Example of Hess' Law Calculations

Problem

Given the following:

a. $2\,N_2O_{(g)} \rightarrow O_{2(g)} + 2\,N_{2(g)}$ $\quad \Delta H_{rxn\,a} = -164\,kJ$

b. $2\,NH_{3(g)} + 3\,N_2O_{(g)} \rightarrow 4\,N_{2(g)} + 3\,H_2O_{(l)}$ $\quad \Delta H_{rxn\,b} = -1.012 \times 10^3\,kJ$

Calculate ΔH_{rxn} for $4\,NH_{3(g)} + 3\,O_{2(g)} \rightarrow 2\,N_{2(g)} + 6\,H_2O_{(l)}$

Note: a) Reversing chem. reaction, sign change with ΔH_{rxn}

b) Doubling each coefficient in chem rxn, doubles ΔH_{rxn}

Trick: Look at target reaction and find product species and see what you need to do to known reaction to make it a product. Same for reactants.

Solution:

1. Need to reverse Rxn a, since want O_2 as reactant.
2. Need $3\,O_2$ so need to multiply 3 to all coefficient in rxn a.
3. Need to multiply 2 to all coefficient in rxn b, cause N_2O to cancel since it is not in target reaction.

$3\,O_{2(g)} + 6\,N_{2(g)} \rightarrow 6\,N_2O_{(g)}$ $\quad \Delta H_{rxn} = (-1)(3)(-164\,kJ) = 492\,kJ$

$4\,NH_{3(g)} + 6\,N_2O_{(g)} \rightarrow 8\,N_{2(g)} + 6\,H_2O_{(l)}$ $\quad \Delta H_{rxn} = (2)\left(-1.012 \times 10^3\,\frac{kJ}{}\right) = -2.024 \times 10^3\,kJ$

$4\,NH_{3(g)} + 3\,O_{2(g)} \rightarrow 2\,N_{2(g)} + 6\,H_2O_{(l)}$ $\quad \Delta H_{rxn} = -1.532 \times 10^3\,\frac{kJ}{}$

$\boxed{\Delta H_{rxn} = -1.53 \times 10^3\,kJ}$