

Chapter 6 : 22, 30, 36, 42, 47, 52, 54, 59, 62, 64, 66, 68, 85, 90, 98

$$22. \quad \Delta E = q_{\text{heat}} + w_{\text{work}}$$

$$\text{Step 1: } \Delta E_1 = 72 \text{ J} + 35 \text{ J} = 107 \text{ J}$$

$$\text{Step 2: } \Delta E_2 = 35 \text{ J} - 72 \text{ J} = -37 \text{ J}$$

$$\Delta E_{\text{overall}} = \Delta E_1 + \Delta E_2 = 107 \text{ J} - 37 \text{ J} = 70. \text{ J}$$

$$30. \quad w = -P\Delta V$$

$$P = \underline{1.00 \text{ atm}}$$

$$\Delta V = V_f - V_i = V_{\text{water vapor}} - V_{\text{liquid water}}$$

$$V_{\text{H}_2\text{O}(g)} = 30.6 \text{ L}$$

$$V_{\text{H}_2\text{O}(\ell)} = 1 \text{ mole H}_2\text{O} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mole H}_2\text{O}} \times \frac{1 \text{ cm}^3 \text{ H}_2\text{O}}{0.996 \text{ g H}_2\text{O}} \times \frac{1 \text{ L H}_2\text{O}}{1000 \text{ cm}^3 \text{ H}_2\text{O}} = 0.0181 \text{ L}$$

$$\Delta V = 0.0181 \text{ L} - 30.6 \text{ L} = \underline{-30.6 \text{ L}}$$

$$w = -(1.00 \text{ atm})(-30.6 \text{ L}) = 30.6 \text{ L-atm}$$

$$30.6 \text{ L-atm} \times \frac{101.3 \text{ J}}{1 \text{ L-atm}} = 3097.9 \text{ J} = \underline{3.10 \text{ kJ}}$$

$$q = -40.66 \text{ kJ}$$

$$w = +3.10 \text{ kJ}$$

$$\Delta E = -40.66 \text{ kJ} + (+3.10 \text{ kJ}) = \underline{-37.56 \text{ kJ}}$$

$$36. \quad \text{a.} \quad 1.00 \text{ mole H}_2\text{O} \times \frac{-572 \text{ kJ}}{2 \text{ mole H}_2\text{O}} = \underline{-286 \text{ kJ heat released}}$$

$$\text{b.} \quad 4.03 \text{ g H}_2 \times \frac{1 \text{ mole H}_2}{2.016 \text{ g H}_2} \times \frac{-572 \text{ kJ}}{2 \text{ mole H}_2} = \underline{-572 \text{ kJ}}$$

$$\text{c.} \quad 186 \text{ g O}_2 \times \frac{1 \text{ mole O}_2}{32.00 \text{ g O}_2} \times \frac{-572 \text{ kJ}}{1 \text{ mole O}_2} = \underline{-3320 \text{ kJ}}$$

d.
$$n_{\text{H}_2} = \frac{PV}{RT} = \frac{1.0 \text{ atm} * 2.0 * 10^8 \text{ L}}{\frac{0.08206 \text{ L atm}}{\text{mol K}} * 298 \text{ K}} = 8.2 * 10^6 \text{ mol H}_2$$

$$8.2 * 10^6 \text{ mol H}_2 * \frac{-572 \text{ kJ}}{2 \text{ mol H}_2} = -2.3 * 10^9 \text{ kJ heat released}$$

