Chapter 04: Reactions in Aqueous Solution

1. Which of the following compounds is a *strong electrolyte*?
   A) H_2O B) CH_3OH C) CH_3CH_2OH D) HF E) NaF

3. Which of the following compounds is a *strong electrolyte*?
   A) H_2O
   B) N_2
   C) CH_3COOH (acetic acid)
   D) CH_3CH_2OH (ethanol)
   E) KOH

5. Which of the following compounds is a *weak electrolyte*?
   A) HCl B) NH_3 C) $C_6H_{12}O_6$ (glucose) D) N_2 E) KCl

7. Which of the following compounds is a *nonelectrolyte*?
   A) NaOH
   B) HNO_3
   C) C_2H_6O (ethanol)
   D) KF
   E) CH_3COOH (acetic acid)

9. Identify the *major* ionic species present in an aqueous solution of K_2SO_4.
   A) K^{2+}, S^{6+}, O_4^{8-}
   B) K^{2+}, S^{6+}, $4O^{2-}$
   C) $2K^{+}$, S^{6+}, O_4^{8-}
   D) $2K^{+}$, S^{6+}, $4O^{2-}$
   E) $2K^{+}$, SO_4^{2-}

11. Based on the solubility rules, which one of the following compounds should be *insoluble* in water?
    A) NaCl B) $MgBr_2$ C) $FeCl_2$ D) AgBr E) $ZnCl_2$

13. Based on the solubility rules, which one of the following compounds should be *insoluble* in water?
    A) $CaCO_3$ B) $(NH_4)_2CO_3$ C) Na_2CO_3 D) K_2CO_3 E) KNO_3

15. Based on the solubility rules, which one of the following should be *soluble* in water?
    A) AgBr B) AgCl C) Ag_2CO_3 D) $AgNO_3$ E) Ag_2S

17. Based on the solubility rules, which one of the following should be *soluble* in water?
    A) $CaSO_4$ B) $BaSO_4$ C) $PbSO_4$ D) K_2SO_4 E) AgCl

19. Based on the solubility rules, which of the following will occur if solutions of $CuSO_4(aq)$ and $BaCl_2(aq)$ are mixed?
    A) $CuCl_2$ will precipitate; Ba^{2+} and SO_4^{2-} are spectator ions.
    B) $CuSO_4$ will precipitate; Ba^{2+} and Cl^- are spectator ions.
    C) $BaSO_4$ will precipitate; Cu^{2+} and Cl^- are spectator ions.
    D) $BaCl_2$ will precipitate; Cu^{2+} and SO_4^{2-} are spectator ions.
    E) No precipitate will form.

21. Which of the following is the correct *net ionic equation* for the reaction that occurs when solutions of $Pb(NO_3)_2$ and NH_4Cl are mixed?
    A) $Pb(NO_3)_2(aq) + 2NH_4Cl(aq) \rightarrow NH_4NO_3(aq) + PbCl_2(s)$
    B) $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$
    C) $Pb^{2+}(aq) + 2NO_3^-(aq) + 2NH_4^+(aq) + 2Cl^-(aq) \rightarrow 2NH_4^+(aq) + 2NO_3^-(aq) + PbCl_2(s)$
    D) $NH_4^+(aq) + NO_3^-(aq) \rightarrow 2NH_4NO_3(s)$
    E) No reaction occurs when the solutions are mixed.

23. Which of the following compounds is a *weak acid*?
    A) HF B) HCl C) HBr D) HI E) $HClO_4$

25. Identify the *major* ions present in an aqueous HNO_3 solution.
    A) HN^+, O^{2-}
    B) OH^-, NO_3^-
    C) OH^-, NO
    D) H^+, N^{3-}, O^{2-}
    E) H^+, NO_3^-

27. What is the correct formula of the salt formed in the neutralization reaction of hydrochloric acid with calcium hydroxide?
    A) CaO B) $CaCl_2$ C) CaH_2 D) CaCl E) CaClH

29. What is the chemical formula of the salt produced by the neutralization of nitric acid with calcium hydroxide?
    A) $CaNO_3$ B) $Ca_2(NO_3)_3$ C) $Ca_3(NO_3)_2$ D) Ca_2NO_3 E) $Ca(NO_3)_2$

31. What is the chemical formula of the salt produced by the neutralization of potassium hydroxide with sulfuric acid?
    A) KSO_3 B) $K_2(SO_4)_3$ C) K_2SO_4 D) $K(SO_4)_2$ E) KSO_4

33. The oxidation number of S in K_2SO_4 is
A) +6. B) +4. C) +2. D) –1. E) None of the above.

35. The oxidation number of Fe in $K_3Fe(CN)_6$ is
A) +3. B) +2. C) +1. D) –3. E) –4.

37. The oxidation number of Cl in ClO_3^- is
A) –1. B) +7. C) +5. D) +3. E) None of the above.

39. The highest possible oxidation number of nitrogen is
A) +8. B) +5. C) +3. D) +1. E) –3.

41. The highest possible oxidation number of carbon is
A) +8. B) +6. C) +4. D) +2. E) –4.

43. The oxidation number of N in N_2H_4 is
A) +4. B) –4. C) +2. D) –2. E) 0.

45. Which choice gives the correct oxidation numbers for all three elements in $Ca(ClO)_2$ in the order that the elements are shown in the formula?
A) +2, +1, –2 B) +2, –2, +1 C) +2, –3, +2 D) –2, +2, –1 E) –2, +3, –2

47. Which one of the following is a *redox* reaction?
A) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
B) $2KBr(aq) + Pb(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + PbBr_2(s)$
C) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
D) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
E) $CO_3^{2-}(aq) + HSO_4^-(aq) \rightarrow HCO_3^-(aq) + SO_4^{2-}(aq)$

