Name: ______________________________ Date: ____

AP Chemistry 30 – Lab 14: Redox Titration of Hydrogen Peroxide

Learning Objectives

1. Standardize a solution and conduct a titration
2. Calculate the concentration of an unknown using data and stoichiometric ratios in a redox reaction

Pre-Lab Questions

1. Write a balanced half-reaction for the reduction of permanganate ions to manganese(II) ions in acidic solution. Indicate the oxidation states for manganese in this reaction.
2. Write a balanced half-reaction for the oxidation of hydrogen peroxide to oxygen gas and aqueous hydrogen ions. Indicate the oxidation states for oxygen in this reaction.
3. Write the overall balanced reaction between permanganate and hydrogen peroxide and identify how many electrons are transferred.
4. Write a balanced half-reaction for the oxidation of iron(II) ions to iron(III) ions.
5. Write the overall balanced reaction between permanganate and iron and identify how many electrons are transferred.
6. A sample of oxalic acid, $H_2C_2O_4$ was analyzed using a standardized solution of $KMnO_4$. 25.0 mL of oxalic acid is titrated after heating. 12.30 mL of a 0.0226 M $KMnO_4$ solution was added to the sample when a faint pink colour was observed. The balanced equation for this reaction is:

   $$6\ H^+ (aq) + 2\ MnO_4^- (aq) + 5\ H_2C_2O_4 (aq) \rightarrow 10\ CO_2 (g) + 8\ H_2O (l) + 2\ Mn^{2+} (aq)$$

   a. What does the faint pink colour indicate?
   b. Determine the molarity of the oxalic acid solution.
   c. If the density of the oxalic acid solution is 1.00 g/mL, what was the percentage by mass of oxalic acid in the solution?

Experiment

Part A: Standardization of $KMnO_4$

Perform a titration using potassium permanganate as the titrant and iron(II) sulfate (0.100 M) as the analyte.

1. Measure approximately 1 gram of iron(II) sulfate heptahydrate into a 250-mL Erlenmeyer flask. Record the mass of the solid to at least two decimal places.
2. Add 25.0 mL of distilled water to the sample and swirl the flask to dissolve the solid. Then add 15.0 mL of 3 M sulfuric acid to acidify the solution.
3. Fill the burette with $KMnO_4$ solution. Ensure that there are no air bubbles in the burette.
4. Titrate the iron(II) sample with $KMnO_4$ solution until a faint pink colour persists in the solution. Record the volume of permanganate added.
5. Clean the Erlenmeyer well and repeat the titration.
6. Use the mass of $FeSO_4 \bullet 7H_2O$ and the volume of permanganate to calculate the molarity of the $KMnO_4$ solution. Perform the calculations for each trial, then average the results.

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Part B: Determination of Percentage of H_2O_2

Perform a titration using 10.0 mL of 3% hydrogen peroxide and 10.0 mL of 3.0 M sulfuric acid with the potassium permanganate in the burette. Repeat the titration at least three times, so that you have three titrant volumes within 0.5 mL. Average your permanganate volumes, then determine the percent by mass of hydrogen peroxide in the solution, assuming the density of the solution is 1.00 g/mL.

Discussion

1. Is the calculated percent by mass of H_2O_2 higher or lower than the reported value of 3%? What are the likely causes of any errors? Justify your explanation.
2. Dietary supplements do not undergo the same rigorous approval process as new medications. If you performed a redox titration to determine the percentage of a specific component in a dietary supplement, how might your results differ from a titration with a medication?