Unit 10 Practice Problems (with answers at end)

The equilibrium constant, K_c

1. Determine the value of the equilibrium constant for the reaction below if $[N_2O_4]$ = 1.50×10^{-3} M and $[NO_2]$ = 0.571 M.

$$N_2O_4(g) \leftrightharpoons 2 NO_2(g)$$
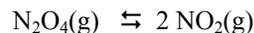
2. For the reaction $2 SO_2(g) + O_2(g) \leftrightharpoons 2 SO_3(g)$, $[SO_2]$ = 2.00 M and $[SO_3]$ = 10.0 M. What is $[O_2]$ if K_c = 800.0?

3. For the reaction $2 HI(g) \leftrightharpoons H_2(g) + I_2(g)$, K_c = 0.016 at $520^{\circ}C$. Calculate the equilibrium concentrations of all three substances if the initial concentration of HI is 0.50 M and the other two gases are not initially present.

4. In the catalytic converter of an automobile exhaust system, some SO_2 is converted to SO_3 by the reaction

$$SO_2(g) + \frac{1}{2} O_2(g) \leftrightharpoons SO_3(g)$$

If one starts with $[SO_2]$ = 2.0×10^{-4} M and if the $[O_2]$ remains constant at 1.0×10^{-2} M, what will be the equilibrium concentration of SO_3? (K_c = 20.0)

LeChâtelier's Principle

5. For each of the following reactions write the K_c expression and indicate what happens to the equilibrium position (shift left or right) when the indicated stress or condition change occurs:

a. $N_2(g) + 3 H_2(g) \leftrightharpoons 2 NH_3(g)$ + heat
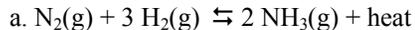
(1) remove NH_3 (2) decrease pressure (3) decrease temperature

b. $CO_2(g) + C(s)$ + heat $\leftrightharpoons 2 CO(g)$
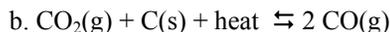
(1) increase temperature (2) add CO (3) add catalyst

c. $CO_2(g) + H_2(g)$ + heat $\leftrightharpoons CO(g) + H_2O(\ell)$

(1) decrease temperature (2) add H_2 (3) remove CO

K_{sp} and solubility

6. A saturated solution of lead(II) chloride contains 4.50 g of the compound per Litre. What is the K_{sp} of this compound?

7. $BaCO_3$ has a solubility of 7.00×10^{-5} mol/L. What is the K_{sp}?

8. The K_{sp} of CuS is 6.31×10^{-36}. What is its solubility in g/L?

9. The K_{sp} of $Al(OH)_3$ is 1.26×10^{-33}. What is its solubility in mol/L?

10. 105 mL of 0.10 M $AgNO_3$ is added to 125 mL of 0.35 M K_2CrO_4. Will a precipitate form? (K_{sp} for Ag_2CrO_4 is 1.12×10^{-12})

Common ion effect [NOTE: YOU MAY NEED TO LOOK UP K_{sp} VALUES]

11. Decide whether a precipitate will form when enough Ag^+ is added to tap water in which $[Cl^-]$ = 2×10^{-4} M to make $[Ag^+]$ = 1×10^{-5} M.

12. What is the solubility in mol/L of $BaSO_4$ in a solution that is already 0.1 M in SO_4^{2-} ?

Answers:

1. 217
2. 0.0313 M
3. [HI] = 0.396   [H$_2$] = 0.052   [I$_2$] = 0.052
4. 1.3 x 10^{-4} M
5.
   (a) right, left, right $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$

   (b) right, left, neither $K = \dfrac{[CO]^2}{[CO_2]}$

   (c) left, right, right $K = \dfrac{[CO]}{[CO_2][H_2]}$

6. 1.6 x 10^{-5}
7. 4.90 x 10^{-9}
8. 2.40 x 10^{-16}
9. 2.61 x 10^{-9}
10. YES, Q = 4.0 x 10^{-4} which is greater than K$_{sp}$
11. YES, Q = 2 x 10^{-9}
12. 1 x 10^{-9}