Chemical Equilibrium:

Equilibrium (K) vs Kinetics (k):

$$A \leftrightarrows B$$

$$Rate_{Forward} = Rate_{Reverse}$$

$$k_1[A] = k_{-1}[B]$$

$$\frac{k_1}{k_{-1}} = \frac{[B]}{[A]} = K_{eq}$$

Law of Mass Action:

$$jA + kB \rightleftarrows lC + mD$$

The Equilibrium Constant:

$$K_C = \frac{[C]^l[D]^m}{[A]^j[B]^k} \qquad K_P = \frac{(P_C)^l(P_D)^m}{(P_A)^j(P_B)^k}$$

Note: Solids and liquids are not included in the equilibrium expression. They receive a value of 1.

Reaction Adjustments:

$A + B \rightarrow C$ $\quad K$

$2A + 2B \rightarrow 2C$ $\quad K^2$

$\frac{1}{2}A + \frac{1}{2}B \rightarrow \frac{1}{2}C$ $\quad K^{1/2}$

$C \rightarrow A + B$ $\quad \frac{1}{K}$

Equilibrium Partial Pressure From K_c:

$$jA + kB \rightleftarrows lC + mD$$

$$K_P = K_C(RT)^{\Delta n} \qquad R = 0.08206\ \frac{L * atm}{mol * K}$$

$$\Delta n = (l + m) - (j + k)$$

$$T_K = T_C + 273.15$$

Additive Reactions:

$A + B \rightarrow C$ $\quad K_1$
$C + D \rightarrow E$ $\quad K_2$

$A + B + D \rightarrow E$ $\quad k = k_1 \cdot k_2$

The Reaction Quotient Q:

$$Q = \frac{[C]^l[D]^m}{[A]^j[B]^k}$$

$Q \rightarrow Initial\ Concentrations$
$K \rightarrow Equilibrium\ Concentrations$

The Position of Equilibrium:

(a) If K > > 1, Reaction = Product Favored.
(b) If 0 < K < < 1, Reaction = Reactant Favored.

The Direction of the Reaction:

1. If Q < K, the reaction will shift to the Right.
2. If Q > K, the reaction will shift to the Left.
3. If Q = K, the system is at equilibrium.

Le Chatelier's Principle:

If a change is imposed on a system at equilibrium, the reaction will shift in a direction that tends to reduce that change.

Quadratic Equations:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$