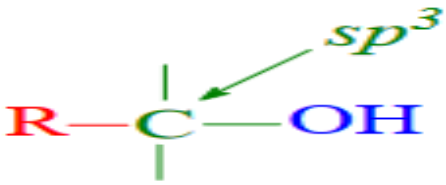
alcohols

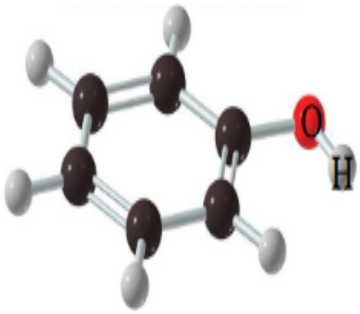
-Alcohols are characterized by the hydroxyl group -OH

-As all alcohols are the compounds containing hydroxyl group (-OH) attached to the alkyl group, hybridization is sp3

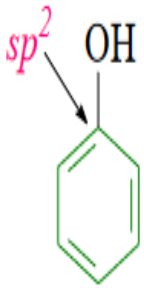


Phenols or, Aryl alcohols

♣ Are hydroxyl derivatives of aromatic hydrocarbons, which are derived by replacing hydrogen atom attached to sp2 hybridized carbon atom(s) of benzene ring by hydroxyl group.

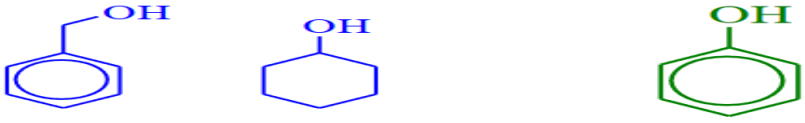


Phenols , ArOH



Alcohols and phenols have a common functional group the hydroxyl group, —OH.
Alcohols and phenols may be viewed as organic derivatives of water.

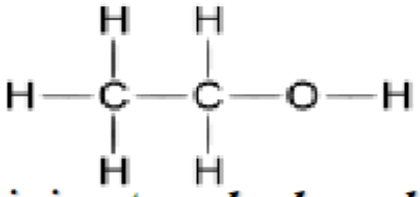
H-O-H	R-O-H or $PhCH_2OH$	Ph-O-H
Water	Alcohol	Phenol

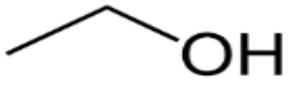


Types of Alcohols

1. Monohydroxyls: containing one ***hydroxyl group***.

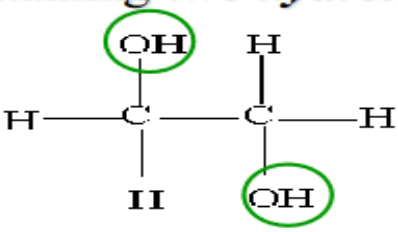
Example; ethanol (C_2H_5OH)

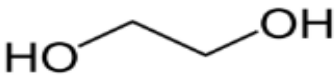




2. Dihydroxyls (glycols): containing two ***hydroxyl groups*** connected by **different** carbon atoms.

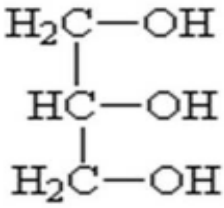
Example; 1,2-Ethanediol
Ethylene glycol
(CH_2OH-CH_2OH).

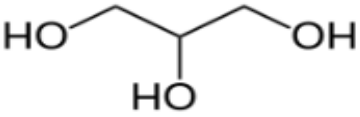




3. Polyhydroxyls: containing more than two ***hydroxyl groups*** on **different** carbon atoms.

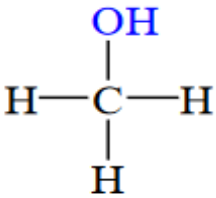
Example; 1,2,3-propanetriol
Glycerol or **Glycerin**
(CH_2OH-$CHOH$-CH_2OH).



