Which Brand of Antacid Is the Most Effective in Neutralizing Stomach Acid?

We have learned that digestive stomach enzymes create an acid environment that can, at times, become too acidic. There are a number of products on the market that claim to neutralize these acids. But how can you tell which brand of antacid is the most effective in neutralizing stomach acid?

In this investigation, you will compare the relative effectiveness of several products in order to make informed decisions in this area of personal health. Your team will be given 4 different antacid tablets in order to determine which would neutralize the most acid. We will use vinegar to simulate a potential food product that could bring about acid indigestion and/or “heartburn.”

After you determine a procedure you will use, you will collect your data and analyze results in order to draw conclusions. Remember to ensure that the testing you conduct will be “fair.”
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Suggested Grade Span
6–8

Task
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Big Ideas and Unifying Concepts

Cause and effect
Change and constancy

Physical Science Concept

Properties of matter

Science in Personal and Societal Perspectives Concept

Personal health

Mathematics Concepts

Comparison of attributes or effects
Cost and pricing
Data collection, organization and analysis
Graphs, tables and representations
Time Required for the Task

This task required 45 minutes for groups to plan their investigation, 60 minutes to conduct the investigation and one additional night of homework to complete the analysis and write-up the investigation.

Context

In advance of this assessment task, the classes had spent two weeks studying acids and bases and had conducted another lab where students investigated the relative acidity of several clear carbonated beverages.

What the Task Accomplishes

This task was intended to assess the students’ ability to design and execute an investigation of the neutralization process. They were expected to use any one of the organic indicators, which they had been introduced to during this unit, to demonstrate the change from base to acid condition. The results of the lab needed to be quantitative in order to make the comparison. Reliable lab procedures were essential.

Acids and bases are two of the families of chemical compounds. This investigation invites students to investigate the effect of combining acids and bases to create a neutral environment. Students can determine that this is a reversible event and therefore a physical change in the compounds. Additionally, they can consider the importance of this neutralization process in the usefulness of antacid products available on the market.

How the Student Will Investigate

Students were given four different antacid tablets and required to determine which would neutralize the most acid. Vinegar was used as a safe choice; it would also simulate a potential food product that could bring about acid indigestion and “heartburn.”

Interdisciplinary Links and Extensions

Science

Other questions which could be investigated at this time might include:

- Is there a difference in results if the tablets are crushed or tested whole? This would get at the concept of surface area as a factor of kinetics (reaction rate).
- Which tablet neutralized the acid fastest?
- Which tablet had the longest-acting effect on the acid?
- Which tablet was the most cost-effective?
- Do liquid antacid products react in a similar fashion?
- How do other products (which the students bring in) compare?
My grandmother always used a solution of baking soda in water as a home remedy for relief of an “acid” stomach. How does its effectiveness compare with commercial products? Can you do a cost comparison?

*Language Arts/Music*
Write an advertisement for your choice of antacid product describing the attributes that make it the best choice. Set your advertisement to music.

*Mathematics*
Calculate the cost-effectiveness of each product. Calculate the mass of the tablet and the number of drops of acid it neutralizes, and make a chart or graph showing the unit comparisons for all products.

**Teaching Tips and Guiding Questions**

- Why is it important to place the tablets in solution to do this investigation?
- Why is crushing the tablets before adding them to the water in the test tube a good idea?
- What are your choices of indicators? Which one will your group use and why? (bromethyl blue? phenolphthalein? litmus paper? red cabbage juice? universal pH paper?)
- Why must each test tube contain the same amount of water? the same number of drops of chosen indicator? (fair testing/controlling variables)
- Are you keeping track of the number of drops of vinegar added to each test tube? (fair testing/controlling variables)
- Does the most effective antacid take the most or least number of drops of vinegar to show a permanent change of color? (Note: This question generated more disequilibrium of thought than I expected.)
- How does the cost of the tablet relate to its effectiveness?

**Concepts to be Assessed**

(Unifying concepts/big ideas and science concepts to be assessed using the Science Exemplars Rubric under the criterion: Science Concepts and Related Content)

*Physical Science – Properties of Matter:* Students understand that acids and bases are at opposite ends of the pH spectrum and that combining the two brings the resulting solution to neutralization. Students determine that this is a reversible event and therefore a physical change in the compounds.

