# Practice Exercises

Multiple-Choice

For the first three problems below, one or more of the following responses will apply; each response may be used more than once or not at all in these questions.

I. K_a
II. K_{sp}
III. Q
IV. K_c
V. Le Châtelier's principle

1. The effect of temperature on a chemical system is best described using

   (A) I and III
   (B) II
   (C) III and V
   (D) IV
   (E) V

2. This is the correct term to use to determine if a system has come to equilibrium.

   (A) I and III
   (B) II
   (C) III
   (D) IV
   (E) V

3. The term(s) most useful in determining the solubility of a substance is (are)

   (A) I and III
   (B) II
   (C) III and V
   (D) IV
   (E) V

4. A chemical system in equilibrium will.

   (A) have the same concentrations of all products and reactants
   (B) form more products if the temperature is increased
   (C) have a specific ratio of product to reactant concentrations
   (D) not have any precipitates
   (E) represent a spontaneous chemical process

5. Chemical equilibrium may be used to describe

   (A) chemical reactions
   (B) acids and bases
   (C) solubility
   (D) A and C
   (E) A, B, and C

6. For the following reaction:

   $$\text{heat} + 2NO_2(g) \rightleftharpoons N_2O_4(g)$$
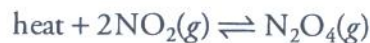
   which change will not be effective in increasing the amount of $N_2O_4(g)$?

   (A) decreasing the volume of the reaction vessel
   (B) increasing the temperature
   (C) adding N_2 to increase the pressure
   (D) adsorbing the $N_2O_4(g)$ with a solid adsorbant
   (E) adding more $NO_2(g)$ to the reaction vessel

7. The reaction

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

has an equilibrium constant of 4.5 $\times 10^3$ at a certain temperature. What is the equilibrium constant of

$$2N_2O_4(g) \rightleftharpoons 4NO_2(g)?$$

(A) 4.5×10^3
(B) 9.0×10^6
(C) 2.2×10^{-4}
(D) 2.0×10^7
(E) 4.9×10^{-8}

8. The correct form of the solubility product for silver chromate, Ag_2CrO_4, is

(A) $[Ag^+]^2[CrO_4^{2-}]$
(B) $[Ag^+][CrO_4^{2-}]$
(C) $[Ag^+][CrO_4^{2-}]^2$
(D) $[Ag^+]^2[CrO^{2-}]^4$
(E) $[Ag]^2[CrO_4]$

9. For which of the following will $K_p = K_c$?

(A) $MgCO_3(s) + 2HCl(g) \rightleftharpoons MgCl_2(s) + CO_2(g) + H_2O(\ell)$
(B) $C(s) + O_2(g) \rightleftharpoons CO_2(g)$
(C) $CH_4(g) + 3O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(g)$
(D) $Zn(s) + 2HCl(aq) \rightleftharpoons H_2(g) + ZnCl_2(aq)$
(E) $2NO_2(g) + O_2(g) \rightleftharpoons N_2O_5(g)$

10. Which is an appropriate formulation of the equilibrium law for the reaction

$$MgCO_3(s) + 2HCl(g) \rightleftharpoons MgCl_2(s) + CO_2(g) + H_2O(\ell)?$$

(A) $\dfrac{[CO_2]}{[HCl]}$

(B) $\dfrac{[MgCl_2][CO_2][H_2O]}{[HCl]^2[MgCO_3]}$

(C) $\dfrac{[HCl]^2[MgCO_3]}{[MgCl_2][CO_2][H_2O]}$

(D) $\dfrac{[CO_2]}{[HCl]^2}$

(E) $\dfrac{[CO_2][H_2O]}{[HCl]^2}$

11. In the reaction

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$
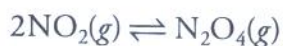
the equilibrium constant is 0.020. If 0.200 mol of HI is placed in a 10.0-L flask, how many moles of I2(g) will be in the flask when equilibrium is reached?

(A) 0.022
(B) 0.025
(C) 0.0022
(D) 2.2
(E) 0.0025

12. For the reaction

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

$K_p = 8.8$ when pressures are measured in atmospheres. Under which of the following conditions will the reaction proceed in the forward direction?

$NO_2(g)$	$N_2O_4(g)$
(A) 0.200 atm	0.352 atm
(B) 250 mm Hg	400 mm Hg
(C) 0.00255 atm	0.000134 atm
(D) 46.5 mm Hg	82.3 mm Hg
(E) 0.138 atm	0.764 atm

13. The solubility product of PbI_2 is 7.9×10^{-9}. What is the molar solubility of PbI_2 in distilled water?

(A) 2.0×10^{-3}
(B) 1.25×10^{-3}
(C) 5.0×10^{-4}
(D) 8.9×10^{-5}
(E) 7.9×10^{-3}

14. The solubility of gold(III) chloride is 1.00×10^{-4} g L^{-1}. What is the solubility product of $AuCl_3$ (molar mass = 303)?

