Ch 6 Practice Problems

1. Which of the following statements is true?
   A) When two opposing processes are proceeding at identical rates, the system is at equilibrium.
   B) Catalysts are an effective means of changing the position of an equilibrium.
   C) The concentration of the products equals that of the reactants and is constant at equilibrium.
   D) An endothermic reaction shifts toward reactants when heat is added to the reaction.
   E) None of the above statements is true.

2. Which of the following statements concerning equilibrium is not true?
   A) A system that is disturbed from an equilibrium condition responds in such a way as to restore equilibrium.
   B) Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.
   C) The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.
   D) A system moves spontaneously toward a state of equilibrium.
   E) The equilibrium constant is independent of temperature.

3. If, at a given temperature, the equilibrium constant for the reaction $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$ is 6.0, then the equilibrium constant for the reaction $HCl(g) \rightleftharpoons (1/2)H_2(g) + (1/2)Cl_2(g)$ can be represented as
   A) 6.0.
   B) 36.
   C) 0.41.
   D) 0.17.
   E) 0.028.

4. Choose the mass action or equilibrium expression for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
   A) $\frac{[SO_3]^2}{[SO_2]^2[O_2]^2}$
   B) $\frac{[SO_3]}{[SO_2][O_2]}$
   C) $\frac{[SO_2][O_2]}{[SO_3][O_2]}$
   D) $\frac{[SO_3]^2}{[SO_2][O_2]}$
   E) none of these

5. The value of $K_p$ for the reaction $H_2(g) + O_2(g) \rightleftharpoons H_2O_2(g)$ is $2.3 \times 10^6$ at 640K. Determine the value for $K_c$ for this reaction at 640K.
   A) $4.4 \times 10^4$
   B) $2.3 \times 10^6$
   C) $1.2 \times 10^6$
   D) $4.3 \times 10^7$
   E) $1.2 \times 10^{10}$
6. For the reaction \(2\text{NCl}_3(g) \rightleftharpoons \text{N}_2(g) + 3\text{Cl}_2(g)\), the equilibrium pressures are

\[
\begin{align*}
P(\text{NCl}_3) &= 0.160 \text{ atm} \\
P(\text{N}_2) &= 2.31 \text{ atm} \\
P(\text{Cl}_2) &= 0.0565 \text{ atm}
\end{align*}
\]

Determine \(K_p\) for this reaction.

A) 0.816  \\
B) 0.0163  \\
C) 1.22  \\
D) 7.75  \\
E) 61.4

7. The reaction \(\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)\)

has \(K_p = 45.9\) at 763 K. A particular equilibrium mixture at that temperature contains gaseous HI at a partial pressure of 3.50 atm and hydrogen gas at a partial pressure of 0.230 atm. What is the partial pressure of \(\text{I}_2\)?

A) 0.230 atm  \\
B) 0.332 atm  \\
C) 1.16 atm  \\
D) 0.663 atm  \\
E) 38.7 atm

8. Consider the equation \(2\text{NOCl}_3(g) \rightleftharpoons 2\text{NO}(g) + \text{Cl}_2(g)\). The equilibrium constant is 0.0136 at 115°C. Calculate \(K_p\).

A) 0.0136  \\
B) 0.433  \\
C) 43.9  \\
D) 0.128  \\
E) 4.27 \times 10^{-4}

9. For the reaction below, \(K_p = 1.16\) at 800.°C.

\[
\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)
\]

If a 25.0-g sample of CaCO\(_3\) is put into a 10.2-L container and heated to 800.°C, what percent of the CaCO\(_3\) will react to reach equilibrium?

A) 23.7%  \\
B) 53.8%  \\
C) 13.4%  \\
D) 100.\%  \\
E) 47.4%

10. Consider the reaction \(\text{CaCl}_2(s) + 2\text{H}_2\text{O}(g) \rightleftharpoons \text{CaCl}_2\cdot2\text{H}_2\text{O}(s)\)

What is the equilibrium constant for the reaction as written?

A) \(K = \frac{[\text{CaCl}_2\cdot2\text{H}_2\text{O}]}{[\text{CaCl}_2][\text{H}_2\text{O}]^2}\)  \\
B) \(K = \frac{1}{[\text{H}_2\text{O}]^2}\)  \\
C) \(K = \frac{1}{[\text{CaCl}_2][\text{H}_2\text{O}]^2}\)  \\
D) \(K = [\text{H}_2\text{O}]^2\)  \\
E) \(K = \frac{[\text{CaCl}_2\cdot2\text{H}_2\text{O}]}{[\text{H}_2\text{O}]^2}\)
11. Consider the reaction
\[ 2\text{NOBr}(g) \rightleftharpoons 2\text{NO}(g) + \text{Br}_2(g) \]

A 1.0-L vessel was initially filled with pure NOBr at a pressure of 3.8 atm and 300 K. At equilibrium, the partial pressure of NOBr was 2.0 atm. Determine the value of \( K_p \) for the reaction.

A) 0.81  
B) 1.4  
C) 0.73  
D) 1.6  
E) 0.90

12. Consider the equation \( 2\text{A}(g) \rightleftharpoons 2\text{B}(g) + \text{C}(g) \). At a particular temperature, \( K = 1.6 \times 10^4 \).

If you mixed 5.0 mol B, 0.10 mol C, and 0.0010 mol A in a 1-L container, in which direction would the reaction initially proceed?

A) To the left.  
B) To the right.  
C) The above mixture is the equilibrium mixture.  
D) We cannot tell from the information given.

