HESS'S LAW

The enthalpy change in a chemical or physical process remains constant, regardless of whether the process is executed in a single step or through multiple steps. This principle can be illustrated through two methods:

First Method $C(s)+O_2(g) \rightarrow CO_2(g) \rightarrow \Delta H$

Second Method: $C(s)+1/2O_2(g) \rightarrow CO(g) \rightarrow \Delta H_1$

$2CO(g)+1/2O_2(g) \rightarrow CO_2(g) \rightarrow \Delta H_2$

According to Hess's law, the total enthalpy change (ΔH) for the overall process is equivalent to the sum of the enthalpy changes in each individual step. Mathematically, this relationship is expressed as:

$$\Delta H = \Delta H_1 + \Delta H_2$$

Hess's law thus provides a valuable tool for determining the enthalpy change of a reaction by combining and manipulating data from multiple steps.

Applications of Hess's Law

1. **Calculation of Enthalpy of Formation:**

Hess's Law proves valuable in determining the enthalpy changes for reactions that are impractical to carry out experimentally.

For instance, the direct synthesis of numerous compounds like C_6H_6, C_2H_6, etc., from their constituent elements may not be feasible. Hess's Law enables the calculation of the enthalpy of formation for such compounds. This method allows for the indirect determination of enthalpies by breaking down complex reactions into a series of steps.

2. **Determination of Standard Enthalpies of Reactions:**

Standard enthalpies of reactions can be determined using Hess's Law in conjunction with the standard enthalpies of formation for both reactants and products.

For a given reaction: $pA + qB \rightarrow aC + bD$

the standard enthalpy change (ΔH°) is expressed as the sum of the standard heat of formation of products minus the sum of the standard heat of formation of reactants:

$$\Delta H^\circ = [a\Delta H^\circ_f(C) + b\Delta H^\circ_f(D) - p\Delta H^\circ_f(A) - q\Delta H^\circ_f(B)]$$

This formula facilitates the determination of the standard enthalpy change for a reaction based on the known standard enthalpies of formation for the involved substances.