

# CHAPTER REVIEW

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

## The Nature of Chemical Equilibrium

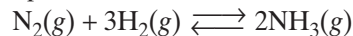
### SECTION 1 REVIEW

- 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  $A + B \rightleftharpoons C + D$ .
- Write the general expression for an equilibrium constant based on the equation  $nA + mB + \dots \rightleftharpoons xC + yD + \dots$ .
  - What information is provided by the value of  $K$  for a given equilibrium system at a specified temperature?
- In general, which reaction is favored (forward or reverse) if the value of  $K$  at a specified temperature is
  - very small?
  - very large?

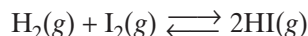
### PRACTICE PROBLEMS

- 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.)
  - $A + B \rightleftharpoons C$ ;  $[A] = 2.0$ ;  $[B] = 3.0$ ;  $[C] = 4.0$
  - $D + 2E \rightleftharpoons F + 3G$ ;  $[D] = 1.5$ ;  $[E] = 2.0$ ;  $[F] = 1.8$ ;  $[G] = 1.2$
  - $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ ;  $[N_2] = 0.45$ ;  $[H_2] = 0.14$ ;  $[NH_3] = 0.62$
- An equilibrium mixture at a specific temperature is found to consist of  $1.2 \times 10^{-3}$  mol/L HCl,  $3.8 \times 10^{-4}$  mol/L  $O_2$ ,  $5.8 \times 10^{-2}$  mol/L  $H_2O$ , and  $5.8 \times 10^{-2}$  mol/L  $Cl_2$  according to the following:  
 $4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$ .  
Determine the value of the equilibrium constant for this system.
- At  $450^\circ C$ , the value of the equilibrium constant for the following system is  $6.59 \times 10^{-3}$ . 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.



- 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?



## Shifting Equilibrium

### SECTION 2 REVIEW

- Predict whether each of the following pressure changes would favor the forward or reverse reaction.  
 $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ 
  - increased pressure
  - decreased pressure
- In heterogeneous reaction systems, what types of substances do not appear in the equilibrium constant expression? Why?
- Explain the effect of a catalyst on an equilibrium system.
- 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).  
 $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g) + 184 \text{ kJ}$ 
  - addition of  $Cl_2$
  - removal of HCl
  - increased pressure
  - decreased temperature
  - removal of  $H_2$
  - decreased pressure
  - addition of a catalyst
  - increased temperature
  - decreased system volume
- 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?
- Explain why changes in the concentrations of the reactants and products at equilibrium have no impact on the value of the equilibrium constant.