Reduction-Oxidation Titration Lab
Chemistry 2
NIVA International School 2010-2011

Thoroughly read the entire procedure before starting the lab.

Note: This lab will be submitted as a formal lab report. All observations must be properly recorded, in pen, on your data sheet (use the back if needed) and submitted with your formal lab report.

The purpose of this lab is to carry out a reduction-oxidation titration between hydrogen peroxide and potassium permanganate in order to determine the mass percentage of hydrogen peroxide in a commercially available solution. This titration will use the permanganate ion (MnO_4^-) as an oxidizing agent. Under acidic conditions, it will reduce to become manganese (II). The deep purple colour of the permanganate ion can be used as an indicator to determine when the titration has reached the endpoint.

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.

Materials:
- 50 mL buret
- Retort stand
- Buret clamp
- Erlenmeyer flask
- 3 - 250 mL beaker
- 4 - 100 mL graduated cylinders

Chemicals:
- Standard $KMnO_4$ Solution
- Hydrogen Peroxide
- 1 M Sulfuric Acid
- Water

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 Erlenmeyer 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. Carry out this process carefully and be particularly aware of how close you are to the endpoint. As the potassium permanganate solution is added, the colour of the solution in the beaker will change purple. To help see the colour change, put a white piece of paper underneath the beaker.

9. 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 on your data sheet.

10. Repeat steps 2-9 twice more to obtain results in triplicate.

11. Dispose of all waste chemicals in the water beaker located in the fume hood. Do not pour any of the solutions from this titration into the sink.

These questions must be answered and attached to your lab report on a separate piece of paper. They can be typed or hand-written, but must be completed neatly and legibly. They will be marked in addition to your formal lab report.

To be clear: You are required to write a formal lab report, and attach your responses to these questions to your report when you submit it.

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).

2.
   a. Determine the average volume of potassium permanganate used on your three trials (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 flask) and record on your data sheet.
   f. Calculate the percentage concentration of hydrogen peroxide as calculated from each trial, and use this to determine the average percentage concentration of the solution.

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

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