Chemistry 101

Chemistry Experiments for the Home

Introduction to Neutralization

I. Objective: To show that bases can neutralize acids. To practice volume measurements. To observe the neutralization of an acid directly (bubble formation) and indirectly (indicator color changes).

II. Discussion: When an acid and a base are mixed together, a chemical reaction occurs. This reaction is called a neutralization reaction. The products of the reaction are a salt and, usually water. The term **neutralization** comes from the fact that one product, water, is neutral, and the other, the salt, is often also neutral.

One such reaction occurs between hydrochloric acid (HCl, muriatic acid or pool acid) and sodium hydroxide (NaOH, lye). It can be written as follows:

$$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

The (aq) means that the substance is dissolved in water to make an aqueous solution. An aqueous solution of table salt is neutral. If just enough sodium hydroxide solution is added to a sample of hydrochloric acid to react completely, the resulting solution is neutral. In practice, a small excess is added, and therefore, the resulting solution would be slightly basic.

In this experiment, the acid used will be acetic acid. Vinegar is a 5 % solution of acetic acid ($HC_2H_3O_2$) in water. Baking soda ($NaHCO_3$, sodium bicarbonate) will be used as the base. The salt produced is sodium acetate.

$$NaHCO_{3\,(aq)} + HC_2H_3O_{2\,(aq)} \rightarrow NaC_2H_3O_{2\,(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

Because the base used is a bicarbonate, we will also generate carbon dioxide gas. Carbon dioxide, while not normally a product of neutralization reactions, is produced when carbonate or bicarbonate bases are used. The baking soda may be used as an aqueous solution, as shown in the above equation, or as a solid. The results will be the same in either case.

Vinegar is acidic. As baking soda is added, the acid is gradually neutralized, until no more remains. The addition of more baking soda makes the solution basic. This neutralization will be monitored by using litmus paper. Litmus paper is red in acidic solutions and blue in basic solutions. Either red or blue litmus paper (or both) may be used to monitor the reaction.

III. Materials: Vinegar, baking soda solution, measuring cup, clear plastic cup, plastic teaspoon, tablespoon, red and/or blue litmus paper, plastic straw or coffee stirrer.

IV. Procedure:

Prepare a baking soda solution by adding 1 level tablespoon of solid baking soda to a cup of water. Stir the mixture until all the baking soda has dissolved.

Measure out 1 tablespoon of vinegar and place it in the plastic cup.

Use your straw or coffee stirrer to transfer a small drop of vinegar onto the litmus paper. Observe the color of the wet paper, and record it in the **Table** below. Indicate in the Table whether the vinegar is acidic or basic.

Add 1 teaspoon of the baking soda solution to the plastic cup containing the vinegar. Observe what occurs. Indicate in the Table whether or not bubbles are formed. Swirl the cup until no more bubbles form.

Use your straw or coffee stirrer to transfer a small drop of the reaction mixture onto a piece of litmus paper. Observe the color of the wet paper, and record it in the Table. Indicate in the Table whether the vinegar solution is acidic or basic.

Repeat steps 4 and 5, until a total of 6 teaspoons of baking soda solution have been added.

Predict the color of litmus paper moistened with the baking soda solution alone. Record your prediction in the Table.

Put a drop of the baking soda solution on the litmus paper, and record the color that you observe in the Table.

When you are finished with the experiment, all chemicals may be poured down the sink.

Data Table

Teaspoons of baking soda solution	Bubbles (yes or no)	Color of the litmus paper	Is the solution acidic or basic?
0			
1			
2			
3			
4			
5			
6			
Predicted color of the litmus with baking soda solution:			
Experimental color of the litmus with baking soda solution:			

V. Questions:

What is the color of litmus in acidic solutions? _____

What is the color of litmus in basic solutions? _____

Describe what happened to the vinegar solution as the baking soda solution was added.

Do you think that the change in color of the litmus paper, and the lack of bubbles when more baking soda was added were related?

Explain your answer.

Write the equation representing the reaction of sulfuric acid and sodium hydroxide.

Write the equation representing the reaction of nitric acid and magnesium hydroxide.

Write the equation representing the reaction of phosphoric acid and aluminum hydroxide.