

CHM 4411 TEST 3

For full credit show reasoning and set-up. Start each problem on a new page. Write your name on each page including the test paper, which must be turned in with your work. NOTE: Set-up is important.

1. Naphthalene melts at 80.2 °C. If the vapor pressure of the liquid is 10 Torr at 85.8 °C and 40 Torr at 119.3 °C, use the Clausius-Clapeyron equation to calculate (i) the enthalpy of vaporization, (ii) the normal boiling point, and the entropy of vaporization at the boiling point. (50)
2. Measuring the equilibrium between (l) and (g) phases of an acetone (A) and methanol (M) solution at 57.2 °C and 1.0 atm=760 Torr, one finds $x_A(g) = 0.516$, and $x_A(l) = 0.400$. Calculate the activities and the activity coefficients of both components in the mixture assuming that Raoult's law and Dalton's law hold. The vapor pressure of the pure components at this temperature are $p_A^* = 786$ Torr and $p_M^* = 551$ Torr. (25)
3. In the gas phase reaction



it was found that when 1.00 mol of A , 2.00 mol of B and 1.00 mol of D were mixed and came to equilibrium at 25 °C the resulting mixture contained 0.90 mol of C at a total pressure of 1.00 bar. Calculate $\Delta_r G^\theta$ for the reaction when the gases can be treated as ideal.(25)

BONUS: Discuss the response of chemical equilibria to temperature changes. Base your discussion on the relationship between the equilibrium constant and the Gibbs function for the reaction using the Gibbs-Helmholtz equation. Discuss the different behavior of endothermic and exothermic reactions. (25)

Information: $R=8.31451\text{JK}^{-1}\text{mol}^{-1}=8.20578\text{L atm K}^{-1}\text{mol}^{-1}$; 1.00 atm = 760 Torr.

Clausius-Clapeyron eq.:

$$\frac{d \ln p}{dT} = \frac{\Delta_{vap}H}{RT^2}. \quad (2)$$

Equilibrium constant relation:

$$\ln K = -\frac{\Delta_r G^\theta}{RT}. \quad (3)$$

Gibbs-Helmholtz eq.:

$$\left(\frac{\partial(\Delta G/T)}{\partial T}\right)_p = -\frac{\Delta H}{T^2} \quad (4)$$