

Objectives

Complete an experiment to react milk of magnesia with vinegar to study acid-base chemistry, chemical equilibrium, solubility, and heat of neutralization. Milk of magnesia (MOM), which still finds wide use as a laxative and antacid, is a suspension of magnesium hydroxide in water. The suspended particles of magnesium hydroxide give MOM its characteristic milky-white appearance. Although the particles are clearly visible, some magnesium hydroxide does dissolve in water, making milk of magnesia basic.

Outcomes

In the experiment, students add acid to MOM and observe the surprising pH changes during the reaction. Universal indicator added to the solution will show the pH changes.

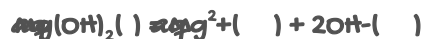
Like any acid-base reaction, a base, in this case magnesium hydroxide, reacts with an acid, HX, to form a salt, MgX_2 , and water:



Students will use vinegar ($C_2H_3O_2H$) as the acid. The balanced chemical equation for this reaction is:



The amount of magnesium hydroxide in solution and therefore available to react is determined by the equilibrium shown below:



Le Châtelier's principle

This equilibrium lies far to the left, leaving very little magnesium hydroxide in solution. As acid reacts with the hydroxide ions, removing them from solution, more magnesium hydroxide dissolves. This shift is an example of Le Châtelier's principle. This process continues until all the magnesium hydroxide is neutralized, leaving only soluble magnesium acetate and water. The solution will be clear and will have the color of the universal indicator solution at that pH.

You may also notice a change in temperature of the mixture after adding the acid. This change is the heat of neutralization that accompanies acid-base reactions. You can feel the temperature change by touching the outside of the beaker.

Materials

- Beaker, 600 mL
- Milk of Magnesia, 20 mL
- Water, 200 mL (deionized, distilled, or tap water)
- Bogen Universal Indicator Solution
- Vinegar, 10 mL
- Stir Plate
- Stirring Bar
- Plastic Pipet, 1 mL
- Hydrochloric acid, 3 M, 25 mL (optional)

Procedure

1. In a 600-mL beaker, mix 50 mL of milk of magnesia with 200 mL of water.
2. Add 1 mL Bogen universal indicator solution to the beaker. The solution will turn violet, indicating a pH of at least 10.
3. Using a pipet, add 1 mL vinegar to the beaker. The solution turns yellow (acidic) then green, blue, and violet (basic) as the magnesium hydroxide neutralizes the acid and then as the magnesium hydroxide dissolves. **Tip:** Slowly add ice to the mixture to slow the reaction.
4. Continue adding vinegar in 1-mL increments to observe the color changes.
5. Feel the outside of the beaker. It will be warm. As with any acid-base experiment, the reaction of magnesium hydroxide and vinegar generates heat.

Optional

To neutralize the MOM quickly, students will need a stronger acid than vinegar. Use about 75 mL of 3 M hydrochloric acid. The solution will turn clear when neutralized.

Extensions

1. Discuss the differences between suspensions, colloids, and solutions.