

These problems are intended to *supplement* the problems in the textbook, not *replace* them.

**Questions**

Indicate whether each of the following is an acid, base, salt, or nonelectrolyte:

- |              |               |               |                    |
|--------------|---------------|---------------|--------------------|
| 1. $K_2SO_4$ | 4. $H_3PO_3$  | 7. $H_2O$     | 10. $(NH_4)_2SO_3$ |
| 2. $NaHCO_3$ | 5. $Co(CN)_2$ | 8. $H_2CrO_4$ | 11. $NO_2$         |
| 3. $CH_3OH$  | 6. $Al(OH)_3$ | 9. $Ca(OH)_2$ | 12. $C_2H_6$       |

Indicate whether each of the following is soluble or insoluble in water. For the soluble compounds, indicate whether they are strong or weak electrolytes.

- |                  |                    |                |              |
|------------------|--------------------|----------------|--------------|
| 13. $Fe(NO_3)_3$ | 16. $HC_2H_3O_2$   | 19. $BaSO_4$   | 22. $HClO_4$ |
| 14. $Mg(OH)_2$   | 17. $CuCl_2$       | 20. $K_2CrO_4$ | 23. $BaS$    |
| 15. $AgCl$       | 18. $(NH_4)_3PO_4$ | 21. $NiCO_3$   | 24. $ZnI_2$  |

Write the names or formulas for these acids (assume they are in aqueous solution, so name them as acids, not molecular compounds):

- |                  |                       |                          |
|------------------|-----------------------|--------------------------|
| 25. $HNO_3$      | 34. $HNO_2$           | 43. hydrophosphoric acid |
| 26. $HCl$        | 35. $H_2S_2O_3$       | 44. thiocyanic acid      |
| 27. $H_2Cr_2O_7$ | 36. $H_3N$            | 45. chlorous acid        |
| 28. $H_2SO_3$    | 37. $HF$              | 46. hydrobromic acid     |
| 29. $HI$         | 38. perchloric acid   | 47. carbonic acid        |
| 30. $H_2C_2O_4$  | 39. hydrocyanic acid  | 48. hydroarsenic acid    |
| 31. $HMnO_4$     | 40. phosphoric acid   | 49. chloric acid         |
| 32. $H_2Se$      | 41. hypochlorous acid | 50. hydrosulfuric acid   |
| 33. $H_2CrO_4$   | 42. sulfuric acid     | 51. acetic acid          |

Write the molecular, complete ionic, and net ionic equations for each of the following exchange reactions:

- barium chloride + copper(II) sulfate
- potassium carbonate + manganese(III) sulfate
- nitric acid + aluminum hydroxide
- sodium hydroxide + sulfuric acid
- rubidium carbonate + perchloric acid
- permanganic acid + calcium hydroxide\*
- magnesium sulfide + nitric acid
- acetic acid + strontium hydroxide
- zinc bromide + ammonium phosphate
- copper(II) chloride + potassium hydroxide

*\*Assume the salt produced is soluble.*

## Answers

If you cannot figure out how to get the correct answer, go to your instructor, the Science Tutoring Center, SI, etc.

