

Today

Sections 2.1, 2.3, 2.12
Acids and Bases

Next Class

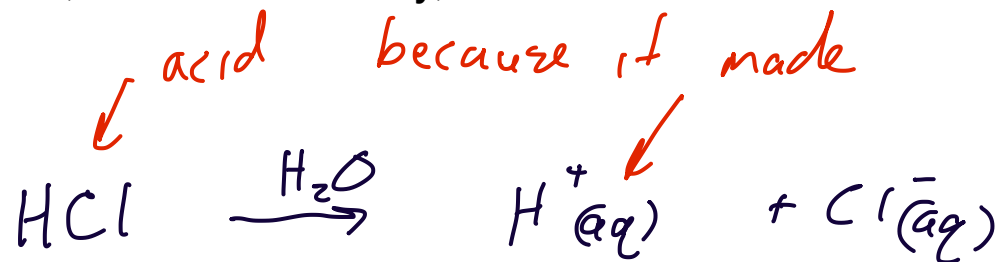
Sections 2.6 - 2.9
How structure affects acidity and basicity

In aqueous solutions, the solution is considered **acidic** if the concentration of **H⁺** is **greater than** the concentration of **OH⁻**. At 25 °C, this occurs when the pH is less than 7.

In every day language, we might say that the solution is an acid. More precisely, there is an **acid in the solution that is causing the solution to be acidic**.

We will call molecules or ions **acids or bases based on how they react** (or could do).

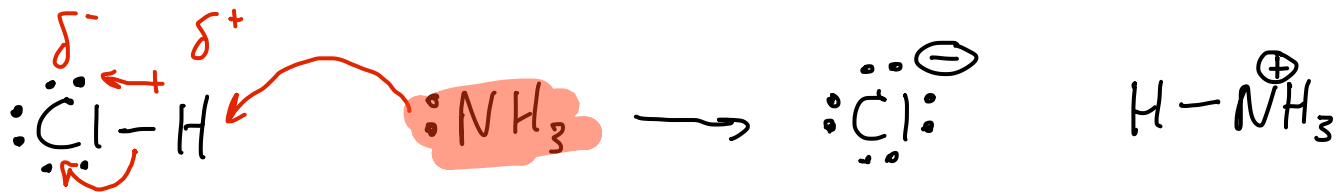
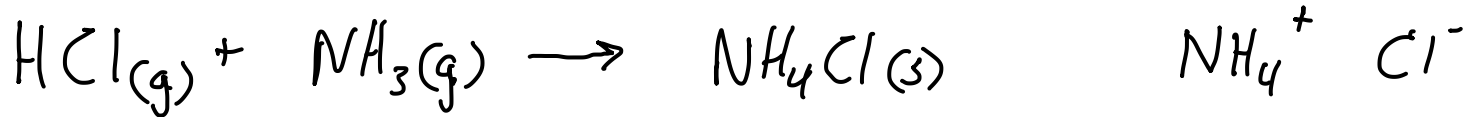
There are **many molecules** that can **act as a base** in some circumstances **or an acid** in other circumstances.



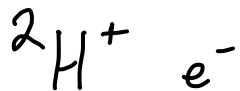
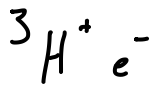
an Arrhenius base because it dissociated
in Na^+ + OH^-



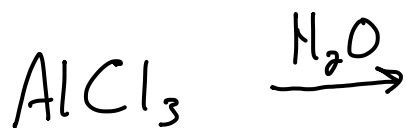
↑
donates/releases H^+ acid



accepts a proton



$1 \text{H}^+ \text{e}^-$
↑
this is just a proton

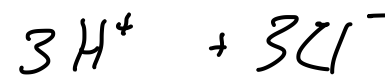
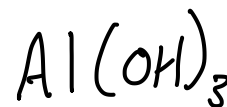
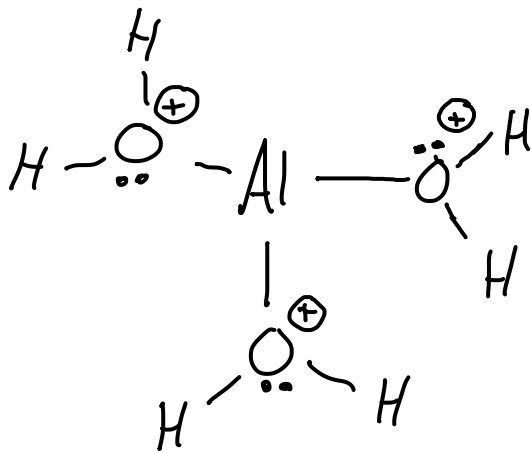


