Name: ______________________
Period: ___

Lab: Redox Titration

Introduction:
In this experiment, a reduction-oxidation titration between hydrogen peroxide and potassium permanganate will be performed in order to determine the mass percentage of hydrogen peroxide in a commercially available solution.

Hydrogen peroxide (H_2O_2) is a clear, colourless liquid with a variety of industrial and medical uses. In redox reactions, hydrogen peroxide is commonly used as a reducing agent as it is easily oxidized to become oxygen. Potassium permanganate ($KMnO_4$) is a deep purple solution. In redox reactions, the permanganate ion is commonly used as an oxidizing agent. Under acidic conditions, the permanganate ion is reduced to manganese (II). The purple colour of the permanganate ion can be used as an indicator to determine when the titration reaction is complete.

In this experiment, the volume of a standard solution of potassium permanganate required to titrate a sample of hydrogen peroxide solution will be determined. The volume for three trials will be averaged. Since the concentration of potassium permanganate is known, the average volume of potassium permanganate can be used to calculate the moles of potassium permanganate reacting. From the moles of potassium permanganate reacting, the moles of hydrogen peroxide reacting can be determined. The number of moles of hydrogen peroxide can then be used to calculate the mass of hydrogen peroxide (solute) present in the sample solution. From the mass of hydrogen peroxide and the mass of the solution, a percentage composition can be determined and compared to the value reported on the hydrogen peroxide bottle.

Procedure:
(1) Obtain approximately 100 mL of water, 30 mL of sulphuric acid, 20 mL of hydrogen peroxide solution, and 100 mL of potassium permanganate. Record the concentration of the potassium permanganate solution.
(2) Rinse a 50 mL buret with a small amount of potassium permanganate. Using a funnel, fill the buret with potassium permanganate and empty a small amount through the tip to remove any air bubbles. Clamp the buret to a ring stand.
(3) Determine the mass of an empty erlenmyer flask. Record.
(4) Determine the initial reading of the buret and record the volume in the table below (Trial 1).
(5) Place 25 drops of hydrogen peroxide into the Erlenmeyer flask. Determine the mass of the Erlenmeyer flask and the hydrogen peroxide solution and Record. Calculate the mass of the hydrogen peroxide solution.
(6) Add approximately 30 mL of water and 10 mL of sulphuric acid to the hydrogen peroxide solution. (Note: the sulphuric acid is added because the redox reaction requires acidic conditions)
(7) Put the Erlenmeyer flask under the buret and arrange the height of the buret so that it will empty into the flask.
(8) Slowly add the potassium permanganate solution to the Erlenmeyer flask, stirring the flask constantly. As the potassium permanganate solution is added, the colour of the solution in the Erlenmeyer flaks will change purple. To help see the colour change, put a white piece of paper underneath the Erlenmeyer flask. When the colour of the solution in the flask begins to turn purple, add the potassium permanganate drop-by-drop until the solution changes entirely to the lightest shade of purple. The complete colour change indicates that the redox reaction is complete. Determine the final reading of the buret and record the volume in the table below (Trial 1).
(9) Repeat steps 3 – 8 for Trial 2 and Trial 3. (Refill the buret with potassium permanganate if necessary and be sure to record the initial and final volume of the buret for each trial. Clean the Erlenmeyer between each trial.)
(10) Discard the liquid waste in the sink.

Data:

Concentration of $KMnO_4$ = _____ M

Mass of empty Erlenmeyer flask = _____ g

	Trial 1	**Trial 2**	**Trial 3**
Mass of Erlenmeyer flask + Hydrogen Peroxide solution			
Mass of Hydrogen Peroxide solution			
Initial reading of buret (mL)			
Final reading of buret (mL)			
Volume of $KMnO_4$ used (mL)			

Questions:

(1) Determine a balanced chemical equation for the redox reaction between hydrogen peroxide and permanganate ion (note: the reaction takes place under acidic conditions).

For each trial:

(2) (a) Determine the volume of potassium permanganate used (volume used = final volume – initial volume) and record in the table.

(b) From the concentration of potassium permanganate and the volume of potassium permanganate, determine the moles of potassium permanganate reacting.

(c) From the moles of potassium permanganate reacting, determine the moles of hydrogen peroxide reacting.

(d) From the moles of hydrogen peroxide reacting and the molar mass of hydrogen peroxide, determine the mass of hydrogen peroxide (mass solute).

(e) Determine the mass of hydrogen peroxide solution used (mass hydrogen peroxide solution = mass of Erlenmeyer flask + hydrogen peroxide solution - mass of empty Erlenmeyer flaks) and record in the table.

(f) Calculate the percentage composition of hydrogen peroxide in the solution.

$$percentage\ composition = \frac{mass\ solute}{mass\ solution} x100\%$$

(3) Calculate the average percentage composition for the three trials.

Conclusion:

State your result for the percentage composition of hydrogen peroxide in a commercially available solution.

Error Analysis:

Calculate the percent error for your result. Compare the percentage composition to the value reported on a hydrogen peroxide bottle and explain your results. What experimental factors could give a percent composition that is higher than the actual value? What experimental factors could give a percent composition that is lower than the actual value?