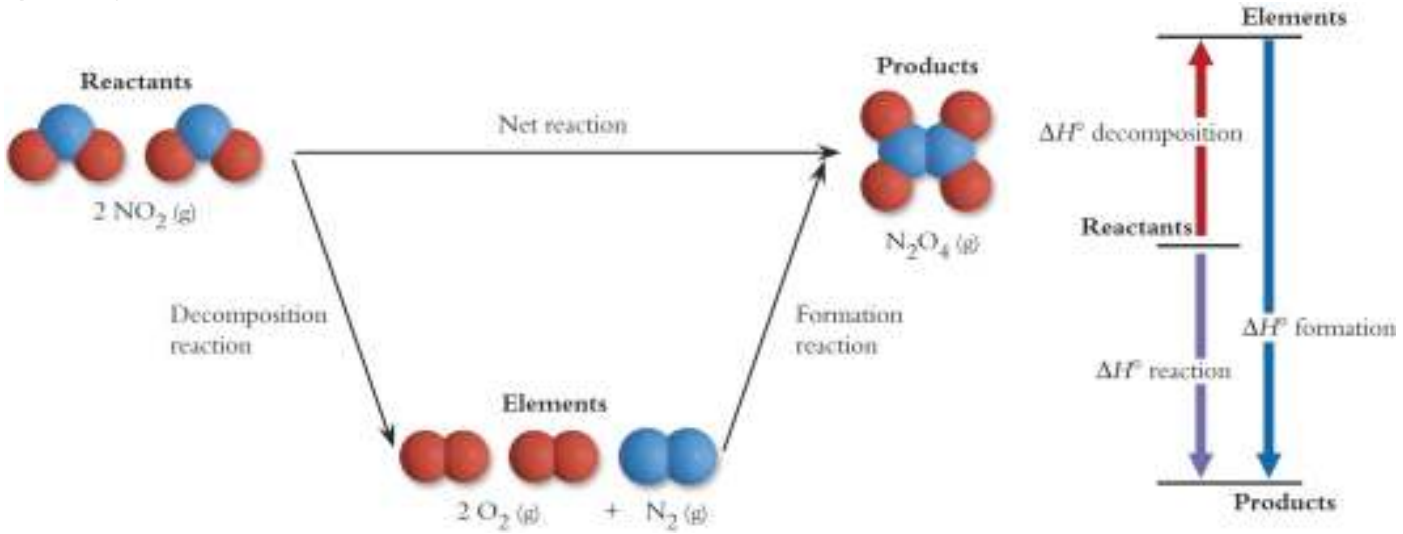
Hess's Law

For a chemical equation that can be written as the sum of two or more steps the enthalpy change for the overall equation equals the sum of the enthalpy changes of the individual steps



The enthalpy change for the reaction of NO_2 to produce N_2O_4 can be determined by using a two-step path. In the first step, NO_2 decomposes to N_2 and O_2. In the second step, the elements react to form N_2O_4.

Using Hess's Law: there are various ways to do this examples are now given to illustrate its use. In the example below the strategy is to combine equations so that the reactants are on the LHS only.

Rules:

- if you reverse direction of eqn. then sign of energy is reversed
- multiples : ΔH is reversed
- same stuff on both sides cancels

Write down the target equation first

-then you can see what to do

example

$C(s) + 1/2\ O_2(g) \longrightarrow CO(g)$

enthalpy for this reaction is hard to measure

However

1. $C(s) + O_2(g) \longrightarrow CO_2(g)\ \Delta H^O = -393.5$
2. $2CO(g) + O_2(g) \longrightarrow 2\ CO_2(g)\ \Delta H^O = -566.0$

So:

1. $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H^O = -393.5$

-2/2 $CO_2(g) \longrightarrow CO(g) + 1/2O_2(g)$ $\Delta H^O = +566.0/2$

Add → $C(s) + 1/2\ O_2(g)$ $CO(g)$ $\Delta H^O = -110.5$ kJ