14. What relative pressure (high or low) would result in the production of the maximum level of CO_2 according to the following equation? Why?

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$$

15. What relative conditions (reactant concentrations, pressure, and temperature) would favor a high equilibrium concentration of the underlined substance in each of the following equilibrium systems?

a. $2CO(g) + O_2(g) \rightleftharpoons \underline{2CO_2(g)} + 167\ kJ$

b. $Cu^{2+}(aq) + 4NH_3(aq) \rightleftharpoons \underline{Cu(NH_3)_4^{2+}(aq)} + 42\ kJ$

c. $2HI(g) + 12.6\ kJ \rightleftharpoons H_2(g) + \underline{I_2(g)}$

d. $4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + \underline{2Cl_2(g)} + 113\ kJ$

e. $PCl_5(g) + 88\ kJ \rightleftharpoons PCl_3(g) + \underline{Cl_2(g)}$

16. The reaction between hemoglobin, Hb, and oxygen, O_2, in red blood cells is responsible for transporting O_2 to body tissues. This process can be represented by the following equilibrium reaction:

$$Hb(aq) + O_2(g) \rightleftharpoons HbO_2(aq)$$

What will happen to the concentration of oxygenated hemoglobin, HbO_2, at high altitude, where the pressure of oxygen is 0.1 atm instead of 0.2 atm, as it is at sea level?

17. What two factors determine the extent to which reacting ions are removed from solution?

18. Identify the three conditions under which ionic reactions can run to completion, and write an equation for each.

Equilibria of Acids, Bases, and Salts

SECTION 3 REVIEW

19. a. Write the ion product constant expression for water.

b. What is the value of this constant at 25°C?

20. List and distinguish between the four general categories of salts, based on their hydrolysis properties, and give an example of each.

21. Explain why the pH of a solution containing both acetic acid and sodium acetate is higher than that of a solution containing the same concentration of acetic acid alone.

22. The ionization constant, K_a, for acetic acid is 1.8×10^{-5} at 25°C. Explain the significance of this value.

23. a. From the development of K_a described in Section 3, show how you would express an ionization constant, K_b, for the weak base NH_3.

b. In this case, $K_b = 1.8 \times 10^{-5}$. What is the significance of this numerical value to equilibrium?

Solubility Equilibrium

SECTION 4 REVIEW

24. Explain why a saturated solution is not necessarily a concentrated solution.

25. What rule of thumb is used to distinguish between soluble, insoluble, and slightly soluble substances?

26. What is the relative ion concentration of an ionic substance typically involved in solubility equilibrium systems?

27. What is the relationship between K_{sp} and the product of the ion concentrations in terms of determining whether a solution of those ions is saturated?

PRACTICE PROBLEMS

28. The ionic substance EJ dissociates to form E^{2+} and J^{2-} ions. The solubility of EJ is 8.45×10^{-6} mol/L. What is the value of the solubility product constant? (Hint: See Sample Problem B.)

29. Calculate the solubility product constant K_{sp} for each of the following, based on the solubility information provided:

a. $BaSO_4 = 2.4 \times 10^{-4}$ g/100. g H_2O at 20°C

b. $Ca(OH)_2 = 0.173$ g/100. g H_2O at 20°C

30. Calculate the molar solubility of a substance MN that ionizes to form M^{2+} and N^{2-} ions, given that $K_{sp} = 8.1 \times 10^{-6}$. (Hint: See Sample Problem C.)