13. Consider the decomposition of hydrazine as shown below.
\[ \text{N}_2\text{H}_4(g) \rightleftharpoons 2\text{H}_2(g) + \text{N}_2(g) \]

At a certain temperature, \( K_p = 2.5 \times 10^3 \). When pure hydrazine is placed in an otherwise empty vessel at this temperature, equilibrium is reached after 30.0% of the hydrazine has decomposed. Calculate the partial pressure of hydrogen gas at equilibrium.

A) 54 atm  
B) 76 atm  
C) 127 atm  
D) 5776 atm  
E) none of these

14. A sample of solid \( \text{NH}_4\text{NO}_3 \) was placed in an evacuated container and then heated so that it decomposed explosively according to the following reaction:
\[ \text{NH}_4\text{NO}_3(s) \rightleftharpoons \text{N}_2\text{O}(g) + 2\text{H}_2\text{O}(g) \]

At equilibrium, the total pressure in the container was found to be 2.03 atm at a temperature of 500°C. Calculate \( K_p \).

A) 33.5  
B) 4.12  
C) 1.83  
D) 1.24  
E) 2.03

15. At \(-75^\circ\text{C}, K \) for the reaction
\[ \text{N}_2\text{O}_3(g) \rightleftharpoons 2\text{NO}_2(g) \]
is \( 4.66 \times 10^{-8} \). We introduce 0.036 mol of \( \text{N}_2\text{O}_3 \) into a 2.1-L vessel at \(-75^\circ\text{C} \) and let equilibrium be established. The total pressure in the system at equilibrium will be

A) 0.23 atm.  
B) 0.28 atm.  
C) 0.11 atm.  
D) 0.56 atm.  
E) 4.66 \times 10^{-8} \text{ atm.}
16. Consider the reaction
$$2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)$$
at constant temperature. Initially a container is filled with pure SO$_3(g)$ at a pressure of 2 atm, after which equilibrium is allowed to be reached. If $y$ is the partial pressure of O$_2$ at equilibrium, what is the value of $K_p$?

A) \( \frac{(2 - 2y)^2}{(y^2)(2y)} \)
B) \( \frac{(2 - y)^2}{(y^2)(y/2)} \)
C) \( \frac{(2 - y)^2}{(2y)^3(y)} \)
D) \( \frac{(2 - 2y)^2}{(2y)(y)} \)
E) none of these

17. The following reaction is investigated (assume an ideal gas mixture).
$$2\text{N}_2\text{O}(g) + \text{N}_2\text{H}_4(g) \rightleftharpoons 3\text{N}_2(g) + 2\text{H}_2\text{O}(g)$$
Initially there are 0.10 mol of N$_2$O and 0.30 mol of N$_2$H$_4$ in a 20.0-L container. If there is 0.050 mol of N$_2$O at equilibrium, how many moles of N$_2$ are present at equilibrium?

A) 0.15
B) 0.067
C) 0.075
D) 0.15
E) 0.050

18. Consider the equation 2A(g) \( \rightleftharpoons \) 2B(g) + C(g). At a particular temperature, $K = 1.8 \times 10^{-5}$.
If you start with 2.0 M of chemical A, calculate the equilibrium concentration of chemical C.

A) \( 6.0 \times 10^{-3} \) M
B) \( 2.6 \times 10^{-2} \) M
C) \( 1.0 \) M
D) \( 2.1 \times 10^{-2} \) M
E) none of these

19. At a certain temperature, $K$ for the reaction is 7.5.
$$2\text{NO}_2 \rightleftharpoons \text{N}_2\text{O}_4$$
If 2.0 mol of NO$_2$ is placed in a 2.0-liter container and permitted to react at this temperature, calculate the concentration of N$_2$O$_4$ at equilibrium.

A) \( 0.39 \) mol/L
B) \( 0.65 \) mol/L
C) \( 0.82 \) mol/L
D) \( 7.5 \) mol/L
E) none of these

20. Nitrogen gas (N$_2$) reacts with hydrogen gas (H$_2$) to form ammonia (NH$_3$). At 200°C in a closed container, 1.1 atm of nitrogen gas is mixed with 2.1 atm of hydrogen gas. At equilibrium, the total pressure is 2.2 atm. Calculate the partial pressure of hydrogen gas at equilibrium.

A) 2.1 atm
B) 0.60 atm
C) 0.70 atm
D) 0.0 atm
E) 1.8 atm
21. Consider the following endothermic reaction at equilibrium: \[ \text{H}_2(g) + \text{I}_2(s) \rightleftharpoons 2\text{HI}(g) \]
Which of the following statements about the equilibrium is false?
A) If the system is heated, the right side is favored.
B) This is a heterogeneous equilibrium.
C) If the pressure on the system is increased by changing the volume, the left side is favored.
D) Adding more H$_2$(g) increases the equilibrium constant.
E) Removing HI as it forms forces the equilibrium to the right.

22. For a certain reaction at 25.0°C, the value of $K$ is $1.2 \times 10^{-3}$. At 50.0°C the value of $K$ is $3.4 \times 10^{-1}$. This means that the reaction is
A) exothermic
B) endothermic
C) We need more information.

Use the following to answer questions 23-24:
Consider the equation \[ 3\text{A}(g) \rightleftharpoons 2\text{B}(g) + \text{C}(g) \]. At a particular temperature, $K = 1.6 \times 10^4$.

23. Addition of chemical B to an equilibrium mixture of the above will
A) cause $[\text{A}]$ to increase.
B) cause $[\text{C}]$ to increase.
C) have no effect.
D) cannot be determined
E) none of these

24. Raising the pressure by lowering the volume of the container will
A) cause $[\text{A}]$ to increase.
B) cause $[\text{B}]$ to increase.
C) have no effect.
D) cannot be determined
E) none of these

Answers: