WHAT DOES AN EQUILIBRIUM CONSTANT TELL US?

1. - Whether the final reaction mixture consists of mainly products or mainly reactants. In other words, which side of the reaction is "favored". ("extent" of reaction)

2. - Whether a reaction will proceed to the left or to the right when the reaction is not yet at equilibrium.

3. - With more math, we can actually determine the final composition of an equilibrium mixture from the initial amount of reactant present WITHOUT doing an experiment!

WHICH IS FAVORED? PRODUCT OR REACTANT?

$$aA + bB \rightleftarrows cC + dD$$

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$HC_2H_3O_2(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + C_2H_3O_2^-(aq)$$

$$K_c = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} = 1.7 \times 10^{-5}$$

To get a small value like this one, the DENOMINATOR of the equilibrium expression must be a lot larger than the NUMERATOR.

Since REACTANTS are the denominator of this fraction, this reaction favors REACTANTS at equilbrium!

- If Kc is small (<<1), then REACTANTS are favored at equilibrium

- If Kc is large (>>1), then PRODUCTS are favored at equilibrium.

HOW TO TELL IF A REACTION IS AT EQUILIBRIUM?

- Use REACTION QUOTIENT (Q)

$$aA + bB \rightleftharpoons cC + dD$$

$$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

Reaction quotient = equilbrium expression using NON-EQUILIBRIUM concentrations.

- If Q = Kc, then reaction is at equiilibrium.
- If Q < Kc, then reaction is NOT at equilibrium and proceeds to the right, forming more products.
- If Q > Kc, then reaction is NOT at equilibrium and proceeds to the left, forming more reactants.

$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$; $K_c = 3.07 \times 10^{-4}$

$[NOBr] = 0.0720\ M$, $[NO] = 0.0162\ M$, $[Br_2] = 0.0123\ M$

Is mix at equilibrium? If not, which direction will reaction proceed?

$$Q = \frac{[NO]^2[Br_2]}{[NOBr]^2} = \frac{(0.0162)^2(0.0123)}{(0.0720)^2} = 6.23 \times 10^{-4}$$

$6.23 \times 10^{-4} > 3.07 \times 10^{-4}$

$Q > K_c$, so the reaction will proceed to the LEFT, forming more NOBr at the expense of NO and bromine.