Handin Homework 12: Solutions and Chemical Equilibria

1. Using Eqs. 19.5.13, 19.5.19 and 19.5.20, derive Eq. 19.5.21.

2. Show that $\phi_i(r) = \frac{A}{r} e^{-\kappa r}$ is the solution to the Eq. 19.5.21.

3. (a). Starting with Eq. 19.5.20, for an aqueous solution containing one pure electrolyte, show:

$$\kappa^2 = \frac{e^2\ 1000\ L\ m^{-3}\ d_o\ N_A\ m^\circ}{\varepsilon_r \varepsilon_o\ kT}\left(z_+^2 \frac{m_+}{m^\circ} + z_-^2 \frac{m_-}{m^\circ}\right) \qquad 1$$

(b). Given the definition of ionic strength in Eq. 19.5.26, show from Eq. 1 that:

$$\kappa = \sqrt{\frac{2\ e^2\ 1000\ L\ m^{-3}\ d_o\ N_A\ m^\circ}{\varepsilon_r \varepsilon_o\ kT}}\ I^{1/2} \qquad 2$$

(c). Starting with Eq. 2, prove that Eq. 19.5.8 gives the Debye length for aqueous solutions of unipositive-uninegative electrolytes, at concentration m molal, at 298.15 K. In Eq. 19.5.8 the constant is given as 305 pm; in your answer give the constant to at least four significant figures. Find the Debye length for a 0.0100 m and 0.100 m solutions of KCl.

4. At 1105. K, the value of K_p for the reaction,

$$SO_2\ (g) + \tfrac{1}{2}\ O_2\ (g) = SO_3\ (g)$$

is 0.630 (with a 1 bar standard state). (a) Calculate the standard Gibbs Energy change at 1105. K for this reaction. (b). Calculate the Gibbs Energy change at 1105. K for the reaction:

$$SO_2\ (1.00\ bar) + \tfrac{1}{2}\ O_2\ (25.0\ bar) = SO_3\ (2.00\ bar)$$