HEAT SUMMATION 1

$$2\,Al_2O_3(s) + 3\,CH_4(g) \longrightarrow Al_4C_3(s) + 6\,H_2O(g) \qquad \Delta H^o = ?$$

$$-30.9 \text{ kcal x } \frac{4.184 \text{ kJ}}{1 \text{ kcal}} = -129.3 \text{ kJ}$$

$$\Delta H^o = [\Delta H^o_{Al_4C_3(s)} + 6\Delta H^o_{H_2O(g)}] - [2\Delta H^o_{Al_2O_3(s)} + 3\Delta H^o_{CH_4(g)}]$$
$$\Delta H^o = [(-129.3 \text{ kJ}) + 6(-241.8 \text{ kJ})] - [2(-1866.44 \text{ kJ}) + 3(-74.4 \text{ kJ})]$$
$$\Delta H^o = +2376.0 \text{ kJ}$$

$$2\,Al_2O_3(s) + 3\,CH_4(g) \longrightarrow Al_4C_3(s) + 6\,H_2O(g) \qquad \Delta H^o = +2376.0$$

Please note that the ΔH value for water should be -241.8 kJ because water is in the gas state in this question.

HEAT SUMMATION 2

$$C_8H_{18}(l) + \tfrac{25}{2}\,O_2(g) \longrightarrow 8\,CO_2(g) + 9\,H_2O(l) \qquad \Delta H^o = -5470.1\text{ kJ}$$

$$\begin{aligned}
\Delta H^o &= [8\Delta H^o_{CO_2(g)} + 9\Delta H^o_{H_2O(l)}] - [\Delta H^o_{C_8H_{18}(l)} + \tfrac{25}{2}\Delta H^o_{O_2(g)}] \\
-5470.1\text{ kJ} &= [8(-393.5\text{ kJ}) + 9(-285.8\text{ kJ})] - [\Delta H^o_{C_8H_{18}(l)} + \tfrac{25}{2}(0)] \\
\Delta H^o_{C_8H_{18}(l)} &= -5720.2\text{ kJ} + 5470.1\text{ kJ} \\
\Delta H^o_{C_8H_{18}(l)} &= -250.1\text{ kJ}
\end{aligned}$$

Please note that the textbook value (pg 799) for the heat of formation of C_8H_{18} is -250.1 kJ !!!

HEAT SUMMATION 3

$$C_{18}H_{34}O_2(l) + \tfrac{51}{2}\,O_2(g) \longrightarrow 18\,CO_2(g) + 17\,H_2O(l) \qquad \Delta H^o = ?$$

$$\Delta H^o = [18\Delta H^o_{CO_2(g)} + 17\Delta H^o_{H_2O(l)}] - [\Delta H^o_{C_{18}H_{34}O_2(l)} + \tfrac{51}{2}\Delta H^o_{O_2(g)}]$$
$$\Delta H^o = [18(-393.5\text{ kJ}) + 17(-285.8\text{ kJ})] - [(-818.81\text{ kJ}) + \tfrac{51}{2}(0)]$$
$$\Delta H^o = -11122.8\text{ kJ}$$

$$C_{18}H_{34}O_2(l) + \tfrac{51}{2}\,O_2(g) \longrightarrow 18\,CO_2(g) + 17\,H_2O(l) \qquad \Delta H^o = -11122.8\text{ kJ}$$

HEAT SUMMATION 4

$FeSO_4(s) \longrightarrow Fe(s) + SO_2(g) + O_2(g) \qquad \Delta H^o = ?$

$$\Delta H^o = [\Delta H^o_{Fe(s)} + \Delta H^o_{SO_2(g)} + \Delta H^o_{O_2(g)}] - [\Delta H^o_{FeSO_4(s)}]$$
$$\Delta H^o = [(0\text{ kJ}) + (-296.8\text{ kJ}) + (0\text{ kJ})] - [(-922.6\text{ kJ})]$$
$$\Delta H^o = +625.8\text{ kJ}$$

$FeSO_4(s) \longrightarrow Fe(s) + SO_2(g) + O_2(g) \qquad \Delta H^o = +625.8\text{ kJ}$

$$Q = -\Delta H$$
$$Q = -625.8\text{ kJ/mol } FeSO_4(s)$$

$CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2\,H_2O(l) \qquad \Delta H^o = ?$

$$\Delta H^o = [\Delta H^o_{CO_2(g)} + 2\Delta H^o_{H_2O(l)}] - [\Delta H^o_{CH_4(g)} + 2\Delta H^o_{O_2(g)}]$$
$$\Delta H^o = [(-393.5\text{ kJ}) + 2(-285.8\text{ kJ})] - [-74.4\text{ kJ} + 2(0)]$$
$$\Delta H^o = -890.7\text{ kJ}$$

$CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2\,H_2O(l) \qquad \Delta H^o = -890.7\text{ kJ}$

$$Q = -\Delta H$$
$$Q = 890.7\text{ kJ/mol } CH_4(g)$$

$$750\text{ kg } FeSO_4 \text{ x } \frac{1000\text{ g}}{1\text{ kg}} \text{ x } \frac{1\text{ mol } FeSO_4}{151.92\text{ g } FeSO_4} \text{ x } \frac{625.8\text{ kJ}^*}{1\text{ mol } FeSO_4} \text{ x } \frac{1\text{ mol } CH_4}{890.7\text{kJ}}$$
$$\text{x } \frac{16.05\text{ g } CH_4}{1\text{ mol } CH_4} \text{ x } \frac{1\text{ kg}}{1000\text{ g}} = 55.7\text{ kg } CH_4$$

* Please note that the sign has been dropped on the conversion factor for heat per mole of ferrous sulphate. This is done for convenience. Heat energy is absorbed by this decomposition reaction is provided by heat produced by the combustion of methane.

HEAT SUMMATION 5

$$2\,Al(NO_3)_3(aq) + 3\,(NH_4)_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(s) + 6\,NH_4NO_3(s) \qquad \Delta H^o = ?$$

$$-273.65 \text{ kcal x } \frac{4.184 \text{ kJ}}{1 \text{ kcal}} = -1145.0 \text{ kJ}$$

$$-281.86 \text{ kcal x } \frac{4.184 \text{ kJ}}{1 \text{ kcal}} = -1179.3 \text{ kJ}$$

$$-820.98 \text{ kcal x } \frac{4.184 \text{ kJ}}{1 \text{ kcal}} = -3435.0 \text{ kJ}$$

$$\Delta H^o = [\Delta H^o_{Al_2(SO_4)(s)} + 6\Delta H^o_{NH_4NO_3(s)}] - [2\Delta H^o_{Al_2(NO_3)_3(aq)} + 3\Delta H^o_{(NH_4)_2SO_4(aq)}]$$

$$\Delta H^o = [(-3435.0 \text{ kJ}) + 6(-365.6 \text{ kJ})] - [2(-1145.0 \text{ kJ}) + 3(-1179.3 \text{ kJ})]$$

$$\Delta H^o = +199.8 \text{ kJ}$$

$$2\,Al(NO_3)_3(aq) + 3\,(NH_4)_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(s) + 6\,NH_4NO_3(s) \qquad \Delta H^o = +199.8 \text{ kJ}$$

HEAT SUMMATION 6

$\mathrm{ZnS(s)} + \frac{3}{2}\,\mathrm{O_2(g)} \longrightarrow \mathrm{ZnO(s)} + \mathrm{SO_2(g)} \qquad \Delta\mathrm{H^o} = ?$

$$\Delta\mathrm{H^o} = [\Delta\mathrm{H^o_{ZnO(s)}} + \Delta\mathrm{H^o_{SO_2(g)}}] - [\Delta\mathrm{H^o_{ZnS(s)}} + \tfrac{3}{2}\Delta\mathrm{H^o_{O_2(g)}}]$$
$$\Delta\mathrm{H^o} = [(-350.5\ \mathrm{kJ}) + (-296.8\ \mathrm{kJ})] - [(-206.0\ \mathrm{kJ}) + \tfrac{3}{2}(0)]$$
$$\Delta\mathrm{H^o} = -441.3\ \mathrm{kJ}$$

$\mathrm{ZnS(s)} + \frac{3}{2}\,\mathrm{O_2(g)} \longrightarrow \mathrm{ZnO(s)} + \mathrm{SO_2(g)} \qquad \Delta\mathrm{H^o} = -441.3\ \mathrm{kJ}$ Thermodynamic Equation

$\mathrm{ZnS(s)} + \frac{3}{2}\,\mathrm{O_2(g)} \longrightarrow \mathrm{ZnO(s)} + \mathrm{SO_2(g)} + 441.3\ \mathrm{kJ}$ Thermochemical Equation