Answer on Question #81929, Chemistry/ General Chemistry

For the reaction A (aq) + B (aq) C (aq) + D (aq), the equilibrium constant is 21.8 at 25 degrees celsius and 35.8 at 50 degrees celsius. What is the value of the variation in Gibbs standard free enthalpy (in kJ) of this reaction at 75 degrees celsius?

Solution

We should use Van't Hoff equation to answer this question:

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

$$\ln\frac{35.8}{21.8} = -\frac{\Delta H}{R}\left(\frac{1}{323} - \frac{1}{298}\right)$$

$$\frac{\Delta H}{R} = 1909.7$$

To find K_3 at $75^{O}C$ we can use either data for K_1 or for K_2. We will use data for K_2, T_2=323 K

$$\ln\frac{K_3}{K_2} = -\frac{\Delta H}{R}\left(\frac{1}{T_3} - \frac{1}{T_2}\right)$$

$$\ln\frac{K_3}{35.8} = -1909.7\left(\frac{1}{348} - \frac{1}{323}\right)$$

$$K_3 = 54.7$$

$$\Delta G = -RTlnK$$

$$\Delta G = -8.314\frac{J}{mol} \times K \times 348\,K\ \times \ln 54.7$$

$$\Delta G = -11581\frac{J}{mol} = -11.581\ kJ/mol$$

Answer: -11.581 kJ/mol