water is the Lewis base.
It is donating a pair of e^- 's



Al^{3+} is
an acid

it is an e^- pair
acceptor

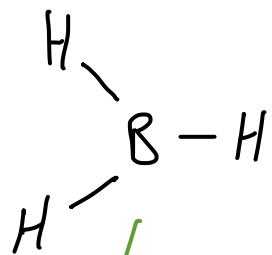


+2 + +3

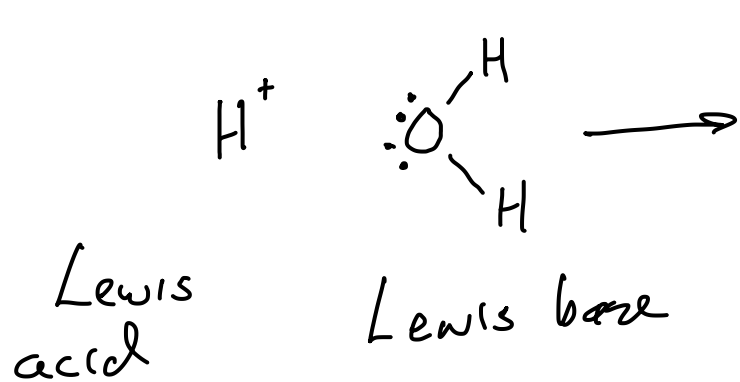
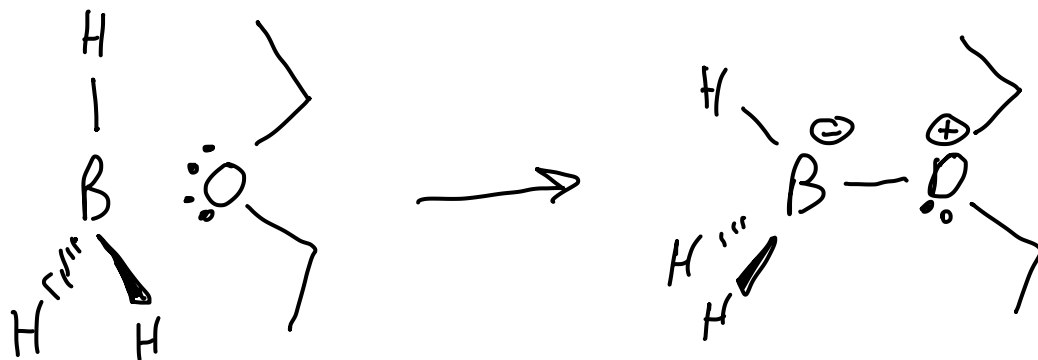
metals

