Homework Assignment 3
CE 59700 008, Fall 2009

1. Draw a diagram that shows the solubility of $Cd(OH)_{2,s}$ as a function of solution pH, and that also shows the concentration of other cadmium hydroxide complexes in a saturated solution. From inspection of your graph, at what pH does $Cd(OH)_{2,s}$ have minimum solubility?

	Reactions:	Equilibrium Constant
1.	$Cd(OH)_{2,s} \leftrightarrow Cd^{2+} + 2OH^-$	$K_{sp} = 2 \times 10^{-14}$
2.	$Cd^{2+} + OH^- \leftrightarrow Cd(OH)^+$	$K_1 = 10^{6.08}$
3.	$Cd(OH)^+ + OH^- \leftrightarrow Cd(OH)_{2,aq}$	$K_2 = 10^{2.62}$
4.	$Cd(OH)_{2,aq} + OH^- \leftrightarrow Cd(OH)_3^-$	$K_3 = 10^{-0.32}$
5.	$Cd(OH)_3^- + OH^- \leftrightarrow Cd(OH)_4^{2-}$	$K_3 = 10^{0.04}$

2. With the formation constants provided below, find the concentrations of all copper species in water at pH = 6 and at pH = 7, with a total soluble copper concentration of 10^{-6} M.

	Reactions:	Equilibrium Constant
1.	$Cu^{2+} + OH^- \leftrightarrow Cu(OH)^+$	$\beta_1 = 10^{6.3}$
2.	$Cu^{2+} + 2\ OH^- \leftrightarrow Cu(OH)_{2,aq}$	$\beta_2 = 10^{12.8}$
3.	$Cu^{2+} + 3\ OH^- \leftrightarrow Cu(OH)_3^-$	$\beta_3 = 10^{14.5}$
4.	$Cu^{2+} + 4\ OH^- \leftrightarrow Cu(OH)_4^{2-}$	$\beta_3 = 10^{16.4}$

3. A solution contains 2×10^{-3} M Ca^{2+} and 3×10^{-4} M Mg^{2+}. The Formation constants for $CaEDTA^{2-}$ and $MgEDTA^{2-}$ are $10^{10.6}$ and $10^{8.7}$, respectively. Calculate:
a) The concentration of $MgEDTA^{2-}$ after the addition of 1.5×10^{-3} M $EDTA^{4-}$ to the solution.
b) The concentration of $MgEDTA^{2-}$ after the addition of 2.0×10^{-3} M $EDTA^{4-}$ to the solution. Does the presence of Mg^{2+} significantly interfere with the determination of Ca^{2+} by the $EDTA^{4-}$ titration method?

4. A water has an initial Ca^{2+} concentration of 2 mM, and the total concentration of inorganic carbon in solution is 20 mM. It is desired to reduce $[Ca^{2+}]$ to 0.2 mM by precipitation of $CaCO_{3,s}$. What minimum pH would be required to effect this removal, and what would be the final molar concentration of inorganic dissolved carbon? The solubility product of $CaCO_{3,s}$ is $K_{sp} = 5 \times 10^{-9}$.