Chapter 5

5.25 a) $\Delta E = q + w$

$\Delta E = 85 kJ - 29 kJ$

$\Delta E = 56 kJ$ endothermic

b) $q = 1.50 kJ$ $w = {}^-657 J$

$w = -657 J \left(\frac{1 kJ}{10^3 J}\right) = {}^-0.657 kJ$

$\Delta E = 1.50 kJ + {}^-0.657 kJ$

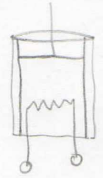
$\Delta E = 0.843 kJ$ endothermic

c) $q = {}^-57.5 kJ$

$w = {}^-13.5 kJ$

$\Delta E = q + w = {}^-57.5 kJ + {}^-13.5 kJ =$ ${}^-71.0 kJ$ exothermic

5.27.



100 J of heat added by wire

case 1: piston allowed to move

case 2: piston cannot move

a) which case has higher temperature? case 2, because the system cannot do work, so all energy the wire brings in must stay as heat.

b) In case 1: $q > 0$, $w < 0$

case 2: $q = 100 J$, $w = 0$

c) $\Delta E = q + w$

case 1: $q > 0$, $w < 0$

case 2: $q = 100 J$ $w = 0$

ΔE will be larger for case 2, because the same energy is put in (100 J) for both cases but case 1 uses some energy to do work on the surroundings while case 2 doesn't.

5.37) $2 Mg_{(s)} + O_{2(g)} \rightarrow 2 MgO_{(s)}$ $\Delta H = {}^-1204 kJ$

a) exothermic because $-1204 kJ$ is negative.

b) $2.4 g\ Mg \left(\frac{1 mol\ Mg}{24.3 g\ Mg}\right) = 0.099 mol\ Mg$ $0.099 mol\ Mg \left(\frac{{}^-1204 kJ}{2 Mg}\right) =$ ${}^-60 kJ$

c) $-96.0 kJ \left(\frac{2 mol\ MgO}{-1204 kJ}\right)\left(\frac{40.3 g}{1 mol\ MgO}\right) = 6.43 g\ MgO$

d) $2 MgO_{(s)} \rightarrow 2 Mg_{(s)} + O_{2(g)}$ $\Delta H = 1204 kJ$

$7.50 g\ MgO \left(\frac{1 mol\ MgO}{40.3 g\ MgO}\right)\left(\frac{1204 kJ}{2 MgO}\right) = 112 kJ$

5.39) $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$ $\Delta H = {}^-65.5 kJ$

a) $0.200 mol\ AgCl \left(\frac{{}^-65.5 kJ}{1 AgCl}\right) = {}^-13.1 kJ$

b) $2.5 g\ AgCl \left(\frac{1 mol\ AgCl}{143.4 g}\right)\left(\frac{{}^-65.5 kJ}{1 AgCl}\right) = {}^-1.14 kJ$

c) $AgCl_{(s)} \rightarrow Ag^+_{(aq)} + Cl^-_{(aq)}$ $\Delta H = 65.5 kJ$

$0.150 mmol \left(\frac{10^{-3} mol}{1 mmol}\right)\left(\frac{65.5 kJ}{1 mol\ AgCl}\right) =$ $9.83 kJ$

5.49 a) $S = 4.184\ J/g \cdot K$

b) $\left(4.184 \frac{J}{g \cdot K}\right)\left(\frac{18\ g\ H_2O}{1\ mol}\right) = 75.3\ J/mol \cdot K$

c) $185\ g\ H_2O \left(\frac{4.184\ J}{g \cdot K}\right) = 774\ J/K$

d) $10.00\ Kg\ H_2O$

$46.2\ °C - 24.6\ °C = 21.6\ °C = \Delta T$

$(10.00\ Kg\ H_2O)(21.6\ °C)\left(\frac{10^3\ g}{1\ kg}\right)\left(\frac{4.184\ J}{g \cdot K}\right) = \boxed{9.04 \times 10^5\ J}$

