

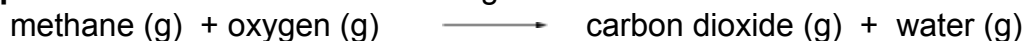
## Hess' Law and the Additivity of Heats

**Hess' Law:** The value of  $\Delta H$  for any reaction that can be written in steps equals the sum of the values of  $\Delta H$  for the individual steps.

### Method 1: Additivity of Heats

1. Identify the target equation and balance it (if not given).
2. Identify the individual step equations. These are provided or are found on a Table of Heats of Formation on the back of your Periodic Table.
3. Reverse any step equations so that the position of reactants/products matches that of the target equation. If an equation is reversed, also reverse the sign of  $\Delta H$  for the step equation.
4. Multiply the step equations by the appropriate coefficient to match those in the target equation. Also multiply the  $\Delta H$  by the same coefficient.
5. Add up the modified step equations and their  $\Delta H$  values. The sum of the modified individual step equation should be identical to the target equation.

**Example:** Determine  $\Delta H$  for the following reaction:



**Method 2: Summation of Heats**

Identify the  $\Delta H_f$  for each product and reactant and solve using the equation:

$$\Delta H = \Sigma(n\Delta H_f(\text{products})) - \Sigma(n\Delta H_f(\text{reactants}))$$

**Example:** Determine  $\Delta H$  for the following reaction:

ammonia (g) + oxygen (g)  $\longrightarrow$  nitrogen dioxide (g) + water (g)

