Hess's Law

1. Calculate ΔH for the reaction: $N_2(g) + 2\,O_2(g) \rightarrow 2\,NO_2(g)$.

Given: $N_2(g) + O_2(g) \rightarrow 2\,NO(g)$ $\Delta H = 180\ kJ/mol_{rxn}$

$2\,NO(g) + O_2(g) \rightarrow 2\,NO_2(g)$ $\Delta H = -112\ kJ/mol_{rxn}$

$N_2(g) + O_2(g) + 2NO(g) + O_2(g) \rightarrow 2NO(g) + 2NO_2(g)$

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = 180 - 112$

$\Delta H = 68\ \frac{kJ}{mol_{rxn}}$

2. Calculate ΔH for the reaction: $C_{graphite}(s) \rightarrow C_{diamond}(s)$

Given: $C_{graphite}(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -394\ kJ/mol_{rxn}$

FLIP $C_{diamond}(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -396\ kJ/mol_{rxn}$

$CO_2(g) \rightarrow C_{diamond}(s) + O_2(g)$ $\Delta H = +396\ \frac{kJ}{mol_{rxn}}$

$C_{graphite}(s) + O_2(g) + CO_2(g) \rightarrow CO_2(g) + C_{diamond}(s) + O_2(g)$

$C_{graphite}(s) \rightarrow C_{diamond}(s)$ $\Delta H = -394 + 396 = 2\ \frac{kJ}{mol_{rxn}}$

3. Calculate ΔH for the reaction: $2\,H_3BO_3(aq) \rightarrow B_2O_3(s) + 3\,H_2O(l)$

Given: $H_3BO_3(aq) \rightarrow HBO_2(aq) + H_2O(l)$ $\Delta H = -0.02\ kJ/mol_{rxn}$ X4

FLIP #2 $H_2B_4O_7(aq) + H_2O(l) \rightarrow 4\,HBO_2(aq)$ $\Delta H = -11.3\ kJ/mol_{rxn}$

$H_2B_4O_7(aq) \rightarrow 2\,B_2O_3(s) + H_2O(l)$ $\Delta H = 17.5\ kJ/mol_{rxn}$

#2) $4\,HBO_2(aq) \rightarrow H_2B_4O_7(aq) + H_2O(l)$ $\Delta H = +11.3\ \frac{kJ}{mol_{rxn}}$

#1) $4\,H_3BO_3(aq) \rightarrow 4\,HBO_2(aq) + 4\,H_2O(l)$ $\Delta H = (-0.02)(4)$

$\Delta H = -0.08\ \frac{kJ}{mol_{rxn}}$

$4\,H_3BO_3(aq) \rightarrow 2\,B_2O_3(s) + 6\,H_2O(l)$

$\Delta H = 17.5 + 11.3 - 0.08 = 28.72\ kJ/mol_{rxn}$

Divide By 2

$2\,H_3BO_3(aq) \rightarrow B_2O_3(s) + 3\,H_2O(l)$ $\Delta H = \frac{28.72}{2} = 14.36\ \frac{kJ}{mol_{rxn}}$