5.53) $9.55\ g\ NaOH \left(\frac{1\ mol}{40\ NaOH}\right) = 0.239\ mol\ NaOH$

$47.4\ °C - 23.6\ °C = 23.8\ °C = \Delta T$

100g H_2O + 9.55g = 109.55g (gives answer in back)

$\left(4.184 \frac{J}{g \cdot K}\right)(100\ g\ H_2O)(23.8\ °C) = 9.96 \times 10^3\ J$

$NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$ $\quad \Delta H = \frac{9.96 \times 10^3\ J}{0.239\ mol}\left(\frac{1\ kJ}{10^3\ J}\right) = 41.7\ kJ/mol$

$\Delta H = -41.7\ kJ/mol$ because the dissociation of NaOH heats up the water.

5.61

$P_4O_{6(s)} \rightarrow P_{4(s)} + 3O_2$ $\quad \Delta H = 1640.1\ kJ$

$P_4 + 5O_{2(s)} \rightarrow P_4O_{10(s)}$ $\quad \Delta H = -2940.1\ kJ$

$P_4O_{6(s)} + \cancel{P_4} + \cancel{5}^{2}O_2 \rightarrow \cancel{P_{4(s)}} + \cancel{3O_2} + P_4O_{10}$ $\quad \Delta H = -1300\ kJ$

5.63

$[H_{2(g)} + F_{2(g)} \rightarrow 2HF \quad \Delta H = -537\ kJ] \times 2$

$[C_{(s)} + 2F_{2(g)} \rightarrow CF_4 \quad \Delta H = -680\ kJ] \times 2$

(reversed): $C_2H_{4(g)} \rightarrow 2C_{(s)} + 2H_{2(g)}$ $\quad \Delta H = +52.3\ kJ$

$\cancel{2H_{2(g)}} + 2F_{2(g)} + \cancel{2C_{(s)}} + 4F_{2(g)} + C_2H_{4(g)} \rightarrow 4HF_{(g)} + 2CF_{4(g)} + \cancel{2C_{(s)}} + \cancel{2H_2}$ $\quad \boxed{\Delta H = -2.38\ kJ}$

5.69 $2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_{3(s)} + 2Fe_{(s)}$

$2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$ $\quad \Delta H_f^\circ = -1669.8\ kJ/mol$

~~$2Fe + \frac{3}{2}O_2 \rightarrow Fe_2O_3$ $\quad \Delta H_f^\circ = -822.16\ kJ/mol$~~

reverse

$Fe_2O_3 \rightarrow 2Fe + \frac{3}{2}O_2$ $\quad \Delta H_f^\circ = 822.16\ kJ/mol$

$2Al_{(s)} + Fe_2O_{3(s)} \rightarrow Al_2O_3 + 2Fe$ $\quad \Delta H^\circ = -847.64\ kJ/mol$

5.75 $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO$ $\Delta H^\circ = -1203.6$ kJ

reverse ×2 ⟹ $Mg(OH)_{2(s)} \rightarrow MgO_{(s)} + H_2O_{(l)}$ $\Delta H^\circ = +37.1$ kJ

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ $\Delta H^\circ = -571.7$ kJ

$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO$ $\Delta H^\circ = -1203.6$ kJ

$2MgO_{(s)} + 2H_2O_{(l)} \rightarrow 2Mg(OH)_2$ $\Delta H^\circ = -74.2$ kJ

\+ $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ $\Delta H^\circ = -571.7$ kJ

$2Mg_{(s)} + O_{2(g)} + \cancel{2MgO_{(s)}} + \cancel{2H_2O_{(l)}} + 2H_{2(g)} + O_{2(g)} \rightarrow \cancel{2MgO_{(s)}} + 2Mg(OH)_{2(s)} + \cancel{2H_2O_{(l)}}$ $\Delta H = 1849.5$ kJ

$2Mg_{(s)} + 2O_{2(g)} \rightarrow 2Mg(OH)_{2(s)}$ $\Delta H = 1849.5$ kJ

÷ 2

$Mg_{(s)} + O_{2(g)} \rightarrow Mg(OH)_{2(s)}$ $\Delta H = 924.8$ kJ