactants, catalysts, products and predominant products for the following reactions of alcohols & phenols. (** See separate Reaction Summary)
 - Dehydration
 - Halogenation; (PX₃ vs. HX for alcohols) (X₂ w/FeX₃ for phenols)
 - Oxidation; Jones (CrO₃, Acetone, H₂SO₄) vs. PCC
 - Nitration
 - Oxidation of Thiols
 - Oxidation of hydroxyquinones
 - Ester formation
 - Miscellaneous phenol reactions – see Reaction Summary Sheet or Chapter 4

Alcohol: _____

Phenol: _____

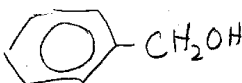
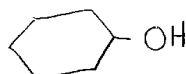
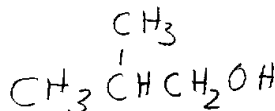
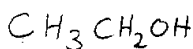
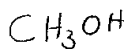
Thiol: _____

Thiophenol: _____

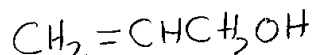
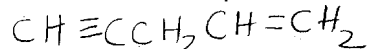
Alcohol Names

IUPAC name:

- Hydroxyl group _____
- Use longest chain w/-OH
- Number beginning nearest the -OH
- Alkyl substituent group name (drop “e” & put “yl”) followed by “alcohol”
- Examples:

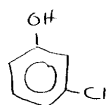


6. Unsaturated alcohols: 2 endings
- ene* or *yne* for double/triple bond
 - ol* for the hydroxyl group. (Listed last & given numbering priority)
 - Example:

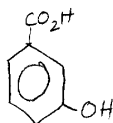


Phenol Names:

1. Phenol: Parent name

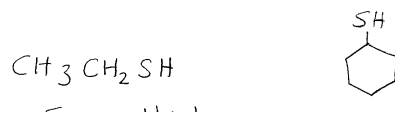


2. *Hydroxy*: To name -OH as substituent group when benzene ring has larger substituent w/common name

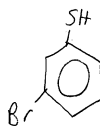


Thiols & thiophenol Names:

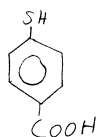
1. Thiols: Named like alcohols except _____



2. Thiophenol: common name of benzene ring _____



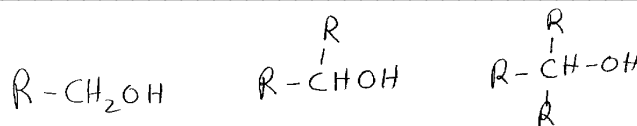
3. *Mercapto*: _____



Name Formula Old common name	Uses	Dangers
Methanol (methyl alcohol)		
Ethanol (ethyl alcohol):		
2-propanol:		

Classification of Alcohols

1. Based on _____



2. Methanol considered _____

Hydrogen Bonding in Alcohols & Phenols

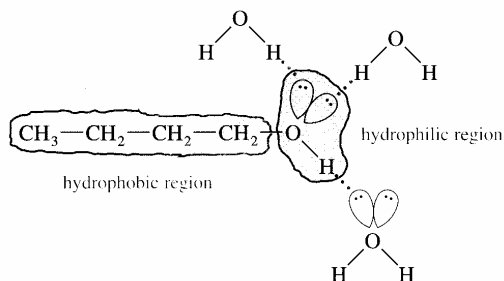
1. Hydrogen bonds form _____

2. _____ than alkanes of similar molecular mass

Molar Mass Comparison (For the fun of it!)			
<u>Formula</u>	<u>Molar Mass (amu)</u>	<u>State at Room Temp</u>	<u>Intermolecular Bonds</u>
H ₂ O			
CH ₄			
C ₃ H ₈			
CH ₃ OH			

3. Low mass alcohols _____

4. Bigger/longer alcohols may be _____ in nonpolar solvents b/c _____



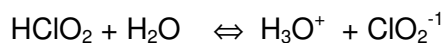
Acids & Bases

1st Model

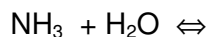
1. Acid: Substance that _____ **IN** the formula & _____ in solution to produce _____
2. Base: Substance that _____ group **IN** the formula & & ionizes in solution to produce _____
3. Shortcomings:
 - a. _____
 - b. _____