- |                      |                       |   |
|----------------------|-----------------------|---|
| 1. salt              | 18. soluble – strong  | 35. thiosulfuric acid   |
| 2. salt              | 19. insoluble         | 36. hydronitric acid  |
| 3. nonelectrolyte    | 20. soluble – strong  | 37. hydrofluoric acid   |
| 4. acid              | 21. insoluble         | 38. HClO <sub>4</sub>   |
| 5. salt              | 22. soluble – strong  | 39. HCN   |
| 6. base              | 23. soluble – strong  | 40. H <sub>3</sub> PO <sub>4</sub>  |
| 7. nonelectrolyte    | 24. soluble – strong  | 41. HClO  |
| 8. acid              | 25. nitric acid       | 42. H <sub>2</sub> SO <sub>4</sub>  |
| 9. base              | 26. hydrochloric acid | 43. H <sub>3</sub> P  |
| 10. salt             | 27. dichromic acid    | 44. HSCN  |
| 11. nonelectrolyte   | 28. sulfurous acid    | 45. HClO <sub>2</sub>   |
| 12. nonelectrolyte   | 29. hydroiodic acid   | 46. HBr   |
| 13. soluble – strong | 30. oxalic acid       | 47. H <sub>2</sub> CO <sub>3</sub>  |
| 14. insoluble        | 31. permanganic acid  | 48. H <sub>3</sub> As   |
| 15. insoluble        | 32. hydroselenic acid | 49. HClO <sub>3</sub>   |
| 16. soluble – weak   | 33. chromic acid      | 50. H <sub>2</sub> S  |
| 17. soluble – strong | 34. nitrous acid      | 51. HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> or CH <sub>3</sub> COOH |
52. molecular:  $\text{BaCl}_2(aq) + \text{CuSO}_4(aq) \rightarrow \text{BaSO}_4(s) + \text{CuCl}_2(aq)$   
ionic:  $\text{Ba}^{2+}(aq) + 2 \text{Cl}^{-}(aq) + \text{Cu}^{2+}(aq) + \text{SO}_4^{2-}(aq) \rightarrow \text{BaSO}_4(s) + \text{Cu}^{2+}(aq) + 2 \text{Cl}^{-}(aq)$   
net:  $\text{Ba}^{2+}(aq) + \text{SO}_4^{2-}(aq) \rightarrow \text{BaSO}_4(s)$
53. molecular:  $3 \text{K}_2\text{CO}_3(aq) + \text{Mn}_2(\text{SO}_4)_3(aq) \rightarrow \text{Mn}_2(\text{CO}_3)_3(s) + 3 \text{K}_2\text{SO}_4(aq)$   
ionic:  $6 \text{K}^{+}(aq) + 3 \text{CO}_3^{2-}(aq) + 2 \text{Mn}^{3+}(aq) + 3 \text{SO}_4^{2-}(aq) \rightarrow \text{Mn}_2(\text{CO}_3)_3(s) + 6 \text{K}^{+}(aq) + 3 \text{SO}_4^{2-}(aq)$   
net:  $3 \text{CO}_3^{2-}(aq) + 2 \text{Mn}^{3+}(aq) \rightarrow \text{Mn}_2(\text{CO}_3)_3(s)$
54. molecular:  $3 \text{HNO}_3(aq) + \text{Al}(\text{OH})_3(s) \rightarrow 3 \text{H}_2\text{O}(l) + \text{Al}(\text{NO}_3)_3(aq)$   
ionic:  $3 \text{H}^{+}(aq) + 3 \text{NO}_3^{-}(aq) + \text{Al}(\text{OH})_3(s) \rightarrow 3 \text{H}_2\text{O}(l) + \text{Al}^{3+}(aq) + 3 \text{NO}_3^{-}(aq)$   
net:  $3 \text{H}^{+}(aq) + \text{Al}(\text{OH})_3(s) \rightarrow 3 \text{H}_2\text{O}(l) + \text{Al}^{3+}(aq)$
55. molecular:  $2 \text{NaOH}(aq) + \text{H}_2\text{SO}_4(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{Na}_2\text{SO}_4(aq)$   
ionic:  $2 \text{Na}^{+}(aq) + 2 \text{OH}^{-}(aq) + \text{H}^{+}(aq) + \text{HSO}_4^{-}(aq) \rightarrow 2 \text{H}_2\text{O}(l) + 2 \text{Na}^{+}(aq) + \text{SO}_4^{2-}(aq)$   
net:  $2 \text{OH}^{-}(aq) + \text{H}^{+}(aq) + \text{HSO}_4^{-}(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{SO}_4^{2-}(aq)$
56. molecular:  $\text{Rb}_2\text{CO}_3(aq) + 2 \text{HClO}_4(aq) \rightarrow 2 \text{RbClO}_4(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$   
ionic:  $2 \text{Rb}^{+}(aq) + \text{CO}_3^{2-}(aq) + 2 \text{H}^{+}(aq) + 2 \text{ClO}_4^{-}(aq) \rightarrow 2 \text{Rb}^{+}(aq) + 2 \text{ClO}_4^{-}(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$   
net:  $\text{CO}_3^{2-}(aq) + 2 \text{H}^{+}(aq) \rightarrow \text{H}_2\text{O}(l) + \text{CO}_2(g)$

