1. **(a)** Weigh out (0.400 L)(0.155 mol/L)(121.6 g/mol) = 7.54 g of $Sr(OH)_2$, dissolve in water to form 0.400 L of solution.

(b) Weigh out (1.75 L)(0.333 mol/L)(96.09 g/mol) = 56.0 g of $(NH_4)_2CO_3$, dissolve in water to form 1.75 L of solution.

7. **(a)** Na_2SO_4 (soluble) **(b)** $Fe(NO_3)_3$ (soluble)

(c) AgCl **(d)** $Cr(OH)_3$

13. **(b)** $2Ag^+(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)$

(c) $2Co^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Co_2(CO_3)_3(s)$

(d) $3Ba^{2+}(aq) + 2PO_4^{3-}(aq) \rightarrow Ba_3(PO_4)_2$

17. **(a)** $Co^{3+}(aq) + 3OH^-(aq) \rightarrow Co(OH)_3(s)$

$n_{OH^-} = (0.02500\ L)(0.0630\ mol/L) = 0.001575\ mol$

$n_{Co^{3+}} = 0.001575\ mol/3 = 0.000525\ mol$

$$V = \frac{0.000525\ mol}{0.5000\ mol/L} = 0.00105\ mL = 1.05\ mL$$

(b) $2Co^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Co_2(CO_3)_3(s)$

$$n_{CO_3^{2-}} = \frac{5.00\ g}{106.0\ g} = 0.0472\ mol$$

$n_{Co^{3+}} = 0.0472\ mol \times 2/3 = 0.0314\ mol$

$$V = \frac{0.0314\ mol}{0.5000\ mol/L} = 0.0628\ L = 62.8\ mL$$

(c) $Co^{3+}(aq) + PO_4^{3-}(aq) \rightarrow CoPO_4(s)$

$n_{PO_4^{3-}} = (0.01250\ L)(0.1249\ mol/L) = 0.001561\ mol = n_{Co^{3+}}$

$$V = \frac{0.001561\ mol}{0.5000\ mol/L} = 0.003122\ L = 3.122\ mL$$

21. **(a)** H^+ **(b)** H^+ **(c)** HNO_2 **(d)** H^+

(e) $HC_3H_5O_3$

23. **(a)** OH^- **(b)** $(CH_3)_3N$ **(c)** $C_6H_5NH_2$ **(d)** OH^-

27. **(a)** $HNO_2(aq) + OH^-(aq) \rightarrow NO_2^-(aq) + H_2O$

(b) $HF(aq) + OH^-(aq) \rightarrow F^-(aq) + H_2O$

(c) $H^+(aq) + C_6H_5NH_2(aq) \rightarrow C_6H_5NH_3^+(aq)$

33. **(a)** $H_2SO_3(aq) + 2\,OH^-(aq) \rightarrow SO_3^{2-}(aq) + 2H_2O$

$n_{H_2SO_3} = 0.0325\ L \times 0.569\ mol/L = 0.0185\ mol$

$n_{OH^-} = 2 \times 0.0185\ mol = 0.0370\ mol$

$$V = \frac{0.0370\ mol}{1.222\ mol/L} = 0.0303\ L = 30.3\ mL$$

(b) $H_2C_2O_4(aq) + 2OH^-(aq) \rightarrow C_2O_4^{2-}(aq) + 2H_2O$

$$nH_2C_2O_4 = \frac{5.00\ g}{90.04\ g/mol} = 0.0555\ mol$$

$n_{OH^-} = 2 \times 0.0555\ mol = 0.111\ mol$

$$V = \frac{0.111\ mol}{1.222\ mol/L} = 0.0909\ L = 90.9\ mL$$

(c) $HC_2H_3O_2(aq) + OH^-(aq) \rightarrow C_2H_3O_2^-(aq) + H_2O$

$$n_{HC_2H_3O_2} = \frac{15.0\ g \times 0.88}{60.05\ g/mol} = 0.22\ mol = n_{OH^-}$$

$$V = \frac{0.22}{1.222\ mol/L} = 0.18\ L = 1.8 \times 10^2\ mL$$

39. $$n_{H_2C_4H_4O_6} = \frac{12.0\ g}{150.09\ g/mol} = 0.0800\ mol$$

$n_{KOH} = 2 \times 0.0800\ mol = 0.160\ mol$

mass KOH $= 0.160\ mol \times 56.11\ g/mol = 8.98\ g$

$$\text{mass solution} = 8.98\ g \times \frac{100.0}{5.00} = 1.80 \times 10^2\ g$$

$$V = \frac{1.80 \times 10^2\ g}{1.045\ g/cm^3} = 172\ cm^3$$

41. **(a)** NO: N = +2, O = −2 **(b)** NH_3: N = −3, H = +1

(c) K_2O_2: K = +1, O = −1 **(d)** ClO_3^-: Cl = +5, O = −2

45. **(a)** reduction **(b)** reduction **(c)** reduction **(d)** oxidation

51. **(a)** $Ag(s) \rightarrow Ag^+(aq)$ Ag is oxidized, NO_3^- reduced

$NO_3^-(aq) \rightarrow NO(g)$ NO_3^- oxid. agent, Ag red. agent

(b) $CO_2(g) \rightarrow C_2H_4(g)$ CO_2 reduced, H_2O oxidized

$H_2O(l) \rightarrow O_2(g)$ CO_2 oxid. agent, H_2O red. agent

55. **(a)**

$$8[Ni^{2+}(aq) \rightarrow Ni^{3+}(aq) + e^-]$$
$$IO_4^-(aq) + 8e^- + 8H^+(aq) \rightarrow I^-(aq) + 4H_2O$$
$$8Ni^{2+}(aq) + IO_4^-(aq) + 8H^+(aq) \rightarrow 8Ni^{3+}(aq) + I^-(aq) + 4H_2O$$