*Scientific Method:* By observing patterns of how acids and bases behave, students can then begin to understand the effects of any other conditions that cause observed changes in results. Students understand that various organic indicators can be used to show the change from basic to neutral and that the comparative amounts of acid required to create this change determine the effectiveness of each antacid tablet. (The greater the number of drops of acid required to create this change, the more effective the antacid.) Students use the pH scale and/or a graph or table of measurements to determine the effectiveness of each antacid tablet. (change and constancy) Students observe and explain reactions when variables are controlled, then make
predictions and classify materials. (Students determine what causes the color of the indicator to change and how many drops of vinegar it takes to permanently change the color of the indicator in the antacid solution.) (cause and effect)

**Science in Personal and Societal Perspectives – Personal Health:** Students understand that digestive stomach enzymes create an acid environment that can at times become too acidic, and that there are a number of products on the market that claim to neutralize these acids. Students are invited to read the labels on the various packages of antacids (looking for health warnings, ingredients, dosage and cost), and are encouraged to incorporate this information into their decisions in choosing the most best choice.

**Mathematics:** Students collect, organize and analyze data and use graphs, tables and representations appropriately. Students apply the concept of cost and pricing and compare attributes or effects.

**Skills to be Developed**

*(Science process skills to be assessed using the Science Exemplars Rubric under the criteria: Scientific Procedures and Reasoning Strategies, and Scientific Communication Using Data)*

**Scientific Method:** Observing, predicting/hypothesizing, collecting/recording data, measuring pH, drawing conclusions, communicating findings, challenging misconceptions and raising new questions.

**Other Science Standards and Concepts Addressed**

**Scientific Method:** Students describe, predict, investigate and explain phenomena. Students control variables.

**Scientific Theory:** Students look for evidence that explains why things happen and modify explanations when new observations are made.

**Physical Science – Properties of Matter:** Students observe and describe physical properties of acids and bases. Students describe and sort objects and materials according to observations of similarities and differences of physical properties.

**Science in Personal and Societal Perspectives – Personal Health:** Students observe that properties and changes of properties in matter (pH) can cause changes in the human digestive system.

**Suggested Materials**

I used four mint (not fruit-flavored) antacid tablets. All products recommended a dosage of two to four tablets, so I figured they were all about the same strength.
I provided students with all the indicators we had used during this unit (bromethyl blue, phenolphthalein, litmus paper, red cabbage juice, universal pH paper). They also had access to glassware, test tubes, beakers, stirring rods, mortars and pestles, eyedroppers, funnels, balances and safety glasses.

Possible Solutions

Students should have hypotheses, materials used, procedures, data recorded in tables, data analysis and a written discussion that analyzes data collected. Students were expected to follow the “Lab Report Format” and include each section as described in the scoring rubric.

The average number of drops of vinegar to neutralize the solution varied by group, as each added different amounts of water and used droppers of varying sizes. There was consistency within each group (variables were controlled) but not across groups. This may be why my students did not elect to compare data but rather to compare overall findings as to which antacid tablet worked best.

That ranking was consistent, with Mylanta in first place, followed by Rolaids, Titralac and Tums in a distant last place.

(Sample) Tablets Used  pH (dissolved in 10 ml. water)
Mylanta  9
Rolaids  9
Titrilac  8
Tums  8

Task-Specific Assessment Notes

General Notes
I developed a scoring rubric, “Lab Report Scoring Guide,” to guide students when using our school's required lab-report format. The rubric is included with this task and suggests the number of points possible for each criterion, which assists grading. Refer to pages 8–9.

Novice
This student comes to an incorrect conclusion based on faulty reasoning that the antacid that changed the color of the indicator first is the best. The student also does not have an investigable question as the objective for the experiment. The hypothesis is not based on research or scientific findings but rather on an instance of personal experience. The materials list is incomplete, and there are several details missing from the procedure. The data table contains some confusing information about time, which is unexplained and not referenced in the data analysis. While the student completes the task, the solution lacks conceptual understanding and scientific reasoning.
Apprentice
This student’s solution is lacking in detail, although the task is completed. The student begins with a testable question and attempts a hypothesis, but seems to be confusion as to the makeup of an antacid tablet. The procedure lacks units of measure as well as some important details. The data table is complete and accurate, but it could be better organized. The data is recorded but never analyzed. Our local scoring rubric calls for the “significance” this activity to concepts currently under study in the classroom, and the student fails to do this.

Practitioner
This student’s solution is complete. The original problem statement is well-written in that it is expressed as a testable question and has a well-stated hypothesis indicating prior knowledge and experience. The list of materials is lacking a few details but does include most measurements/amounts. There is an accurate data table, but the inclusion of other forms of representation would have enhanced the student’s analysis of the results. The conclusions are well-stated. The student does not consider any other dimensions of information, such as relative cost, verification of results or new questions raised that would have enhanced the solution.

