

Name \_\_\_\_\_

## Testing the Effectiveness of Antacid Tablets



This packet is a step-by-step guide to designing and carrying out your science project. In this science project, you will use a titration to see which antacid tablet is the most effective.

Your written science project will include the following sections:

**Title, Testable Question, Introduction, Hypothesis, Materials, Procedure, Data, Data Analysis, Conclusion, Works Cited**

**Google search:**

What is heartburn?

What is acid reflux?

What is an antacid tablet?

**Antacid Tablets:**

Watch Tums and Rolaid's commercials on Youtube.com with your project group.

What have you learned from the commercials?

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**Go to:**

<http://tums.com/>

<http://www.rolaids.com/>

Look at the claims from each website. Write information from the websites below:

Information from Tums' website	Information from Rolaid's website

## Project Ideas



Use the following to help you and your group to decide what topic you would like to focus on for your project. Look at the materials that are available.

<b>Antacid Tablets Available</b>	<b>Active Ingredients in Each Tablet</b>
Tums Regular Strength	500 mg Calcium Carbonate
Tums Extra Strength	750 mg Calcium Carbonate
Tums Ultra Strength	1000 mg Calcium Carbonate
Rolaids Extra Strength	675 mg Calcium Carbonate 135 mg Magnesium Hydroxide
CVS Brand Antacid Tablets	750 mg Calcium Carbonate
Kirkland (Costco's Brand) Antacid Tablets	500 mg Calcium Carbonate
Equate (Walmart's Brand) Antacid Tablets	675 mg Calcium Carbonate 135 mg Magnesium Hydroxide

### **Antacid Equations – Active Ingredients**

Calcium Carbonate is  $\text{CaCO}_3$

Work with your group to write the equation for calcium carbonate neutralizing hydrochloric acid to form calcium chloride, carbon dioxide and water.

*Teacher approval:* \_\_\_\_\_

Magnesium Hydroxide is  $\text{Mg}(\text{OH})_2$

Work with your group to write the equation for magnesium hydroxide neutralizing hydrochloric acid to form magnesium chloride and water.

*Teacher approval:* \_\_\_\_\_

## Possible project ideas:

### Measure Effectiveness per 0.5 gram (the amount you use in the experiment)

- Calculate how much HCl is neutralized per 0.5 grams

### Measure Effectiveness per Tablet

- Calculate how much HCl is neutralized per tablet

### Measure Effectiveness per Dose

- Calculate how much HCl is neutralized per tablet
- See how many tablets are in the recommended dose
- Calculate how much HCl is neutralized per recommended dose for each antacid

### Cost Effectiveness

- You should think of using this if you're testing a generic brand
- Visit different shopping websites (amazon.com, google stores, the store that makes the generic brand, ...) and take the average price per bottle
- How much it costs to neutralize 1.00 moles of HCl

Group's Project Topic:

Write a citation in the citation section of this packet if you are using a claim or other information from a website.

## Creating a Testable Question

Now that you have the background information about your topic, we need to brainstorm some testable questions for the experiment. **A testable question is a question that we have about the topic that can be answered using a scientific experiment.**

*For example:*

Does Tums Ultra or Rolaids Extra Strength neutralize more hydrochloric acid?

Are Equate generic antacid tablets or Rolaids Extra Strength more cost effective?

Write your group's testable question below.

## Introduction Section

Once you have your title and your testable question, you're ready to write your individual introduction section. You will conduct your background research and write about it in your introduction section.

All of the acid and base information we learned in our first packet will help us write some of our introduction section. You will also need to research on your own.

### Purpose of the Introduction:

- Introduce the topic to the reader
- Give background information about the topic
- Provide an explanation of scientific concepts that will be discussed and used in the lab procedure
- Present the testable question, hypothesis, and variables.

### Complete the outline below for your introduction section:

Tell where you can find the information so that you can easily access it for your writing in the next step.

#### I. Introduction paragraph

- a. Hook to catch reader's attention:

\_\_\_\_\_

- b. Introduction sentence about acids and bases:

\_\_\_\_\_

- c. What is an acid and what is a base?

- Arrhenius' Theory (What page of packet one contains this information? \_\_\_\_\_)
- Bronsted-Lowery's Theory (What page of packet one contains this information? \_\_\_\_\_)
- pH scale (What page of packet one contains this information? \_\_\_\_\_)
- Common acids and bases:

\_\_\_\_\_

- What is molarity of an acid or base? (What page of packet one contains this information? \_\_\_\_\_)

#### II. The chemicals we're using in this lab

- a. Hydrochloric Acid (Where will you find this information?)

