

Chemistry CP

Name: _____

Review Sheet—Equilibrium

Section: _____

After studying this chapter, you should be able to:

- Define chemical equilibrium.
- Explain the nature of the equilibrium constant.
- Write chemical equilibrium expressions and carry out calculations involving them.
- Discuss the factors that disturb equilibrium.
- Discuss conditions under which reactions go to completion.
- Describe the common-ion effect.
- Explain what is meant by solubility-constant products, and calculate their values.
- Calculate solubilities using solubility-constant products.
- Define and identify spectator ions.

Problems for you to try:

1. Write the K_{eq} expressions for the following reactions.
 - a) $HF(aq) + H_2O(l) \leftrightarrow F^-(aq) + H_3O^+(aq)$
 - b) $C_6H_5OH(aq) + H_2O(l) \leftrightarrow C_6H_5O^-(aq) + H_3O^+(aq)$
 - c) $C_5H_5N(aq) + H_2O(l) \leftrightarrow C_5H_5N^+(aq) + OH^-(aq)$
 - d) $HClO_2(aq) + H_2O(l) \leftrightarrow ClO_2^-(aq) + H_3O^+(aq)$
2. Write the K_{sp} expressions for the following reactions.
 - a) $BaF_2(s) \leftrightarrow Ba^{2+}(aq) + 2F^-(aq)$
 - b) $Hg_2I_2(s) \leftrightarrow Hg_2^{2+}(aq) + 2I^-(aq)$
 - c) $PbF_2(s) \leftrightarrow Pb^{2+}(aq) + 2F^-(aq)$
 - d) $Cu(IO_3)_2(s) \leftrightarrow Cu^{2+}(aq) + 2IO_3^-(aq)$
3. For each of the following values for K_{eq} , determine whether the reactants or products will be favored.
 - a) $K_{eq} = 15.0$
 - b) $K_{eq} = 2.056$
 - c) $K_{eq} = 1.00$
 - d) $K_{eq} = 8.74 \times 10^{-17}$
4. What is the K_{eq} of formic acid, $HCHO_2$, in water if the equilibrium concentrations are 2.00M for $[HCHO_2]$ and 6.00×10^{-6} for both $[H_3O^+]$ and $[CHO_2^-]$?
 $HCHO_2(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + CHO_2^-(aq)$ (1.80 x 10⁻¹¹)

5. What is the K_{eq} of H_2SO_3 in water if the equilibrium concentrations are 3.00M for $[H_2SO_3]$ and 0.219 M for both $[H_3O^+]$ and $[HSO_3^-]$? (0.0160)
- $$H_2SO_3(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + HSO_3^-(aq)$$

6. Calculate the concentration of HNO_2 in water if the equilibrium concentrations of $H_3O^+(aq)$ and $NO_2^-(aq)$ are 0.0430 M. (4.30 M)
- $$HNO_2(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + NO_2^-(aq)$$
- $$K_{eq} = 4.30 \times 10^{-4}$$

7. Explain LeChatelier's principle.

8. Explain what can be done to the following reaction to achieve each of the desired effects listed below.



- increase the concentration of reactants
 - increase the concentration of products
 - shift the equilibrium position to the right
 - shift the equilibrium position to the left
9. For each of the changes listed, apply LeChatelier's principle to the given complex ion equation to determine the direction in which the equilibrium will shift.
- $$Cr(H_2O)_3Cl_3 + 3 H_2O \leftrightarrow [Cr(H_2O)_5]^{3+} + 3 Cl^-$$

a) addition of water

b) addition of hydrochloric acid, HCl (What is the role of the H^+ ?)

10. For each of the following reactions, indicate the direction in which the equilibrium will shift if the system is stressed as indicated.

a) $NH_4NS(s) \leftrightarrow NH_3(g) + H_2S(g)$ remove NH_3

b) $2 SO_2(g) + O_2(g) \leftrightarrow 2 SO_3(g)$ remove $SO_2(g)$

c) $HClO_4(aq) + H_2O(l) \leftrightarrow H_3O^+(aq) + ClO_4^-(aq)$ remove H_2O

d) $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$ reduce the pressure

11. Explain why insoluble salts are really considered very slightly soluble.
12. What is the concentration of tin (II) ion in a saturated solution of SnS? The K_{sp} of SnS is 1.00×10^{-25} . (3.16 x 10⁻¹³)
13. Calculate the solubility product constant, K_{sp} , for copper (I) chloride, CuCl, if the solubility of this compound at 25°C is 1.09×10^{-3} M. (1.19 x 10⁻⁶)
14. A saturated solution of calcium fluoride has a calcium ion concentration of .0011 M. What is the K_{sp} of CaF₂? (5.3 x 10⁻⁹)
15. Silver sulfide, Ag₂S, is an ingredient used to make ceramics. If the Ag₂S in your dog's ceramic water dish dissolves in the water, giving an Ag⁺ concentration of 4.93×10^{-17} M, what concentration of S²⁻ will be in your dog's water? The K_{sp} value for Ag₂S is 6.00×10^{-50} at 288 K. (2.47 x 10⁻¹⁷ M)