Expert
This student’s work is detailed and accurate and shows proficient use of lab procedure and data analysis. The analysis demonstrates understanding of cause and effect. The inclusion of a cost analysis goes beyond the assigned task and adds to the comparison. The student recognizes significant experimental errors and considers their effect on the results. This student clearly communicates the evidence used to answer the question investigated here.
Template

Quest Lab Report Format

Students should follow the format below when submitting a lab unless otherwise instructed.

1. Cover page:
   Title: Centered
   Name, class, date in lower right corner

2. Objectives: Why was this lab conducted?

3. Hypothesis: Hypotheses are written in the third person.
   Ex. It will be demonstrated that...
   Or
   Students will demonstrate that.....

4. Materials: Materials should be expressed in metric units and written in columns.

5. Procedures: Procedures should be written in the third person.
   Ex. Step 1- The student will read all instructions before beginning the experiment.

6. Data section: This section should include all graphs, tables and charts accurately labeled and organized.

7. Conclusions: Students should discuss the data and how it relates or does not relate to their hypothesis. They should discuss where possible error occurred as well as how to make the experiment better. Students should also propose alternative hypotheses.

8. Significance: Students should briefly discuss how this lab relates to topics covered in class.
## Quest Team Science
### Lab Report Scoring Guide

<table>
<thead>
<tr>
<th>Name</th>
<th>Group</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Cover page</th>
<th>Follows format exactly (1 pt)</th>
<th>Incorrect or incomplete (0 pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objectives</strong></td>
<td>Clearly stated, includes problem stated as a question (2 pts)</td>
<td>Does not state problem as a question (1 pt)</td>
</tr>
<tr>
<td><strong>Hypothesis</strong></td>
<td>Shows evidence of research (2 pts)</td>
<td>An &quot;uneducated&quot; guess (1 pt)</td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>List is complete, is written in columns, metric measurements given (2 pts)</td>
<td>Missing one of three elements (1 pt)</td>
</tr>
<tr>
<td><strong>Procedures</strong></td>
<td>All steps clearly stated, procedure could be exactly replicated (3 pts)</td>
<td>Missing few details (2 pts)</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>Contains data collection table, graphical representation of data analysis, analysis shows careful thought (3 pts)</td>
<td>Contains data collection and analysis (2 pts)</td>
</tr>
<tr>
<td><strong>Conclusions</strong></td>
<td>Relates learning to hypothesis, accounts for exp. Errors, proposes alternative hypothesis (3 pts)</td>
<td>Contains only two elements (2 pts)</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td>Relates lab to topics studied in class (2 pts)</td>
<td>Discusses significance but doesn’t relate to classwork (1 pt)</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td>Word processed, written in third person, grammatically correct (2 pts)</td>
<td>One element missing (1 pt)</td>
</tr>
</tbody>
</table>

*Which Brand of Antacid Is the Most Effective in Neutralizing Stomach Acid?*

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Novice

Objective: The objective of this lab is to see which tablet would be better to use for an upset stomach.

Hypothesis: My hypothesis is that Tums will work better because it works on me.

Materials:
- 4 clear graduated 30ml cups
- 4 different tablets
- Mortar and Pestle
- 25ml graduated cylinder
- jar, vile or dropper bottle of vinegar
- 1 pint of blue B.B. solution.

Procedure:
1. Get all materials needed
2. Crush all tablets and put in test tube
3. Count how long it takes to dissolve
4. Add 1 drop of BTB
5. Add vinegar drop by drop until it turns yellow
6. Count all of the drops you put in the tub

Data:

<table>
<thead>
<tr>
<th>Name of indicator</th>
<th># needed to change</th>
<th># needed to stay</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUMS</td>
<td>2</td>
<td>56</td>
<td>30</td>
</tr>
<tr>
<td>ROLDAIDS</td>
<td>2</td>
<td>24</td>
<td>2:00</td>
</tr>
<tr>
<td>MYLANTA</td>
<td>2</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>TITARLAC</td>
<td>2</td>
<td>40</td>
<td>2</td>
</tr>
</tbody>
</table>

Analysis:
The analysis shows the time each tablet took to dissolve and number of drops in each tube.

Significance: The significance of this lab is that we found out that Rolaid was the best one because it holds the most acid in it. Some errors are that you could have put to much of the BTB or vinegar in which could cause some effect on the reaction.

