### **Polyols:**

If more than one hydroxyl group is present, a prefix is added to the "ol" :

2 OH's	diol (glycol)
3 OH's	triol
4 OH's	tetraol
5 OH's	pentaol

### **Physical Properties of Alcohols**

- The hydroxyl group is a very polar group. This allows small alcohols (methanol, ethanol, propanols) to be miscible with water (if the number of C < 4) as they are good hydrogen bond donors *and* acceptors.

- Soluble in H<sub>2</sub>O, as the #C increases, the solubility decreases.

- Alcohol densities are usually  $\rho < 1.0$  g/cm<sup>3</sup>.

- They have high boiling and melting points, again due to their hydrogen bonding capabilities.

Look at the following comparisons:

Name	Methanol	Ethane
Formula	CH <sub>3</sub> OH	CH <sub>3</sub> CH <sub>3</sub>
Molecular Weight (g/mol)	32	30
Boiling Point (° C)	65	-89
State (at room temp)	liquid	gas

Ethane has almost the same molecular weight as methanol. However, the boiling point is much lower than methanol. Methanol molecules like to stick together via H-bonding while ethane molecules interact with each other via hydrophobic interactions.

# R<sup>∕O</sup>∖H

O-H bond - easy to break

R-O bond - hard to break; always needs a strong acid to break and can proceed either  $S_{\rm N}\text{-}1$  /  $S_{\rm N}\text{-}2,$  or E1 / E2

**Miscibility of Alcohols with Water** 



\*butanol is soluble in H<sub>2</sub>O but not miscible





- pKa depends on conjugate base stability
- Harder to make a t-butoxide than methoxide. The alkyl group donates electron density to the C–O bond and destabilizes the negative charge (less favorable).



#### Methoxide vs. Isopropoxide:



Alkyl groups donate electrons through single bonds, destabilizing the negative charge (Inductive Effect), therefore, isopropoxide is less stable than methoxide

- Inductive effect – donation or withdrawal through single bonds

## **Conjugated/Aromatic R-OH**



- More acidic than H<sub>2</sub>O
- Resonance (resonance effect) takes electron density away from the O atom, resulting in stabilization of the negative charge.
- Resonance effect is strong through  $\pi$  system



The alkoxide of phenol is a conjugated anion and is therefore much more acidic

Example 2: *p*-Chlorophenol



pKa = 9.3

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Example 3: *p*-Nitrophenol



pKa = 7.3

*p*-Nitrophenol is more acidic than phenol because on top of the resonance forms that phenol contains, *p*-nitrophenol also contains the above extra resonance form, making the proton on the alcohol even more acidic.

## Example 4: *m*-Nitrophenol



Less acidic than *p*-nitrophenol because there is less stabilization of the negative charge. The negative charge is not conjugated with the nitro group double bond.

## More examples:



- As you get more resonance possibilities, the negative charge is more spread out across the molecules, and is more stabilized, resulting in lower pKa (more acidic).

## **Ethers**

## Recall:

Ethers are unreactive except in strongly acidic conditions (e.g. H<sub>2</sub>SO<sub>4</sub>) to undergo SN or E The difference between ester and ethers



#### Nomenclature:

-In the absence of other functional groups, name the two alkyl groups attached to the O and add the word "ether"

О.

**Examples:** 



In the presence of other functional groups, name ethers as a group, drop "yl" and add "oxy" as seen below:



methoxy

ethoxy

phenoxy

Example 1:

OH Ο

(Z)-3-methoxyhept-3-en-1-ol

Alcohol (-OH) takes priority over other functional groups
Number the longest C chain so as to give the OH group the lowest number possible

Example 2:

OH ()

2-phenoxyethan-1-ol or 2-phenoxy-1-ethanol

Example 3:

