## **Antacid Analysis: A Back-Titration**



## Introduction

The results of this lab will be presented as a poster not as a Lab Report.

- You will form a team of four students (two pairs) to perform this experiment
- Your team will be asked to create a poster and to present it to the class
- The grade for this lab is based on three components:
  - Poster presentation
  - o The data, reasoning, and claims made on your poster
  - Post experiment: submitting the answers online to questions about the lab
- **Good News:** there is no formal lab report to write for this lab, **but** you <u>must answer post lab</u> <u>questions (online) to receive a grade.</u>

#### **Learning Goals**

- 1. Use a back-titration to determine the amount of acid neutralized by two different antacid tablets.
- 2. Compare the active ingredients in two different antacid tablets to find the most effective neutralizer of dilute acid.
- 3. Use the class data to determine the most cost effective brand of antacid tablet.

### Abstract

Gastric acid (Hydrochloric acid) is produced by the parietal cell lining of the stomach. Hydrochloric acid (HCI) suppresses the growth of bacteria and aids in the digestion of certain starches. Gastric hyperacidity, also known as indigestion, is caused by an excess production of this acid. Antacids are used for mild, infrequent cases of indigestion; but they must be taken in limited doses because the amount of acid needs to be decreased but should not be eliminated.

There are many different antacid products on the market. The antacid contain various kinds and amounts of active antacid ingredients as well as inactive binders, flavors, etc. The active ingredients neutralize acid through a variety of reactions while the inactive ingredients provide bulk and make the antacid more palatable.

#### **Table 1: Active Ingredients in Commercial Antacid Tablets**

Chemical Name	Chemical Formula	Chemical Reaction
Magnesium Hydroxide	Mg(OH) <sub>2</sub>	$Mg(OH)_2 + 2H^+ \Rightarrow Mg^{2+} + 2H_2O$
Calcium Carbonate	CaCO <sub>3</sub>	$CaCO_3 + 2H^+ \Rightarrow Ca^{2+} + H_2O + CO_2 (g)$
Sodium Bicarbonate	NaHCO₃	$NaHCO_3 + H^+ \Rightarrow Na^+ + H_2O + CO_2 (g)$
Aluminum Hydroxide	AI(OH) <sub>3</sub>	$AI(OH)_3 + 3H^+ \Rightarrow AI^{3+} + 3H_2O$
Dihydroxyaluminum Sodium Carbonate	NaAl(OH) <sub>2</sub> CO <sub>3</sub>	$NaAI(OH)_2CO_3 + 4H^+ \Rightarrow Na^+ + AI^{3+} + 3H_2O + CO_2(g)$

In this experiment, a Back-Titration technique is used to determine the amount of acid neutralized by two different brands of antacid tablets. The back-titration is performed by adding a measured excess of standardized acid to a weighed sample of an antacid tablet. Some of the acid is neutralized by the tablet and some will remain. The remaining amount of acid is then titrated against a standardized base, and the amount of acid neutralized by the antacid can be calculated.

# See your text (Brown, LeMay, ect., 13th Edition , page 139) for more information about Antacid Chemistry.

## **Prelab Assignment**

A short movie to review <u>titration techniques</u> is avaliable.

In your lab notebook, prepare the following information:

- 1. A brief (2-3 sentence) introduction to the lab.
- 2. A table of safety information including the chemicals used in the lab and safety handling precautions.
- 3. If Jane titrated her 25.00 mL sample of hydrochloric acid solution to an end-point and used 22.67 mLs of 0.123*M* NaOH, how many moles of acid were in present in her sample? Show your work and your reasoning in your pre-lab.

## Procedure

Chemicals	Glassware and Equipment	
Two different brands of <u>Antacids</u>	Mortar and pestle	
<ul> <li>Standardized solution of <u>Hydrochloric acid</u> (<u>HCI</u>)</li> </ul>	<ul><li> 250mL Erlenmeyer flasks</li><li> electronic balance</li></ul>	
<ul> <li>Standardized solution of <u>Sodium hydroxide</u> (<u>NaOH</u>)</li> </ul>	<ul><li><u>Burets</u></li><li>Ring stand and buret clamp</li></ul>	
<u>Methyl Red</u> indicator		

