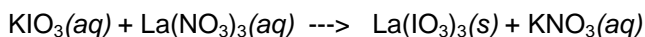


Problem Set 4. Ionic Strength and Equilibrium. Answer Sheet.

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)



- write the balanced net ionic equation.
 - 50.0 mL of a 0.100M solution of KIO_3 is added to 15.0 mL of 0.100 M $\text{La}(\text{NO}_3)_3$. 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,
- calculate the ionic strength.
 - 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.
- Write the chemical equation corresponding to K_{sp} .
 - Write the defining expression for the thermodynamic solubility product constant, K_{sp}° .
 - Write the defining expression for the conditional solubility product constant, K_{sp}' .
 - Write the mathematical relation defining activity of the lead ion in terms of its concentration and activity coefficient.
 - Based on your answers above, derive a relationship for K_{sp}' in terms of K_{sp}° and activity coefficients.
 - Calculate the value of K_{sp}' and the molar solubility of the lead iodide, given that $K_{\text{sp}}^\circ = 7.9 \times 10^{-9}$. (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 $\text{Pb}(\text{NO}_3)_2$, taking ionic strength effects into account.
5. The fundamental definition of pH is $\text{pH} = -\log(a_{\text{H}^+})$. Calculate the pH of 0.0500 M NaOH,
- ignoring activity coefficients (i.e., use $\text{pH} = -\log[\text{H}^+]$)
 - taking activity coefficients into account.

Answers

- $[\text{IO}_3^-] = 7.69 \times 10^{-3} \text{ M}$; $[\text{La}^{3+}] = 2.2 \times 10^{-5} \text{ M}$; $[\text{K}^+] = 0.0769 \text{ M}$; $[\text{NO}_3^-] = 0.0692 \text{ M}$.
- $\mu = 0.035$
 - $a_{\text{Ca}^{2+}} = 2.5 \times 10^{-3}$
- $K_{\text{sp}}' = 3.8 \times 10^{-8}$; $S_{\text{PbI}_2} = [\text{Pb}^{2+}] = 2.1 \times 10^{-3} \text{ M}$
- $S_{\text{PbI}_2} = 6.0 \times 10^{-4} \text{ M}$ (approx); 6.0×10^{-4} (exact). Input data indicates only 2 significant figures.
- pH = 12.699
 - pH = 12.607