

Chapter 04: Reactions in Aqueous Solution

1. Which of the following compounds is a *strong electrolyte*?
A) H_2O B) CH_3OH C) $\text{CH}_3\text{CH}_2\text{OH}$ D) HF E) NaF

3. Which of the following compounds is a *strong electrolyte*?
A) H_2O D) $\text{CH}_3\text{CH}_2\text{OH}$ (ethanol)
B) N_2 E) KOH
C) CH_3COOH (acetic acid)

5. Which of the following compounds is a *weak electrolyte*?
A) HCl B) NH_3 C) $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) D) N_2 E) KCl

7. Which of the following compounds is a *nonelectrolyte*?
A) NaOH D) KF
B) HNO_3 E) CH_3COOH (acetic acid)
C) $\text{C}_2\text{H}_6\text{O}$ (ethanol)

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

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) $(\text{NH}_4)_2\text{CO}_3$ C) Na_2CO_3 D) K_2CO_3 E) KNO_3

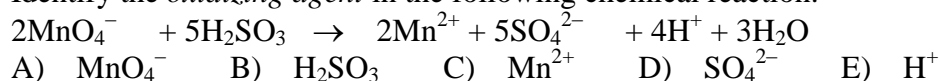
15. Based on the solubility rules, which one of the following should be *soluble* in water?
A) AgBr B) AgCl C) Ag_2CO_3 D) AgNO_3 E) Ag_2S

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

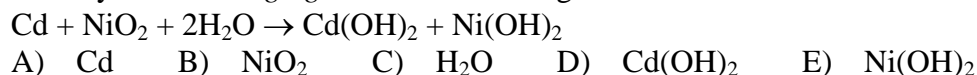
19. Based on the solubility rules, which of the following will occur if solutions of $\text{CuSO}_4(\text{aq})$ and $\text{BaCl}_2(\text{aq})$ are mixed?
- CuCl_2 will precipitate; Ba^{2+} and SO_4^{2-} are spectator ions.
 - CuSO_4 will precipitate; Ba^{2+} and Cl^- are spectator ions.
 - BaSO_4 will precipitate; Cu^{2+} and Cl^- are spectator ions.
 - BaCl_2 will precipitate; Cu^{2+} and SO_4^{2-} are spectator ions.
 - No precipitate will form.
21. Which of the following is the correct *net ionic equation* for the reaction that occurs when solutions of $\text{Pb}(\text{NO}_3)_2$ and NH_4Cl are mixed?
- $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2\text{NH}_4\text{Cl}(\text{aq}) \rightarrow \text{NH}_4\text{NO}_3(\text{aq}) + \text{PbCl}_2(\text{s})$
 - $\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$
 - $\text{Pb}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + 2\text{NH}_4^+(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow 2\text{NH}_4^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) + \text{PbCl}_2(\text{s})$
 - $\text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow 2\text{NH}_4\text{NO}_3(\text{s})$
 - No reaction occurs when the solutions are mixed.
23. Which of the following compounds is a *weak acid*?
- HF
 - HCl
 - HBr
 - HI
 - HClO_4
25. Identify the *major* ions present in an aqueous HNO_3 solution.
- HN^+ , O^{2-}
 - OH^- , NO_3^-
 - OH^- , NO
 - H^+ , N^{3-} , O^{2-}
 - H^+ , NO_3^-
27. What is the correct formula of the salt formed in the neutralization reaction of hydrochloric acid with calcium hydroxide?
- CaO
 - CaCl_2
 - CaH_2
 - CaCl
 - CaClH
29. What is the chemical formula of the salt produced by the neutralization of nitric acid with calcium hydroxide?
- CaNO_3
 - $\text{Ca}_2(\text{NO}_3)_3$
 - $\text{Ca}_3(\text{NO}_3)_2$
 - Ca_2NO_3
 - $\text{Ca}(\text{NO}_3)_2$
31. What is the chemical formula of the salt produced by the neutralization of potassium hydroxide with sulfuric acid?
- KSO_3
 - $\text{K}_2(\text{SO}_4)_3$
 - K_2SO_4
 - $\text{K}(\text{SO}_4)_2$
 - 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 $\text{K}_3\text{Fe}(\text{CN})_6$ 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 $\text{Ca}(\text{ClO})_2$ 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) $2\text{Al}(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3\text{H}_2(\text{g})$
 B) $2\text{KBr}(\text{aq}) + \text{Pb}(\text{NO}_3)_2(\text{aq}) \rightarrow 2\text{KNO}_3(\text{aq}) + \text{PbBr}_2(\text{s})$
 C) $\text{CaBr}_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{CaSO}_4(\text{s}) + 2\text{HBr}(\text{g})$
 D) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
 E) $\text{CO}_3^{2-}(\text{aq}) + \text{HSO}_4^-(\text{aq}) \rightarrow \text{HCO}_3^-(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
49. In the following chemical reaction the *oxidizing agent* is:
 $5\text{H}_2\text{O}_2 + 2\text{MnO}_4^- + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{O}_2$
 A) H_2O_2 B) MnO_4^- C) H^+ D) Mn^{2+} E) O_2

