

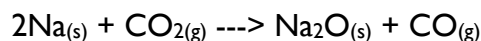
## Standard Enthalpies

The standard enthalpy of formation ( $\Delta H_f^\circ$ ) is defined as the change in enthalpy for the formation of one mole of a compound from its elements at standard conditions.

To use standard enthalpies of formation we need to define standard conditions: Standard temperature is 25°C, for gasses the standard pressure is 1 atm, for a solution the standard concentration is a 1.0 molar solution.

By defining a standard enthalpy and measuring that value for a large number of compounds we can calculate the enthalpy change for any chemical reaction by calculating the sum of the products minus the sum of the reactants.

$$\Delta H_{reaction}^\circ = \sum n_p \Delta H_f^\circ(\text{products}) - \sum n_r \Delta H_f^\circ(\text{reactants})$$



$$\Sigma[\text{products}] - \Sigma[\text{reactants}]$$

$$[\Delta H_{f(\text{Na}_2\text{O})} + \Delta H_{f(\text{CO})}] - [2\Delta H_{f(\text{Na})} + \Delta H_{f(\text{CO}_2)}]$$

$$[-416\text{kJ/mol} + -110.5\text{kJ/mol}] - [2 \cdot 0 + -292.5\text{kJ/mol}]$$

$$\Delta H = -809\text{kJ/mol}$$

Ex:

## Bond Energies

Another way to calculate the enthalpy change for a chemical reaction is to understand what is happening at the atomic level. It takes energy to break a chemical bond, this energy is stored and released when a new bond is formed. We can therefore use bond energy information to calculate  $\Delta H$ .

$$\Delta H_{\text{reaction}}^{\circ} = \sum \text{Energy Bonds Broken}_{(\text{reactants})} - \sum \text{Energy Bonds Formed}_{(\text{products})}$$