

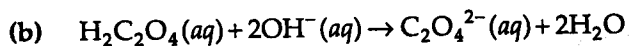




$$n_{\text{H}_2\text{SO}_3} = 0.0325 \text{ L} \times 0.569 \text{ mol/L} = 0.0185 \text{ mol}$$

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

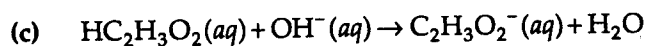
$$V = \frac{0.0370 \text{ mol}}{1.222 \text{ mol/L}} = 0.0303 \text{ L} = 30.3 \text{ mL}$$



$$n_{\text{H}_2\text{C}_2\text{O}_4} = \frac{5.00 \text{ g}}{90.04 \text{ g/mol}} = 0.0555 \text{ mol}$$

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

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



$$n_{\text{HC}_2\text{H}_3\text{O}_2} = \frac{15.0 \text{ g} \times 0.88}{60.05 \text{ g/mol}} = 0.22 \text{ mol} = n_{\text{OH}^-}$$

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

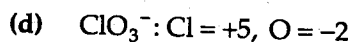
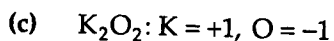
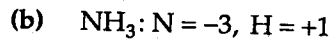
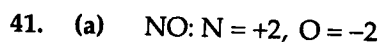
39.  $n_{\text{H}_2\text{C}_4\text{H}_4\text{O}_6} = \frac{12.0 \text{ g}}{150.09 \text{ g/mol}} = 0.0800 \text{ mol}$

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

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

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

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

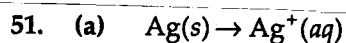


45. (a) reduction

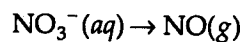
(b) reduction

(c) reduction

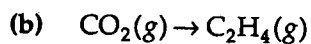
(d) oxidation



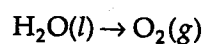
Ag is oxidized, NO<sub>3</sub><sup>-</sup> reduced



NO<sub>3</sub><sup>-</sup> oxid. agent, Ag red. agent



CO<sub>2</sub> reduced, H<sub>2</sub>O oxidized



CO<sub>2</sub> oxid. agent, H<sub>2</sub>O red. agent

55. (a) 
$$8[\text{Ni}^{2+}(\text{aq}) \rightarrow \text{Ni}^{3+}(\text{aq}) + e^-]$$
  

$$\text{IO}_4^- (\text{aq}) + 8e^- + 8\text{H}^+ (\text{aq}) \rightarrow \text{I}^- (\text{aq}) + 4\text{H}_2\text{O}$$

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$$8\text{Ni}^{2+}(\text{aq}) + \text{IO}_4^- (\text{aq}) + 8\text{H}^+ (\text{aq}) \rightarrow 8\text{Ni}^{3+}(\text{aq}) + \text{I}^- (\text{aq}) + 4\text{H}_2\text{O}$$
- (b) 
$$\text{O}_2(\text{g}) + 4e^- + 4\text{H}^+(\text{aq}) \rightarrow 2\text{H}_2\text{O}$$
  

$$2[2\text{Br}^- (\text{aq}) \rightarrow \text{Br}_2(\text{l}) + 2e^-]$$

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$$\text{O}_2(\text{g}) + 4\text{Br}^- (\text{aq}) + 4\text{H}^+(\text{aq}) \rightarrow 2\text{Br}_2(\text{l}) + 2\text{H}_2\text{O}$$
- (c) 
$$3[\text{Ca}(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2e^-]$$
  

$$\text{Cr}_2\text{O}_7^{2-} (\text{aq}) + 14\text{H}^+(\text{aq}) + 6e^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}$$

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$$3\text{Ca}(\text{s}) + \text{Cr}_2\text{O}_7^{2-} (\text{aq}) + 14\text{H}^+(\text{aq}) \rightarrow 3\text{Ca}^{2+}(\text{aq}) + 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}$$
- (d) 
$$\text{IO}_3^- (\text{aq}) + 6e^- + 6\text{H}^+(\text{aq}) \rightarrow \text{I}^- (\text{aq}) + 3\text{H}_2\text{O}$$
  

$$3[\text{Mn}^{2+}(\text{aq}) + 2\text{H}_2\text{O} \rightarrow \text{MnO}_2(\text{s}) + 2e^- + 4\text{H}^+(\text{aq})]$$