2nd Model (Bronsted-Lowry Model)

1. Acid: _____ (same as before)
2. Base: _____ (this is different)
3. **Conjugate acid-base pair**: 2 substances related to each other by _____
4. Example:



5. **Amphoteric**: Substances that can act as _____. Example _____
 - a. Example of water as an acid:



3rd Model: Lewis Acids & Bases (Based on _____)

1. Lewis Acid: Substance that _____ when forming a bond

a. _____

b. Has an _____ OR _____

2. Lewis Base: Substance that can _____ to form a bond

a. _____

b. _____

How to more easily determine if an Acid or a Base:

	Acid	Base	Example Equation
EXAMPLE: List the "1 st " ion associated with each category.			XXXXXXXXXXXXXXXXXXXXXXXXXXXX
1. Is a charge present? What type of charge is associated with each category? (Move to #2 if no charge is present.)			
2. Was H ⁺ transferred? What does each category do with an H ⁺ as it goes through the reaction across the arrow? (Move to #3 if no H ⁺ transfer)			
3. Lewis Acid/Base determined by electron pair transfer to create a bond. What does each category do with an electron pair during the bond formation?			

Acid ionization constants

1. **Ionization equation** for hydrocyanic acid, HCN

2. **Acid ionization constant, K_a**

a. Examples of typical numbers. Very small & difficult to work with.

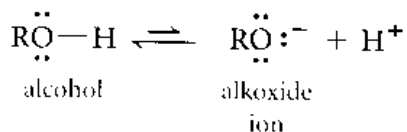
Hydrofluoric Acid: HF 6.3×10^{-4}

Hypochlorous HClO 4.0×10^{-8}

3. **pK_a**

a. _____ pK_a is the _____ acid _____

Sec 7.6 Acidity of Alcohols & Phenols



Alcohols:

1. Alkoxide ion _____

2. Acidity strength varies due to

a. _____

b. Size-must be _____

c. Shape-Acidity of _____ if same size

Phenols

1. _____ acids than alcohols

2. Anion formed = _____

3. \uparrow Acidity when _____ is stabilized by 1 of:

a) _____

b) _____

i. Caused by _____ on an adjacent carbon

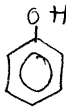
ii. Ie: _____

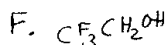
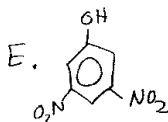
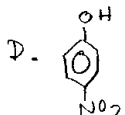
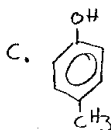
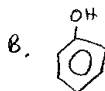
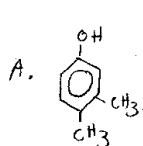
iii. Ie: _____

4. ↓ acidity when _____ (Exception-_____)

5. Examples: Rank from lowest to highest acidity:

A. CH_3OH B. CH_4 C. ClCH_2OH

D. CCl_3OH E. 



Basicity of Alcohols and Phenols

1. _____ bases (**ONLY** alcohols are bases, NOT phenols)

a. Can be _____ by strong acids

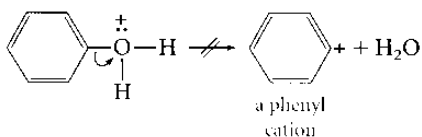
2. _____ is used to initiate some alcohol reactions. Examples:

a. _____

b. _____ (halogen replaces the OH)

Comparison Alcohols to Phenols

- Difficult to break the _____ during protonation
 - (_____ difficult to form– CAN'T pull the –OH off, so NOT a base))
- _____
- _____ (CAN'T replace OH with the halogen)



REACTIONS

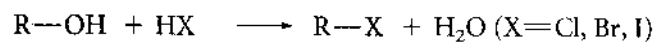
DEHYDRATION of alcohols to alkenes

- Reaction summary:

STEPS:

- Ease of Rx: Easiest/Fastest _____ Hardest/Slowest
- NOTE:** Possible to have ≥ 2 alkene products as, the H^+ can come from any adjacent C
- Zaitsev's Rule:** Most _____ double bond predominates. (Greatest _____ attached to the carbons of the double bond). Example:

