Today

Sections 2.1, 2.3, 2.12
Acids and Bases

Next Class

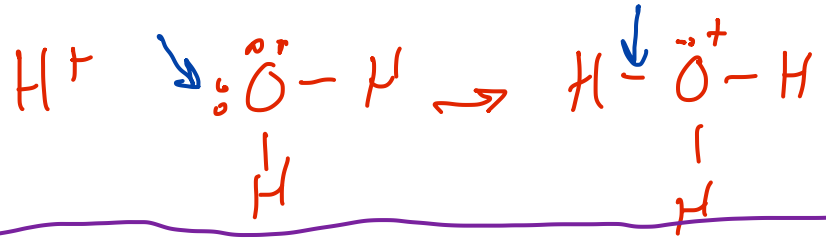
Sections 2.6 - 2.9
How structure affects acidity and basicity

Acids are H^+ donors

Bases are OH^- donors

$HCl(g) \xrightarrow{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$

$HCl(g) + H_2O(l) \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$



$NaOH(s) \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$

$NH_3(g) + H_2O(l) \rightarrow NH_4^{\oplus}{}_{(aq)} + OH^{\ominus}_{(aq)}$

What did the NH_3 do to form the OH^-?

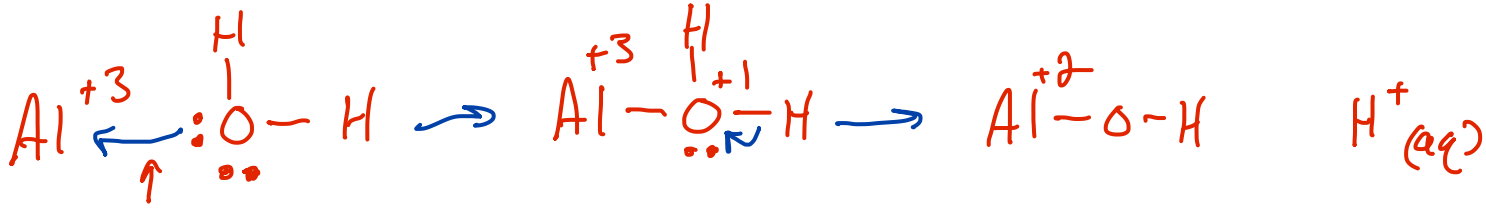
The NH_3 picked up (accepted) an H^+. Base

H^+ donors

Acids

Acids are e^- pair acceptors + Bases are lp-donors

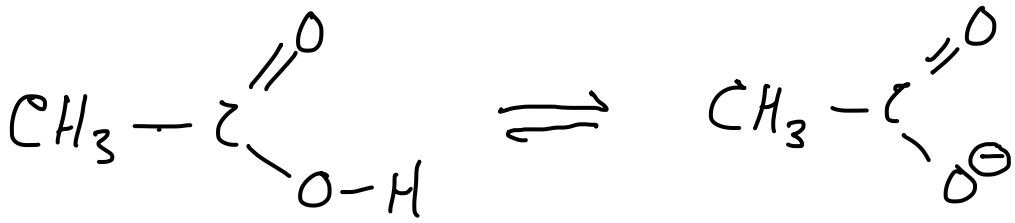
$AlCl_{3(s)} + 3H_2O \rightarrow Al(OH)_3 + HCl_{(aq)}$



K_a and pK_a

K_a is an acid ionization equilibrium constant

Section 2.6



$$K_a = \frac{[CH_3CO_2^-][H^+]}{[CH_3CO_2H]}$$

weak acid = small K_a = $\frac{\text{small number}}{\text{big number}}$ $K_a = 1.8 \times 10^{-5}$

