Dougherty Valley HS Chemistry - AP
Equilibrium – Chemical Equilibrium Problem Set 1

Worksheet #3

Name: **Period:** **Seat#:**

Directions: Show all work in a way that would earn you credit on the AP Test! This is always the rule! Some answers are provided at the end in italics and underlined. If you need more space, use binder paper and staple to your worksheet.

For the following three reactions:

a) Write the K_{eq} expression in terms of concentration, K_c.
b) Given the equilibrium concentrations, state whether each equilibrium is product-favored, reactant-favored, or fairly even ([products] ≈ [reactants]).
c) Calculate the value of K_c.

1) $N_2(g) + 3\ H_2(g) \leftrightarrows 2\ NH_3(g)$

At equilibrium: $[N_2] = 1.50\ \underline{M}$
$[H_2] = 2.00\ \underline{M}$
$[NH_3] = 0.01\ \underline{M}$

2) $HF(aq) \leftrightarrows H^+(aq) + F^-(aq)$

At equilibrium: $[HF] = 0.55\ \underline{M}$
$[H^+] = 0.001\ \underline{M}$
$[F^-] = 0.001\ \underline{M}$

3) $Fe^{3+}(aq) + SCN^-(aq) \leftrightarrows FeSCN^{2+}(aq)$

At equilibrium: $[Fe^{3+}] = 0.55\ \underline{M}$
$[SCN^-] = 0.001\ \underline{M}$
$[FeSCN^{2+}] = 0.001\ \underline{M}$

Summarize:
Fill in the blanks with product-favored, reactant-favored, and approximately equal

K_c	state of equilibrium
$K_c >> 1$	
$K_c << 1$	
$K_c \approx 1$	

4) Knowing that pure water has a density of 1g/1mL calculate the mass of 1.00 Liter of water.

Calculate the number of moles in 1.00 L of H_2O.

What is the concentration ($\underline{M}$) of water in water?

At this temperature, can you get more moles of water into this Liter of water?

The $[H_2O]$ ________ (is / is not) constant.

Remember!
Since the concentrations of solids and liquids are constant, they are incorporated into the equilibrium constant, K_{eq}. That means, just leave them out of the K_c or K_p expression. Only include (g) and (aq)!

5) Write equilibrium expressions for each of the rxns:

a) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

b) $Ni(s) + 4CO(g) \rightleftharpoons Ni(CO)_4(g)$

c) $5CO(g) + I_2O_5(s) \rightleftharpoons I_2(g) + 5CO_2(g)$

d) $Ca(HCO_3)_2(aq) \rightleftharpoons CaCO_3(s) + H_2O(l) + CO_2(g)$

e) $AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$

6) Write the equilibrium expression in terms of partial pressures (K_p) for each of the following reactions. Rate the reactions (a, b, c, d) in order of their increasing tendency to proceed toward completion:

More Reactant Favored ________ ________ ________ ________ More Product Favored

a) $4NH_3(g) + 3O_2(g) \rightleftharpoons 2N_2(g) + 6H_2O(g)$
$K_p = 1 \times 10^{228}$ atm

b) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
$K_p = 5 \times 10^{-31}$

c) $2HF(g) \rightleftharpoons H_2(g) + F_2(g)$
$K_p = 1 \times 10^{-13}$

d) $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$
$K_p = 4.7 \times 10^{-4}$ atm

A Question That You Should Be Able To Answer:
Why don't the K_p's in (b) and (c) have units?

7) **(a)** Write the K_c expression for
$2\ SO_2(g) + O_2(g) \leftrightarrows 2\ SO_3(g)$

Calculate the value of K_c:
At equilibrium: $[SO_2] = 1.50$ M
$[O_2] = 1.25$ M
$[SO_3] = 3.50$ M

b) If we **reverse** the equation, it is:
$2\ SO_3(g) \leftrightarrows 2\ SO_2(g) + O_2(g)$
Write the K_c expression for this equation and calculate the new value of K_c:

How does the expression and the value of K_c in 7(b) compare with those in 7(a)?

c) If we now **multiply all of the coefficients by ½:**
$SO_3(g) \leftrightarrows SO_2(g) + \frac{1}{2}\ O_2(g)$
Write the K_c expression for this equation and calculate the new value of K_c:

How do they compare with 7(b)?

d) What would happen to the K_c expression and its value if we **doubled** the coefficients?

Summarize:

Equation	K_c in terms of original K
doubled	
reversed	
halved	

8) Consider an equilibrium that occurs in two steps:
$H_2S(aq) \leftrightarrows H^+(aq) + HS^-(aq)$
$\underline{HS^-(aq) \leftrightarrows H^+(aq) + S^{2-}(aq)}$

a) Write the overall reaction.
b) How do the K_c's for the two steps (K_{c1} & K_{c2}) relate to the K_c of the overall reaction (K_c)?