57. molecular:  $2 \text{HMnO}_4(aq) + \text{Ca}(\text{OH})_2(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{Ca}(\text{MnO}_4)_2(aq)$   
 ionic:  $2 \text{HMnO}_4(aq) + \text{Ca}^{2+}(aq) + 2 \text{OH}^{1-}(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{Ca}^{2+}(aq) + 2 \text{MnO}_4^{1-}(aq)$   
 net:  $\text{HMnO}_4(aq) + \text{OH}^{1-}(aq) \rightarrow \text{H}_2\text{O}(l) + \text{MnO}_4^{1-}(aq)$
58. molecular:  $\text{MgS}(s) + 2 \text{HNO}_3(aq) \rightarrow \text{Mg}(\text{NO}_3)_2(aq) + \text{H}_2\text{S}(g)$   
 ionic:  $\text{MgS}(s) + 2 \text{H}^{1+}(aq) + 2 \text{NO}_3^{1-}(aq) \rightarrow \text{Mg}^{2+}(aq) + 2 \text{NO}_3^{1-}(aq) + \text{H}_2\text{S}(g)$   
 net:  $\text{MgS}(s) + 2 \text{H}^{1+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{H}_2\text{S}(g)$
59. molecular:  $2 \text{HC}_2\text{H}_3\text{O}_2(aq) + \text{Sr}(\text{OH})_2(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{Sr}(\text{C}_2\text{H}_3\text{O}_2)_2(aq)$   
 ionic:  $2 \text{HC}_2\text{H}_3\text{O}_2(aq) + \text{Sr}^{2+}(aq) + 2 \text{OH}^{1-}(aq) \rightarrow 2 \text{H}_2\text{O}(l) + \text{Sr}^{2+}(aq) + 2 \text{C}_2\text{H}_3\text{O}_2^{1-}(aq)$   
 net:  $\text{HC}_2\text{H}_3\text{O}_2(aq) + \text{OH}^{1-}(aq) \rightarrow \text{H}_2\text{O}(l) + \text{C}_2\text{H}_3\text{O}_2^{1-}(aq)$
60. molecular:  $3 \text{ZnBr}_2(aq) + 2 (\text{NH}_4)_3\text{PO}_4(aq) \rightarrow \text{Zn}_3(\text{PO}_4)_2(s) + 6 \text{NH}_4\text{Br}(aq)$   
 ionic:  $3 \text{Zn}^{2+}(aq) + 6 \text{Br}^{1-}(aq) + 6 \text{NH}_4^{1+}(aq) + 2 \text{PO}_4^{3-}(aq) \rightarrow \text{Zn}_3(\text{PO}_4)_2(s) + 6 \text{NH}_4^{1+}(aq) + 6 \text{Br}^{1-}(aq)$   
 net:  $3 \text{Zn}^{2+}(aq) + 2 \text{PO}_4^{3-}(aq) \rightarrow \text{Zn}_3(\text{PO}_4)_2(s)$
61. molecular:  $\text{CuCl}_2(aq) + 2 \text{KOH}(aq) \rightarrow \text{Cu}(\text{OH})_2(s) + 2 \text{KCl}(aq)$   
 ionic:  $\text{Cu}^{2+}(aq) + 2 \text{Cl}^{1-}(aq) + 2 \text{K}^{1+}(aq) + 2 \text{OH}^{1-}(aq) \rightarrow \text{Cu}(\text{OH})_2(s) + 2 \text{K}^{1+}(aq) + 2 \text{Cl}^{1-}(aq)$   
 net:  $\text{Cu}^{2+}(aq) + 2 \text{OH}^{1-}(aq) \rightarrow \text{Cu}(\text{OH})_2(s)$