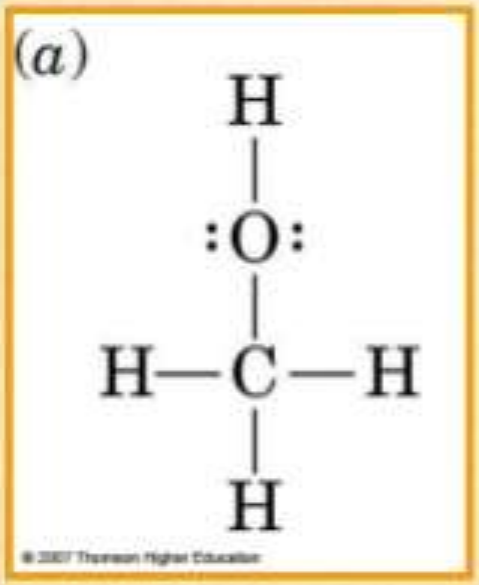
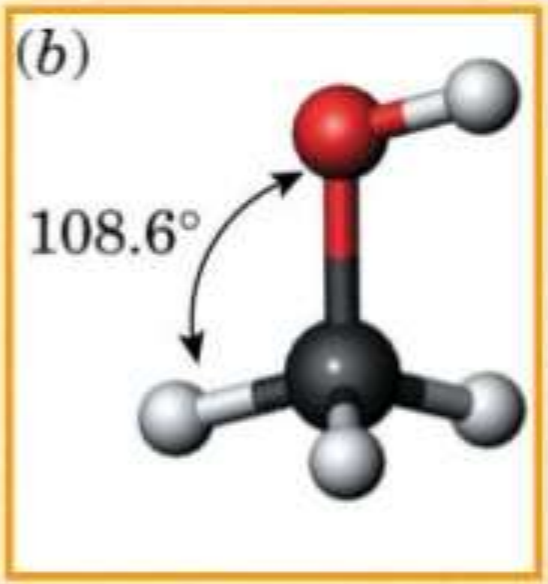
ALCOHOL and PHENOL

ALCOHOL

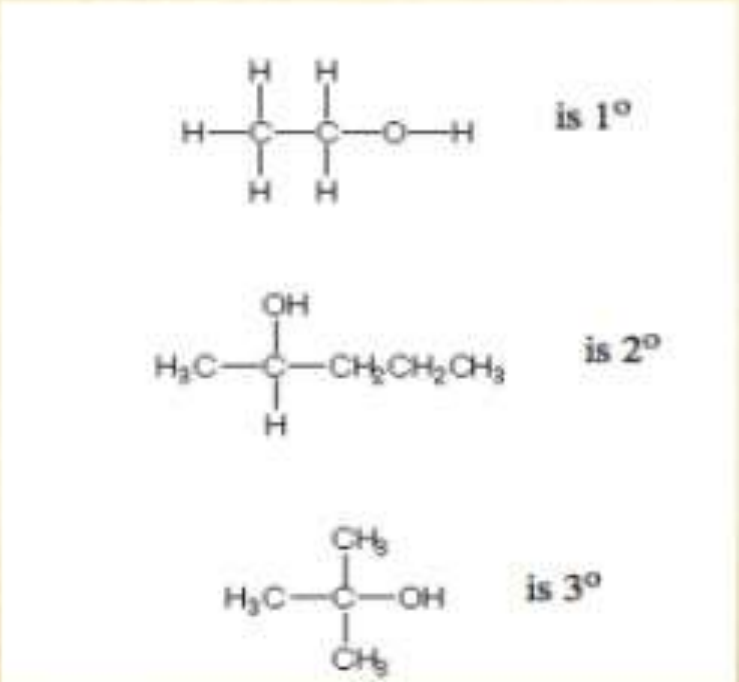
- a compound that contains an -OH (hydroxyl) group bonded to a tetrahedral carbon.





- A hydroxyl group is a hydrogen bonded to an oxygen that is covalently bonded to the rest of the molecule. Just as with alkenes, alkynes, and ketones, the location of the hydroxyl group is made by numbering the molecule such that the hydroxyl group has the lowest number possible.

