Name _____

AP Chemistry: Equilibrium
Multiple Choice

57. For the reaction $A_{(g)} \rightleftarrows B_{(g)} + C_{(g)}$, the equilibrium constant, K_p, is 2×10^{-4} at 25 °C. A mixture of the three gases at 25 °C is placed in a reaction flask and the initial pressures are $P_A = 2$ atm, $P_B = 0.5$ atm, and $P_C = 1$ atm. At the instant of mixing, which of the following is true for the reaction as written?

(A) $\Delta G < 0$ (B) $\Delta G > 0$ (C) $\Delta S = 0$ (D) $\Delta G° = 0$ (E) $\Delta G° < 0$

76. $HgO_{(s)} + 4\ I^- + H_2O \rightleftarrows HgI_4^{2-} + 2\ OH^-$; $\Delta H < 0$

Consider the equilibrium above. Which of the following changes will increase the concentration of HgI_4^{2-}?

(A) Increasing the concentration of OH^- (B) Adding 6 M HNO_3

(C) Increasing the mass of HgO present (D) Increasing the temperature (E) Adding a catalyst

29. In which of the following systems would the number of moles of the substances present at equilibrium NOT be shifted by a change in the volume of the system at constant temperature?

(A) $CO_{(g)} + NO_{(g)} \rightleftarrows CO_{2(g)} + 1/2\ N_{2(g)}$ (B) $N_{2(g)} + 3\ H_{2(g)} \rightleftarrows 2\ NH_{3(g)}$

(C) $N_{2(g)} + 2\ O_{2(g)} \rightleftarrows 2\ NO_{2(g)}$ (D) $N_2O_{4(g)} \rightleftarrows 2\ NO_{2(g)}$

(E) $NO_{(g)} + O_{3(g)} \rightleftarrows NO_{2(g)} + O_{2(g)}$

48. $PCl_{3(g)} + Cl_{2(g)} \rightleftarrows PCl_{5(g)}$ + energy

Some PCl_3 and Cl_2 are mixed in a container at 200 °C and the system reaches equilibrium according to the equation above. Which of the following causes an increase in the number of moles of PCl_5 present at equilibrium?

I. Decreasing the volume of the container

II. Raising the temperature

III. Adding a mole of He gas at constant volume

(A) I only (B) II only (C) I and III only (D) II and III only (E) I, II, and III

51. $4\ HCl_{(g)} + O_{2(g)} \rightleftarrows 2\ Cl_{2(g)} + 2\ H_2O_{(g)}$

Equal numbers of moles of HCl and O_2 in a closed system are allowed to reach equilibrium as represented by the equation above. Which of the following must be true at equilibrium?

I. [HCl] must be less than $[Cl_2]$.

II. $[O_2]$ must be greater than [HCl].

III. $[Cl_2]$ must equal $[H_2O]$.

(A) I only (B) II only (C) I and III only (D) II and III only (E) I, II, and III

65. The solubility of CuI is 2×10^{-6} molar. What is the solubility product constant, K_{sp}, for CuI?

(A) 1.4×10^{-3} (B) 2×10^{-6} (C) 4×10^{-12} (D) 2×10^{-12} (E) 8×10^{-18}

73. $2\ SO_{2(g)} + O_{2(g)} \rightleftarrows 2\ SO_{3(g)}$

When 0.40 moles of SO_2 and 0.60 moles of O_2 are placed in an evacuated 1.00-liter flask, the reaction represented above occurs. After the reactants and the product reach equilibrium and the initial temperature is restored, the flask is found to contain 0.30 moles of SO_3. Based on these results, the expression for the equilibrium constant, K_c, of the reaction is…

(A) $(0.30)^2 / [(0.65)(0.10)^2]$ (B) $(0.30)^2 / [(0.60)(0.40)^2]$ (C) $(2 \times 0.30) / [(0.45)(2 \times 0.10)]$

(D) $(0.30) / [(0.65)(0.10)]$ (E) $(0.30) / [(0.60)(0.40)]$

54. $2NO_{(g)} + O_{2(g)} \rightleftarrows 2\ NO_{2(g)}$; $\Delta H < 0$

Which of the following changes alone would cause a decrease in the value of K_{eq} for the reaction represented above?

