**6-A.** Consider the following equilibria in aqueous solution:

(1) $Ag^+ + Cl^- \rightleftharpoons AgCl(aq)$ $\quad K = 2.0 \times 10^3$

(2) $AgCl(aq) + Cl^- \rightleftharpoons AgCl_2^-$ $\quad K = 9.3 \times 10^1$

(3) $AgCl(s) \rightleftharpoons Ag^+ + Cl^-$ $\quad K = 1.8 \times 10^{-10}$

**(a)** Calculate the numerical value of the equilibrium constant for the reaction $AgCl(s) \rightleftharpoons AgCl(aq)$.

**(b)** Calculate the concentration of $AgCl(aq)$ in equilibrium with excess undissolved solid AgCl.

**(c)** Find the numerical value of $K$ for the reaction $AgCl_2^- \rightleftharpoons AgCl(s) + Cl^-$.

**6-C.** Find $[La^{3+}]$ in the solution when excess solid lanthanum iodate, $La(IO_3)_3$, is stirred with 0.050 M $LiIO_3$ until the system reaches equilibrium. Assume that $IO_3^-$ from $La(IO_3)_3$ is negligible compared with $IO_3^-$ from $LiIO_3$.

**6-D.** Which will be more soluble (moles of metal dissolved per liter of solution), $Ba(IO_3)_2$ ($K_{sp} = 1.5 \times 10^{-9}$) or $Ca(IO_3)_2$ ($K_{sp} = 7.1 \times 10^{-7}$)? Give an example of a chemical reaction that might occur that would reverse the predicted solubilities.

**6-H.** If each compound is dissolved in water, will the solution be acidic, basic, or neutral?

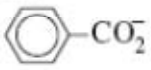
**(a)** $Na^+Br^-$

**(b)** $Na^+CH_3CO_2^-$

**(c)** $NH_4^+Cl^-$

**(d)** $K_3PO_4$

**(e)** $(CH_3)_4N^+Cl^-$

**(f)** $(CH_3)_4N^+$  $CO_2^-$

**(g)** $Fe(NO_3)_3$

**6-4.** Write the expression for the equilibrium constant for each of the following reactions. Write the pressure of a gaseous molecule, X, as $P_X$.

**(a)** $3Ag^+(aq) + PO_4^{3-}(aq) \rightleftharpoons Ag_3PO_4(s)$

**(b)** $C_6H_6(l) + \frac{15}{2}O_2(g) \rightleftharpoons 3H_2O(l) + 6CO_2(g)$

**6-6.** From the equations

$$HOCl \rightleftharpoons H^+ + OCl^- \qquad K = 3.0 \times 10^{-8}$$

$$HOCl + OBr^- \rightleftharpoons HOBr + OCl^- \qquad K = 15$$

find the value of $K$ for the reaction $HOBr \rightleftharpoons H^+ + OBr^-$.

**6-7.** **(a)** A favorable entropy change occurs when $\Delta S$ is positive. Does the order of the system increase or decrease when $\Delta S$ is positive?

**(b)** A favorable enthalpy change occurs when $\Delta H$ is negative. Does the system absorb heat or give off heat when $\Delta H$ is negative?

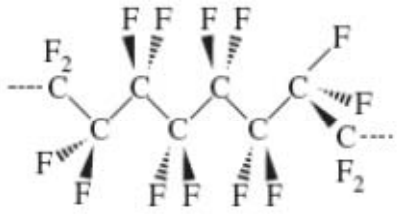
**(c)** Write the relation between $\Delta G$, $\Delta H$, and $\Delta S$. Use the results of parts **(a)** and **(b)** to state whether $\Delta G$ must be positive or negative for a spontaneous change.

**6-9.** The formation of tetrafluoroethylene from its elements is highly exothermic:

$$\underset{\text{Fluorine}}{2F_2(g)} + \underset{\text{Graphite}}{2C(s)} \rightleftharpoons \underset{\text{Tetrafluoroethylene}}{F_2C{=}CF_2(g)}$$

**(a)** If a mixture of $F_2$, graphite, and $C_2F_4$ is at equilibrium in a closed container, will the reaction go to the right or to the left if $F_2$ is added?

**(b)** Rare bacteria from the planet Teflon eat $C_2F_4$ and make Teflon for their cell walls. Will the reaction go to the right or to the left if these bacteria are added?



Teflon

**(c)** Will the reaction go right or left if solid graphite is added? (Neglect any effect of increased pressure due to the decreased volume in the vessel when solid is added.)

**(d)** Will the reaction go right or left if the container is crushed to one-eighth of its original volume?

**(e)** Does the equilibrium constant become larger or smaller if the container is heated?

**6-14.** Find the concentration of $Cu^+$ in equilibrium with CuBr($s$) and 0.10 M $Br^-$.

**6-19.** A solution contains 0.050 0 M $Ca^{2+}$ and 0.030 0 M $Ag^+$. Can 99% of $Ca^{2+}$ be precipitated by sulfate without precipitating $Ag^+$? What will be the concentration of $Ca^{2+}$ when $Ag_2SO_4$ begins to precipitate?

**6-23.** Identify the Lewis acids in the following reactions:

**(a)** $BF_3 + NH_3 \rightleftharpoons F_3\bar{B}{-}\overset{+}{N}H_3$

**(b)** $F^- + AsF_5 \rightleftharpoons AsF_6^-$

**6-36.** Calculate $[H^+]$ and pH for the following solutions:

**(a)** 0.010 M $HNO_3$

**(b)** 0.035 M KOH

**(c)** 0.030 M HCl

**(d)** 3.0 M HCl

**(e)** 0.010 M $[(CH_3)_4N^+]OH^-$

Tetramethylammonium hydroxide

**6-39.** An acidic solution containing 0.010 M $La^{3+}$ is treated with NaOH until $La(OH)_3$ precipitates. At what pH does this occur?