Physical Chemistry Laboratory  
(CHEM 336)  

EXPT 3-1: Partial Molar Volume  

The Partial Molar Volume experiment is based on the procedure for Expt #9, as given in the laboratory textbook. This handout describes the somewhat extensive modifications to that procedure.  

Instead of determining the partial molar volumes of NaCl in aqueous solution, you will study aqueous solutions of ethanol. Instead of the concentrations given in the text, choose concentrations to cover the entire range of mole fractions from 0.0 to 1.0 in 0.1 increments i.e. 0, 0.1, 0.2, 0.3... etc. If time permits, additional concentrations between these values may be performed. To prepare enough ethanol solution to fill a pycnometer but to minimize wasted chemicals, use the following amount of ethanol to prepare each solution.  

Mole Fractions
1.0-0.6 – 60 mL ethanol  
0.5-0.4 – 50 mL ethanol  
0.3 – 40 mL ethanol  
0.2 – 30 mL ethanol  
0.1 – 20 mL ethanol  

METHOD
Read all instructions pertaining to the Weld-type pycnometer prior to coming to class. This procedure will be used to make the measurements.  

Measure the density of water and ethanol 5 times each using a 25 mL volumetric flask. Report the mean values and their associated 95% CI.  

Prepare the ethanol solutions by volume rather than by weight, using burets. Calculate the mole fraction and molality of each solution using the known densities and molecular weights of water and your alcohol.  

From the density and concentration data you obtain, calculate the apparent molar volume, $\phi$, for each ethanol solution using Eq. 17. Plot $\phi$ versus $m^{1/2}$ and determine the line of best fit. From the graph, determine $\phi^0$ and $d\phi/dm^{1/2}$ and calculate $V_2$ and $V_1$ using Eqs 21 & 22 for each mole fraction. Plot $V_2$ and $V_1$ against $m$ on the same graph.  

REFERENCES
Garland et al., Experiments in Physical Chemistry 7th Ed pp 172-178.