Problem Set 4. Ionic Strength and Equilibrium. Answer Sheet.
Chem 2222. Summer 2008
Please complete the example problems and recommended exercises in Chapters 4 and 9 before attempting these problems.

1. Consider the reaction (unbalanced)

   $KIO_3(aq) + La(NO_3)_3(aq) \rightarrow La(IO_3)_3(s) + KNO_3(aq)$

   a) write the balanced net ionic equation.
   b) 50.0 mL of a 0.100M solution of KIO_3 is added to 15.0 mL of 0.100 M $La(NO_3)_3$. Compute the equilibrium concentration of each of the four ions in solution. Ignore activity coefficients.

2. For a solution of 0.0050 M calcium nitrate and 0.020 M nitric acid,
   a) calculate the ionic strength.
   b) what is the activity of the calcium ion? To obtain the activity coefficient, you may need to interpolate from the table values or use the Debye-Huckel equation.

3. Consider a saturated solution of lead(II) iodide in 0.100 M potassium nitrate.
   a) Write the chemical equation corresponding to K_{sp}.
   b) Write the defining expression for the thermodynamic solubility product constant, K_{sp}^{o}.
   c) Write the defining expression for the conditional solubility product constant, K_{sp}'.
   d) Write the mathematical relation defining activity of the lead ion in terms of its concentration and activity coefficient.
   e) Based on your answers above, derive a relationship for K_{sp}' in terms of K_{sp}^{o} and activity coefficients.
   f) Calculate the value of K_{sp}' and the molar solubility of the lead iodide, given that $K_{sp}^{o} = 7.9 \times 10^{-9}$. (Note: You can disregard the contribution of the dissolved lead(II) iodide to the overall ionic strength.)

4. Calculate the solubility of lead iodide in 0.020 M $Pb(NO_3)_2$, taking ionic strength effects into account.

5. The fundamental definition of pH is $pH = -\log(a_{H+})$. Calculate the pH of 0.0500 M NaOH,
   a) ignoring activity coefficients (i.e., use $pH = -\log[H^+]$)
   b) taking activity coefficients into account.

   Answers
   1. $[IO_3^-] = 7.69 \times 10^{-3}$ M; $[La^{3+}] = 2.2 \times 10^{-5}$ M; $[K^+] = 0.0769$ M; $[NO_3^-] = 0.0692$ M.
   2. a) $\mu = 0.035$
      b) $a_{Ca2+} = 2.5 \times 10^{-3}$
   3. f) $K_{sp}' = 3.8 \times 10^{-8}$; $S_{PbI2} = [Pb^{2+}] = 2.1 \times 10^{-3}$ M
   4. $S_{PbI2} = 6.0 \times 10^{-4}$ M (approx); 6.0×10^{-4} (exact). Input data indicates only 2 significant figures.
   5. a) pH = 12.699
      b) pH = 12.607