Problem Set #3

Chem M3LC - Fall 2017.

*You do not need a spreadsheet to complete any of these questions.

Question 1 – Electrochemistry

Consider the following electrochemical cell:

$$Pt \mid Tl^{3+}(5.89 * 10^{-4}\ M), Tl^{+}(3.45 * 10^{-3}\ M) \parallel Ag^{+}(8.75 * 10^{-4}\ M) \mid Ag$$

a) Write down the two half cell reactions (as reductions) and the overall reaction for this electrochemical cell.
b) Calculate the potential that you would expect to measure across this electrochemical cell. Assume room temperature and use (0.0592/n)*log(x) for your Nernst Equations.
c) Is this cell electrolytic or galvanic?

Question 2 – EDTA Titrations

Calculate pNi (= -log[Ni^{2+}]) at the equivalence point of a titration of 50.00 ml of 1.75 x 10^{-3}M Ni^{2+} by a 1.75 x 10^{-3}M EDTA solution. Both solutions are buffered to a pH of 10.0, where the alpha fraction for Y^{4-} is 0.355. For the NiY^{2-} complex, log K_f = 18.62.

Question 3 – Precipitation Separation

MnS is a sparingly soluble solid in aqueous solution:

$$MnS_{(s)} \rightarrow Mn^{2+} + S^{2-} \qquad K_{sp} = 3.00 \times 10^{-11}$$

FeS is also a sparingly soluble solid in aqueous solution:

$$FeS_{(s)} \rightarrow Fe^{2+} + S^{2-} \qquad K_{sp} = 8.00 \times 10^{-19}$$

Consider a solution that has both Mn^{2+} and Fe^{2+} each at a concentration of 1.00 mM. We can separate these two varying the pH because the sulfide ion (S^{2-}) is the dianion of the diprotic acid H_2S (pK_1 = 7.01 ; pK_2= 13.89). Given a total sulfide concentration of 0.100 M, find the following:

a) At what pH will FeS(s) begin to precipitate?

b) At what pH will MnS(s) begin to precipitate?

c) What is the [Fe^{2+}] in solution at the pH you calculate in part b? What percentage of the Fe^{2+} remains in solution at that pH?