42. a. $\Delta T = T_f - T_i = (298 \text{ K} - 273 \text{ K}) = 25 \text{ K} = \text{a difference of } 25 \text{ }^\circ\text{C}$
 (= $(25 \text{ }^\circ\text{C} - 0 \text{ }^\circ\text{C}) = 25 \text{ }^\circ\text{C}$)

$$q = m_{\text{Ag}} s_{\text{Ag}} \Delta T = 150.0 \text{ g Ag} \times \frac{0.24 \text{ J}}{^\circ\text{C} - \text{g Ag}} \times (25 \text{ }^\circ\text{C}) = \mathbf{9.0 \times 10^2 \text{ J}}$$

b. Molar Heat Capacity = $\bar{C} = \frac{0.24 \text{ J}}{^\circ\text{C} - \text{g Ag}} \times \frac{107.9 \text{ g Ag}}{1 \text{ mole Ag}} = \frac{\mathbf{26 \text{ J}}}{^\circ\text{C} - \text{mole Ag}}$

c. $q = m_{\text{Ag}} s_{\text{Ag}} \Delta T; m_{\text{Ag}} = \frac{q}{s_{\text{Ag}} \Delta T} = \frac{1.25 \text{ kJ} \times \frac{1000 \text{ J}}{1 \text{ kJ}}}{\frac{0.24 \text{ J}}{^\circ\text{C} - \text{g Ag}} \times (15.2 \text{ }^\circ\text{C} - 12.0 \text{ }^\circ\text{C})}$
 $= 1627.6 \text{ g} = \mathbf{1.6 \times 10^3 \text{ g Ag}}$

47. Heat loss by Al + heat loss by Fe = heat gain by water

$$-\left(\frac{0.89 \text{ J}}{\text{g } ^\circ\text{C}} * 5.00 \text{ g Al} * (T_f - 100^\circ\text{C})\right) + -\left(\frac{0.45 \text{ J}}{\text{g } ^\circ\text{C}} * 10 \text{ g Fe} * (T_f - 100^\circ\text{C})\right)$$

$$= \frac{4.18 \text{ J}}{\text{g } ^\circ\text{C}} * 97.3 \text{ g H}_2\text{O} * (T_f - 22.0^\circ\text{C})$$

$$4.5(100.0 - T_f) + 4.5(100.0 - T_f) = 407(T_f - 22.0) \quad \mathbf{T_f = 23.7 \text{ }^\circ\text{C}}$$

52. $q_{\text{sol'n}} = \Delta H_{\text{sol'n}} = -C\Delta T = -(m_{\text{sol'n}} \times s_{\text{sol'n}})\Delta T = -(75.0 \text{ g H}_2\text{O} + 1.60 \text{ g NH}_4\text{NO}_3) \times$
 $\frac{4.184 \text{ J}}{^\circ\text{C} - \text{g sol'n}} \times (23.34 \text{ }^\circ\text{C} - 25.00 \text{ }^\circ\text{C}) = \underline{532.02 \text{ J}}$

$$1.60 \text{ g NH}_4\text{NO}_3 \times \frac{1 \text{ mole NH}_4\text{NO}_3}{80.052 \text{ g NH}_4\text{NO}_3} = 0.0200 \text{ mole NH}_4\text{NO}_3$$

$$\Delta H_{\text{sol'n}} = \frac{532.02 \text{ J}}{0.0200 \text{ mole NH}_4\text{NO}_3} = 26618.3 \text{ J/mole NH}_4\text{NO}_3 = \mathbf{26.6 \text{ kJ/mole}}$$

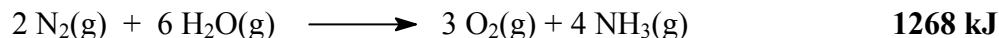
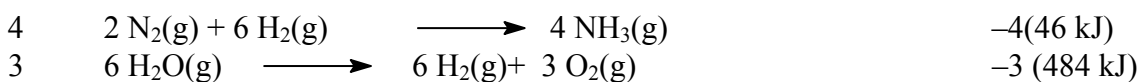
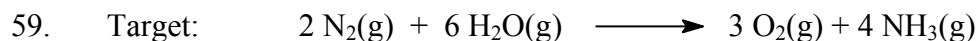
$$54. \quad \frac{0.500 \text{ mole HCl}}{\text{L}} \times 0.1000 \text{ L} \times \frac{-118 \text{ kJ}}{2 \text{ mole HCl}} = -2.95 \text{ kJ}$$

$$\frac{0.100 \text{ mole Ba(OH)}_2}{\text{L}} \times 0.3000 \text{ L} \times \frac{-118 \text{ kJ}}{1 \text{ mole Ba(OH)}_2} = -3.54 \text{ kJ}$$