H^+ can H^+ donate e^- 's? NO, H^+ has no e^- 's to donate

H^+ can only accept e^- 's



6e⁻'s in B's valence shell
room for 2 more



when I add
a H⁺ to
a base I
get the ...
conjugate acid of H₂O

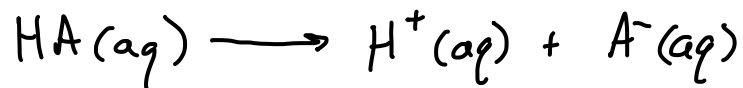
K_a and pK_a



equilibrium constant

[] conc in $\frac{mol}{L}$

Section 2.6



$pK_a = -6$

$pK_a = 6$



$$K = \frac{[\text{products}]}{[\text{reactants}]}$$

reaction goes to the right

$$K = \frac{1000000}{1}$$

reaction stays

$$K = \frac{1}{1000000}$$

$$K = 10^6$$

or left

$$K = 10^{-6}$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

\Rightarrow

$$pK_a = pH + \log \frac{[HA]}{[A^-]} \quad \text{or}$$

$$pK_a = pH - \log \frac{[A^-]}{[HA]} \quad \text{or}$$

$$pK_a = -\log [K_a]$$

$$= -\log [10^{-6}]$$

$$= -[-6] = 6$$

pK_a is backwards

Five ways to stabilize the electrons on the conjugate base

Section 2.6 – 2.9

Same Shell More Positive Nucleus

weakest

CH₄

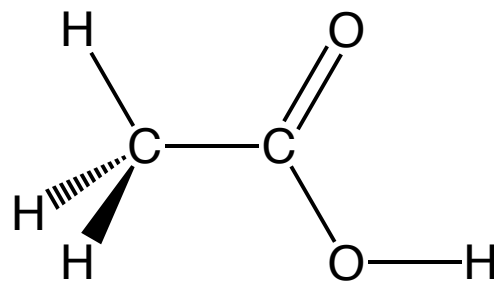
NH₃

H₂O

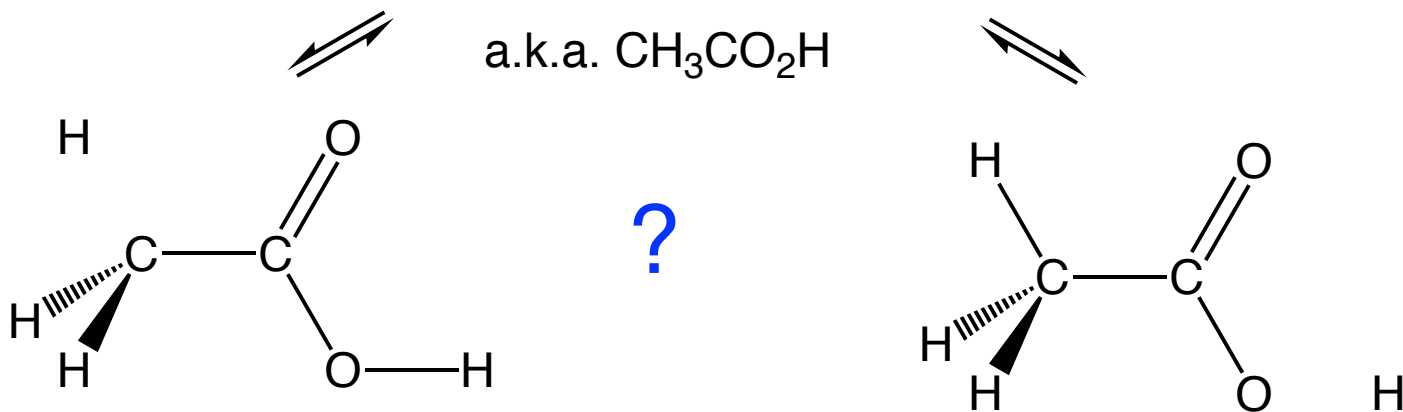
strongest HF

pK_a's CH₄, ~50 NH₃, ~36 H₂O, 15.6 HF, 3.18

Stabilizing the conjugate base



a.k.a. $\text{CH}_3\text{CO}_2\text{H}$



Which is the acidic proton?

Five ways to stabilize the electrons on the conjugate base

Section 2.6 – 2.9

Same Shell More Positive Nucleus

weakest

CH₄

NH₃

H₂O

strongest HF

pK_a's CH₄, ~50 NH₃, ~36 H₂O, 15.6 HF, 3.18

Five ways to stabilize the electrons on the conjugate base

Section 2.6 – 2.9

Same Column Larger Valence Shell

HI

HBr

HCl

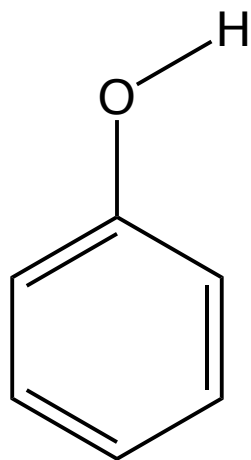
HF

pK_a's HF, 3.18 HCl, -7 HBr, -9 HI, -10

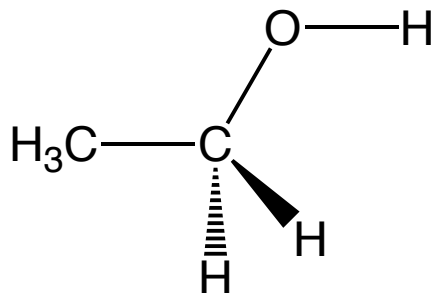
Five ways to stabilize the electrons on the conjugate base

Section 2.6 – 2.9

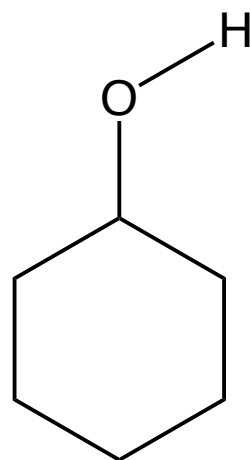
Resonance/Electron Delocalization



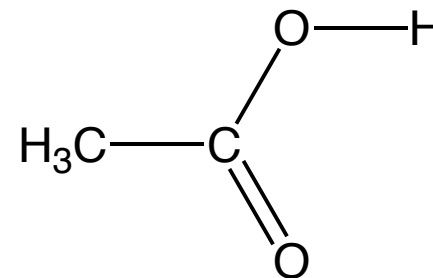
phenol



ethanol



cyclohexanol

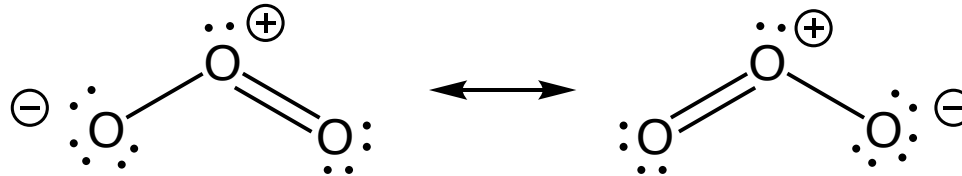


acetic acid

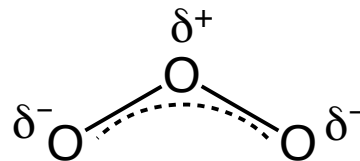
pK_a's cyclohexanol, 16.0 phenol, 10.0 ethanol 16.0 acetic acid 4.74

Wait, what, resonance?

It is a fix for valence bond theory to accommodate extended π systems seen in MO theory

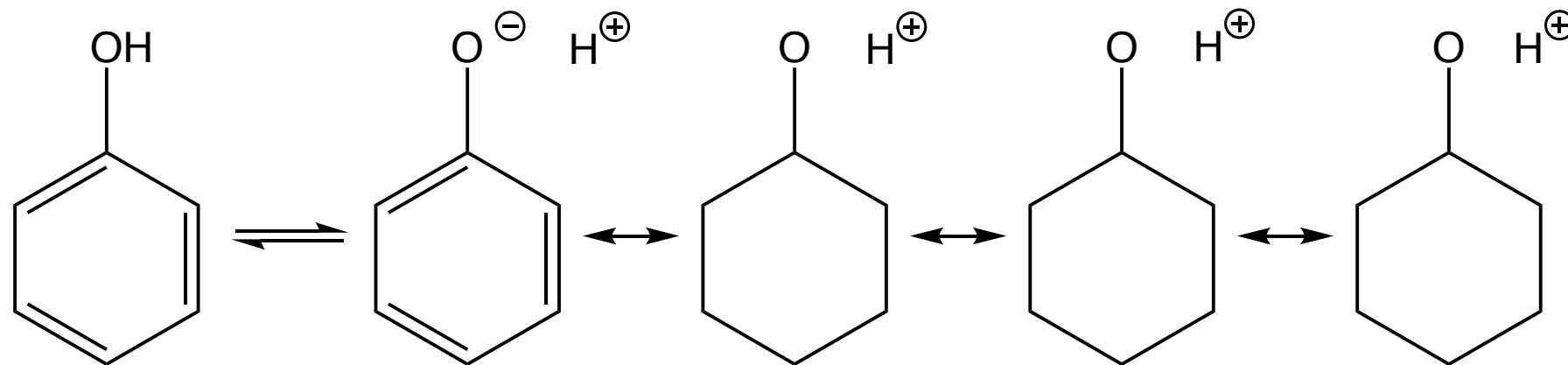
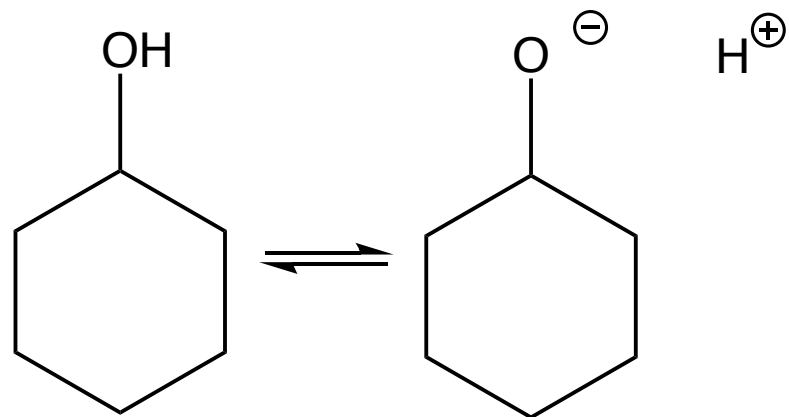


