1. Write an expression for the equilibrium constant of each chemical equation.

   (a) $SbCl_5(g) \rightleftharpoons SbCl_3(g) + Cl_2(g)$

   (b) $2\,BrNO(g) \rightleftharpoons 2\,NO(g) + Br_2(g)$

2. Consider the reaction: $NH_4H_2(s) \rightleftharpoons NH_3(g) + H_2S(g)$

   An equilibrium mixture of this reaction at a certain temperature has $[NH_3]$ = 0.278 M and $[H_2S]$ = 0.355 M. What is the value of K_c at this temperature?

3. Silver sulfate dissolves in water according to the reaction:
   $Ag_2SO_4(s) \rightleftharpoons 2\,Ag^+(aq) + SO_4{}^{2-}(aq)$ $K_c = 1.1 \times 10^{-5}$ at 298 K.
   A 1.5 L solution contains 6.55 g of dissolved silver sulfate. If additional solid silver sulfate is added to the solution, will it dissolve? (Hint: Calculate Q and compare to K)

4. For the reaction: $HC_2H_3O_2(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + C_2H_3O_2^-(aq)$, $K_c = 1.8 \times 10^{-5}$. If a solution initially consisted of 1.0000 M $HC_2H_3O_2$, calculate the equilibrium concentrations of the reactants and products (ignore the water).

5. For the reaction $N_2O_4(g) \rightleftharpoons 2\,NO_2(g)$ $K_c = 0.513$ at 500 K.
If a reaction vessel initially contains an N_2O_4 concentration of 0.0500 M at 500 K, what are the equilibrium concentrations of N_2O_4 and NO_2 at 500 K?

6. Consider the reaction: $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$, $K_c = 102$ at 500 K.
If a reaction mixture initially contains 0.110 M CO and 0.110 M H_2O, what will the equilibrium concentration of each of the reactants and products be?

7. Consider this reaction at equilibrium: $2\,BrNO(g) \rightleftharpoons 2\,NO(g) + Br_2(g)$.
   Predict whether the reaction will shift left, shift right, or remain unchanged after each disturbance.

   (a) NO is added to the reaction mixture (assume the pressure is constant).

   (b) BrNO is added to the reaction mixture (assume the pressure is constant).

   (c) Nothing is added, but the volume is decreased (pressure is increased).

8. This reaction is exothermic (ΔH_{rxn} is negative):
   $C_6H_{12}O_6(s) + O_2(g) \rightleftharpoons 6\,CO_2(g) + 6\,H_2O(g)$.
   Predict the effect (shift right, shift left, or no effect) of increasing and decreasing the reaction temperature. How does the value of the equilibrium constant depend on temperature?

9. Coal can be used to generate hydrogen gas (a potential fuel) by the endothermic reaction:
   $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$
   If this reaction mixture is at equilibrium, predict whether each disturbance will result in the formation of additional hydrogen gas, the formation of less hydrogen gas, or have no effect on the quantity of hydrogen gas.

   (a) adding more C to the reaction mixture

   (b) adding more H_2O to the reaction mixture

   (c) raising the temperature of the reaction mixture

   (d) increasing the volume of the reaction mixture

   (e) adding a catalyst to the reaction mixture

   (f) adding an inert gas to the reaction mixture