Ch16 : Acids + Bases

3 definitions of Acids/Bases.

Already met: Arrhenius (1141)

Acids: H_3O^+ ← form in H_2O
(hydronium)

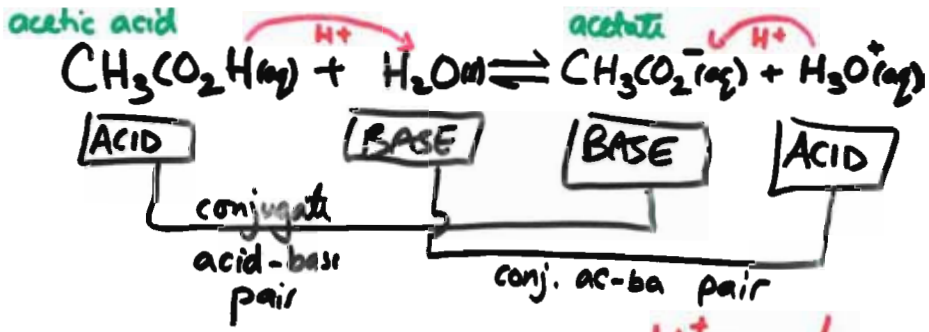
Bases: OH^- ← form in H_2O
(hydroxide)

Brønsted-Löwry B-L

Acids = H^+ donor
Bases = H^+ acceptor

Conjugate Acid-Base Pairs

- Consider what happens if we throw an acid into H_2O



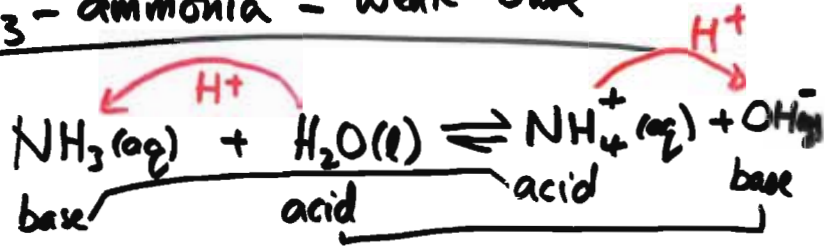
notice: conj. a-b pairs always differ by 1 H^+.

acid: 1 more H^+
base: 1 less H^+

$CH_3CO_2H / CH_3CO_2^-$ H_2O / H_3O^+

acid - base base - acid

NH_3 - ammonia - weak base



Acid-Base properties of H_2O

can act as base: $H_2O + H^+ \rightarrow H_3O^+$

acid: $H_2O \rightarrow OH^- + H^+$

H_2O can react w/ itself!

$$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

(H^+ transfers from one H_2O to the other)

- autoionization of water.
  or ... self-ionization.

LAZY: $H_3O^+ = H_2O + H^+$

$H_3O^+ \approx H^+$

simplify: $\boxed{H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)}$

$$K_c = \frac{[H^+][OH^-]}{[H_2O(l)]}$$

$[H_2O(l)] = 1$ (liq / solvents / solids)

$$K_w = [H^+][OH^-]$$

water ↑ $= 1.0 \times 10^{-14}$ (25°C)

because in pure water, $[H^+] = [OH^-]$

(why: $H_2O \rightleftharpoons H^+ + OH^-$)

$$[H^+] = [OH^-] = \sqrt{1.0 \times 10^{-14}}$$

$$= 1.0 \times 10^{-7}\ M$$

$[H^+] = [OH^-]$ Neutral

$[H^+] > [OH^-]$ Acidic ✗

$[H^+] < [OH^-]$ Basic

ex: if $[H^+] = 1.0 \times 10^{-5} M$ @ 25°C

- what's $[OH^-]$?
- Acidic/Basic/Neutral.

$K_w = 1.0 \times 10^{-14} = [H^+][OH^-]$ ✓ ?

$$[OH^-] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-5}}$$

$$= 1.0 \times 10^{-9} M$$

$[OH^-]$ $1.0 \times 10^{-9} M$ < $[H^+]$ $1.0 \times 10^{-5} M$

Acidic

pH ~ a measure of acidity

pH scale ~ invented in 1909
- Sorenson.

- logarithmic scale.
  - $[H^+]$ can vary by 14 orders of magnitude!

1.0 M ⟷ 0.000 000 000 000 01 M

$$pH = -\log_{10}[H^+] \quad *$$

- change in [] by a factor of 10, leads to a change in pH of 1-unit

$$[H^+] = 10^{-pH} \quad *$$