Question # 82386

Starting with a pure sample of A (g). The following equilibrium is established:

2A (g) <---> B (g) + C (g)

The total pressure is 8.63 atm and the temperature is 25.0oC. The partial pressure of A (g) is 5.66 atm. Calculate the value of the standard free enthalpy change (in kJ) of this reaction at 25.0 degrees celsius.

Solution:

First of all, it is necessary to calculate the constant of equilibrium. The constant of equilibrium expressed in terms of partial pressures of components is:

$$K_p = \frac{\chi_B * \chi_C}{\chi_A^2} * P^{\Sigma \vartheta_i} = K_\chi * P^{\Sigma \vartheta_i}$$

As Σv=2-2=0, $K_p = K_\chi$:

$$K_p = K_\chi = \frac{\chi_B * \chi_C}{\chi_A^2}$$

As $\chi_B = \chi_C$, the equilibrium constant is equal to:

$$K_\chi = \frac{\chi_B^2}{\chi_A^2}$$

To calculate K_χ, it is necessary to calculate χ_A and χ_B:

$$\chi = \frac{p_i}{P}$$

$$\chi_A = \frac{5.66}{8.63} = 0.656$$

$$\chi_B = \frac{1 - 0.6559}{2} = 0.172$$

So, the equilibrium constant is equal to:

$$K_\chi = \frac{0.172^2}{0.656^2} = 0.06875$$

The standard free enthalpy change of this reaction is:

$$\Delta H^0 = \Delta G^0 = -RTlnK_p = -8.314 * 298 * \ln 0.06875 = 6633.15\,J \approx 6.63\,kJ$$

Answer:

The standard free enthalpy change of this reaction is 6.63 kJ.