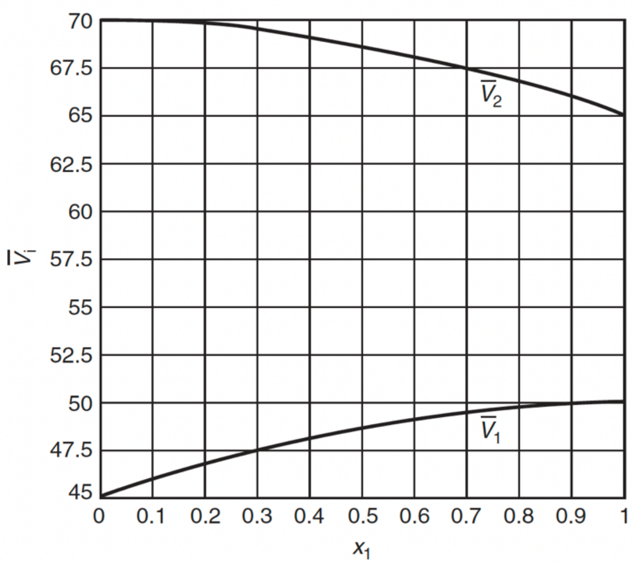
CHE221A
Assignment 06

1. Consider an ideal gas mixture at 83.14 kPa and 500 K. It contains 2 moles of species A and 3 holes of species B. Calculate the following: $\bar{V}_A$, $\bar{V}_B$, v_A, v_B, V_A. V_B, V, v, ΔV_{mix}, Δv_{mix}.
2. For a given binary system at constant T and P, the molar volume (in cm³/mol) is given by

$$v = 100y_a + 80y_b + 2.5y_a y_b$$

   (a) What is the pure species molar volume for species a, v?

   (b) Come up with an expression for the partial molar volume, $\bar{V}_A$, in terms of y_b. What is the partial molar volume at infinite dilution, $\bar{V}_a^{\infty}$?
3. Consider a binary mixture of species 1 and species 2. A plot of the partial molar volumes in [cm³/mol] of species 1 and 2, $\bar{V}_1$, and $\bar{V}_2$, vs. mole fraction of species 1 is shown below. For a mixture of 1 mole of species 1 and 4 moles of species 2, determine the following quantities for this mixture: $\bar{V}_1$, $\bar{V}_2$, v_1, v_2, V_1, V_2, V, v, $\Delta V_{mix.}$



4. For a given binary system, the partial molar volume of species I is constant. What can you say about species 2? Explain.
5. Consider the Berthelot equation of state:

$$P = \frac{RT}{v-b} - \frac{a}{Tv^2}$$

   (a) Develop an expression for the fugacity and fugacity coefficient of a pure species.
   (b) Use the results of Problem 4.29 to write the result of part (a) in terms of reduced pressure, reduced temperature, and reduced volume.
6. Experimental data taken from 0 to 50 bar give the fugacity of a pure gas to be:

$$f = Pe^{-CP}$$

where P is the pressure in bar and C is a constant that depends only on temperature. For the region of 0°C to 100°C. α is given by:

$$C = -0.065 + \frac{30}{T}$$

where T is in Kelvin.

(a) Find an equation of state for this gas that is valid from 0°C to 100°C.

(b) What is the molar volume (in m³/mole) at 80°C and 30 bar?

7. Consider a mixture of species 1, 2, and 3. The following equation of state is available for the vapor phase:

$$P_v = RT + P^2[A(y_1 - y_2) + B]$$

Where,

$$\frac{A}{RT} = -9.0 * 10^{-5} \left[\frac{1}{atm^2}\right]$$

$$\frac{B}{RT} = 3.0 * 10^{-5} [\frac{1}{atm^2}]$$

and y_1,y_2 and y_3 are the mole fractions of species 1, 2 and 3, respectively

A vapor mixture of 1 mole of species 1, 2 moles of species 2, and 2 moles of species 3 is cooled to 300 K at constant pressure of 50 atm, where some of it condenses into a liquid phase.

(a) Calculate an expression for the pure species fugacity coefficient for species 1 in the vapor φ_1^v and the fugacity coefficient, $\widehat{\varphi_1^v}$, of species 1 in the mixture.

(b) If the fugacity of species 1 in the liquid, $\hat{f}_1^l$, is 15 atm, calculate the mole fraction of vapor species 1 in equilibrium with the liquid

8. Verify that,

$$\left(\frac{\partial g_i}{\partial P}\right)_T = v_i = RT\left(\frac{\partial(\ln f_i)}{\partial P}\right)_T$$