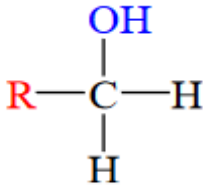


Classification of Monohydroxyl Alcohols

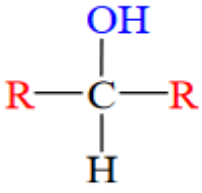
➢ ***The mono hydroxyl alcohols*** can be classified **into three types** according to the type of the carbon atom connected to the hydroxyl group:



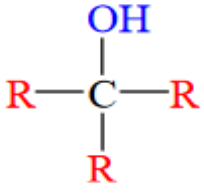
Methyl alcohol



1° alcohol



2° alcohol



3° alcohol

Examples

Ethanol

2-Propanol

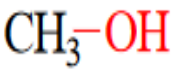
2-Methyl-2-Propanol

Nomenclature

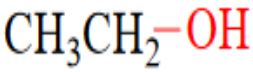
1) Common Nomenclature (Alkyl + alcohol)

- In the common system, you name an alcohol by listing the alkyl group and adding the word alcohol.

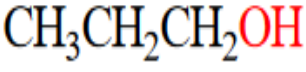
Examples:



Methyl alcohol

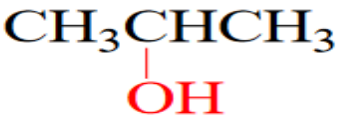


Ethyl alcohol

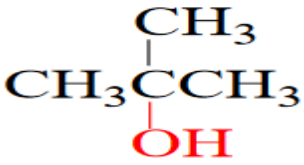


Propyl alcohol

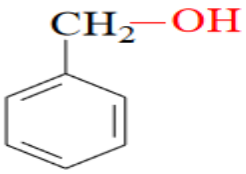
Examples:



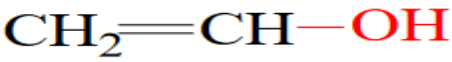
Isopropyl alcohol



t-butyl alcohol



Benzyl alcohol



Vinyl alcohol

Allyl alcohol

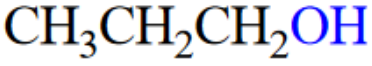
2) IUPAC Nomenclature

1) Select the longest continuous carbon chain to which the hydroxyl is directly attached.

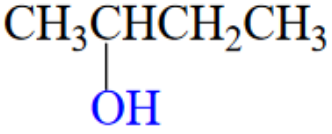
2) Change the name of the alkane corresponding to this chain by dropping the final -e and adding the suffix –ol.

3) Number the longest continuous carbon chain so as to give the carbon atom bearing the hydroxyl group the lower number.

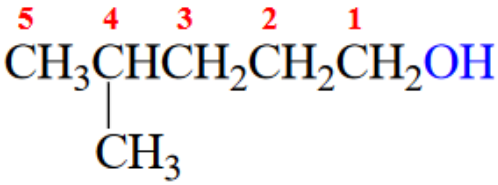
Examples



n-Propanol

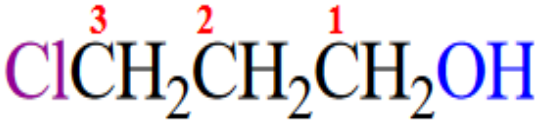


2-Butanol

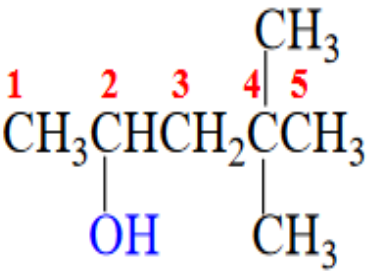


4-Methylpentan-1-ol

Not 2-Methylpentan-5-ol



3-chloropropan-1-ol



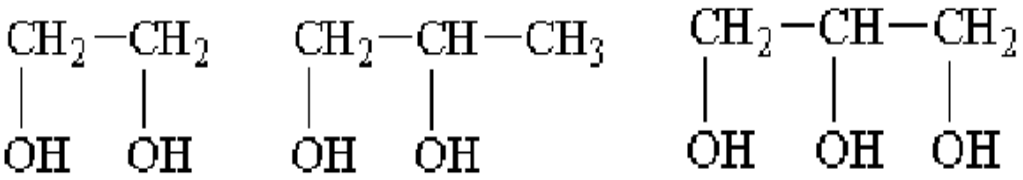
4,4-Dimethylpentan-2-ol

• In the IUPAC system, the suffix diol is added to the name of the

parent hydrocarbon when two hydroxyl groups are present, and the suffix triol is added when there are three OH groups.

• Common names, two OH groups on adjacent carbons are known as 1,2-glycols.

