CEE 543 Aut 2012 HW#8

1. Prepare a $\log c$ – pH diagram for a solution of 3×10^{-4} *M* $CuCl_2$, 10^{-3} *M* NH_4Cl, and 5×10^{-4} *M* $Ca(OH)_2$, showing all Cu-containing species present at concentrations greater than 10^{-6} *M*.

   (a) Find the pH of the solution.
   (b) What partial pressure of ammonia is in equilibrium with the solution in part (a)?
   (c) Prepare a $\log c$ - pH diagram for the solution if it equilibrates with a gas phase containing ammonia at a partial pressure of $10^{-5.5}$ atm.

2. A wastewater contains the following constituents:

Total ferrous iron [*TOT*Fe(II)]	2.0 mg/L
*TOT*Ca	65 mg/L
TOTPO_4-P	10 mg/L
TOTNH_4-N	140 mg/L
Alkalinity	2.5 meq/L
pH	7.5
Ionic Strength	$10^{-2.0}$

   (a) Find the ion activity products of the following solids that might precipitate in the solution, based on the precipitation reactions as they are modeled in Visual Minteq: $Ca(HPO_4)$; $Ca_3(PO_4)_2$(*am*1); $Fe(OH)_2$(*am*); hydroxyapatite; and vivianite.

   (b) What is the value of log *K* associated with the solid vivianite in the default Visual Minteq database, what reaction does it apply to, and what is the corresponding, conventional value of $\log K_{s0}$ for the solid?

   (c) Which of the solids considered in part (a) are supersaturated in the initial solution?

   (d) Which solid(s) is/are present at equilibrium, and what is the equilibrium composition of the solution?

3. Consider a treated domestic wastewater containing 12 mg/L PO_4-P and with an ionic strength of 0.007. You wish to reduce the P concentration to 0.2 mg/L by precipitation of $AlPO_4(s)$, with $pK_{s0} = 22.5$.

   (a) Prepare a $\log c$ - pH diagram showing curves for the concentration of PO_4^{3-} in the untreated and treated solutions. On the same diagram, show the Al^{3+} activity that would cause the PO_4^{3-} concentration in each solution to be in equilibrium with $AlPO_4(s)$.

   (b) Alum [$Al_2(SO_4)_3 \cdot 14H_2O$] is added to the initial solution at a dose corresponding to $10^{-3.0}$ M *TOT*Al. Add a line to the diagram prepared in part (a) representing the Al^{3+} concentration as a function of pH immediately after the alum dissolves, before any solid forms. (Hydrolysis and complexation reactions are typically much faster than precipitation reactions.) In which pH range(s) is $AlPO_4(s)$ supersaturated?

(c) How much $Al_2(SO_4)_3 \cdot 14H_2O$ (in mg/L) must be added to the original solution to achieve the treatment goal, if the pH is well-buffered at 7.5? Keep in mind that one Al ion precipitates for each PO_4 ion removed. For now, ignore possible precipitation of aluminum hydroxide and aluminum oxide solids.

(d) Compute the Al^{3+} concentration that would be in equilibrium with gibbsite [a crystalline form of $Al(OH)_3(s)$] at pH 7.5 in the original solution. Discuss the consequences of this result for your answer to parts (b) and (c).