CHAPTER REVIEW

For more practice, go to the Problem Bank in Appendix D.

The Nature of Chemical Equilibrium

SECTION 1 REVIEW

1. Describe and explain how the concentrations of A, B, C, and D change from the time when A and B are first combined to the point at which equilibrium is established for the reaction $A + B \rightleftarrows C + D$.
2. a. Write the general expression for an equilibrium constant based on the equation $nA + mB + \ldots \rightleftarrows xC + yD + \ldots$
   b. What information is provided by the value of K for a given equilibrium system at a specified temperature?
3. In general, which reaction is favored (forward or reverse) if the value of K at a specified temperature is
   a. very small?
   b. very large?

PRACTICE PROBLEMS

4. Determine the value of the equilibrium constant for each reaction given, assuming that the equilibrium concentrations are found to be those specified. (Concentrations are in mol/L.) (Hint: See Sample Problem A.)
   a. $A + B \rightleftarrows C$; [A] = 2.0; [B] = 3.0; [C] = 4.0
   b. $D + 2E \rightleftarrows F + 3G$; [D] = 1.5; [E] = 2.0; [F] = 1.8; [G] = 1.2
   c. $N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$; $[N_2] = 0.45$; $[H_2] = 0.14$; $[NH_3] = 0.62$
5. An equilibrium mixture at a specific temperature is found to consist of 1.2×10^{-3} mol/L HCl, 3.8×10^{-4} mol/L O_2, 5.8×10^{-2} mol/L H_2O, and 5.8×10^{-2} mol/L Cl_2 according to the following: $4HCl(g) + O_2(g) \rightleftarrows 2H_2O(g) + 2Cl_2(g)$. Determine the value of the equilibrium constant for this system.
6. At 450°C, the value of the equilibrium constant for the following system is 6.59×10^{-3}. If $[NH_3] = 1.23 \times 10^{-4}$ M and $[H_2] = 2.75 \times 10^{-2}$ M at equilibrium, determine the concentration of N_2 at that point.
   $$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$$
7. The value of the equilibrium constant for the reaction below is 40.0 at a specified temperature. What would be the value of that constant for the reverse reaction under the same conditions?
   $$H_2(g) + I_2(g) \rightleftarrows 2HI(g)$$

Shifting Equilibrium

SECTION 2 REVIEW

8. Predict whether each of the following pressure changes would favor the forward or reverse reaction.
   $$2NO(g) + O_2(g) \rightleftarrows 2NO_2(g)$$
   a. increased pressure
   b. decreased pressure
9. In heterogeneous reaction systems, what types of substances do not appear in the equilibrium constant expression? Why?
10. Explain the effect of a catalyst on an equilibrium system.
11. Predict the effect of each of the following on the indicated equilibrium system in terms of the direction of equilibrium shift (forward, reverse, or neither).
    $$H_2(g) + Cl_2(g) \rightleftarrows 2HCl(g) + 184\ kJ$$
    a. addition of Cl_2
    b. removal of HCl
    c. increased pressure
    d. decreased temperature
    e. removal of H_2
    f. decreased pressure
    g. addition of a catalyst
    h. increased temperature
    i. decreased system volume
12. How would the changes in (a) through (i) of item 11 affect the new equilibrium concentration of HCl and the value of K at the new equilibrium?
13. Explain why changes in the concentrations of the reactants and products at equilibrium have no impact on the value of the equilibrium constant.