Examples:



IUPAC:	**1,2-Ethanediol**	**1,2-Propanediol**	**1,2,3-Propanetriol**
Common:	**Ethylene glycol**	**propylene glycol**	**glycerol or glycerin**

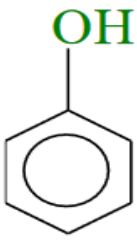
Nomenclature of Phenols

¬ Compounds that have a hydroxyl group attached directly to a benzene ring are called phenols.

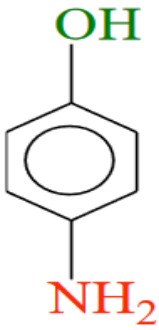
¬The ortho, meta, para system is used in common names.

¬While the numbering system is employed in IUPAC names and in this case numbering of the ring begins at the hydroxyl-substituted carbon and proceeds in the direction of the next substituted carbon that possesses the lower number.

Examples:

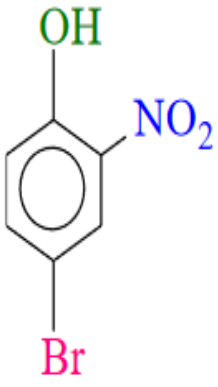


Phenol

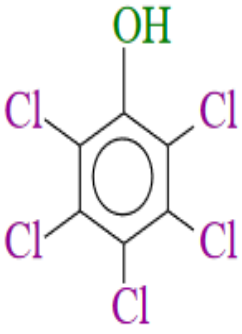


4- Aminophenol

Examples:



4-Bromo-2-nitrophenol



2,3,4,5,6-Pentachlorophenol

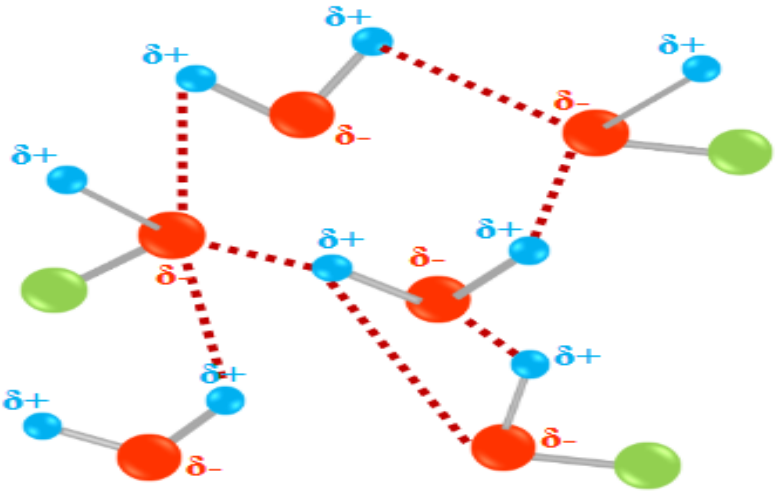
Physical Properties of Alcohols & Phenols

1. Solubility

• Alcohols

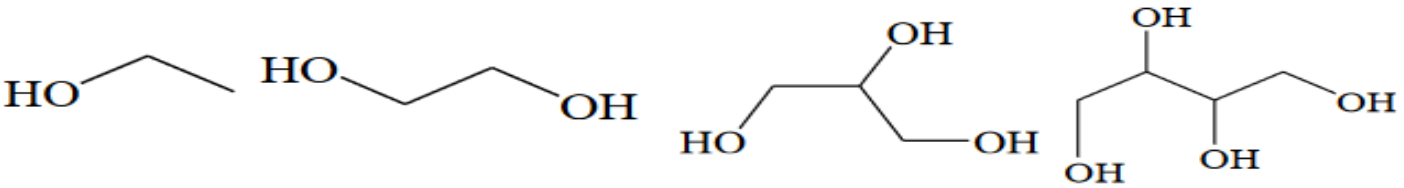
•The first three members are completely miscible with water. The solubility rapidly **decreases** with ***increase in molecular mass***. The higher members are almost insoluble in water but are soluble in organic solvents like benzene, ether etc.

•The solubility of lower alcohols is due to the existence of hydrogen bonds between water and polar -OH group of alcohol molecules.