Conclusion:
I thought the lab was a good thing because I know which tablet to use to help an upset stomach. Also I learned about each tablet.

The student lacks conceptual understanding and scientific reasoning in that the discussion of significance is erroneous. Rolaid is really the worst choice, not the best choice.

The data table is confusing. No units are included for time, nor an explanation: time to do what? "# needed to stay" is also unclear, and is not explained in the analysis of data.

Some steps are missing from procedures. The student does not mention adding water to the tablets. Step four needs more than one drop of BTB. Step 2 implies that all tablets are in the same test tube.
Apprentice

Objective:
What is the best tablet if you have an upset stomach?

Hypothesis:
The students will demonstrate that the best tablet is the one that has the least acid in it.

List of Materials:
- Tums
- Rolaids
- Milanta
- Tiritral
- four clear plastic vials
- 30ml medicine cups or small baby food jars
- mortar and pestle

Step by Step Procedure:
1) Use a mortar and pestle to crush a tablet.
2) Add the powder to a medicine cup, vial, or baby food jar that contains 2 drops of the blue BTB solution.
3) Then add a drop of vinegar and check if it stays yellow.
4) Use this procedure to all other tablets including Tums, Rolaids, Milanta, or Tiritral.

Check to see if it turns yellow. If it does stop the procedure and record it.

Data Table:

<table>
<thead>
<tr>
<th>Name of Indicator</th>
<th>Number needed to change</th>
<th>Number needed to stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tums</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Rolaids</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Tiritral</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Milanta</td>
<td>1</td>
<td>45</td>
</tr>
</tbody>
</table>

Conclusion:
In conclusion, Milanta was the best, then Rolaids, Tiritral, and Tums. But if you think about the math Rolaids is the best tablet because you get 36 tablets in one package for $1.69. The regular student would want to buy it because of the great deal.

Significance:
This lab relates to how the student used BTB as an indicator in its labs. The student can relate this lab to real life if him/her had an upset stomach he/she would know what to buy.

The student’s solution lacks detail, however the task was completed. The student begins with a testable question, and attempts a hypothesis. However, there seems to be confusion about the chemistry of antacids.

The student’s procedures contain no units of measure – lacking evidence of understanding precision and fair testing. The student has a well-designed and executed data table. It could be better organized alphabetically or by total # of drops.

Local rubric calls for significance to relate this activity to concepts learned in class or text. Student does not do so.

The student recalls data but does not analyze it.
Antacid Lab

Objectives- The point of this lab was to answer the question, What is the best tablet to help neutralize your stomach acid?

Hypothesis- It will be demonstrated that the best anti-acid tablets will be the ones that are hard to turn yellow with vinegar. This will happen because the BTB will turn the solution blue and when the vinegar is added to the acid it turns yellow. The more drops of vinegar it takes to keep the color yellow shows that it can neutralize more acid.

Materials- 1) 4 test tubes  
2) 4 different tablets commonly taken for upset stomachs  
3) mortar and pestle (or spoon and bowl)  
4) 25ml graduated cylinder  
5) jar, vial or dropper bottle of vinegar  
6) 15 ml blue BTB solution  
7) medicine dropper  
8) plastic coffee stirrers

Procedures- 1) The student will begin by reading all instructions before beginning the experiment.  
2) The student will use the mortar and pestle to crush each tablet up.  
3) The student should add each tablet powder into it's own test tube that has 5ml of water and then add 5 drops of BTB.  
4) The student will next add drops of vinegar into each cup until the solution changed to yellow color.  
5) The student will then stir the solution gently to mix the vinegar and BTB.  
6) The student will next record the results.

This solution is complete. There is a testable question and well-stated hypothesis, based on prior knowledge.  
The materials list lacks a few details, but includes most amounts.
Practitioner

Data Section

<table>
<thead>
<tr>
<th>Name</th>
<th>drops needed to stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tums</td>
<td>1</td>
</tr>
<tr>
<td>Rolaids</td>
<td>30</td>
</tr>
<tr>
<td>Mylanta</td>
<td>180 and up</td>
</tr>
<tr>
<td>Titralae</td>
<td>4</td>
</tr>
</tbody>
</table>

There is an accurate data table, but the student could have included other representations as well (chart of relative costs, a graph, etc.). The student appropriately uses data to support conclusion as to best tablet.

This chart shows how many drops it took for each indicator to stay at a yellow color. The Mylanta says 180 and up because after 180 drops were added the experiment was ended because the test tube was full and the class was coming to an end. The Tums is clearly the worst choice because it took only one drop to neutralize it. The Mylanta would be the best because it had so many more drops added into it then the others did and we couldn't neutralize it.

