



2. Consider the titration of 50.0 mL of 0.075 M  $\text{Sn}^{2+}$  with 0.030 M  $\text{MnO}_4^-$  in an acidic solution.
- a) Write the equation for the reaction that occurs between  $\text{Sn}^{2+}$  and  $\text{MnO}_4^-$ .

For the following points, calculate the cathodic  $\frac{1}{2}$  cell potential upon the addition of the specified volume of titrant. If necessary, assume  $[\text{H}^+] = 1.00 \text{ M}$  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.

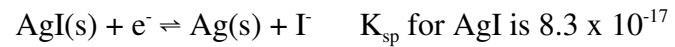
3. The amount of 'chlorine' in bleach can be determined iodometrically. The active ingredient in bleach is sodium hypochlorite ( $\text{NaClO}$ ). The hypochlorite ion is actually the bleaching agent, and is reduced by the iodide ion ( $\text{I}^-$ ) in an acidic solution to form  $\text{Cl}^-$  and  $\text{I}_3^-$ . The triiodide ion is subsequently reacted with a standard thiosulfate ( $\text{S}_2\text{O}_3^{2-}$ ) solution.

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

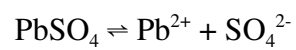
A 1.851 g sample of bleach is obtained, diluted to 125 mL, and reacted with an excess of iodide in an acidic solution. The liberated triiodide ion is then titrated with 41.27 mL of 0.1197 M thiosulfate solution to the starch-iodide endpoint. Calculate the mass percent for sodium hypochlorite (MW = 74.441)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

4. The concentration of hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) 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  $\text{H}_2\text{O}_2$  with  $\text{MnO}_4^-$  in a strongly acidic solution. [When hydrogen peroxide is oxidized it forms bubbles, which contain the  $\text{O}_2$  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  $\text{H}_2\text{O}_2$ .

5. Calculate the standard reduction potential for the following  $\frac{1}{2}$  reaction:



Calculate the equilibrium constant for the following reaction:



<u>Half-Reaction</u>	<u>E°, V</u>	<u>Formal Potential, V</u>
<b>Iron</b>		
$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}(s)$	-0.440	
$\text{Fe}^{3+} + e^- \rightleftharpoons \text{Fe}^{2+}$	+0.771	0.700 in 1M HCl; 0.732 in 1M HClO <sub>4</sub> ; 0.68 in 1M H <sub>2</sub> SO <sub>4</sub> ; 0.71 in 1M HCl, 0.72 in 1M HClO <sub>4</sub> , H <sub>2</sub> SO <sub>4</sub>
$\text{Fe}(\text{CN})_6^{3-} + e^- \rightleftharpoons \text{Fe}(\text{CN})_6^{4-}$	+0.36	0.71 in 1M HCl; 0.72 in 1M HClO <sub>4</sub> , H <sub>2</sub> SO <sub>4</sub>
<b>Lead</b>		
$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}(s)$	-0.126	-0.14 in 1M HClO <sub>4</sub> ; -0.29 in 1M H <sub>2</sub> SO <sub>4</sub>
$\text{PbO}_2(s) + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Pb}^{2+} + 2\text{H}_2\text{O}$	+1.455	
$\text{PbSO}_4(s) + 2e^- \rightleftharpoons \text{Pb}(s) + \text{SO}_4^{2-}$	-0.350	
<b>Manganese</b>		
$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}(s)$	-1.180	
$\text{Mn}^{3+} + e^- \rightleftharpoons \text{Mn}^{2+}$		1.51 in 7.5M H <sub>2</sub> SO <sub>4</sub>
$\text{MnO}_2(s) + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1.23	
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51	
$\text{MnO}_4^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{MnO}_2(s) + 2\text{H}_2\text{O}$	+1.695	
$\text{MnO}_4^- + e^- \rightleftharpoons \text{MnO}_4^{2-}$	+0.564	
<b>Silver</b>		
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}(s)$	+0.799	0.228 in 1M HCl; 0.792 in 1M HClO <sub>4</sub> ; 0.77 in 1M H <sub>2</sub> SO <sub>4</sub>
$\text{AgBr}(s) + e^- \rightleftharpoons \text{Ag}(s) + \text{Br}^-$	+0.073	
$\text{AgCl}(s) + e^- \rightleftharpoons \text{Ag}(s) + \text{Cl}^-$	+0.222	0.228 in 1M KCl
$\text{Ag}(\text{CN})_2^- + e^- \rightleftharpoons \text{Ag}(s) + 2\text{CN}^-$	-0.31	
$\text{Ag}_2\text{CrO}_4(s) + 2e^- \rightleftharpoons 2\text{Ag}(s) + \text{CrO}_4^{2-}$	+0.466	
$\text{Ag}(\text{S}_2\text{O}_3)_2^{3-} + e^- \rightleftharpoons \text{Ag}(s) + 2\text{S}_2\text{O}_3^{2-}$	+0.017	
<b>Sulfur</b>		
$\text{S}_4\text{O}_6^{2-} + 2e^- \rightleftharpoons 2\text{S}_2\text{O}_3^{2-}$	+0.08	
$\text{S}_2\text{O}_8^{2-} + 2e^- \rightleftharpoons 2\text{SO}_4^{2-}$	+2.01	
<b>Tin</b>		
$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}(s)$	-0.136	-0.16 in 1M HClO <sub>4</sub>
$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	+0.154	0.14 in 1M HCl