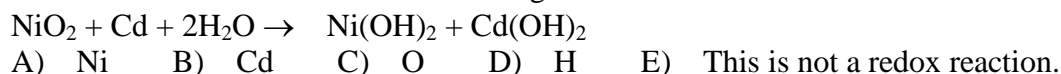
51. Identify the *oxidizing agent* in the following chemical reaction.



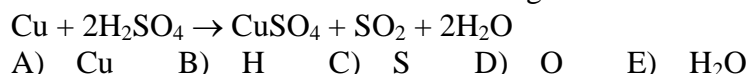
53. Identify the *reducing agent* in the following chemical reaction.



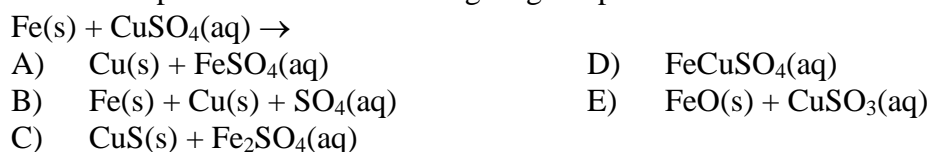
55. What element is *oxidized* in the following chemical reaction?



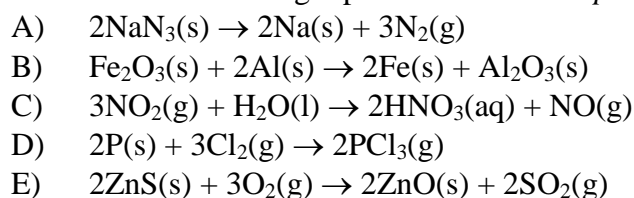
57. What element is *reduced* in the following chemical reaction?



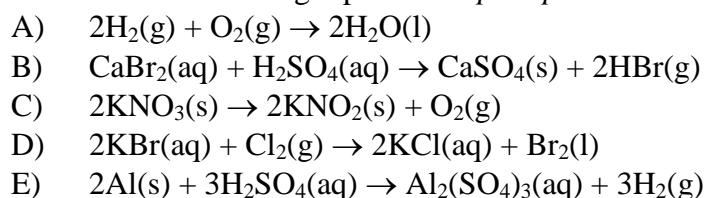
59. Predict the products of the following single replacement reaction.



61. Which of the following represents a *metal displacement reaction*?



63. Which of the following represents a *precipitation reaction*?



65. Which of the following represents a *hydrogen displacement reaction*?
- A) $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
B) $2\text{KBr}(\text{aq}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{KCl}(\text{aq}) + \text{Br}_2(\text{l})$
C) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
D) $\text{CaBr}_2(\text{aq}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{CaSO}_4(\text{s}) + 2\text{HBr}(\text{g})$
E) $2\text{Al}(\text{s}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Al}_2(\text{SO}_4)_3(\text{aq}) + 3\text{H}_2(\text{g})$
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 D) 3.25×10^{-2} M
B) 8.12×10^{-3} M E) 5.08×10^{-4} M
C) 0.406 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 D) 4.93×10^{-2} M
B) 1.05×10^{-2} M E) 0.131 M
C) 6.57×10^{-2} M
75. 35.0 mL of 0.255 M nitric acid is added to 45.0 mL of 0.328 M $\text{Mg}(\text{NO}_3)_2$. 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 AgNO₃ solution is added to 50.0 mL of a solution of MgCl₂, 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 MgCl₂ solution?
- A) 0.300 M D) 2.06×10^{-5} M
B) 8.25×10^{-3} M E) 4.13×10^{-3} M
C) 1.65×10^{-2} M
81. 34.62 mL of 0.1510 M NaOH was needed to neutralize 50.0 mL of an H₂SO₄ 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 NH₄NO₃ 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. cm³. What is the concentration of calcium ions in this solution?
- A) 1.77×10^{-2} M D) 3.54×10^{-2} M
B) 2.80×10^{-2} M E) 1.40×10^{-2} M
C) 1.77×10^{-3} M