Name: ____________________

Chem 2113 Test 3 Fall 2008

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:

$$Pb(s) \mid Pb^{2+} (1.50 \times 10^{-5} M) \mid\mid Sn^{2+} (0.250 M) \mid Sn(s)$$

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 0.10 *M* Ti^{3+} with 0.020 *M* MnO_4^- in an acidic solution.

   a) Write the equation for the reaction that occurs between Ti^{3+} 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*.

   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. Consider the titration of 50.0 mL of 0.100 *M* Fe^{2+} with 0.025 *M* $Cr_2O_7^{2-}$ in an acidic solution.

   a) Write the equation for the reaction that occurs between Fe^{2+} and $Cr_2O_7^{2-}$.

For the following points, calculate the cathodic ½ cell potential upon the addition of the specified volume of titrant. If necessary, assume $[H^+]$ = 0.100 *M*.

   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.

4. The $KClO_3$ in a 0.1279 g sample of an explosive was determined by reaction with 50.00 mL of 0.08930 M Fe^{2+}:

$$ClO_3^- + 6Fe^{2+} + 6H^+ \rightarrow Cl^- + 3H_2O + 6Fe^{3+}$$

When the reaction was complete, the excess Fe^{2+} was back-titrated with 14.93 mL of 0.08361 M Ce^{4+}. Calculate the percentage of $KClO_3$ in the sample.

5. A 30.00-L air sample was passed through an adsorption tower containing a solution of Cd^{2+}, where H_2S was retained as CdS. The mixture was acidified and treated with 10.00 mL of 0.01070 M I_3^-. After the reaction was complete (in which the S^{2-} was converted to solid sulfur and the I_3^- was converted to I^-) , the excess triiodide ion was titrated with 12.85 mL of 0.01344 M thiosulfate.

   Write the reactions that occur - both the reaction of triiodide with S^{2-} and the reaction of the triiodide ion with thiosulfate.

   Calculate the concentration of H_2S in ppm assuming the density of the air is 1.20 g/L.

Half-Reaction	E°, V	Formal Potential, V
Cerium		
$Ce^{4+} + e^- \rightleftharpoons Ce^{3+}$		+1.70 in 1M $HClO_4$; +1.61 in 1M HNO_3; +1.44 in 1M H_2SO_4
Chromium		
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	-0.408	
$Cr^{3+} + 3e^- \rightleftharpoons Cr(s)$	-0.744	
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.33	
Iodine		
$I_2(s) + 2e^- \rightleftharpoons 2I^-$	+0.5355	
$I_2(aq) + 2e^- \rightleftharpoons 2I^-$	+0.615	
$I_3^- + 2e^- \rightleftharpoons 3I^-$	+0.536	
$2IO_3^- + 12H^+ + 10e^- \rightleftharpoons I_2(aq) + 6H_2O$	+1.178	
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
$MnO_2(s) + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+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	
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	
Titanium		
$Ti^{3+} + e^- \rightleftharpoons Ti^{2+}$	-0.369	
$TiO^{2+} + 2H^+ + e^- \rightleftharpoons Ti^{3+} + H_2O$	+0.099	
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