- Alcohols are subdivided by examining the carbon to which the hydroxyl group is bonded. If this carbon is bonded to one other carbon atom, it is a primary (1°) alcohol. If this carbon is bonded to two other carbons, it is a secondary (2°) alcohol. If it is bonded to three other carbons, it is a tertiary (3°) alcohol.



Naming Alcohols

- General classifications of alcohols based on substitution on C to which OH is attached
  Methyl (C has 3 H's), Primary (1°) (C has two H's, one R), secondary (2°) (C has one H, two R's), tertiary (3°) (C has no H, 3 R's),

IUPAC Rules for Naming Alcohol

- Select the longest carbon chain containing the hydroxyl group, and derive the parent name by replacing the -e ending of the corresponding alkane with -ol
- Number the chain from the end nearer the hydroxyl group
- Number substituents according to position on chain, listing the substituents in alphabetical order

Alcohol Name	Formula
Methyl alcohol (methanol)	CH_3OH
Ethyl alcohol (ethanol)	CH_3CH_2OH
n - propyl alcohol	$CH_3CH_2CH_2OH$
Isopropyl alcohol (propanol -2)	$CH_3CHOHCH_3$
n-butyl alcohol (butanol -1)	$CH_3(CH_2)_2CH_2OH$
butyl alcohol (butanol -2)	$CH_3CH_2CHOHCH_3$
n-hexyl alcohol (hexanol-1)	$CH_3(CH_2)_4CH_2OH$
n-heptyl alcohol (heptanol-1)	$CH_3(CH_2)_5CH_2OH$
n-octyl alcohol (octanol-1)	$CH_3(CH_2)_6CH_2OH$
ethylene glycol	CH_2OHCH_2OH
glycerol	$CH_2OHCHOHCH_2OH$

PHYSICAL PROPERTIES

Compound	IUPAC Name	Common Name	Melting Poing (°C)	Boiling Point (°C)	Solubility in H_2O at 23°C
CH_3OH	Methanol	Methyl alcohol	-97.8	65.0	Infinite
CH_3Cl	Chloromethane	Methyl chloride	-97.7	-24.2	0.74 g/100 mL
CH_4	Methane		-182.5	-161.7	3.5 mL (gas)/ 100 mL
CH_3CH_2OH	Ethanol	Ethyl alcohol	-114.7	78.5	Infinite
CH_3CH_2Cl	Chloroethane	Ethyl chloride	-136.4	12.3	0.447 g/100 mL
CH_3CH_3	Ethane		-183.3	-88.6	4.7 mL (gas)/ 100 mL
$CH_3CH_2CH_2OH$	1-Propanol	Propyl alcohol	-126.5	97.4	Infinite
$CH_3CH_2CH_3$	Propane		-187.7	-42.1	6.5 mL (gas)/ 100 mL
$CH_3CH_2CH_2CH_2OH$	1-Butanol	Butyl alcohol	-89.5	117.3	8.0 g/100 mL
$CH_3(CH_2)_4OH$	1-Pentanol	Pentyl alcohol	-79	138	2.2 g/100 mL

CHEMICAL PROPERTIES

- An alcohol is made up of a chain of carbons and hydrogen, where an –OH molecule attaches to where a Hydrogen molecule is supposed to be attached to a Carbon.
- The position of the OH group has little effect on the chemical properties except in their response to mild oxidizing agents.
- general formula for a simple acyclic alcohol is $C_nH_{2n+1}OH$
- classified into 1^0, 2^0, 3^0 alcohols

REACTIONS

- Alcohols are versatile organic compounds since they undergo a wide variety of transformations – the majority of which are either oxidation or reduction type reactions.
- Alcohols are only slightly weaker acids than water, with a K_a value of approximately 1×10^{-16}. The reaction of ethanol with sodium metal (a base) produces sodium ethoxide and hydrogen gas.

USES of ALCOHOL

- Drinks - The "alcohol" in alcoholic drinks is simply ethanol.
- Industrial methylated spirits (meths) - Ethanol is usually sold as industrial methylated spirits which is ethanol with a small quantity of methanol added and possibly some colour. Methanol is poisonous, and so the industrial methylated spirits is unfit to drink. This avoids the high taxes which are levied on alcoholic drink.
- As a fuel - Ethanol burns to give carbon dioxide and water and can be used as a fuel in its own right, or in mixtures with petrol (gasoline).
- As a solventEthanol is widely used as a solvent. It is relatively safe, and can be used to dissolve many organic compounds which are insoluble in water. It is used, for example, in many perfumes and cosmetics.