(A) Decreasing the temperature (B) Increasing the temperature

(C) Decreasing the volume of the reaction vessel (D) Increasing the volume of the reaction vessel

(E) Adding a catalyst

74. How many moles of NaF must be dissolved in 1.00 liter of a saturated solution of PbF_2 at 25 °C to reduce the $[Pb^{2+}]$ to 1×10^{-6} molar? (K_{sp} of PbF_2 at 25 °C = 4.0×10^{-8})

(A) 0.020 mole (B) 0.040 mole (C) 0.10 mole (D) 0.20 mole (E) 0.40 mole

52. The test for the presence of Ag^+ in an unknown solution involves the treatment of the silver-ammonia complex with dilute hydrochloric acid. The appearance of a white precipitate at this point indicates the presence of silver ion in the original sample. The net ionic equation that represents this test is…

(A) $Ag(NH_4)_4^+ + 4\ H^+ \rightleftarrows Ag_{(s)} + 4\ NH_4^+$ (B) $Ag(NH_4)_4^+ + Cl^- \rightleftarrows AgCl_{(s)} + 4\ NH_4^+$

(C) $Ag(NH_3)_4^+ + 4\ HCl \rightleftarrows AgCl_{(s)} + 4\ NH_4^+ + 3\ Cl^-$ (D) $Ag(NH_3)_4^+ + Cl^- \rightleftarrows Ag(NH_3)_2Cl_{(s)}$

(E) $Ag(NH_3)_4^+ + 2\ H^+ + Cl^- \rightleftarrows AgCl_{(s)} + 2\ NH_4^+$

66. $MnS_{(s)} + 2\ H^+ \rightleftarrows Mn^{2+} + H_2S_{(g)}$

At 25 °C the solubility product constant, K_{sp}, for MnS in 5×10^{-15} and the acid dissociation constants K_1 and K_2 for H_2S are 1×10^{-7} and 1×10^{-13}, respectively. What is the equilibrium constant for the reaction represented by the equation above at 25 °C?

(A) $1 \times 10^{-13} / 5 \times 10^{-15}$ (B) $5 \times 10^{-15} / 1 \times 10^{-7}$ (C) $1 \times 10^{-7} / 5 \times 10^{-20}$

(D) $5 \times 10^{-15} / 1 \times 10^{-20}$ (E) $1 \times 10^{-20} / 5 \times 10^{-15}$

27. Appropriate uses of a visible-light spectrophotometer include which of the following?

I. Determining the concentration of a solution of $Cu(NO_3)_2$

II. Measuring the conductivity of a solution of $KMnO_4$

III. Determining which ions are present in a solution that may contain Na^+, Mg^{2+}, Al^{3+}

(A) I only (B) II only (C) III only (D) I and II only (E) I and III only

$$2\ SO_{3(g)} \rightleftarrows 2\ SO_{2(g)} + O_{2(g)}$$

41. After the equilibrium represented above is established, some pure $O_{2(g)}$ is injected into the reaction vessel at constant temperature. After equilibrium is reestablished, which of the following has a lower value compared to its value at the original equilibrium?

(A) K_{eq} for the reaction
(B) The total pressure in the reaction vessel
(C) The amount of $SO_{3(g)}$ in the reaction vessel
(D) The amount of $O_{2(g)}$ in the reaction vessel
(E) The amount of $SO_{2(g)}$ in the reaction vessel

37. $HCO_3^-(aq) + OH^-(aq) \rightleftarrows H_2O(l) + CO_3^{2-}(aq)$ $\quad \Delta H° = -41.4kJ$

When the reaction represented by the equation above is at equilibrium at 1 atm and 25°C, the ratio $\frac{[CO_3^{2-}]}{[HCO_3^-]}$ can be increased by doing which of the following?

(A) Decreasing the temperature (B) Adding acid
(C) Adding a catalyst (D) Diluting the solution with distilled water
(E) Bubbling neon gas through the solution

42. $H_{2(g)} + Br_{2(g)} \rightleftarrows 2HBr_{(g)}$

At a certain temperature, the value of the equilibrium constant, K, for the reaction represented above is 2.0×10^5. What is the value of K for the reverse reaction at the same temperature?

(A) -2.0×10^{-5} (B) 5.0×10^{-6} (C) 2.0×10^{-5} (D) 5.0×10^{-5} (E) 5.0×10^{-4}

75. In a saturated solution of $Zn(OH)_2$ at 25°C , the value of $[OH^-]$ is 2.0×10^{-6}M. What is the value of the solubility-product constant, K_{sp}, for $Zn(OH)_2$ at 25°C ?

(A) 4.0×10^{-18} (B) 8.0×10^{-18} (C) 1.6×10^{-17} (D) 4.0×10^{-12} (E) 2.0×10^{-6}

36. $CuO_{(s)} + H_{2(g)} \rightleftarrows Cu_{(s)} + H_2O_{(g)}$; $\quad \Delta H = -2.0$ kilojoules

When the substances in the equation above are at equilibrium at pressure P and temperature T, the equilibrium can be shifted to favor the products by…

(A) increasing the pressure by means of a moving piston at constant T.

(B) increasing the pressure by adding an inert gas such as nitrogen.

(C) decreasing the temperature.

(D) allowing some gases to escape at constant P and T.

(E) adding a catalyst.