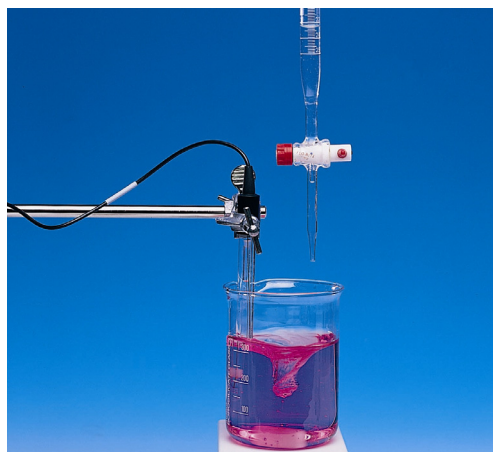


Acid - Base Titration

- ✚ Introduction
- ✚ Equipment
- ✚ Equipment Setup Procedure
- ✚ MultiLog Set Up
- ✚ Experimental Procedure
- ✚ Data Analysis
- ✚ Questions
- ✚ Further Suggestions



Introduction

In aqueous solutions, addition of bases to water leads to an increase in the pH of the solution, while the addition of acids leads to a decrease in the pH. The changes in the pH can be followed using either specific dyes, called - indicators, or a pH electrode. Acids and bases neutralize, or reverse, the action of one another. By adding a known amount of acid to a basic solution, until it completely reacts with it, the amount of the base can be determined. This procedure is called: acid - base titration. During neutralization, acids and bases react with each other to produce ionic substances, called salts.

In this experiment, changes in pH and temperature, occurring while an acid (hydrochloric acid) is added to a base (sodium hydroxide) solution, are followed using a pH electrode and a temperature sensor.


Equipment

- A pH electrode
- A temperature sensor (-25 – 110°C)
- A polystyrene coffee cup
- 50 ml burette pipette.



A glass funnel.
2 grams NaOH
100 ml NHCl solution
Magnetic stirrer
A MultiLog

Equipment Setup Procedure

1. Connect the MultiLog to the serial port of the computer.
2. Turn the MultiLog on.
3. Connect the pH electrode to the I/O 1 port and the temperature sensor to I/O port 2 of the MultiLog.
4. Assemble the equipment as illustrated in figure 1 below.
5. Click  on the bottom of the screen. MultiLab will automatically set up the MultiLog Pro.

MultiLog Set Up

Input 1: pH
Input 2: temperature -25 – 110°C
Rate: 1/sec.
Samples: 5000.

Experimental Procedure

1. Prepare a polystyrene cover to the polystyrene coffee cup. The cover should be flat and larger than the circumference of the coffee cup (see figure 1).
2. Pierce 3 holes in the cover: one for the pH electrode, one for the temperature sensor and one for the glass funnel.
3. Add 50 ml 0.5N NaOH solution to the coffee cup.
4. Place the coffee cup on a magnetic stirrer.
5. Put the cover on the cup.

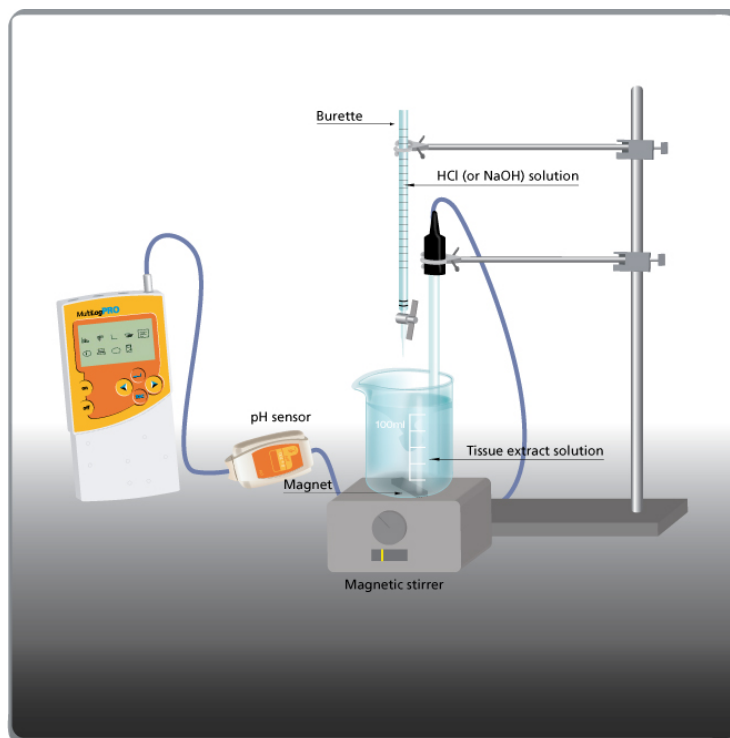



Figure 1

6. click **Run**  on the main toolbar.

