Chapter 2 Acid-Base Reactions: Proton Transfers

Acid: $H^{\oplus}$ (proton) donor **Base:** $H^{\oplus}$ (proton) acceptor *(Bronsted-Lowry definitions)*

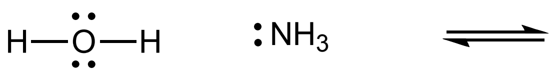
Acid-Base Reaction (B&P 2.2) (mechanism needs two arrows)

base acid

Two acids are in competition - forward and reverse reactions are in **equilibrium**. (B&P 2.4)

****Equilibrium lies in the direction of the ______________ acid/base pair ****

Which is the stronger acid? Use pK_a table (B&P 2.3) or predict...



acid base

Acidity vs. Structure (B&P 2.5)

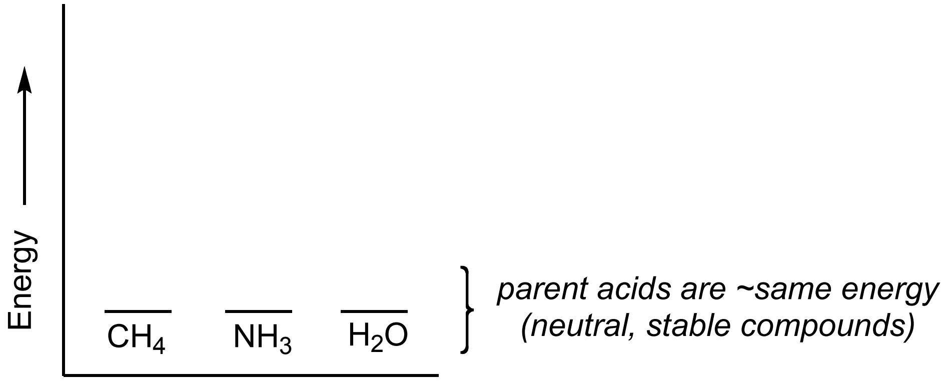
1) Periodic Trend (across row)

compare these acids:	CH_4	NH_3	H_2O
pK_a	50	38	16

why such a large difference in pK_a? Look at conjugate bases!

draw the conj. bases:

Conclusion: the stronger acid is the one with the most stable (less reactive, weaker) conjugate base!



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2) Periodic Trend (down a family/column)

compare these acids:	HF	HCl	HBr	HI
pK_a	3	-7	-9	-10

why such a large difference in pK_a? Look at conjugate bases!

draw the conj. bases:

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3) Inductive Effects Which is the stronger acid? CH_3OH vs. CF_3OH

draw the conj. bases:

4) Resonance Effects

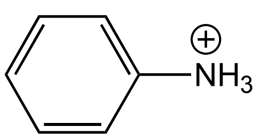
$CH_3CH_2{-}OH$ vs. $CH_3{-}C(=O){-}OH$

I, pK_a 16 — **II**, pK_a 5

II is 100,000,000,000
(100 **BILLION**)
times more acidic
than **I** !! Why?!
Compare conj. bases!

CB-I

CB-II



vs.

NH_4^{+}

I, pK_a 5

II, pK_a 10

CB-I

CB-II

see http://www.cpp.edu/~lsstarkey/courses/CHM201
for Acid/Base homework assignment

Acid Dissociation Constant, K_a, and pK_a : a measure of acid strength (B&P 2.3)

$$HA + H_2O \rightleftharpoons A^{\ominus} + H_3O^{\oplus}$$

if HA is a STRONG acid

if HA is a WEAK acid

K_{eq} is the equilibrium constant

$$K_{eq} = \frac{[\text{products}]}{[\text{reactants}]}$$

K_a is the acid dissociation constant

$$K_a = \frac{[H_3O^+]\,[A^-]}{[HA]}$$

since K_a is often VERY large or VERY small, it's easier to work with pK_a

$$pK_a = -\log(K_a)$$

if K_a is a LARGE number (>1), then the acid is stronger weaker

if an acid is stronger, then the pK_a is higher lower

for example, sulfuric acid (H_2SO_4) has a K_a of ~1.6×10^5 and a pK_a of -5.2

acetic acid (CH_3CO_2H) has a K_a of 1.8×10^{-5} and a pK_a of 4.75

Lewis Acids and Bases (B&P 2.6)

Lewis Acid: electron-pair acceptor
- has a vacancy (no octet)
- also called an **Electrophile**

Lewis Base: electron-pair donor
- has a lone pair of electrons
- also called a **Nucleophile**

$$NH_3 + AlCl_3 \rightleftharpoons$$

$$CH_3{-}\overset{\oplus}{C}H{-}CH_3 + H_2O \rightleftharpoons$$

Suggested Problems *(the answers to these problems can be found at the back of the book)***:**
Chapter 2 (Brown & Poon): 1–6, Quick Quiz, 7–33 (odd only, skip 23)