\_\_\_\_\_)

- b. Sodium Hydroxide (Where will you find this information?)

\_\_\_\_\_)

- c. Phenylethene (What page of packet one contains this information?)

\_\_\_\_\_)

- d. Antacids you're using (Where will you find this information?)

\_\_\_\_\_)

**III. The environment of the human stomach**

- a. What causes the acidity? (Where will you find this information?  
\_\_\_\_\_)
- b. Why does it need to be acidic? (What page of packet one contains this information? \_\_\_\_\_)
- c. What is acid reflux? (What page of this packet contains this information?  
\_\_\_\_\_)

**IV. Explain the process and chemical reactions we're using**

- a. Titration (What page of packet one contains this information?  
\_\_\_\_\_)
- b. Neutralization reaction (Where will you find this information?  
\_\_\_\_\_)
- c. The chemical reactions between your antacid tablets and stomach acid (Where will you find this information? \_\_\_\_\_)

**V. Your testable question, hypothesis, and variables (see page 11 of this packet for help with variables, control, and constants)**

- a. What is your testable question?  
\_\_\_\_\_  
\_\_\_\_\_
- b. What is your hypothesis?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- c. What is your independent variable?  
\_\_\_\_\_
- d. What is your dependent variable  
\_\_\_\_\_  
\_\_\_\_\_
- e. What are your constants?  
\_\_\_\_\_  
\_\_\_\_\_

Write a rough draft of your paragraphs for your introduction section below. Have a partner in your group read it before typing it on computer. Remember to use quotes from the readings and your own research. Use the outline above to help you organize your writing.

**Paragraph 1: Introduction paragraph**

**Paragraph 2: The chemicals we're using in this lab**

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**Paragraph 3: The environment of the human stomach**

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**Paragraph 4: Explain the process and chemical reactions we're using**

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**Paragraph 5: Your testable question, hypothesis, control, independent and dependent variables, constants (see page 11 of this packet for help with variables, control, and constants)**

### **Citation Section**

For each website and source that you use, you will need to write a FULL citation in MLA format ([www.bibme.org](http://www.bibme.org) or [easybib.com](http://easybib.com) can help). All citations go into your Works Cited section of your project, which is the final section.

In-text citations are when you tell where you got the information in the body of the project.

*For an in-text citation for a quote or one sentence of paraphrased information:*

- This is usually the author's last name, a space and the year the article was written. Ex: (Smith 2010).
- If there is no author, use a shortened version of the title in quotations if it is a short work and underlined if it is a long work such as a book. Ex: ("Stomach Acid" 2011).

*For an in-text citation for multiple sentences of paraphrased information:*

- Write the author's last name and then end with the year when you're finished paraphrasing information from the source.
- Ex: According to Smith, \_\_\_\_\_.  
\_\_\_\_\_. \_\_\_\_\_ (2011).

## Writing a Hypothesis

A hypothesis is a prediction of what you will find out from the experiment. It is usually written in an “**If ..., then...because...**” format.

**Make sure to give a reason for your hypothesis and tell the source that you got the reason from.**

Two Examples:

- **If** I test Equate brand antacids and Rolaid Extra Strength antacids, **then** they should both neutralize the same amount of HCl acid **because** they both have 675 mg of calcium carbonate and 135 mg of magnesium hydroxide. Based on information from Carpi, I know that acids and bases create salt and water when they’re mixed together (2003). Therefore, I believe that since both Rolaid Extra Strength and Equate brand antacids have the same amount of antacids (bases) then they should both neutralize the same amount of HCl (acid).
- **If** I test Tums Ultra Strength and Rolaid Extra Strength to see which neutralizes more HCl, **then** I think that Tums Ultra Strength will neutralize more HCl **because** it has 1000 mg of antacids while Rolaid Extra Strength only has 810 total mg of antacids. Based on information from Carpi, I know that acids release H<sup>+</sup> in solution and that bases take up H<sup>+</sup> in solution (2003). Therefore, I believe that Tums Ultra will be able to take up more H<sup>+</sup> because it has more mg of antacid.

Create a hypothesis below. Think about the hypothesis as being an “answer” to your testable question.

HYPOTHESIS: \_\_\_\_\_

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## Variables, Control and Constants

**Independent Variable** -- is the variable that you change.

**Dependent Variable** – is the variable that changes as a result of the independent variable (this is what you measure during the experiment).

For example, if my hypothesis were: *If plant A is fertilized with chemicals and plant B is fertilized with cow waste, then plant B will be taller than plant A.*

Then the independent variable would be the type of fertilizer because that is what **I change** between the plants. The dependent variable would be the height of the plants because that is **what would be measured**. The height of the plants changes as a result of the fertilizer.