Wait till readings from the sensors are stable.

7. Start stirring the NaOH solution in the coffee cup.

8. Add, drop-by-drop, 1N HCl solution from the burette, to the cup, through the glass funnel.

9. Follow changes in pH and temperature registered on the monitor.

10. As the pH just start to change, stop the flow of HCl. Find the volume of HCl added till that point.

11. Renew drop wise flow of HCl. Follow pH changes very carefully.

12. Stop immediately flow of HCl as the pH stabilizes.

Data Analysis

1. Calculate the change in the pH obtained during the neutralization process:

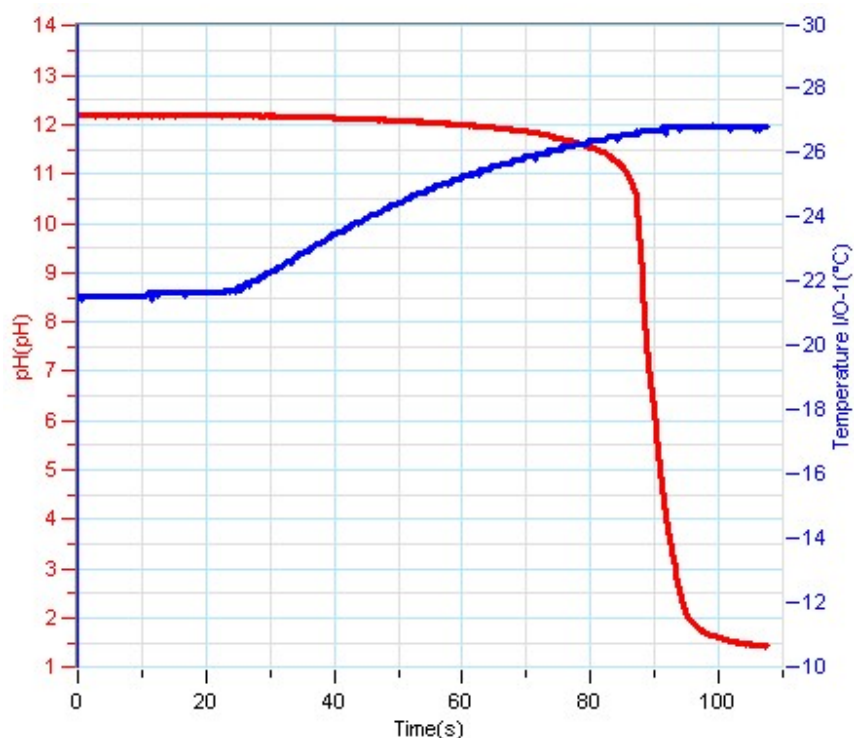
What was the initial pH value? The final value? The difference between the two values?

Tip: Use the cursor to find the appropriate values – click **Display Cursor** on the graph toolbar

2. What was the volume of HCl added till the pH started to change? Compare it with the volume of HCl added till a complete neutralization of NaOH was achieved.
3. Find the time interval between the point of “start of change” in pH and the point of pH “start of stabilization”.
4. Calculate the change in temperature obtained in the process and the time needed to reach the final temperature value.
5. Calculate the heat of reaction: C- water capacity, Δt - temperature change.

Water specific heat capacity at 25 °C is 4.18 (J/g*°C).

An example of the graph obtained in this experiment, is shown below:





Questions

1. Did you observe a fast pH change? Explain the difference in the short time interval needed for the completion of the drastic changes of pH and that of the whole neutralization process.
2. Is the neutralization reaction an exothermic reaction? Base your conclusions on the experiment you performed.
3. Try to assume the results of acid - base reaction at different concentrations of NaOH added to the coffee cup: What will be the pH change in each case? What will be the extent of change in the temperature?
4. What will be the effect of reacting other acids (like, for example, acetic acid) with NaOH?

Further Suggestions

1. React different concentrations of NaOH with a constant concentration of HCl.
2. Calculate unknown concentrations of the titrated NaOH (or HCl): this can be achieved by setting the flow of acid (or base) from the Burette pipette at a constant rate (from the time interval on X axis multiplied by the flow rate, the volume added, can be calculated).
3. Examine the effect of increasing the water and/or the surroundings temperature, on the reaction.
4. Perform acid - base reaction with different types of acids and/or bases: a weak acid with a strong base and vice versa.