USES of ALCOHOL

- Disinfectants
- Solvents
- Liquor
- High efficiency fuels
- Used to synthesize other organic compounds
- Fungicides
- Cosmetics
- Used to make vinegar
- Used in the manufacturing of plastics

USES OF ALCOHOL

- Isopropyl Alcohol

  - Rubbing alcohol

  - Rapid evaporation

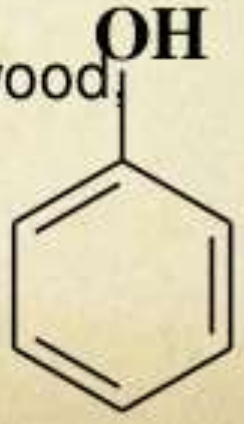
  - Antiseptic

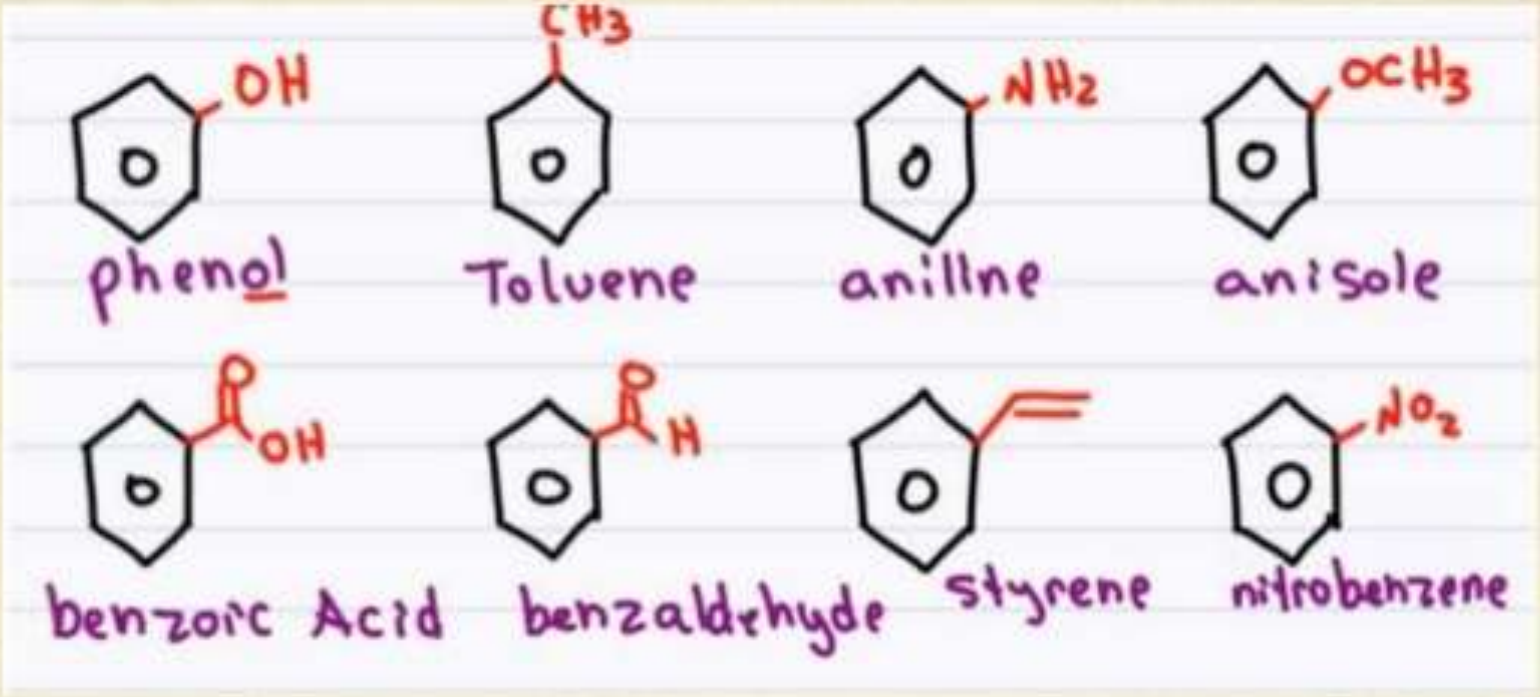
  - More toxic than ethanol, but induces vomiting

