# Chapter 16 Chemical Equilibrium Practice

Understanding Equilibrium

1. Define Q and K, and explain their relationship to equilibrium.

2. Which best describes the relationship between K & Q for an equilibrium that strongly favors products:
    a. Q<<1
    b. K<<1
    c. K>>1
    d. Q>>1
    e. Q=K

3. A reaction has a relationship of Q<K, which is true?
    a. The reaction is at equilibrium
    b. the reaction is not at equilibrium, and will make more products at the expense of reactants.
    c. The reaction is not at equilibrium and will shift to produce more reactants at the expense of products.
    d. The value of K will decrease until it is equal to Q.

Equilibrium Expressions

4. Write an expression for the equilibrium constant of each of the following chemical equations.
    a. $SbCl_5(g) \rightleftharpoons SbCl_3(g) + Cl_2(g)$
    b. $2BrNO(g) \rightleftharpoons 2NO(g) + Br_2(g)$
    c. $CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$

Manipulating Equilibrium Constants

5. Explain the relationship of the equilibrium constant between a forward and a backwards reaction.

6. For the chemical equilibrium $A + 2B \rightleftharpoons 2C$, the value of the equilibrium constant, K=10. What is the value of the equilibrium constant for the reaction written in reverse?

   $2C \rightleftharpoons A + 2B$ K = ? If: $A + 2B \rightleftharpoons 2C$ K = 10

   a. 0.10
   b. 10
   c. 1
   d. 100

7. The reaction $A(g)+B(g) \rightleftharpoons C(g)$ has a $K = 1.2 \times 10^{-2}$. If the reaction is multiplied by 2, what is the new value of the equilibrium constant?

Equilibrium Calculations

8. What is the equilibrium concentration of $Br_2$ if [HBr] = 0.35 M and $[H_2]$ = 0.22 M at equilibrium?

   $H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$ K = 62.5

9. For the following equation, what is the value of the equilibrium constant with the concentrations shown?

   $A(aq) + 2B(aq) \rightleftharpoons 2C(aq) + D(aq)$ K=??

| | |
|---|---|
| [A] | $4.5 \times 10^{-5}$ M |
| [B] | $2.2 \times 10^{-2}$ M |
| [C] | $9.4 \times 10^{-3}$ M |
| [D] | $1.2 \times 10^{-2}$ M |

10. Calculate the equilibrium constant for the following reaction, given the following equilibrium concentrations of $H_2$, CO, and $H_2O$.
    $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$ K = ??

| | |
|---|---|
| $H_2O$ | 1.60 M |
| CO | 0.030 M |
| $H_2$ | 0.030 M |

11. Calculate Kc for each reaction.
    a. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ Kp = 6.2 X $10^5$ (at 298K)
    b. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ Kp= 0.14 (at 298K)

12. Consider the reaction: $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$

At a certain temperature, Kc = 8.5 X $10^{-3}$, A reaction mixture at this temperature with solid $NH_4HS$ has $[NH_3] = 0.0822$ M and $[H_2S] = 0.0822$ M.
Will more solid form, or decompose as the reaction reaches equilibrium?

ICE Tables

13. Consider the reaction: $A(g) \rightleftharpoons B(g)$. The equilibrium constant is K = 10.
    The Reaction mixture initially contains [A] =1.3. Determine the concentration of [B] at equilibrium:

14. $HC_2H_3O_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + C_2H_3O_2^-(aq)$, Kc = 1.8 X $10^{-5}$ at 25 °C, The solution initially contains 0.210M of $HC_2H_3O_2$, determine the equilibrium concentration of $H_3O^+$ at 25 °C:

15. 0.60 mol of $Br_2$ and 0.60 mol of $Cl_2$ are placed in a 1.00 L flask and allowed to reach equilibrium. After reaching equilibrium, the flask contains 0.28 mol of BrCl. Determine the equilibrium constant for this reaction. $Br_2(g) + Cl_2(g) \rightleftharpoons 2BrCl(g)$
    K=

16. The reaction of bromine gas with chlorine gas, $Br_2(g) + Cl_2(g) \rightleftharpoons 2BrCl(g)$, has a Kc value of 7.20 at 200ºC. If a closed vessel is filled with the reactants, both at an initial concentration of 0.200 M, what would be the equilibrium concentration of BrCl(g)?

Le Chatelier's Principle

17. Which would occur if you increase the temperature of an endothermic reaction?
    a. more products and fewer reactants.
    b. more reactants and fewer products.
    c. more reactants and products.
    d. fewer reactants and products.

18. Given the following reaction at equilibrium: $SO_2(g) + Cl_2(g) \rightleftharpoons SO_2Cl_2(g)$ $\Delta H^\circ = -67$ kJ, which change would increase the amount of moles of $SO_2Cl_2(g)$?
    a. adding heat to the system
    b. Adding Cl2 to the system.
    c. removing $Cl_2$ from the system.
    d. increasing the volume of the reaction vessel.

19. Which of the following would you expect if products were added to a reaction at equilibrium?
    a. Q increases, so the equilibrium shifts to produce more products.
    b. Q increases, so the equilibrium shifts to produce more reactants.
    c. Q decreases, so the equilibrium shifts to produce more products.
    d. Q decreases, so the equilibrium shifts to produce more reactants.