$H-Cl \longrightarrow H^+ + Cl^-$ strong acid large $K_a \sim 10^6$

pK_a of a weak acid

$$pK_a = -\log[K_a] = -\log[10^{-5}] = -(-5) = 5$$

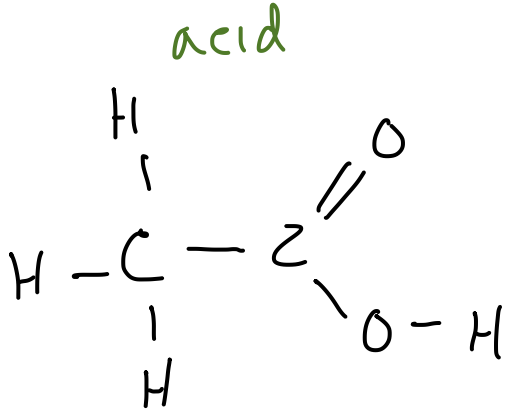
$$pK_a = -\log[K_a] = -\log[10^{6}] = -(6) = -6$$

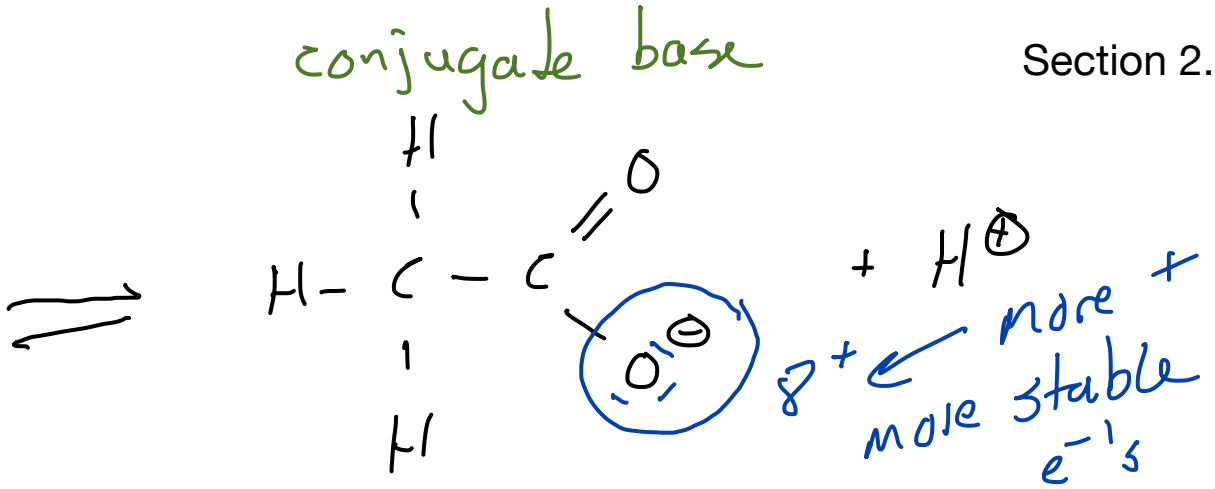
pK_a 25 vs 50

pK_a is *backwards*

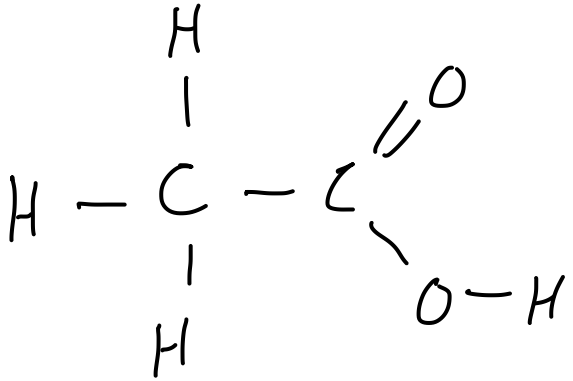
Which is the stronger acid? the acid with the lower pK_a

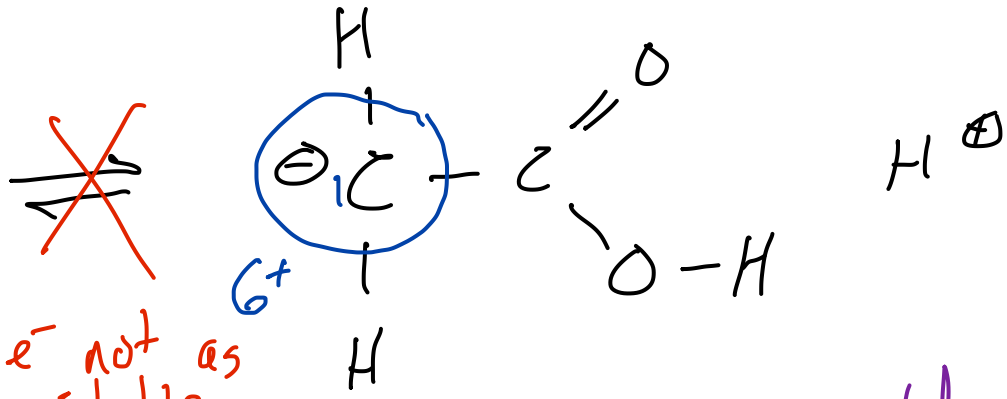
Stabilizing the conjugate base





vs

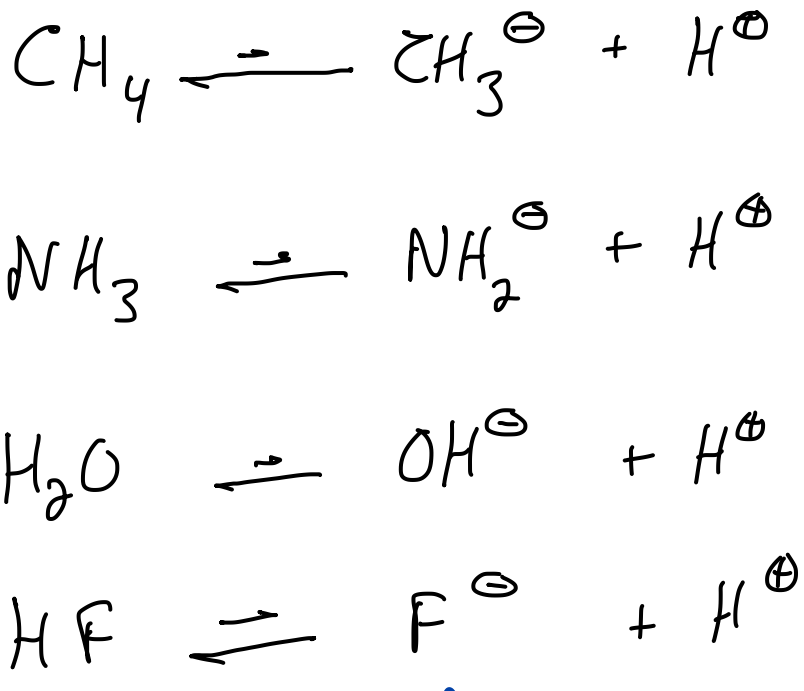




which conjugate base would be more stable ... easier to make

Which is the acidic proton?

Same Shell More Positive Nucleus



weakest acid

n = 2

same

more positive nucleus

strongest acid

stabilizes conjugate base

the weaker the conjugate base the stronger the acid

CH_4, ~50 NH_3, ~36 H_2O, 15.6 HF, 3.18

Same Column Larger Valence Shell

n = 2

3,18

H - F ⟶ $F^{\ominus}$ + $H^{\oplus}$

-7

H - Cl ⟶ $Cl^{\ominus}$ + $H^{\oplus}$

-9

H - Br ⟶ $Br^{\ominus}$ + $H^{\oplus}$

-10

H - I ⟶ $I^{\ominus}$ + $H^{\oplus}$

n = 5

diffuse e^-'s

HF, 3.18 HCl, -7 HBr, -9 HI, -10

Resonance

cyclohexanol, 16.0 phenol, 10.0

Inductive Effect

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

Greater s character

0.01 M HCl

$H^+ = 0.01$

$H_2O \rightleftharpoons H^+ + OH^-$ $\quad K_w = 10^{-14}$

$[H^+] = 10^{-7}$

$pH = -\log[10^{-7}]$

$pH = 7$

$pH = -\log(10^{-2})$

$= 2$

50, 44, 25

Practice