  - Used for the manufacture of acetone

PHENOL

- The antiseptic property of phenol was discovered in 1865 by Joseph Lister, a physician in Scotland.
- Listerine, named after him, contains phenol as the active ingredient.
- Today, over two million tons of phenol are made each year in the US alone.
- Phenol is used for resins, glue to make plywood, plastics, and pharmaceuticals.




OH
phenol
CH3
Toluene
NH2
anillne
OCH3
anisole
OH
benzoic Acid
H
benzaldehyde
styrene
NO2
nitrobenzene

PHYSICAL PROPERTIES

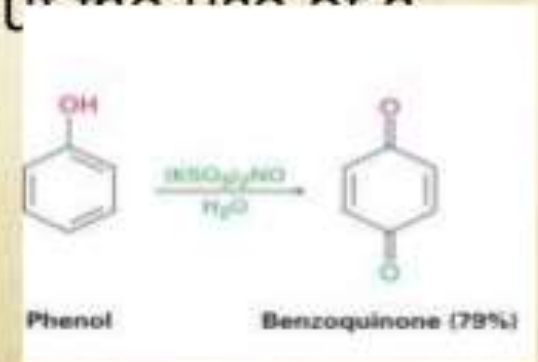
- - polar nature of the O-H bond (due to the electronegativity difference of the atoms) results in the formation of hydrogen bonds with other phenol molecules or other H-bonding systems (e.g. water). The implications of this are:high melting and boiling points compared to analogous areneshigh solubility in aqueous media

Chemical Properties

- Reaction with Lucas Reagent
  - Lucas reagent: $ZnCl_2$ in HCl
  - Positive result: formation of turbidity or two layers
  - General equation:

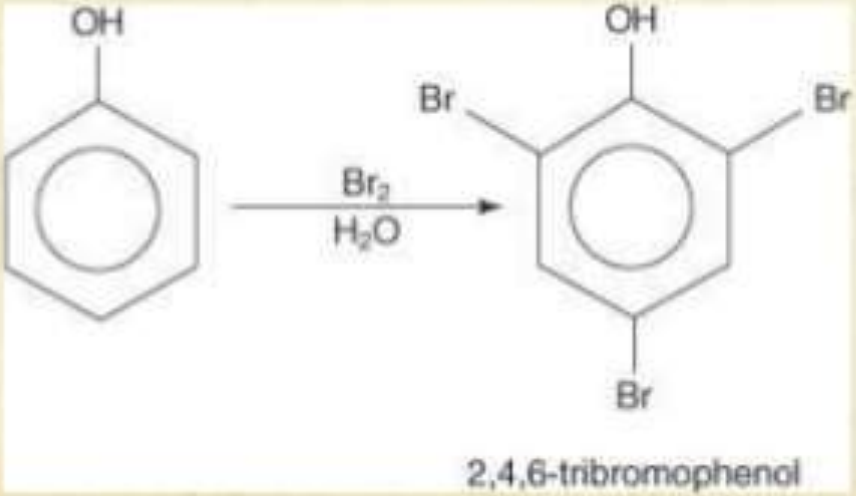
Reaction of Phenol

- electrophilic aromatic substitution
- oxidation to yield quinones with Fremy's salts (potassium nitrosodisulfonate)
- The hydroxy group in a phenol molecule exhibits a strong activating effect on the benzene ring because it provides a ready source of electron density for the ring. This directing influence is so strong that you can often accomplish substitutions on phenols without the use of a catalyst.

