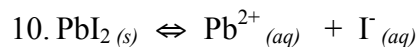
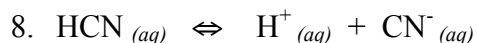
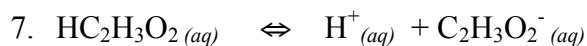
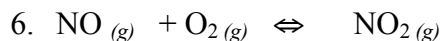
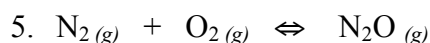
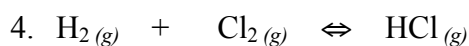
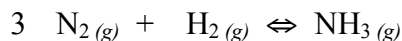
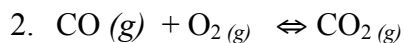
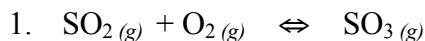
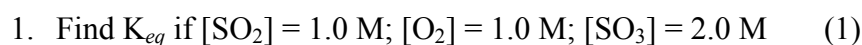


# Equilibria

**I. Balance each equation and write an equilibrium expression for each of the following reactions.**



**II. In each of the following, determine the unknown quantity from the information given. The number in parentheses refers to the corresponding reaction in Part I to which you should refer.**



2. Find  $K_{eq}$  if  $[CO] = 0.5 \text{ M}$ ;  $[O_2] = 0.5 \text{ M}$ ;  $[CO_2] = 2.5 \text{ M}$  (2)
3. Find  $K_{eq}$  if  $[N_2] = 0.25 \text{ M}$ ;  $[H_2] = 0.10 \text{ M}$ ;  $[NH_3] = 0.010 \text{ M}$  (3)
4. Find  $K_{eq}$  if  $[H_2] = 2.0 \times 10^{-3} \text{ M}$ ;  $[Cl_2] = 2.5 \times 10^{-2} \text{ M}$ ;  $[HCl] = 1.5 \times 10^{-3} \text{ M}$  (4)
5. Find  $[O_2]$  if  $K_p = 45.0 \text{ atm}^{-1}$ ;  $[N_2] = 1.0 \text{ atm}$ ;  $[N_2O] = 1.0 \text{ atm}$  (5)
6. Find  $[NO]$  if  $[O_2] = 0.10 \text{ M}$ ;  $[NO_2] = 0.20 \text{ M}$ ;  $K_{eq} = 10.0$  (6)
7. Find  $[N_2]$  if  $[H_2] = 1.0 \times 10^{-2} \text{ M}$ ;  $[NH_3] = 2.0 \times 10^{-3} \text{ M}$ ;  $K_{eq} = 1.5 \times 10^{-4}$  (3)
8. Find  $[CO]$  if  $[O_2] = 1.3 \times 10^{-3} \text{ M}$ ;  $[CO_2] = 2.5 \times 10^{-4} \text{ M}$ ;  $K_{eq} = 3.6 \times 10^{-3}$  (2)
9. Find  $K_a$  if  $[HC_2H_3O_2] = 0.10 \text{ M}$ ;  $[H^+] = [C_2H_3O_2^-] = 0.0010 \text{ M}$  (7)
10. Find  $K_a$  if  $[HCN] = 0.0010 \text{ M}$ ;  $[H^+] = 0.010 \text{ M}$ ;  $[CN^-] = 2.0 \times 10^{-8}$  (8)
11. Find  $[C_2H_3O_2^-]$  if  $[HC_2H_3O_2] = 1.5 \times 10^{-2} \text{ M}$ ;  $[H^+] = 2.0 \times 10^{-3} \text{ M}$ ;  $K_a = 1.8 \times 10^{-5}$  (7)

12. Find  $[H^+]$  if  $[HCN] = 3.6 \times 10^{-3} \text{ M}$  and  $[CN^-] = [H^+]$ ;  $K_a = 5.8 \times 10^{-8}$  (8)

13. Find  $K_{sp}$  if the solubility of silver chloride is  $4.3 \times 10^{-6} \text{ g/100 mL}$  (9)

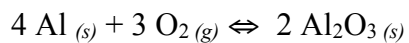
14. Find  $K_{sp}$  if the solubility of bismuth (III) sulfide is  $2.9 \times 10^{-5} \text{ g/100 mL}$  (11)

15. Find  $[Pb^{2+}]$  if  $K_{sp}$  for  $PbI_2$  is  $7.5 \times 10^{-9}$  (10)

**III. Solve each of the following problems involving equilibria.**

1. Calculate the equilibrium constant for the following reaction;  $2A + B \rightleftharpoons 3C + D$ , where the concentrations are  $A = 3.0 \text{ M}$ ;  $B = 2.0 \text{ M}$ ;  $C = 2.0 \text{ M}$ ; and  $D = 4.0 \text{ M}$
2. The equilibrium constant for the reaction  $A + B \rightleftharpoons 2C$  is 50. After mixing equimolar quantities of A and B, the equilibrium concentration of C is found to be 0.50 M. What are the concentrations of A and B at equilibrium?
3. Consider the reaction  $PCl_5 (g) \rightleftharpoons PCl_3 (g) + Cl_2 (g)$ . the equilibrium mixture in a 9.0 L container was found to include 0.25 moles of  $PCl_5$ , 0.36 moles of  $PCl_3$ , and 0.36 moles of  $Cl_2$ . From this data calculate the equilibrium constant for the reaction at the reaction temperature of  $225^\circ \text{ C}$ .
4. Nitrogen is caused to react with hydrogen to form ammonia at  $450^\circ \text{ C}$  in a 4.0 L vessel. At equilibrium, the partial pressures observed for each of the species in the reaction was as follows: ammonia 900 mm Hg, nitrogen 180 mm Hg and hydrogen 305 mm Hg. From this information calculate the equilibrium constant for the reaction at this temperature.
5. Consider the reaction  $H_2 (g) + I_2 (g) \rightleftharpoons 2 HI (g)$ . The equilibrium constant for this reaction is 32. If at equilibrium the concentration of HI is 0.40 M and that of  $I_2$  is 0.05 M, what is the concentration of hydrogen?

6. The equilibrium constant of the following reaction is 8. What is the concentration of oxygen at equilibrium?



7. For the reaction  $\text{H}_{2(g)} + \text{I}_{2(g)} \rightleftharpoons 2 \text{ HI}_{(g)}$  what is the equilibrium constant if the following concentrations are observed at equilibrium?  $[\text{H}_2] = 5.62 \text{ M}$   $[\text{I}_2] = 0.130 \text{ M}$   $[\text{HI}] = 7.89 \text{ M}$

8. Given the equilibrium concentrations shown below, what is the dissociation constant for ammonia?

$$[\text{NH}_3] = 0.0015 \text{ M}$$

$$[\text{H}_2] = 0.032 \text{ M}$$

$$[\text{N}_2] = 0.069 \text{ M}$$