MOM and pH

Neutralization Reactions

Concepts

- Buffers
- Acid—base chemistry
- LeChâtelier's principle

Background

Have you ever had to take an antacid such as milk of magnesia (MOM), Maalox™, or Gaviscon™? Pretty awful stuff, thick and gooey and no matter how they flavor it, it just doesn't taste good. How do liquid antacids work? This experiment will give you a chance to find out, while reviewing solubility concepts and acid–base chemistry.

Your stomach contains an acid mixture, roughly equivalent to 0.1 M hydrochloric acid, HCl (aq). The active ingredients in the antacids are primarily magnesium and/or aluminum hydroxides and carbonates. Among the other ingredients are compounds that help the hydroxide and carbonates adhere to the lining of your esophagus. As long as the acid remains in your stomach, there is no discomfort; it is only when the acid rises up into the esophagus that you feel the burning sensation. The solubility rules help you to understand why the products are so thick. They are suspensions of whatever active ingredients a particular brand employs. Due to hydroxides low solubility, there will only be a small amount of hydroxide ion present in solution at any given time.

In your body, the acid is already present; drinking the antacid introduces the slurry of metal hydroxide, only a portion of which is present as dissolved ions. The hydroxide ions in solution react immediately with hydrogen ions from the stomach acid. This causes more of the compound to dissociate so that more hydroxide ions are available for neutralization. The process continues either until the acid is neutralized or until all of the metal hydroxide is consumed.

To better illustrate the chemistry involved, you will reverse the order described above. You will start with the antacid slurry and add acid to it. To make the results easier to follow, you will use an acid solution that is much stronger than what is in your stomach. The pH will be monitored with a CBL, using a Vernier pH sensor.

Materials

Hydrochloric acid, HCl, 3 M, 5-10 mL
Magnesium hydroxide solution, $Mg(OH)_2$, 20 mL
Beaker, 250 mL
CBL-2
Magnetic stirrer
pH sensor
Pipet, graduated
Single Buret clamp
Stir bar
Support stand
Universal indicator solution, 1 mL
Water, distilled or deionized

Safety Precautions

Hydrochloric acid is toxic by ingestion and inhalation; severely corrosive to skin and eyes. Universal indicator is an alcohol-based flammable liquid. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

Preparation

Design a Data Table with the following headings

Trial	Initial pH	Minimum pH	Time to min. pH	10 second pH	Final pH	Remarks	CBL Set-Up

1. Follow the instructions for your graphing calculator, prepare the CBL to collect pH readings (ChemBio for CBL;

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DataMate for CBL2 or LabPro).

2. Choose Set Up Probes from the Main Menu. Make the appropriate selections for one probe in Channel 1, to measure pH.
3. When the calculator returns you to the Main Menu, select option 2: Collect Data, followed by Time Graph. You will be asked for Time Between Samples: 0.1 [ENTER]; then for the number of samples: 200 [ENTER].
4. The next screen will give you a summary of your selections; [ENTER].
5. Next, you will be asked if you want to keep the time set up; you do—[ENTER].
6. When the calculator asks you for Y Minimum and Y Maximum, select 1.0 and 12.0, respectively.
7. For Y scale, enter 0.1. This will allow you to collect your data as a function of time and will give you a total run time of 20 seconds per run; you will conduct at least 5 runs.

Procedure

1. A sketch of the apparatus is shown in Figure 1. Use a wooden, clothes pin-type clamp to hold the pH probe in place.

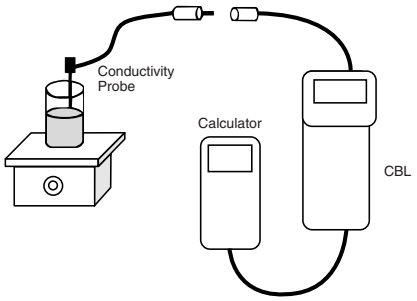

Figure 1.

2. Connect the pH amplifier and pH probe to the CBL. Remove the probe from the bottle in which it is stored.
3. Place 20 mL of liquid antacid in the beaker, with 100 mL of distilled water.
4. Place the stirring bar in the beaker with the mixture. Be sure the tip of the pH probe is covered by the antacid-water mixture but is high enough that the stirring bar will not hit it. If necessary, add distilled water to the beaker to give added depth.
5. Turn on the stirrer and adjust the speed to as high as possible without causing a vortex (whirlpool). Note: Recall that each complete run of the experiment is only 10 seconds long, so be sure both partners are ready.
6. As one partner presses [ENTER], the other waits for one second (estimated) then injects 2.0 mL of 10% hydrochloric acid into the beaker. When the 10 seconds have expired, the CBL screen will read, Done. Note: If stirring is done manually, the person adding the acid should also press [ENTER].
7. The calculator will tell you where the time and pH data are stored (probably L1 and L2). Accept this by pressing [ENTER]. The calculator will then display the graph that was produced during the experiment.
8. When you pressed [ENTER], the pH reading dropped briefly to (about) 7. This is a false reading and should be ignored. Use the right arrow on your calculator to trace along the curve until you reach the highest pH that precedes the sharp drop. This is taken to be the pH at the instant that you added the hydrochloric acid, and is recorded under "Initial pH" in the data table.
9. Continue tracing along the curve until you get to the lowest pH value. Record this value and the number of readings between the initial and lowest pH values. Since each new reading represents 0.1s, you can determine the time elapsed during the sharp drop in pH.
10. Finally, trace all the way to the end of the curve to get the highest pH reached in the 10-second run. Record this value and the current pH reading. (By the time you take this pH reading, the value displayed by the CBL unit can be assumed to be "final.")
11. Repeat the experiment until you have 5 trials or until the mixture in the beaker turns clear, whichever comes first.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. Check the CBL reading to determine the pH. If it is between 6 and 8, the mixture is sufficiently neutral that it can be flushed down the drain with water according to Flinn Suggested Disposal Method #26b. If the pH is outside the allowable range, adjust it as necessary, using acid and antacid from the experiment.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Form and function

Content Standards: Grades 5–8
Content Standard A: Science as Inquiry; understandings about scientific inquiry
Content Standard B: Physical Science; properties and changes of properties in matter
Content Standard C: Life Science; structure and function in living systems

Content Standards: Grades 9–12
Content Standard A: Science as Inquiry; understandings about scientific inquiry
Content Standard B: Physical Science; structure and properties of matter, chemical reactions
Content Standard C: Life Science; structure and function in living systems

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *MOM and pH* activity, presented by John Little, is available in *Neutralization Reactions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *MOM and pH* are available from Flinn Scientific, Inc.

Catalog No.	Description
M0122	Magnesium Hydroxide Solution, 500 mL
TC1503	pH Sensor
H0034	Hydrochloric Acid, 3 M, 500 mL
TC1525	CBL-2
U0009	Universal Indicator Solution, 35 mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.