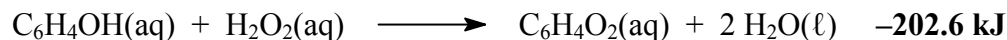
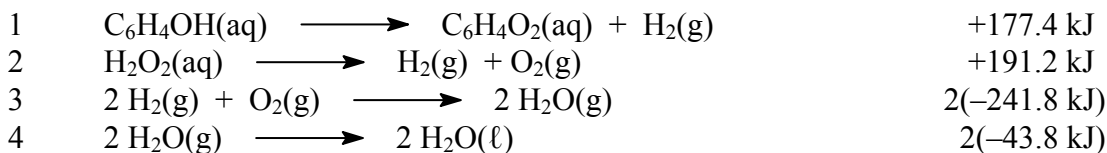
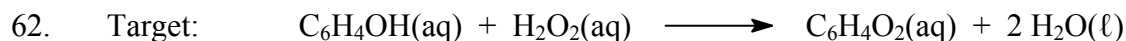
$$\Delta H_{\text{rxn}} = -C\Delta T = -(m_{\text{sol'n}} \times s_{\text{sol'n}}) \Delta T = -(m_{\text{sol'n}} \times s_{\text{sol'n}})(T_f - T_i)$$

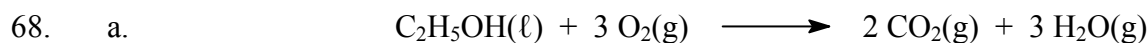
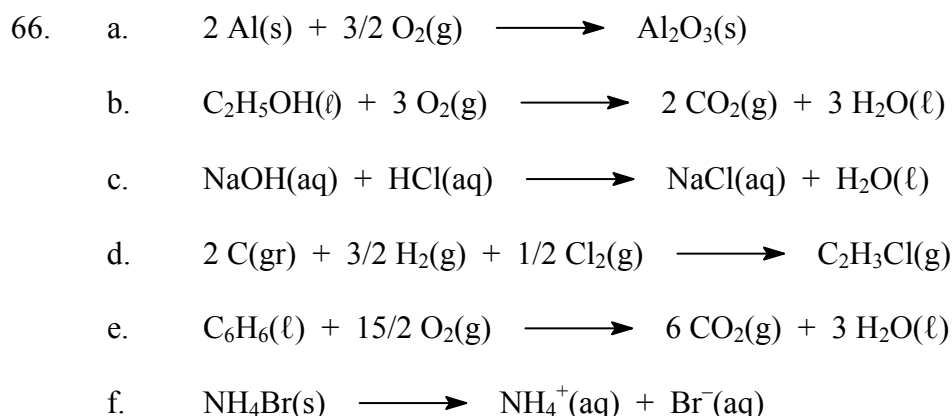
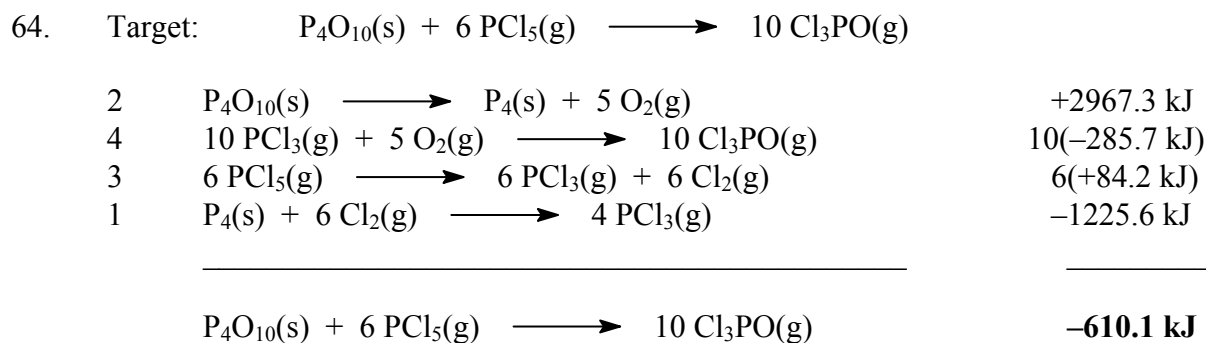
$$-2.95 \text{ kJ} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = -\left(400.0 \text{ g} \times \frac{4.184 \text{ J}}{^\circ\text{C} \cdot \text{g H}_2\text{O}}\right)(T_f - 25.0 \text{ }^\circ\text{C})$$