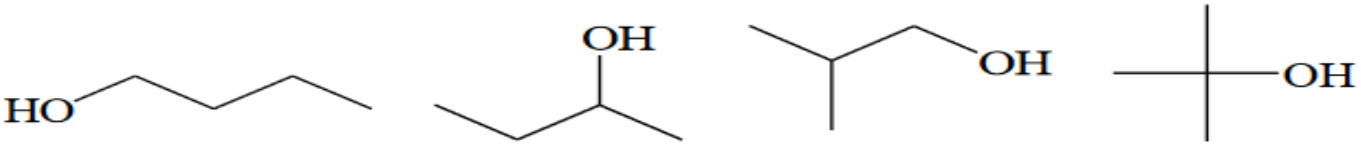


Hydrogen bonding between alcohols and water molecules

•The number of hydroxyl groups **increases** the solubility.



•The solubility increases with branching of chain.

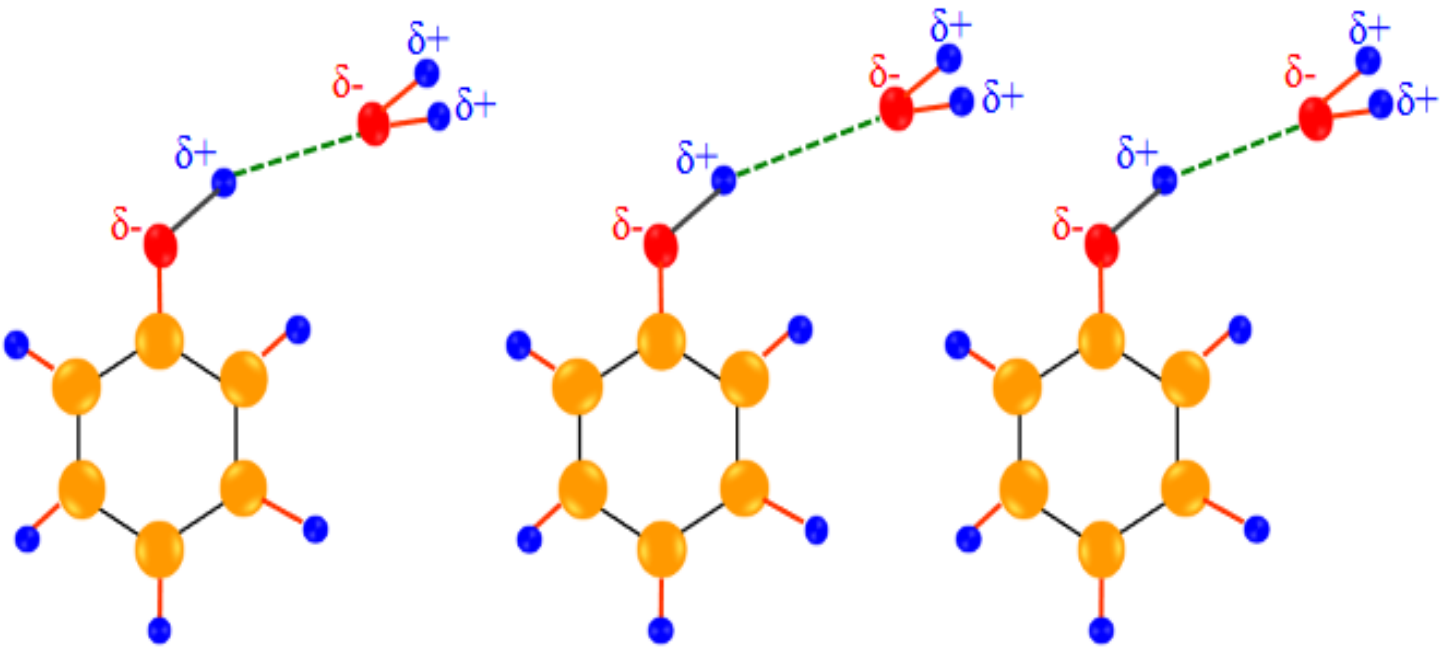


- **Phenols**

Phenols differ from alcohols in that the -OH is *directly* attached to the aromatic ring.

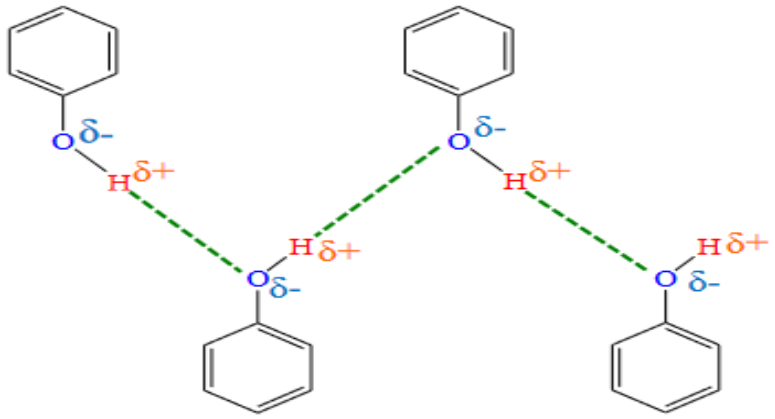
• Phenols are sparingly soluble in water but readily soluble in organic solvents .