MO Theory matches reality



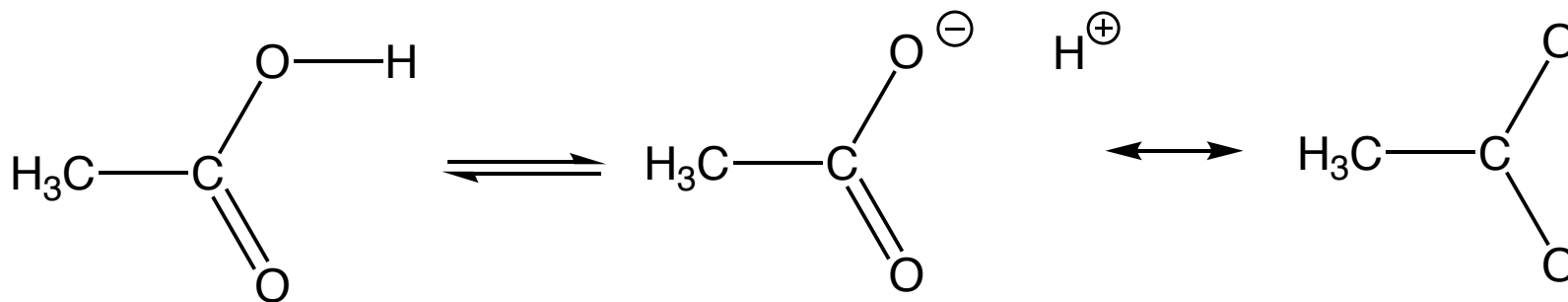
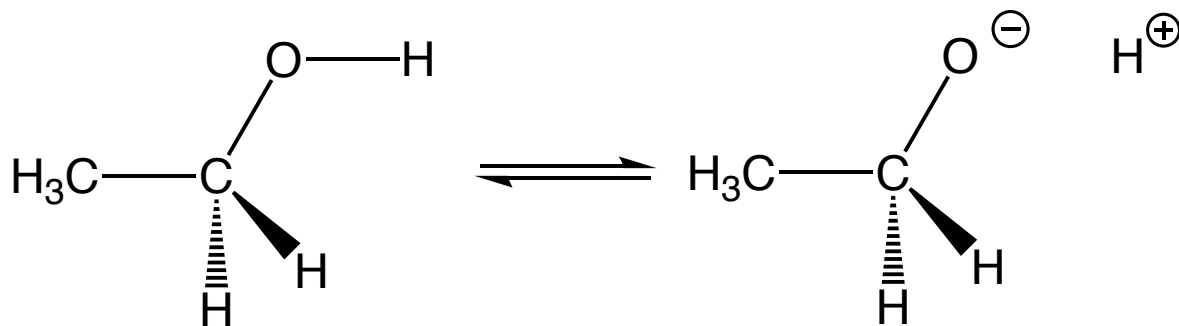
When there are lone-pair e^- 's adjacent to a π bond or more than two p orbitals in a row, we must consider drawing resonance contributors must be drawn to have a better understanding of the structure and properties of a molecule

Resonance



pK_a 's cyclohexanol, 16.0 phenol, 10.0 ethanol 16.0 acetic acid 4.74

Resonance



pK_a's cyclohexanol, 16.0 phenol, 10.0 ethanol 16.0 acetic acid 4.74

Five ways to stabilize the electrons on the conjugate base

Section 2.6 – 2.9

Inductive Effect

acetic, 4.76; formic, 3.75; chloroacetic, 2.87; dichloroacetic, 1.25

Five ways to stabilize the electrons on the conjugate base

Section 2.6

Greater s character

pK_a 's ethane 50, ethene 44, ethyne 25

Practice: For each molecule, which proton is the most likely to be lost and for each pair, which is the stronger acid