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$$\text{IO}_3^- (\text{aq}) + 3\text{Mn}^{2+}(\text{aq}) + 3\text{H}_2\text{O} \rightarrow \text{I}^- (\text{aq}) + 3\text{MnO}_2(\text{s}) + 6\text{H}^+(\text{aq})$$
57. (a) 
$$\text{SO}_2(\text{g}) + 2\text{OH}^- (\text{aq}) \rightarrow \text{SO}_3(\text{g}) + 2e^- + \text{H}_2\text{O}$$
  

$$\text{I}_2(\text{aq}) + 2e^- \rightarrow 2\text{I}^- (\text{aq})$$

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$$\text{SO}_2(\text{g}) + \text{I}_2(\text{aq}) + 2\text{OH}^- (\text{aq}) \rightarrow \text{SO}_3(\text{g}) + 2\text{I}^- (\text{aq}) + \text{H}_2\text{O}$$
- (b) 
$$4[\text{Zn}(\text{s}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2e^-]$$
  

$$\text{NO}_3^- (\text{aq}) + 8e^- + 6\text{H}_2\text{O} \rightarrow \text{NH}_3(\text{g}) + 9\text{OH}^- (\text{aq})$$

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$$4\text{Zn}(\text{s}) + \text{NO}_3^- (\text{aq}) + 6\text{H}_2\text{O} \rightarrow 4\text{Zn}^{2+}(\text{aq}) + \text{NH}_3(\text{g}) + 9\text{OH}^- (\text{aq})$$
- (c) 
$$3[\text{ClO}^- (\text{aq}) + 2e^- + \text{H}_2\text{O} \rightarrow \text{Cl}^- (\text{aq}) + 2\text{OH}^- (\text{aq})]$$
  

$$2[\text{CrO}_2^- (\text{aq}) + 4\text{OH}^- (\text{aq}) \rightarrow \text{CrO}_4^{2-} (\text{aq}) + 3e^- + 2\text{H}_2\text{O}]$$

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$$3\text{ClO}^- (\text{aq}) + 2\text{CrO}_2^- (\text{aq}) + 2\text{OH}^- (\text{aq}) \rightarrow 3\text{Cl}^- (\text{aq}) + 2\text{CrO}_4^{2-} (\text{aq}) + \text{H}_2\text{O}$$
- (d) 
$$2[\text{K}(\text{s}) \rightarrow \text{K}^+(\text{aq}) + e^-]$$
  

$$2\text{H}_2\text{O} + 2e^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^- (\text{aq})$$

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$$2\text{K}(\text{s}) + 2\text{H}_2\text{O} \rightarrow 2\text{K}^+(\text{aq}) + 2\text{OH}^- (\text{aq}) + \text{H}_2(\text{g})$$
59. (a) 
$$3[\text{N}_2\text{H}_4(\text{l}) \rightarrow \text{N}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4e^-]$$
  

$$2[\text{BrO}_3^- (\text{aq}) + 6\text{H}^+(\text{aq}) + 6e^- \rightarrow \text{Br}^- (\text{aq}) + 3\text{H}_2\text{O}]$$

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$$3\text{N}_2\text{H}_4(\text{l}) + 2\text{BrO}_3^- (\text{aq}) \rightarrow 2\text{Br}^- (\text{aq}) + 3\text{N}_2(\text{g}) + 6\text{H}_2\text{O}$$
- (b) 
$$3[\text{P}_4(\text{s}) + 16\text{H}_2\text{O} \rightarrow 4\text{H}_2\text{PO}_4^- (\text{aq}) + 20e^- + 24\text{H}^+(\text{aq})]$$
  

$$20[\text{NO}_3^- (\text{aq}) + 3e^- + 4\text{H}^+(\text{aq}) \rightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}]$$

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$$3\text{P}_4(\text{s}) + 20\text{NO}_3^- (\text{aq}) + 8\text{H}_2\text{O} + 8\text{H}^+(\text{aq}) \rightarrow 12\text{H}_2\text{PO}_4^- (\text{aq}) + 20\text{NO}(\text{g})$$
- (c) 
$$5[\text{SO}_3^{2-} (\text{aq}) + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} (\text{aq}) + 2e^- + 2\text{H}^+(\text{aq})]$$
  

$$2[\text{MnO}_4^- (\text{aq}) + 5e^- + 8\text{H}^+(\text{aq}) \rightarrow \text{Mn}^{2+}(\text{aq}) + 4\text{H}_2\text{O}]$$

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$$5\text{SO}_3^{2-} (\text{aq}) + 2\text{MnO}_4^- (\text{aq}) + 6\text{H}^+(\text{aq}) \rightarrow 5\text{SO}_4^{2-} (\text{aq}) + 2\text{Mn}^{2+}(\text{aq}) + 3\text{H}_2\text{O}$$
63. (a) 
$$\text{H}_2(\text{g}) + \text{S}(\text{s}) + 2\text{OH}^- (\text{aq}) \rightarrow \text{S}^{2-} (\text{aq}) + 2\text{H}_2\text{O}$$
- (b) 
$$n_{\text{S}} = \frac{3.00\text{g}}{32.07\text{g/mol}} = 0.0935\text{ mol} = n_{\text{Ba}(\text{OH})_2}$$
  

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