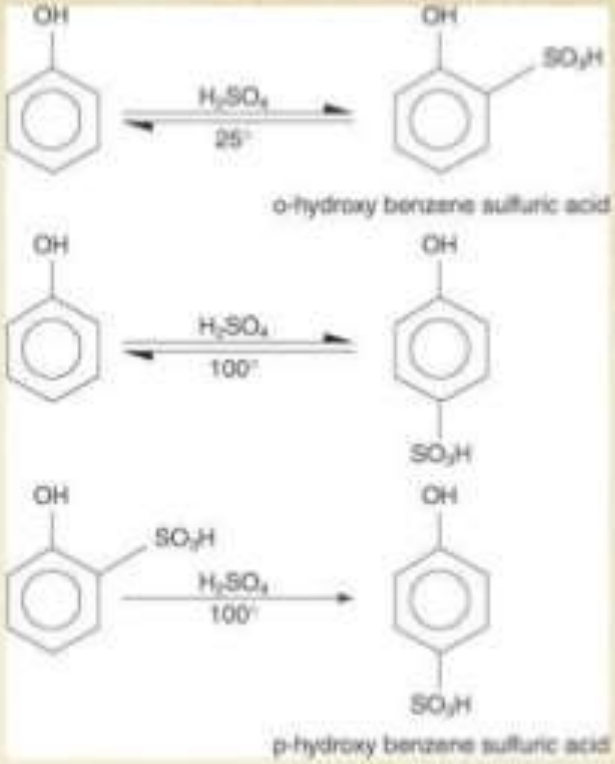


REACTION

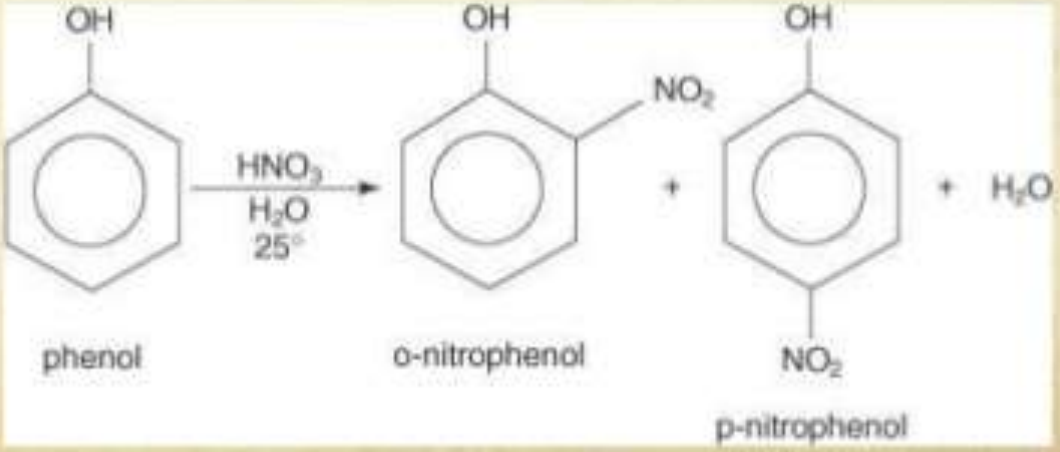
- Halogenation - Phenols react with halogens to yield mono-, di-, or tri-substituted products, depending on reaction conditions. For example, an aqueous bromine solution brominates all ortho and para positions on the ring.



Sulfonation - The reaction of phenol with concentrated sulfuric acid is thermodynamically controlled. At 25°C, the ortho product predominates while at 100°C, the para product is the major product.



NitrationPhenol, when treated with dilute nitric acid at room temperature, forms ortho- and para-nitrophenol.



Reaction Phenol		Benzene
Nitration / H_2SO_4	dil. HNO_3 in H_2O or CH_3CO_2H	HNO_3
Sulfonation conc.	H_2SO_4	H_2SO_4 or SO_3 / H_2SO_4
Halogenation	X_2	X_2 / Fe or FeX_3
Alkylation	ROH / H^+ or RCl / $AlCl_3$	RCl / $AlCl_3$
Acylation	RCOCl / $AlCl_3$	RCOCl / $AlCl_3$
Nitrosation	aq. $NaNO_2$ / H^+	

USES

- embalming of bodies and as an oral analgesic in the manufacture of cosmetics and drugs.
- The hydrocarbon is used in the health industry as an antiseptic for surgical instruments.
- Used a raw material for the production of plastic additives, dyes, and herbicides.

Thanks