

Molar Enthalpies of Formation

SUMMARY

Using Enthalpies of Formation to Predict ΔH

According to Hess's law, the net enthalpy change for a chemical reaction is equal to the sum of the enthalpies of formation of the products minus the sum of the enthalpies of formation of the reactants.

$$\Delta H = \sum nH_{f(\text{products})} - \sum nH_{f(\text{reactants})}$$

Example

What is the standard molar enthalpy for the slaking of lime?



$$\Delta H = \sum n\Delta H_{f(\text{products})}^\circ - \sum n\Delta H_{f(\text{reactants})}^\circ$$

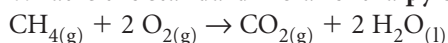
where n represents the amount (in moles) of each particular product or reactant. Substitute our known molar enthalpies of formation into this equation:

$$\begin{aligned} \Delta H &= n\Delta H_{f(\text{Ca(OH)}_{2(s)})}^\circ - (n\Delta H_{f(\text{CaO}_{(s)})}^\circ + n\Delta H_{f(\text{H}_2\text{O}_{(l)})}^\circ) \\ &= -\left(1 \cancel{\text{mol}} \times \frac{986.1 \text{ kJ}}{1 \cancel{\text{mol}}}\right) - \left(\left(1 \cancel{\text{mol}} \times \frac{-634.9 \text{ kJ}}{1 \cancel{\text{mol}}}\right) + \left(1 \cancel{\text{mol}} \times \frac{-285.8 \text{ kJ}}{1 \cancel{\text{mol}}}\right)\right) \\ \Delta H &= -65.4 \text{ kJ} \end{aligned}$$



Example

What is the standard molar enthalpy of combustion of methane fuel?



$$\begin{aligned} \Delta H &= \sum n\Delta H_{f(\text{products})}^\circ - \sum n\Delta H_{f(\text{reactants})}^\circ \\ &= \left(1 \cancel{\text{mol}} \times \frac{-393.5 \text{ kJ}}{1 \cancel{\text{mol}}}\right) + 2 \cancel{\text{mol}} \times \frac{-285.8 \text{ kJ}}{1 \cancel{\text{mol}}} - \\ &\quad \left(1 \cancel{\text{mol}} \times \frac{-74.4 \text{ kJ}}{1 \cancel{\text{mol}}} + 2 \cancel{\text{mol}} \times \frac{0 \text{ kJ}}{1 \cancel{\text{mol}}}\right) \\ &= -965.1 \text{ kJ} - (-74.4 \text{ kJ}) \end{aligned}$$

$$\Delta H = -890.7 \text{ kJ}$$

$$\Delta H_c = \frac{\Delta H}{n} = \frac{-890.7 \text{ kJ}}{1 \text{ mol CH}_4}$$

$$= -890.7 \text{ kJ/mol CH}_4$$

The molar enthalpy of combustion of methane fuel is -890.7 kJ/mol .