Temperature Effects on Equilibrium: A Study Guide

Show that

\[ \frac{\text{DH}}{R} \frac{d \ln K}{d(1/T)} = - \frac{d}{dT} \frac{1}{T} \]

**Solution**

Since

\[ \Delta G = -RT \ln K, \]
\[ \ln K = - \frac{\Delta G}{RT} \]

Differentiate both sides with respect to \((1/T)\) in the above equation gives,

\[ \frac{d}{dT} \frac{\ln K}{(1/T)} = \frac{-1}{R} \frac{d}{dT} \frac{\Delta G}{T} \]
\[ = - \frac{\Delta H}{RT^2} \]

**DISCUSSION**

If \( K_1 \) and \( K_2 \) are the equilibrium constant at \( T_1 \) and \( T_2 \) respectively, show further that

\[ \ln \left( \frac{K_1}{K_2} \right) = - \frac{\Delta H}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right). \]

This is achieved by definite integral. This relationship indicates that the plot of \( \ln (K) \) versus \( 1/(T) \) is a straight line, and the slope is \(- (\Delta H / R)\). Thus, \( \Delta H \) can be determined by measuring the equilibrium constant at different temperatures.

\[ G^0 = 8.312 \text{ J} \times 298 \ln(3166) \]
\[ = 20.0 \text{ kJ/hr} \]

**DISCUSSION**

This example illustrates the evaluation of Gibb's energy when the equilibrium constant is known.

**Contributors and Attributions**

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