Name: _____

Chem 2113 Test 3 Spring 2005

Questions are worth 25 points each. OMIT ONE QUESTION by clearly writing OMIT in the space provided for your work. If you fail to mark OMIT on a question I will omit the last question of the test. Show your work and circle your answers for full credit.

1. Consider the following electrochemical cell:

   $Pt(s) \mid Fe^{2+}$ (0.750M), Fe^{3+} (1.50×10^{-4}M) $\parallel CrO_4^{2-}$ (4.22×10^{-6} M), Ag_2CrO_4 (s) $\mid$ Ag

   a) Write the cathodic ½ reaction, and calculate the ½ cell potential (vs. the SHE) for the cathode.

   b) Write the anodic ½ reaction, and calculate the ½ cell potential (vs. the SHE) for the anode.

   c) Write the overall reaction, and calculate the overall cell potential. Is this cell electrolytic or voltaic as written? Explain.

   d) Determine the overall cell potential at equilibrium.

   e) What is the equilibrium constant for the reaction in (c)?

2. Consider the titration of 50.0 mL of 0.075 *M* Sn^{2+} with 0.030 *M* MnO_4^- in an acidic solution.

a) Write the equation for the reaction that occurs between Sn^{2+} and MnO_4^-.

For the following points, calculate the cathodic ½ cell potential upon the addition of the specified volume of titrant. If necessary, assume $[H^+] = 1.00$ *M* for all points.

b) After 10.00 mL of titrant is added;

c) After 25.0 mL of titrant is added;

d) After 50.0 mL of titrant is added;

e) After 75.0 mL of titrant is added.

3. The amount of 'chlorine' in bleach can be determined iodometrically. The active ingredient in bleach is sodium hypochlorite (NaClO). The hypochlorite ion is actually the bleaching agent, and is reduced by the iodide ion (I^-) in an acidic solution to form Cl^- and I_3^-. The triiodide ion is subsequently reacted with a standard thiosulfate ($S_2O_3^{2-}$) solution.

   Write the reactions that occur - both the reaction of iodide with sodium hypochlorite and the reaction of the triiodide ion with thiosulfate.

   A 1.851 g sample of bleach is obtained, diluted to 125 mL, and reacted with an excess of iodide in an acidic solution. The liberated triiodide ion is then titrated with 41.27 mL of 0.1197 M thiosulfate solution to the starch-iodide endpoint. Calculate the mass percent for sodium hypochlorite (MW = 74.441) in the sample of bleach.

4. The concentration of hydrogen peroxide (H_2O_2) can be determined by the titration of a sample with a standard permanganate solution in a strongly acidic solution.

   a) Write the balanced chemical equation for the reaction of H_2O_2 with MnO_4^- in a strongly acidic solution. [When hydrogen peroxide is oxidized it forms bubbles, which contain the O_2 gas that is released by the reaction.]

   b) A 25.00 mL volume of a commercial hydrogen peroxide solution was diluted to 250.0 mL in a volumetric flask. Then 25.00 mL of this diluted solution was mixed with 200 mL of water and 20 mL of 3M sulfuric acid. This solution was then titrated with 0.02123 *M* permanganate solution. The first pink color was observed after 27.72 mL titrant was added to the solution. Determine the molarity of the commercial H_2O_2.

5. Calculate the standard reduction potential for the following ½ reaction:

$$AgI(s) + e^- \rightleftharpoons Ag(s) + I^- \qquad K_{sp} \text{ for AgI is } 8.3 \times 10^{-17}$$

Calculate the equilibrium constant for the following reaction:

$$PbSO_4 \rightleftharpoons Pb^{2+} + SO_4^{2-}$$

Half-Reaction	E°, V	Formal Potential, V
Iron		
$Fe^{2+} + 2e^- \rightleftharpoons Fe(s)$	-0.440	
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.771	0.700 in 1M HCl; 0.732 in 1M $HClO_4$; 0.68 in 1M H_2SO_4; 0.71 in 1M HCl, 0.72 in 1M $HClO_4$, H_2SO_4
$Fe(CN)_6^{3-} + e^- \rightleftharpoons Fe(CN)_6^{4-}$	+0.36	0.71 in 1M HCl; 0.72 in 1M $HClO_4$, H_2SO_4
Lead		
$Pb^{2+} + 2e^- \rightleftharpoons Pb(s)$	-0.126	-0.14 in 1M $HClO_4$; -0.29 in 1M H_2SO_4
$PbO_2(s) + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$	+1.455	
$PbSO_4(s) + 2e^- \rightleftharpoons Pb(s) + SO_4^{2-}$	-0.350	
Manganese		
$Mn^{2+} + 2e^- \rightleftharpoons Mn(s)$	-1.180	
$Mn^{3+} + e^- \rightleftharpoons Mn^{2+}$		1.51 in 7.5M H_2SO_4
$MnO_2(s) + 4H^+ + 2\,e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+1.23	
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.51	
$MnO_4^- + 4H^+ + 3e^- \rightleftharpoons MnO_2(s) + 2H_2O$	+1.695	
$MnO_4^- + e^- \rightleftharpoons MnO_4^{2-}$	+0.564	
Silver		
$Ag^+ + e^- \rightleftharpoons Ag(s)$	+0.799	0.228 in 1M HCl; 0.792 in 1M $HClO_4$; 0.77 in 1M H_2SO_4
$AgBr(s) + e^- \rightleftharpoons Ag(s) + Br^-$	+0.073	
$AgCl(s) + e^- \rightleftharpoons Ag(s) + Cl^-$	+0.222	0.228 in 1M KCl
$Ag(CN)_2^- + e^- \rightleftharpoons Ag(s) + 2CN^-$	-0.31	
$Ag_2CrO_4(s) + 2e^- \rightleftharpoons 2Ag(s) + CrO_4^{2-}$	+0.466	
$Ag(S_2O_3)_2^{3-} + e^- \rightleftharpoons Ag(s) + 2S_2O_3^{2-}$	+0.017	
Sulfur		
$S_4O_6^{2-} + 2e^- \rightleftharpoons 2\,S_2O_3^{2-}$	+0.08	
$S_2O_8^{2-} + 2e^- \rightleftharpoons 2\,SO_4^{2-}$	+2.01	
Tin		
$Sn^{2+} + 2e^- \rightleftharpoons Sn(s)$	-0.136	-0.16 in 1M $HClO_4$
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+0.154	0.14 in 1M HCl