(A) 1.00×10^{-16}
(B) 2.7×10^{-15}
(C) 1.2×10^{-26}
(D) 3.2×10^{-25}
(E) 9.6×10^{-25}

15. If units were used with the equilibrium constant, K_c, for the following reaction:

$$CH_4(g) + 3O_2(g) \rightleftharpoons CO_2(g) + 2H_2O(g)$$
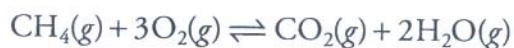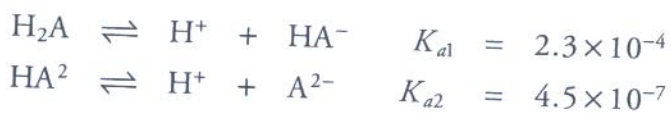
they would be

(A) M^{-2}
(B) M^2
(C) M
(D) M^{-1}
(E) M^3

16. Which of the following CANNOT affect the extent of reaction?

    (A) changing the temperature
    (B) adding a catalyst
    (C) increasing the amounts of reactants
    (D) removing some product
    (E) changing the volume

17. In which of the following cases is the reaction expected to be exothermic?

    (A) Increasing the pressure increases the amount of product formed.
    (B) Increasing the amount of reactants increases the amount of product formed.
    (C) Increasing the temperature increases the amount of product formed.
    (D) Increasing the volume decreases the amount of product formed.
    (E) Increasing the temperature decreases the amount of product formed.

18. A reaction has a very large equilibrium constant of 3.3×10^{13}. Which statement is NOT true about this reaction?

    (A) The reaction is very fast.
    (B) The reaction is essentially complete.
    (C) The reaction is spontaneous.
    (D) The equilibrium constant will change if the temperature is changed.
    (E) The products will react to yield very little reactant.

19. The K_{sp} of AgCl is 1.0×10^{-10}, and the K_{sp} of AgI is 8.3×10^{-17}. A solution is 0.100 M in I^- and Cl^-. What is the molarity of iodide ions when AgCl just starts to precipitate?

    (A) 1.0×10^{-5}
    (B) 9.1×10^{-9}
    (C) 8.3×10^{-7}
    (D) 8.3×10^{-8}
    (E) 1.2×10^{4}

20. One liter of solution contains 2.4×10^{-3} mol of sulfate ions. What is the molar solubility of $BaSO_4$ in this solution? ($K_{sp} = 1.1 \times 10^{-10}$ for $BaSO_4$.)

    (A) 1.05×10^{-5}
    (B) 1.1×10^{-9}
    (C) 2.6×10^{-13}
    (D) 2.2×10^{7}
    (E) 4.6×10^{-8}

21. The equilibrium constant for the reaction

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

must be determined. If 1.00 g of HI is placed in a 2.00-L flask, which of the following is LEAST important in determining the equilibrium constant?

    (A) The temperature must remain constant at the desired value.
    (B) Several measurements must be made to assure that the reaction is at equilibrium.
    (C) Only one of the three concentrations needs to be accurately determined.
    (D) All three concentrations must be accurately measured.
    (E) The original mass and volume of the flask must be accurately measured.

22. In an experiment 0.0300 mol each of $SO_3(g)$, $SO_2(g)$, and $O_2(g)$ were placed in a 10.0-L flask at a certain temperature. When the reaction came to equilibrium, the concentration of $SO_2(g)$ in the flask was 3.50×10^{-5} M. What is K_c for the reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$
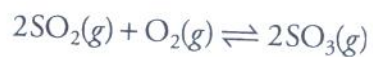
(A) 3.5×10^{-5}
(B) 1.9×10^{7}
(C) 5.2×10^{-8}
(D) 1.2×10^{-9}
(E) 8.2×10^{8}

23. The weak acid H_2A ionizes in two steps with these equilibrium constants:

$$H_2A \rightleftharpoons H^+ + HA^- \qquad K_{a1} = 2.3 \times 10^{-4}$$
$$HA^2 \rightleftharpoons H^+ + A^{2-} \qquad K_{a2} = 4.5 \times 10^{-7}$$

What is the equilibrium constant for the reaction:

$$H_2A \rightleftharpoons 2H^+ + A^{2-}$$

(A) 6.8×10^{-11}
(B) 1.0×10^{-10}
(C) 2.3045×10^{-4}
(D) 2.0×10^{-3}
(E) 5.1×10^{2}