•The -OH group in phenols contain a hydrogen bonded to an electronegative oxygen atom. Thus they form hydrogen bonds with water molecules



- Phenols

Phenols tend to have **higher** boiling points than alcohols of similar molecular weight **because** they have stronger intermolecular hydrogen bonding.



Representations of intermolecular hydrogen bonding in phenol

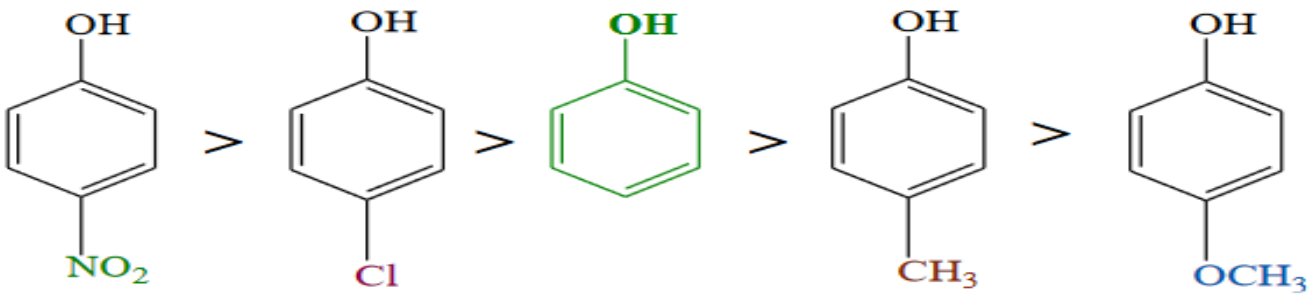
Acidity of phenols

Effect of substituents on the acidity of phenols

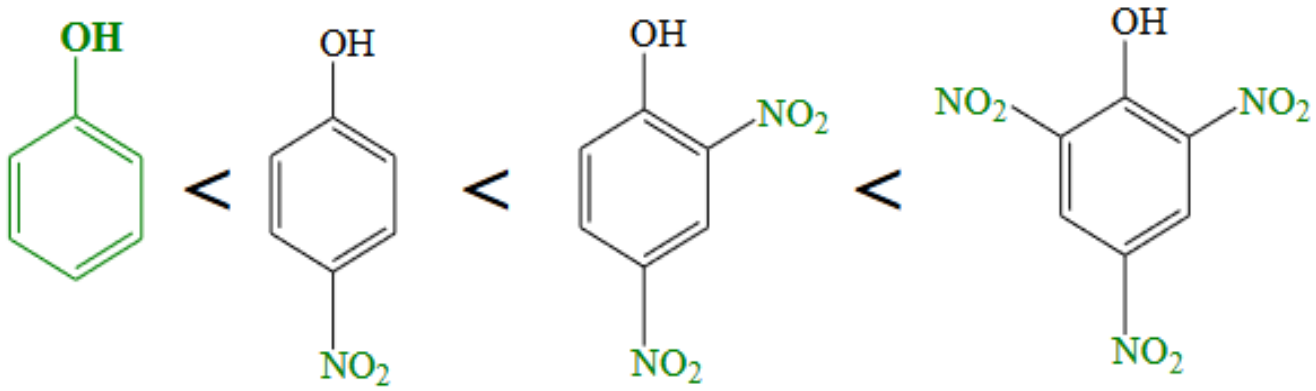
- Introduction of electron-withdrawing groups (EWG), such as NO_2 or CN, X on the ring ***increases the acidity*** of phenol.

- Also, introducing electron-donating groups (EDG), such as NH_2, R, OR ***decrease the acidity*** of phenols.

Acidity order



- The greater **the number** of electron withdrawing at *o*- and *p*-position, ***more in the acidic character*** of phenol.



	Phenol	4-Nitrophenol	2,4-Dinitrophenol	2,4,6-Dinitrophenol
pK_a	10.0	7.2	4.0	0.4