# Thermodynamics

**Unit 16B:** Thermodynamics Review – Hess’s Law

### Skills:

* solve ΔHrxn problems using Hess’s Law

### Notes:

Hess’s Law, named for the Russian chemist Germain Hess, states that because enthalpy change is a state function (is independent of the path), the enthalpy change of a reaction can be calculated by performing algebraic manipulations on a set of other reactions that involve the same chemical species.

#### Rules:

* Add and subtract chemical equations just as you do with algebraic equations, such as when solving simultaneous equations in multiple variables.
* If you multiply an entire equation by a coefficient, ΔH is multiplied by that same coefficient.
* If you reverse an equation, it changes the sign of ΔH.

For example, suppose we wanted to find ΔHrxn for the reaction:

2 B (s) +  O2 (g) → B2O3 (s)

Suppose we have ΔH data for the following reactions:

1. B2O3 (s) + 3 H2O (g) → 3 O2 (g) + B2H6 (g) ΔHrxn = +2,035 kJ/mol
2. H2O (ℓ) → H2O (g) ΔHrxn = +44 kJ/mol
3. H2 (g) +  O2 (g) → H2O (ℓ) ΔHrxn = −286 kJ/mol
4. 2 B (s) + 3 H2 (g) → B2H6 (g) ΔHrxn = +36 kJ/mol

We would perform the following steps:

|  |  |  |
| --- | --- | --- |
| Eqn # | Equation | ΔH () |
| (d) | 2 B (s) + 3 H2 (g) → B2H6 (g) | +36 |
| +(−a) | 3 O2 (g) + B2H6 (g) → B2O3 (s) + 3 H2O (g) | −2,035 |
|  | 2 B (s) + 3 H2 (g) + 3 O2 (g) → B2O3 (s) + 3 H2O (g) | −1,999 |
| +(−3b) | 3 H2O (g) → 3 H2O (ℓ) | −132 |
|  | 2 B (s) + 3 H2 (g) +  O2 (g) +  O2 (g) → B2O3 (s) + 3 H2O (ℓ) | −2,131 |
| +(−3c) | 3 H2O (ℓ) → 3 H2 (g) +  O2 (g) | +858 |
|  | 2 B (s) +  O2 (g) → B2O3 (s) | −1,273 |

Note that in the next-to-last step, we rewrote 3 O2 (g) as  O2 (g) +  O2 (g).

Therefore, according to Hess’s Law, ΔHrxn for the reaction 2 B (s) +  O2 (g) → B2O3 (s) is −1,273 .