- 1. For each of your Antacids to be tested record the following:
  - a. Cost of the bottle of antacid
  - b. Number of tablets per bottle (for non-tablet antacid, number of doses/bottle)
  - c. Active ingredient in the antacid
- Record the mass of one tablet (or dose) of your antacid sample. Now crush the antacid using a clean dry mortar and pestle. Record the mass of three clean, labeled 250mL Erlenmeyer flasks and then divide the crushed antacid about evenly between the flasks. Record the exact mass of antacid that was added to each flask. Repeat this step with the other antacid (six samples total). (Be sure to clean the motar and pestal inbetween samples.)
- Add about 100 mL of distilled water to each of the flasks and heat to dissolve the antacid. <u>Do not boil</u>. The solution may remain cloudy because the starch binders in a tablet will not dissolve completely. Cool to room temperature.
- 4. Meanwhile, fill and label two burets with the standardized solutions of NaOH and HCl. Be sure to record the concentration of the solutions and the initial volume reading of each buret.
- 5. Add about ten drops of Methyl Red indicator to each of the six samples.
- 6. Using the HCl buret, add about 35 mLs of the standardized HCl solution to one of the Erlenmeyer flasks. The solution should now be reddish-pink.
- 7. Titrate the sample with the standardized NaOH solution in the second buret. The endpoint is reached when the solution's color changes from <u>red to yellow</u> and remains yellow after swirling.

- 8. You may go back and forth at the end point by adding additional drops of acid and/or base until you reach the exact point of the color change. Record the final volume reading from each buret, to determine the volume of acid and base added to the sample to reach the endpoint.
- 9. Refill the HCl and NaOH burets, record the initial volume reading and repeat from step #6, until all of the samples have been titrated.
- 10. Clean up all of your equipment and dispose of all of your chemicals in the appropriately labeled containers.
- 11. Leave the burets filled with distilled water.

## **Postlab Assignment**

The following should be included in your poster presentation.

- 1. Total number of moles of HCl added to each sample of each antacid.
- 2. The number of moles of HCI neutralized with NaOH for each antacid sample (moles of HCI not neutralized by the antacid).
- 3. The number of moles of HCl that were neutralized by each antacid sample.
- 4. The number of moles of HCl that were neutralized per gram of antacid for each sample.
- 5. The average number of moles HCl neutralized per gram for each brand of antacid that you tested (3 values from #4 above).
- 6. The number of moles HCl neutralized by a whole tablet (or dose) of the antacid.
- 7. Cost per tablet (or dose) for each brand.

Be sure to clearly label all data and show examples of all calculations on your poster .

Which antacid was the most effective at neutralizing acid? Which one was most cost effective? Besides cost and ability to neutralize acid, what other factors should be considered when purchasing antacid tablets? (Give at least two more.)

Remember, at the endpoint of an Acid-Base titration

the number of moles of Acid = the number of moles of Base.

If you know the molarity (moles/L) of Acid and the volume (in L), you can find the moles of Acid and then you will also know the moles of Base.

#### Poster and Post Lab Instructions

#### Antacid Analysis - A Back Titration

#### A. Create a poster containing the following elements:

- 1. Have a title and include the names of all members of your team.
- 2. Name and describe the two Anatcids you have chosen to analyze.
- 3. List the equipment and techniques used analyze the samples.
- 4. Present your data and sample calculations along with any assumptions you have made.
- 5. Use reasoning to evaluate your data and make any reasonable claims that are supported by your data.

#### B. Present your poster in class: poster presentation

- 1. During your presentation, each member of the team should be introduced.
- 2. Any predictions, data, reasoning, and claims presented on the poster should be discussed.

# Your grade will be based on the poster, the presentation, and submission of the answers to the questions at the bottom of this page and will include the following components:

- 1. Pre-lab assignment: 10 pts.
- 2. The poster: 60 pts. (See Rubric below)
- 3. In class presentation: 20 pts.
- 4. Post lab questions: 10 pts.

Submit answers to the following post lab questions (submit a pdf or word file on InterChemNet as you would a full lab report). There is no other "lab report" to submit. However, in order to receive credit for this lab, you are required to submit these answers. Failure to do this will result in a zero for the lab experiment.

## Questions for Post-Lab submission on ICN:

#### (Required for Grade)

- 1. After presenting your poster and listining to the other presentations, which of the sampled Antacids do you think represents the best choice for acid indegestion relief? Explain your reasoning.
- 2. List any experimental errors that you can find in this experiment. Remember that experimental errors are errors in measurements that can not be avoided given the procedures, materials and equipment in the experiment, they are not mistakes or human error.

## **Rubric for the Poster**

Title and Team Member Names (5 pts) Results:	Introduction: Contains title, Team member names, and brief statement about the poster Results
supports the claim. (20 pts total)	Summarize your experimental data in a table and/or figure.
Reasoning: Scientific explanations that use evidence and appropriate chemistry concepts to construct claims. (20 pts total)	<b>Reasoning:</b> Present an analysis of your results Explain the overall chemical reaction for this process. <b>Give any possible places for experimental error.</b>
Claim(s): Statement(s), derived from evidence, using scientific reasoning. (15 pts total)	Summary of claims: What claims may you construct? Are the claims connected to the evidence and reasoning?

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