$$T_f = 26.8 \text{ }^\circ\text{C}$$



No, since the reaction is very endothermic (requires a lot of heat) it would not be a practical way of making ammonia due to the high energy costs required.





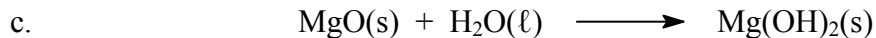
$$\Delta H_f^\circ \text{ kJ/mole} \quad -278 \quad 0 \quad -393.5 \quad -242$$

$$\Delta H^\circ = \left(2 \text{ mole} \times \frac{-393.5 \text{ kJ}}{\text{mole CO}_2} + 3 \text{ mole} \times \frac{-242 \text{ kJ}}{\text{mole H}_2\text{O}} \right) - \left(1 \text{ mole} \times \frac{-278 \text{ kJ}}{\text{mole C}_2\text{H}_5\text{OH}} + 3 \text{ mole} \times \frac{0 \text{ kJ}}{\text{mole O}_2} \right) = -1235 \text{ kJ}$$



$$\Delta H_f^\circ \text{ kJ/mole} \quad -687 \quad -286 \quad -911 \quad 0 \quad -167$$

$$\Delta H^\circ = \left(1 \text{ mole} \times \frac{-911 \text{ kJ}}{\text{mole SiO}_2} + 4 \text{ mole} \times \frac{0 \text{ kJ}}{\text{mole H}^+} + 4 \text{ mole} \times \frac{-167 \text{ kJ}}{\text{mole Cl}^-} \right) - \left(1 \text{ mole} \times \frac{-687 \text{ kJ}}{\text{mole SiCl}_4} + 2 \text{ mole} \times \frac{-286 \text{ kJ}}{\text{mole H}_2\text{O}} \right) = -320. \text{ kJ}$$



$$\begin{array}{r} \Delta H_f^\circ \text{ kJ/mole} \quad -602 \quad \quad -286 \quad \quad \quad -925 \\ \Delta H^\circ = \left(1 \text{ mole} \times \frac{-925 \text{ kJ}}{\text{mole Mg(OH)}_2} \right) - \\ \left(1 \text{ mole} \times \frac{-602 \text{ kJ}}{\text{mole MgO}} + 1 \text{ mole} \times \frac{-286 \text{ kJ}}{\text{mole H}_2\text{O}} \right) = \mathbf{-37 \text{ kJ}} \end{array}$$

85. $\frac{0.500 \text{ mole NaOH}}{\text{L}} \times 0.1500 \text{ L} = 0.0750 \text{ mole NaOH}$ Limiting

$\frac{0.400 \text{ mole HCl}}{\text{L}} \times 0.2000 \text{ L} = 0.0800 \text{ mole HCl}$

$$0.0750 \text{ mole NaOH} \times \frac{1 \text{ mole H}_2\text{O}}{1 \text{ mole NaOH}} \times \frac{-56 \text{ kJ}}{1 \text{ mole H}_2\text{O}} = \mathbf{-4.2 \text{ kJ}}$$

