1. (a) Use Table 10.2 in Levine to calculate the activities of the electrolytes in the following aqueous solutions at 25°C: (i) 0.5 m LiBr, (ii) 0.01 m CaCl₂, (iii) 0.1 m Na₂SO₄, and (iv) 0.001 m CuSO₄.

(b) In each case above, use the Davies equation to estimate $\gamma_±$ and the fraction $\alpha$ of unassociated $M^{±}$ ions. (Hint: You may need to do an iterative calculation here.)

2. (a) Show that the result of Problem 10.24a in Levine can be written as $d(m\phi) = dm_i + m_i d\ln \gamma_i$ at constant $T$ and $P$. Then integrate this equation to show that

$$\phi(m) = 1 + m^{-1} \int_0^m m_i d\ln \gamma_i$$

const $T$, $P$

(b) Use the Debye-Hückel limiting law to show that in a very dilute electrolyte solution,

$$\phi = 1 - |z_+z_-| C I m^{1/2},$$

where $C$ is a proportionality constant.

3. (a) Use the result in Problem 2b together with the definition of $\phi$ to obtain an expression for $\ln \gamma_A$ for a 1:1 electrolyte. Express this result as a power series in $x_i^{1/2}$ and obtain coefficients for the first two terms.

(b) Repeat the procedure in Problems 2b and 3a for the case where $\ln \gamma_{m,i} = Bm_i$, which occurs for dilute solutions of nonelectrolytes.

4. The solubility of sodium propionate (NaOPr) in water at 25°C is 9.80 m°, and near this molality the activity coefficient follows the equation, $\log \gamma_i = -0.2454 + 0.103 m_i$. Calculate $\Delta G^°_{298}$ for $\text{NaOPr}(s) \rightleftharpoons \text{Na}^{+}(aq) + \text{OPr}^-(aq)$. At what molality will $\mu$ of NaOPr(aq) equal $\mu_i^{°}$ for NaOPr(aq)?

5. The solubility of MgCl₂(s) in H₂O at 25°C is about 56 g/100 g H₂O. Use this information together with tabulated thermodynamic data (CRC Handbook or elsewhere) to estimate: (a) $\gamma_i$ for MgCl₂ in its saturated aqueous solution, and (b) the differential heat of solution at infinite dilution, both at 25°C. (Hint: See problems 10.41 and 11.22 in Levine. Be sure to state clearly the values you use for the required data, and their source.)

6. The solubility of AgCl in water at 25°C is $10^{-4.895}$ m°. (a) Calculate $\Delta G^°$ for the process, $\text{AgCl}(s) \rightleftharpoons \text{Ag}^+(aq) + \text{Cl}^-(aq)$. (b) Calculate the solubility of AgCl in a 0.010 m° solution of KNO₃.

7. The degree of dissociation $\alpha$ of acetic acid was measured at 25°C over a range of concentrations, yielding the data given below. Use the Debye-Hückel limiting law to extract $K_a$ from these data in the limit of low $m$.

| $10^3m$(m°) | 0.0280 | 0.1114 | 0.2184 | 1.0283 | 2.4140 | 5.9115 |
| $\alpha$ | 0.5393 | 0.3277 | 0.2477 | 0.1238 | 0.0829 | 0.0540 |