What is your **independent variable** (what will you change?)

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What is your **dependent variable** (what will you measure?)

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## A Scientific Control

A control is the factor that is the “normal” situation; it doesn’t receive the independent variable. A control is used in an experiment so that you can compare the independent variable group to it.

For example, if my hypothesis was: *If plant A is fertilized with chemicals and plant B is fertilized with cow waste, then plant B will be taller than plant A.*

Then I would treat plant A with chemical fertilizer, plant B with cow waste and plant C with no fertilizer at all. **Plant C would be the control because it receives no fertilizer**. This allows a scientist to see if the fertilizer has an effect on growth compared to a plant with no fertilizer.

Not all experiments need a control group.

What is your **control** for this experiment?

## Constants

Constants are the things that you will keep the same between your samples. With the plant example, I would give plant A, B and C equal amounts of water, soil, sunlight and growing time.

What things would you keep the same when completing the titrations on your various antacid tablets?

## Materials and Procedure Section

You are now ready to write your Materials and Procedure sections which come after your introduction in the report.

This section should include:

A list of the materials you will use. (Be specific about amounts, sizes...)

The procedure – a specific description of what you will do and how you plan to do it. Someone reading the procedure should be able to repeat the experiment exactly. **Do not** use names of specific people or places in your procedure. **Do not** use specific days and times, unless they are an important part of your experiment.

A labeled diagram (picture) showing how you set up the experiment. Include an explanation of this diagram. If you used a picture from the internet or book, be sure to CITE this.

Be sure to cite any sources you used to design your experiment. Even though you created your own procedure, cite any sources that gave you ideas or helped you.

## Procedure

Using your information from our class titration of HCl and NaOH and the reading below, **develop a procedure** for this experiment. Be VERY specific about what you will do and what you will observe/measure to test your hypothesis. Be sure to cite where you found the ideas for your experiment. This section can be written in paragraph form or can be bulleted steps.

First observe your teacher as she performs a sample procedure for this experiment. Write notes below from watching her.

**Next, read the information below. It tells you important information about your procedure. Underline additional important information that you'll want to include in your own procedure.**

The following is from:

“Back-Titration of an Antacid.” (n.d) Retrieved on October 28, 2011 from  
<http://www.mrteverett.com/Chemistry/>

The acid neutralizing capacity of a tablet is the amount of hydrochloric acid that it can neutralize. It is the quantity which is referred to in some advertisements when it is stated that the tablet "neutralizes x times its mass in stomach acid". This capacity can be determined by a technique called back-titration. A known amount of antacid is dissolved in an excess of HCl, and then the excess acid is back-titrated with standardized NaOH solution. When the endpoint is reached, the number of moles of acid which was added to the antacid sample is equal to the number of moles of base present, NaOH plus the antacid. Therefore, the number of moles of HCl which was neutralized by the antacid is equal to the total number of moles of HCl added minus the number of moles which were neutralized by the NaOH:

$$\begin{aligned} \text{moles acid neutralized} &= (\text{moles of HCl added}) - (\text{moles of NaOH required for back-titration}) \\ &= (M_{\text{HCl}} \times V_{\text{HCl}}) - (M_{\text{NaOH}} \times V_{\text{NaOH}}) \end{aligned}$$

What additional information did you learn from this reading that will help you when you write your procedure? Underline where you found the information above.

**Procedure**

Write your own procedure based on what your teacher showed you and the reading that you did above. This section can be written in paragraph form or can be bulleted steps.



### Data Tables

Work with your project group to make a list of the important information that you will need to record in your data table. Write them below. Tell when during the lab you will record this information. When possible, draw a picture that shows where you will get this information from.

<b>Data needed in table</b>	<b>When during the lab will you record this information?</b>	<b>Drawing of where this information will be found</b>
<i>Example:</i> <i>Grams of tablet used</i>	<i>Before you put tablet into flask with HCl.</i>	

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>
Name of tablet: _____	Grams of tablet used	Liters of HCl added	Molarity of HCl	Moles of HCl added (remember M=mol/liters)	Liters of NaOH	Molarity of NaOH	Moles of NaOH added (remember M=mol/liters)	Moles of HCl neutralized by amount of tablet (column E – H)
TRIAL 1			0.1 M			0.1 M		
TRIAL 2			0.1 M			0.1 M		
TRIAL 3			0.1 M			0.1 M		

Sample Data Table Above

## Results Section

After you have collected all the data, you are now ready to organize your results and write the results section of your report.

