Temperature Effects on Equilibrium: A Study Guide

Show that

$$\frac{DH}{d \ln K} = -\frac{1}{R T} \frac{d}{d(T)}$$

**Solution**

Since

$$DG = -R T \ln K,$$

$$\ln K = \frac{DG}{R T}$$

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

$$\frac{d(\ln K)}{dT} = \frac{-1}{R(T \frac{d(DG)}{dT})} = -\frac{DH}{R T^2}$$

**DISCUSSION**

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

$$\ln \left(\frac{K_1}{K_2}\right) = -\frac{DH}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right).$$

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 \(-\frac{DH}{R}\). Thus, \(DH\) can be determined by measuring the equilibrium constant at different temperatures.

\[
\begin{align*}
101,300 \text{ N m}^{-2} & \quad 23.756 \text{ mmHg} = 3166 \text{ Pa} \\
760 \text{ mmHg} & \\
G^0 = 8.312 \text{ J} \ast 298 \ln(3166) & = 20.0 \text{ kJ/hr}
\end{align*}
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**DISCUSSION**

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

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**Contributors and Attributions**

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