

# The Effectiveness of Antacid Tablets

## Introduction:

Stomach acid (hydrochloric acid) is vital to human digestion. Without this strong mineral acid the digestive function of the stomach and intestine would be severely limited. HCl catalyzes the formation of pepsin—an enzyme that digests proteins in meats, seeds, eggs, and dairy products. In order for pepsin to be effective, the pH of the stomach must remain below 3.0. Under situations of stress or overindulgence, the pH can plunge to 1.0 or less. When this occurs, the stomach becomes **hyperacidic** and an upset stomach or “heartburn” can result. Prolonged hyperacidity can result in the erosion of the stomach lining—a condition known as an ulcer.

There are several over-the-counter remedies for heartburn and upset stomach. These products, known more commonly as antacids, neutralize excess stomach acid by absorbing excess  $H^+$  ions. Antacids come in liquid form (Pepto Bismol, Milk of Magnesia, Maalox), effervescent form (Alka-Seltzer), and in tablet form (Rolaids, Tums, etc.). In this lab, you will test the effectiveness of different over-the-counter antacids by means of an acid-base titration.

Since most antacids contain more than one active ingredient, as well as several other inactive ingredients (binders, flavoring agents, etc.), a direct titration will not produce accurate results. As a result, you'll have to perform a **back titration**. Here, you're going to react an antacid with a known amount of **excess** acid. Once the reaction is complete, you will titrate the solution with standardized base (NaOH) to determine how much of the original acid is remaining. From this data, you can calculate how much acid the antacid neutralized and subsequently determine the effectiveness of the product.

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## Materials:

Balance	Three Erlenmeyer Flasks (250 mL)
Ring stand	Wash Bottles (w/distilled water)
Buret Clamp	Antacid Tablets
Buret	Standardized 0.1 M NaOH
Glass Stirring Rod	Standardized 0.1 M HCl
Hot Plate or Bunsen burner	Waste beaker

## Safety precautions:

Safety goggles should be worn at all times. Since both hydrochloric acid and sodium hydroxide are corrosive, skin contact should be avoided. If you spill either reagent on your hands, make sure to wash them immediately.

## Procedure:

1. Select a brand of antacid and weigh out one tablet to the nearest 0.01 gram. Place the tablet in a clean Erlenmeyer flask.
2. Using a graduated cylinder, measure out *exactly* 50 mL of “stomach acid” (0.1 M HCl). **Slowly** add the acid to your flask. (Note: if using an effervescent tablet like Alka-Seltzer, do NOT add the acid all at once.)

- Heat the flask on a hot plate or Bunsen burner until all the effervescence has ceased. Then boil gently for 1-2 minutes to ensure a complete reaction. Be careful not to allow the solution to boil over!
- Allow the solution to cool and add 3-5 drops of phenolphthalein. If the solution turns pink, add 25 more mL of HCl. (Make sure to record this data in your table).
- While the solution is cooling, obtain a buret and rinse with ~ 5 mL of water. Then rinse with ~ 5 mL of NaOH. Fill the buret with NaOH and record the initial volume.
- Titrate the cooled antacid solution with NaOH until you reach the end point. (The solution will turn a pale pink color).
- Record the final volume of NaOH.
- Repeat steps 1-7 for each additional antacid and record all results in your data table.

### Data:

Your data table should resemble the following:

Trial	Brand of Antacid	Cost per bottle	Tablets per bottle	Mass of antacid	Volume of HCl	Initial Volume of NaOH	Final Volume of NaOH	Actual Volume of NaOH

### Calculations:

- Calculate the cost **per tablet** for each antacid.
- Calculate the cost **per gram** for each antacid.
- Calculate the volume of HCl neutralized by the tablets.
- Calculate the volume of HCl neutralized **per gram** of each antacid.

### Questions:

- Which antacid is most economical? Which one is least economical? This can be calculated by using your data and the following formula:

$$\frac{\text{Volume of HCl}}{1 \text{ Gram of Antacid}} \times \frac{1 \text{ gram of antacid}}{\text{cost in cents}} = \frac{\text{mL of HCl neutralized}}{\text{cent}}$$

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(from calculation 4)

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(from calculation 2)

- Using the data in question 1, construct a bar graph comparing the effectiveness of the different antacids. (You may use Microsoft Excel or draw the graph by hand).
- Why could continued neutralization with antacids do more harm than good to the digestive system? (You may have to do some research for this question).