Chemistry Lecture 6: Acids and Bases

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Definitions

Arrhenius acid: H+ donor
Arrhenius base: OH- donor
Bronsted-Lowry acid: H+ donor
Bronsted-Lowry base: H+ acceptor
Lewis acid: electron pair acceptor
Lewis base: electron pair donor
pH: $pH = -\log[H+]$
Conjugate acid: a base that has lost an OH- or gained an H+
Conjugate base: an acid that has gained an OH- or lost an H+
Weak acids have strong conjugate bases, strong acids have weak conjugate bases
Amphoteric: a substance that can act both as an acid and a base i.e. water
Polyprotic: an acid that can donate more than one proton
Diprotic: an acid that can donate two protons

Acid Strength

Strong acid: one that completely dissociates in water
Weak acid: one that doesn't completely dissociate in water
Stronger acids can stabilize a negative charge better: larger molecule or more oxygens

Strong Acids

HI, HBr, **HCl**, **HNO3**, HClO4, HClO3, **H2SO4**

Strong Bases

NaOH, **KOH**, NH2-, H-, Ca(OH)2, Na2O, CaO

Equilibrium Constant

$K_w = [H^+][OH^-] = 10^{-14}$ for reaction $H_2O + H_2O \rightarrow H_3O^+ + OH^-$

$pH + pOH = pK_w = 14$

$K_a = \frac{[H^+][A^-]}{[HA]}$ for reaction $HA + OH^- \rightarrow A^- + H_2O$

$K_b = \frac{[OH^-][HA]}{[A^-]}$ for reaction $A^- + H_2O \rightarrow HA + OH^-$

$K_a K_b = K_w,\ pK_a + pK_b = pK_w = 14$

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<u>How to Find pH?</u>
For weak acids, there's a K_a
If you start out with n molar acid, you can write the equilibrium:
$K_a = \frac{[H^+][A^-]}{[HA]} = \frac{[x][x]}{[n-x]} \approx \frac{[x][x]}{[n]}$, then solve for x
If you have salts, they can change the pH by the common ion effect.

<u>Titration</u>
Mixing an acid and a base drop by drop
Equivalence point: equal concentrations of acid, base = usually vertical
Half-equivalence point: half of acid neutralized by base (or vice versa) = usually horizontal
Buffer point: at half equivalence point, changes in added base/acid doesn't change pH

Titration curves:
Strong acid + strong base: one equivalence point usually around pH 7
Weak acid + strong base: half equivalence point (buffer), then equivalence point above pH 7
Henderson-Hasselbach Equation: $pH = pK_a + \log\frac{[A^-]}{[HA]}$
At the half equivalence point, pH = pKa

<u>Indicators</u>
Change color at a specific pH called the *end point*

<u>Polyprotic Titration</u>
Half equivalence point #1 -> Equivalence point #1 -> HEP #2 -> EP #2 etc.