ALKYL HALIDE FORMATION-1st method; w/HX X = Cl, Br, I



1. Rx rate: _____
2. Examples & steps:

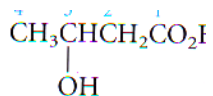
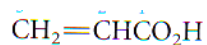
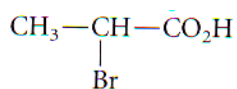
ALKYL HALIDE FORMATION-2ND method; w/PX₃

1. Used w/ _____ alcohols for _____
2. Also produces a 2nd reaction product; _____ (Phosphoric Acid)
 - a. Phosphoric acid has high _____ & can be separated from the alkyl halide by _____
3. Summary

Review of Phenol reactions: _____

Other Functional Groups to know:

1. Carbonyl: Many variations-subgroups following
2. Aldehyde:
3. Ketone:
4. Carboxylic Acid:
 - a. **Naming** of carboxylic acids: Change the "e" in the name of the alkane of the same length with the suffix *-oic acid*. The -COOH group is on carbon #1
 - b. Examples:

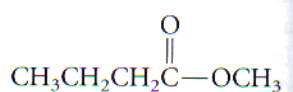
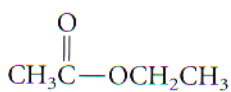
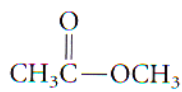


5. Ether

6. Ester

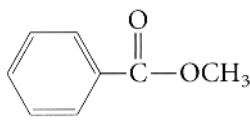
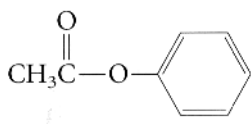
a. Naming of esters:

- 1st name the part WITHOUT the C=O. This was originally an alcohol and is named as a substituent; methyl, ethyl...
- 2nd name the part WITH the C=O. It was originally the carboxylic acid. Change the "ic" ending changed to "oate".
- Examples:

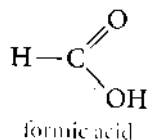
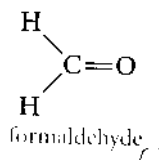


Example Ester Formation Equation:

More Ester Naming:



Which of the following is more oxidized? Why?



Special Alcohols:

1. Glycol-_____ on a carbon chain of any length.

➤ Ethylene glycol: _____

2. Glycerol-_____ on a 3-carbon chain. Many derivatives of glycerol.

- a. Triglyceride: _____ added to glycerol
- i. _____
- ii. _____
- iii. Formed w/ _____
- b. Phospholipids: **2 fatty acids & 1 phosphate group** attached to glycerol
- i. _____
- c. Nitroglycerin: _____ of glycerol
- i. _____
- ii. _____

Nitration of Alcohols

REVIEW of nitration of phenol:

Oxidation of Alcohols

1. Oxidation: Reaction that _____
2. The number of oxidation steps an alcohol can go through is _____
- a) 1° alcohols go through the following oxidation steps: _____
- b) 2° alcohols \Rightarrow _____
- c) 3° – _____
3. **Oxidizing Reagents:**
- a) Jones' Reagent: _____
- b) PCC (pyridium chlorochromate): _____

4. Example alcohol oxidation reactions:

5. EtOH oxidation in the human body after drinking alcoholic beverages:

Oxidation of Special Phenols (2-OH groups)

1. Produces _____ called 1,4-_____, sometimes 1,2

2. Reversible to _____

3. Quinones uses/functions:

a) _____

b) _____.

c) _____

d) _____

e) _____

Aromatic Substitution in Phenols

➤ See page 133: OH- usually_____

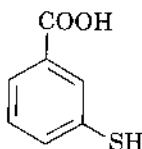
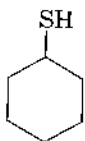
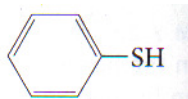
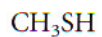
Thiols

1. _____.

2. Naming

a) If name as "thiol", count from end closest to SH. Name & add _____

b) -SH is _____ group



3. Oxidation of thiols to disulfides:

4. Disulfide significance:

a) _____

b) Create _____ between _____ within a protein molecule

⇒ used to _____

5. Example Oxidation of Thiol problems:

✿ What disulfides would you obtain from oxidation of the following thiols?

(a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{SH}$ (b) 3-Methyl-1-butanethiol (skunk scent)