

Chem 531: Problem Set #7

Due in class: Tues, November 7th

- (1) Species A and B form an ideal solution. At a total pressure of 0.900 bar, $y_A = 0.450$ and $x_A = 0.650$. Using this information, calculate the vapor pressures of pure A and pure B.
- (2) At -47°C the vapor pressure of pure ethyl bromide is 10.0 Torr and that of pure ethyl chloride is 40.0 Torr. Assume that the solution is ideal and that only a trace of liquid is present. The mole fraction of ethyl chloride in the vapor is 0.80.
- (a) What is the total pressure and the mole fraction of ethyl chloride in the liquid?
- (b) If there are 5.00 mol of liquid and 3.00 mol of vapor present at the same pressure as in part (a), what is the overall composition of the system in terms of $Z_i = \frac{n_l^i + n_v^i}{n_{\text{total}}}$?
- (3) At -31.2°C pure propane and *n*-butane have vapor pressures of 1200 and 200 Torr, respectively.
- (a) Calculate the mole fraction of propane in the (ideal) liquid mixture that boils at -31.2°C at a pressure of 760 Torr.
- (b) Calculate the mole fraction of propane in the vapor that is in equilibrium with the liquid of part (a).
- (4) At 39.9°C a solution of ethanol ($x_1 = 0.9006$, $P_1^* = 130.4$ Torr) and isooctane ($P_2^* = 43.9$ Torr) forms a vapor phase with $y_1 = 0.6667$ at a total pressure of 185.9 Torr.
- (a) Calculate the activity coefficient and activity (Raoult's law std. state) of each component.
- (b) Calculate the total pressure that the solution would have if it was ideal.

- (5) At 39.9°C the vapor pressure of water is 55.03 Torr (component A) and that of methanol (component B) is 255.6 Torr. Using the data below, calculate the activity coefficients for both components using a Raoult's law standard state.

x_A	y_A	P (Torr)
0.0490	0.0175	257.9
0.3120	0.1090	211.3
0.4750	0.1710	184.4
0.6535	0.2550	156.0
0.7905	0.3565	125.7

- (6) Use the data from the following table to determine the Henry's law constant for Br₂ in CCl₄ at 25°C in terms of molality. Use a graphical method.

m_{Br_2}	P (Torr)	m_{Br_2}	P (Torr)
0.026	1.52	0.086	5.43
0.028	1.60	0.157	9.57
0.039	2.39	0.158	9.83
0.067	4.27	0.167	10.27

- (7) Calculate the activity coefficient and activity for CS₂ in a CS₂–Acetone solution with $x_{\text{CS}_2} = 0.7220$ for both a Raoult's law and a Henry's law standard state.

Some relevant data: $P_{\text{CS}_2} = 446.9$ Torr, $P_{\text{acetone}} = 207.7$ Torr, $P_{\text{CS}_2}^* = 512.3$ Torr,

$$k_{\text{CS}_2}^H = 2010 \text{ Torr}$$

- (8) The partial molar volumes of water and ethanol in a solution with $x_{\text{H}_2\text{O}} = 0.60$ at 25°C are 17 and 57 cm³ mol⁻¹, respectively. Calculate the volume change upon mixing sufficient ethanol with 2 mol of water to give this concentration. The densities of water and ethanol are 0.997 and 0.7873 g cm⁻³, respectively, at this temperature.