(b)

$$O_2(g) + 4e^- + 4H^+(aq) \rightarrow 2H_2O$$
$$2[2Br^-(aq) \rightarrow Br_2(l) + 2e^-]$$
$$O_2(g) + 4Br^-(aq) + 4H^+(aq) \rightarrow 2Br_2(l) + 2H_2O$$

(c)

$$3[Ca(s) \rightarrow Ca^{2+}(aq) + 2e^-]$$
$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O$$
$$3Ca(s) + Cr_2O_7^{2-}(aq) + 14H^+(aq) \rightarrow 3Ca^{2+}(aq) + 2Cr^{3+}(aq) + 7H_2O$$

(d)

$$IO_3^-(aq) + 6e^- + 6H^+(aq) \rightarrow I^-(aq) + 3H_2O$$
$$3[Mn^{2+}(aq) + 2H_2O \rightarrow MnO_2(s) + 2e^- + 4H^+(aq)]$$
$$IO_3^-(aq) + 3Mn^{2+}(aq) + 3H_2O \rightarrow I^-(aq) + 3MnO_2(s) + 6H^+(aq)$$

57. **(a)**

$$SO_2(g) + 2\,OH^-(aq) \rightarrow SO_3(g) + 2e^- + H_2O$$
$$I_2(aq) + 2e^- \rightarrow 2I^-(aq)$$
$$SO_2(g) + I_2(aq) + 2\,OH^-(aq) \rightarrow SO_3(g) + 2I^-(aq) + H_2O$$

(b)

$$4[Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-]$$
$$NO_3^-(aq) + 8e^- + 6H_2O \rightarrow NH_3(g) + 9\,OH^-(aq)$$
$$4Zn(s) + NO_3^-(aq) + 6H_2O \rightarrow 4Zn^{2+}(aq) + NH_3(g) + 9\,OH^-(aq)$$

(c)

$$3[ClO^-(aq) + 2e^- + H_2O \rightarrow Cl^-(aq) + 2\,OH^-(aq)]$$
$$2[CrO_2^-(aq) + 4\,OH^-(aq) \rightarrow CrO_4^{2-}(aq) + 3e^- + 2H_2O]$$
$$3ClO^-(aq) + 2CrO_2(aq) + 2\,OH^-(aq) \rightarrow 3Cl^-(aq) + 2CrO_4^{2-}(aq) + H_2O$$

(d)

$$2[K(s) \rightarrow K^+(aq) + e^-]$$
$$2H_2O + 2e^- \rightarrow H_2(g) + 2\,OH^-(aq)$$
$$2K(s) + 2H_2O \rightarrow 2K^+(aq) + 2\,OH^-(aq) + H_2(g)$$

59. **(a)**

$$3[N_2H_4(1) \rightarrow N_2(g) + 4H^+(aq) + 4e^-]$$
$$2[BrO_3^-(aq) + 6H + (aq) + 6e^- \rightarrow Br^-(aq) + 3H_2O]$$
$$3N_2H_4(l) + 2BrO_3^-(aq) \rightarrow 2Br^-(aq) + 3N_2(g) + 6H_2O$$

(b)

$$3[P_4(s) + 16H_2O \rightarrow 4H_2PO_4^-(aq) + 20\,e^- + 24H^+(aq)]$$
$$20[NO_3^-(aq) + 3e^- + 4H^+(aq) \rightarrow NO(g) + 2H_2O]$$
$$3P_4(s) + 20NO_3^-(aq) + 8H_2O + 8H^+(aq) \rightarrow 12H_2PO_4^-(aq) + 20NO(g)$$

(c)

$$5[SO_3^{2-}(aq) + H_2O \rightarrow SO_4^{2-}(aq) + 2e^- + 2H^+(aq)]$$
$$2[MnO_4^-(aq) + 5e^- + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 4H_2O]$$
$$5SO_3^{2-}(aq) + 2MnO_4^-(aq) + 6H^+(aq) \rightarrow 5SO_4^{2-}(aq) + 2Mn^{2+}(aq) + 3H_2O$$

63. **(a)** $H_2(g) + S(s) + 2\,OH^-(aq) \rightarrow S^{2-}(aq) + 2H_2O$

(b) $n_S = \dfrac{3.00\text{g}}{32.07\text{ g/mol}} = 0.0935\text{ mol} = n_{Ba(OH)_2}$

$$V = \frac{0.0935\text{ mol}}{0.349\text{ mol/L}} = 0.268\text{ L} = 268\text{ mL}$$