49. In the following chemical reaction the *oxidizing agent* is:
$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$
A) H_2O_2 B) MnO_4^- C) H^+ D) Mn^{2+} E) O_2

51. Identify the *oxidizing agent* in the following chemical reaction.
$2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+ + 3H_2O$
A) MnO_4^- B) H_2SO_3 C) Mn^{2+} D) SO_4^{2-} E) H^+

53. Identify the *reducing agent* in the following chemical reaction.
$Cd + NiO_2 + 2H_2O \rightarrow Cd(OH)_2 + Ni(OH)_2$
A) Cd B) NiO_2 C) H_2O D) $Cd(OH)_2$ E) $Ni(OH)_2$

55. What element is *oxidized* in the following chemical reaction?
$NiO_2 + Cd + 2H_2O \rightarrow Ni(OH)_2 + Cd(OH)_2$
A) Ni B) Cd C) O D) H E) This is not a redox reaction.

57. What element is *reduced* in the following chemical reaction?
$Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$
A) Cu B) H C) S D) O E) H_2O

59. Predict the products of the following single replacement reaction.
$Fe(s) + CuSO_4(aq) \rightarrow$
A) $Cu(s) + FeSO_4(aq)$
B) $Fe(s) + Cu(s) + SO_4(aq)$
C) $CuS(s) + Fe_2SO_4(aq)$
D) $FeCuSO_4(aq)$
E) $FeO(s) + CuSO_3(aq)$

61. Which of the following represents a *metal displacement reaction*?
A) $2NaN_3(s) \rightarrow 2Na(s) + 3N_2(g)$
B) $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(s) + Al_2O_3(s)$
C) $3NO_2(g) + H_2O(l) \rightarrow 2HNO_3(aq) + NO(g)$
D) $2P(s) + 3Cl_2(g) \rightarrow 2PCl_3(g)$
E) $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

63. Which of the following represents a *precipitation reaction*?
A) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
B) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
C) $2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$
D) $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
E) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

65. Which of the following represents a *hydrogen displacement reaction*?
    A) $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
    B) $2KBr(aq) + Cl_2(g) \rightarrow 2KCl(aq) + Br_2(l)$
    C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
    D) $CaBr_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + 2HBr(g)$
    E) $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

67. What mass of K_2CO_3 is needed to prepare 200. mL of a solution having a potassium ion concentration of 0.150 M?
    A) 4.15 g B) 10.4 g C) 13.8 g D) 2.07 g E) 1.49 g

69. What mass of Li_3PO_4 is needed to prepare 500. mL of a solution having a lithium ion concentration of 0.175 M?
    A) 6.75 g B) 10.1 g C) 19.3 g D) 30.4 g E) 3.38 g

71. A 20.00 mL sample of 0.1015 M nitric acid is introduced into a flask, and water is added until the volume of the solution reaches 250. mL. What is the concentration of nitric acid in the final solution?
    A) 1.27 M
    B) 8.12×10^{-3} M
    C) 0.406 M
    D) 3.25×10^{-2} M
    E) 5.08×10^{-4} M

73. A 4.691 g sample of $MgCl_2$ is dissolved in enough water to give 750. mL of solution. What is the magnesium ion concentration in this solution?
    A) 3.70×10^{-2} M
    B) 1.05×10^{-2} M
    C) 6.57×10^{-2} M
    D) 4.93×10^{-2} M
    E) 0.131 M

75. 35.0 mL of 0.255 M nitric acid is added to 45.0 mL of 0.328 M $Mg(NO_3)_2$. What is the concentration of nitrate ion in the final solution?
    A) 0.481 M B) 0.296 M C) 0.854 M D) 1.10 M E) 0.0295 M

77. 25.0 mL of a 0.2450 M NH_4Cl solution is added to 55.5 mL of 0.1655 M $FeCl_3$. What is the concentration of chloride ion in the final solution?
    A) 0.607 M B) 0.418 M C) 1.35 M D) 0.190 M E) 0.276 M

79. When 50.0 mL of a 0.3000 M $AgNO_3$ solution is added to 50.0 mL of a solution of $MgCl_2$, an AgCl precipitate forms immediately. The precipitate is then filtered from the solution, dried, and weighed. If the recovered AgCl is found to have a mass of 0.1183 g, what is the concentration of magnesium ions in the original $MgCl_2$ solution?
A) 0.300 M
B) 8.25×10^{-3} M
C) 1.65×10^{-2} M
D) 2.06×10^{-5} M
E) 4.13×10^{-3} M

81. 34.62 mL of 0.1510 M NaOH was needed to neutralize 50.0 mL of an H_2SO_4 solution. What is the concentration of the original sulfuric acid solution?
A) 0.0229 M B) 0.218 M C) 0.0523 M D) 0.209 M E) 0.105 M

83. A 250. mL sample of 0.0328M HCl is partially neutralized by the addition of 100. mL of 0.0245M NaOH. Find the concentration of hydrochloric acid in the resulting solution.
A) 0.00700 M B) 0.0164 M C) 0.0383 M D) 0.0230 M E) 0.0575 M

85. 158 mL of a 0.148M NaCl solution is added to 228 mL of a 0.369M NH_4NO_3 solution. The concentration of ammonium ions in the resulting mixture is
A) 0.157 M. B) 0.218 M. C) 0.625 M. D) 0.369 M. E) 0 M.

87. Calcium sulfate dihydrate (commonly known as gypsum) dissolves in cold water to the extent of 0.241 g per 100. cm^3. What is the concentration of calcium ions in this solution?
A) 1.77×10^{-2} M
B) 2.80×10^{-2} M
C) 1.77×10^{-3} M
D) 3.54×10^{-2} M
E) 1.40×10^{-2} M