16C – ANTACIDS: AN INQUIRY STUDY

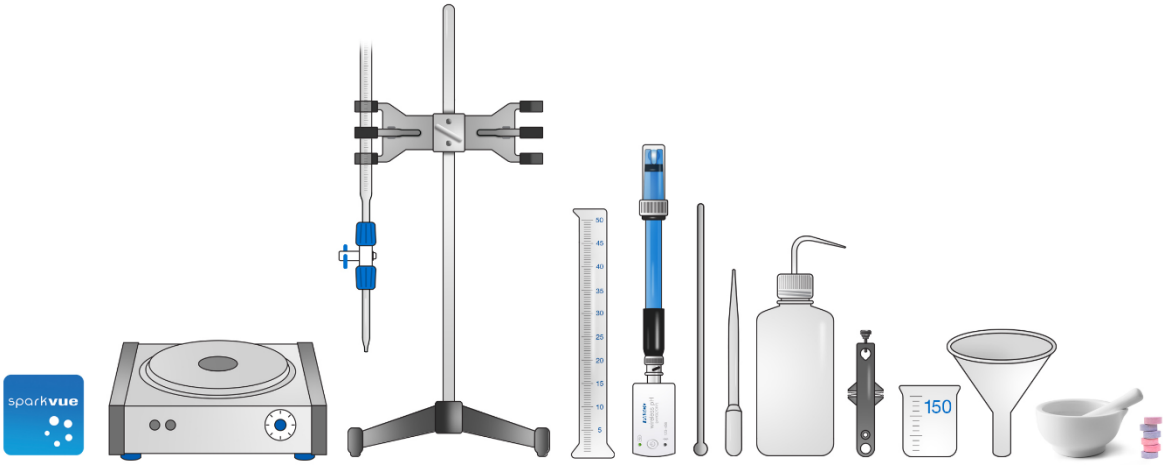
INQUIRY

How do antacids settle an upset stomach?

MATERIALS

- Device with SPARKvue software
- pH sensor
- Electrode support
- Graduated cylinder, 50-mL
- Beaker, 150-mL
- Burette, 50-mL (readability: 0.01 mL)
- Burette clamp
- Funnel to fit burette
- Magnetic stirrer with magnet
  or Heater stirrer* with magnet
- Stirring rod
- Pipet, with 1 mL graduations
- Mortar and pestle
- Ring stand
- 0.1 M HCl, 50 mL
- 0.1 M NaOH, 100 mL
- Phenolphthalein indicator solution
- pH 4 and pH 10 buffer solutions
- 2-3 brands of antacid tablets
- Wash bottle with distilled water

* *Your instructor may not require a heater stirrer*



BACKGROUND

Antacids are a class of drugs that neutralize stomach acid. Stomach acid consists of hydrochloric acid (HCl) which breaks down food for digestion and protects us from harmful bacteria. The dietary choices we make and digestive illnesses may cause our bodies to produce too much hydrochloric acid. This results in an upset stomach.

You will investigate how antacid tablets work and determine how much of the active ingredient is found in one tablet using a *back titration* method. A back titration allows you to indirectly determine the concentration of a substance by performing two reactions. The first reaction occurs between the active ingredient in the antacid tablet and an excess of acid. The second reaction is a titration that allows you to determine how much acid was left over after the acid-antacid reaction. From there, you can determine how much acid was neutralized by the antacid and calculate the amount of active ingredient present in the antacid.

SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.
- Clean up acid spills with sodium bicarbonate solution.
- Clean up base spills with dilute acetic acid solution.

PROCEDURE

1. Open SPARKvue.
2. Open the 16C Antacids An Inquiry Study lab file in SPARKvue.
3. Use the Bluetooth icon to connect the pH sensor. Calibrate the sensor with pH 4 and 10 buffer solutions.
4. Use the mortar and pestle to crush an antacid tablet into a fine powder.
5. Measure between 0.10 to 0.20 g of the powdered antacid tablet. Record the powdered antacid mass in the table. Dispose of the unused powder according to your teacher's directions and clean the mortar and pestle.
6. Add 25.0 mL of 0.10 M HCl to the 150-mL beaker. Use the stirring rod to dissolve the measured antacid powder in the solution.

Note: If your antacid contains carbonate or bicarbonate you may see bubbling as carbon dioxide is produced. To drive off carbon dioxide and help dissolve the antacid, heat the mixture in the beaker to approximately 70 °C for a few minutes. Then allow the mixture to cool before moving to the next step.

7. Rinse along the inside of the beaker with distilled water. Continue adding distilled water to the 150-mL beaker until the total volume is about 70 mL.
8. Add a magnetic stir bar to the beaker and place it on the magnetic stirrer.
9. Use the ring stand and electrode support to suspend the pH sensor into the solution. Make sure the glass bulb of the pH sensor is covered by the solution. Position the sensor near the edge of the beaker to keep it safely away from the magnetic stir bar.
10. Add 2-3 drops of phenolphthalein indicator.
11. For this experiment, you need to make sure that all the antacid has reacted and that there is excess acid in the beaker. If your solution is pink, it is basic. Fill the graduated cylinder with 50.0 mL of 0.1 M HCl. Use the pipet to transfer HCl from the graduated cylinder to the beaker until the solution is acidic and colorless; keep track of the volume added. Add this extra HCl volume to the initial 25 mL of HCl to get the total volume of acid added to the beaker. Record the total volume of acid added to the beaker in Table 1 on your answer sheet.
12. Rinse the burette with 0.1 M NaOH. Close the burette and use the funnel to help you fill the burette with 0.1 M NaOH. Remove bubbles from the burette tip by gently tapping the tip while the burette is open. Fill the burette with 0.1 M NaOH solution up to the 0.00 mL mark.
13. Use the burette clamp on the ring stand to position the burette to drain into the beaker when opened.
14. Start collecting data. Use the check mark in SPARKvue to record the initial pH of the solution with 0.0 mL of NaOH added.

PROCEDURE

15. Add about 0.5 mL of NaOH solution into the beaker. Record the pH and the exact volume of NaOH added in SPARKvue.

16. With constant stirring, continue adding NaOH into the beaker in 0.5 mL increments. Continue recording the pH and volume.

Note: If the addition of NaOH causes a change of pH that is greater than 0.5 pH units, slow down the addition of NaOH to 0.1 mL or drop increments.

17. Continue adding the 0.10 M NaOH until a faint pink color just begins to persist for 30 seconds. Record the volume of NaOH added to reach this point in Table 2 on your answer sheet.

18. Continue collecting data until the readings level off and are similar for 5 data points. Stop collecting data and sketch the graph of pH versus volume of titrant added in Graph 1 on your answer sheet.

19. Dispose of the solution in the beaker according to your teacher's instructions. Rinse and thoroughly dry the beaker and the magnetic stir bar. Refill the burette to the 0.00 mL mark with NaOH.

20. Return to Step 4 to repeat the titration process for each brand of antacid.

ANALYSIS

Complete the analysis on your answer sheet.

QUESTIONS

Answer the questions on your answer sheet.