In your RESULTS section, be sure to include:

**Qualitative Observations:** This is a record of what you saw during your experiment. You may present your qualitative observations in the form of a table. Include a brief explanation of the table.

**Quantitative Observations:** This is the sample data table on page 15. Include a brief explanation of the table.

**Graph:** Your numerical data must also be presented in the form of a graph. The graph should have a title and the axes labeled with units.

What type of graph is best for you to use (a bar graph, scatter plot, pie, or line graph)?

Why?

## Analysis Section

This section should be about 1 page. You will need to examine and evaluate the procedure and your results carefully.

You should answer the following questions in your analysis section:

*In first paragraph:*

- What do the results suggest overall?
- Give one or more possible scientific reasons why these are the results. (You may need to look back at your background research).
- Are there any pieces of the result that go against the overall result?
- What are they and why do you think they occurred?

*In second paragraph:*

- What mistakes may you have made in the design of your experiment?
- How could this have been **bias** against or in favor of one of the items you were testing?
- How could this have affected your results?
- How could you improve this if you did this experiment again?

*In third paragraph:*

- What mistakes may you have made in carrying out the experimental testing?
- How could this have been **bias** against or in favor of one of the items you were testing?
- How could this have affected your results?
- How could you improve this if you did this experiment again?

## Conclusion Section

Your conclusion section should be two paragraphs.

*In first paragraph:*

- Summarize the results again briefly.
- Overall, do the results support your hypothesis?
  - o What specific parts **DO** support your hypothesis? Why?
  - o What specific parts **DO NOT** support your hypothesis? Why?

*In second paragraph:*

- What does your experiment mean to people in the real world?
- Why is it important?
- What other questions did this experiment make you think of? Why?

Complete the **Works Cited**: This includes all the citations (**MLA format**) in alphabetical order. All the sources you used need to be listed.

Read through a paper from a student in your project group carefully using the **following sheet** to see if he/she has missed anything.

Author's Name \_\_\_\_\_  
Peer Editor's Name \_\_\_\_\_

### Science Project Grading Sheet

Title and Question: \_\_\_\_\_

	Missing	Revise	Passing	Good
Title includes independent and dependent variables				
Question is a testable question				

#### Introduction:

	Missing	Revise	Passing	Good
Discusses background information about the topic				
Explains important <b>scientific concepts</b> relating to the topic				
Explains the basic idea of the experiment				
Includes a testable question and hypothesis				
Explains the reasons for the hypothesis				
Explains the dependent and independent variables				
Explains the control and constants				
Explains why this is related to real life and is an important topic				

#### Methods and Materials:

	Missing	Revise	Passing	Good
Lists all materials needed in the experiment				
Lists steps of the procedure				
Provides enough information to repeat the experiment exactly				
Includes a labeled picture/diagram showing the experimental setup				

#### Results:

	Missing	Revise	Passing	Good
Observations and data are represented in tables				
Quantitative data is represented in graphs				
The data and graphs are accurately summarized in paragraph form				
Graphs and tables are well organized and are labeled correctly				

#### Analysis:

	Missing	Revise	Passing	Good
Discusses whether the results support or does not support hypotheses				
Discusses possible reasons for results (uses research)				
Discusses problems and sources of error in the experiment				
Discusses HOW the results are affected by sources of error				
Discusses improvements to the experiment for the future				

Conclusion:

	Missing	Revise	Passing	Good
Discusses the results and reasoning for the results				
Relates the results to real-world issues				

Citations/Works Cited:

	Missing	Revise	Passing	Good
Information is cited <b>within text</b>				
All writing is in the writer's own words or he/she uses quotations correctly				
The works cited follows MLA format				
The works cited is in alphabetical order				

Overall Writing:

	Missing	Revise	Passing	Good
The project is organized by section. Each section is labeled and is in the correct order.				
It is clear that the author has proofread. There are few grammar/spelling mistakes.				
The overall project writing is clear and well organized.				

What partner did well:

What needs improvement?

**Presentation:**

Complete the following on note cards with help from your project group.

For this experiment, my testable question was...

I conducted background research and learned that (choose three things that you learned)

...

My hypothesis for this experiment was ...

To test this hypothesis, I had an independent and dependent variable. My independent variable was .... My dependent variable was ...

The procedure that I followed was (give a brief two sentence summary of your procedure)...

As you can see from my graph, my results suggested that...

Overall, my hypothesis (was or was not) supported because...

One mistake that I made during this experiment that may have caused bias was ...

To improve this experiment in the future I would...

Rotate to another table, share your presentation, and listen to the presentation of another person who wasn't in your group.

What feedback did the person have about your presentation? Write it below so that you can remember what you want to work on improving in a future presentation.