7.1(a)

At 2257 K and 1.00 atm total pressure, water is 1.77 per cent dissociated at equilibrium by way of the reaction \(2 \text{H}_2\text{O}(g) \rightleftharpoons 2 \text{H}_2(g) + \text{O}_2(g)\). Calculate (a) \(K\), (b) \(\Delta_r G^\circ\), and (c) \(\Delta_r G\) at this temperature.

7.4(a)

In the gas-phase reaction \(2 \text{A} + \text{B} \rightleftharpoons 3 \text{C} + 2 \text{D}\), it was found that when 1.00 mol A, 2.00 mol B, and 1.00 mol D were mixed and allowed to come to equilibrium at 25°C, the resulting mixture contained 0.90 mol C at a total pressure of 1.00 bar. Calculate (a) the mole fractions of each species at equilibrium, (b) \(K_{eq}\), (c) \(K\), and (d) \(\Delta_r G_\circ\).

7.6(a)

The equilibrium constant of the reaction \(2 \text{C}_3\text{H}_6(g) \rightleftharpoons \text{C}_2\text{H}_4(g) + \text{C}_4\text{H}_8(g)\) is found to fit the expression \(\ln K = A + B/T + C/T^2\) between 300 K and 600 K with \(A = -1.04\), \(B = -1088\) K, and \(C = 1.51 \times 10^5\) K\(^2\). Calculate the standard reaction enthalpy and standard reaction entropy at 400 K.

7.9(a)

The equilibrium constant for the gas phase isomerization of borneol (\(\text{C}_{10}\text{H}_{17}\text{OH}\)) to isoborneol at 503 K is 0.106. A mixture consisting of 7.50 g of borneol and 14.0 g isoborneol in a container of volume 5.0 dm\(^3\) is heated to 503 K and allowed to come to equilibrium. Calculate the mole fractions of the two substances at equilibrium.

7.11(a)

The standard Gibbs energy of formation of \(\text{NH}_3(g)\) is \(-16.5\) kJ mol\(^{-1}\) at 298 K. What is the reaction Gibbs energy when the partial pressure of the \(\text{N}_2\), \(\text{H}_2\), and \(\text{NH}_3\) (treated as perfect gases) are 3.0 bar, 1.0 bar, and 4.0 bar, respectively? What is the spontaneous direction of the reaction in this case?
**Answers**

7.1(a) $K = 2.85 \times 10^{-6}$; (b) $\Delta_r G^\circ = +240 \text{ kJ mol}^{-1}$; (c) $\Delta_r G = 0$

7.4(a) Mole fractions A: 0.087, B: 0.370, C: 0.196, D: 0.348, Total: 1.001; (b) $K_x = 0.33$; (c) $p = 0.33$; (d) $\Delta_r G^\circ = +2.8 \times 10^3 \text{ J mol}^{-1}$.

7.6(a) $\Delta_r H^\circ = +2.77 \text{ kJ mol}^{-1}$, $\Delta_r S^\circ = -16.5 \text{ J K}^{-1} \text{ mol}^{-1}$

7.9(a) $\chi_B = 0.904$, $\chi_I = 0.096$

7.11(a) $\Delta_r G^\circ = -14.38 \text{ kJ mol}^{-1}$, spontaneous reaction favors the products