Conclusion- The best anti-acid tablet to use would be the Mylanta. This is so because it took so long to neutralize. The others didn't last very long. The worst one to use would be the Tums because it neutralized after only one drop of vinegar. This data helps prove my hypothesis right. The best tablets would take the longest to turn yellow. Some possible error could be that we never finished the Mylanta test. We knew that it was the best because it was still blue after so many drops but we never really saw it turn yellow. Another error could be that after thinking that the solution in a test tube was changed, it settles out blue. A way to make this lab better would be to use bigger test tubes to be able to fully do the experiment with out running out of room. Also to have more time that we had to be able to test it fully. There really isn't an alternative hypothesis.

Significance- This lab relates to class because lately we have been learning about acids and bases an how to neutralize them. This lab shows us how we can neutralize them using vinegar and BTB. Which we have been also talking about. We also used the pH paper in this lab and we have been learning how to read and use it.

Significance – does not relate to recent class work per local rubric.

Conclusions are well stated. The student could have also considered other dimensions of information, such as comparing these results to class results, but did not.
Expert

Objective: How can students find the best acting anti-acid or base, using different substances like BTB? Also, just which is the best anti-acid?

Hypothesis: The student hypothesizes that BTB will show the anti-acids becoming neutralized when vinegar is added and that the Titralac will prove to be the best working anti-acid because I believe that since it cost more, it must be more efficient.

Materials: - 4 clear plastic containers. About 30ml
- 4 different anti-acid tablets (Mylanta, Tums, Rolaids, Titralac.
- Spoon and a bowl
- Container of Vinegar
- BTB solution
- Medicine dropper
- Coffee stir sticks
- 25ml graduated cylinder (Optional)

Procedure: Separately, crush the 4 tablets in the bowl. Add each crushed pill into a plastic container containing 6 ml of water and stir. Add 6 drops of BTB solution. Record how many drops it took to neutralize each anti-acid. Hint: The solution turns yellow once the anti-acid pill is neutralized. Keep adding drops until the solution stays yellow and record that as well.

Data:
This chart shows the number of drops of vinegar it took to turn each solution yellow and neutralize it.

<table>
<thead>
<tr>
<th>Anti-acid tablet</th>
<th># of drops to change solution yellow</th>
<th># of drops to keep solution yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mylanta</td>
<td>3</td>
<td>161</td>
</tr>
<tr>
<td>Rolaids</td>
<td>2</td>
<td>83</td>
</tr>
<tr>
<td>Titralac</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Tums</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

The more drops that an anti-acid takes without becoming neutralized, proves it's stronger than lesser tablets. This is because if it takes more acid to neutralize it, it can neutralize more acid than other anti-acids. For example, Tums was

This student’s work is detailed, accurate, and shows proficient use of lab procedures and data analysis. There is a well stated objective. The student demonstrates an understanding of cause and effect in data analysis.
neutralized by three drops of vinegar, which means if you swallowed 3 small drops of vinegar you would need one whole pill just for that vinegar. On the other hand if you swallowed 161 drops of vinegar, you could just take a Mylanta pill and it would easily be neutralized. As you can see, Mylanta is the best neutralizer but is it the best buy? The student created this table to show the price and value.

<table>
<thead>
<tr>
<th>Anti-acid</th>
<th>Cost per box</th>
<th># of pills per box</th>
<th>Cost per pill</th>
<th># of pills to neutralize 300 drops of vinegar</th>
<th>Total price to neutralize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mylanta</td>
<td>$3.28</td>
<td>24</td>
<td>14 cents</td>
<td>About 2</td>
<td>28 cents</td>
</tr>
<tr>
<td>Rolaids</td>
<td>$1.69</td>
<td>36</td>
<td>5 cents</td>
<td>About 4</td>
<td>20 cents</td>
</tr>
<tr>
<td>Titralac</td>
<td>$4.87</td>
<td>100</td>
<td>5 cents</td>
<td>About 30</td>
<td>$1.50</td>
</tr>
<tr>
<td>Tums</td>
<td>$1.79</td>
<td>36</td>
<td>5 cents</td>
<td>About 100</td>
<td>$5.00</td>
</tr>
</tbody>
</table>

As you can see, the best buy is the Rolaids brand. Even though Mylanta is a better pill, Rolaids still have a better overall price. Also, the student would suggest that you don't buy Tums. Not only do they cost the most per pill, they are the worst pills as well.

**Conclusion:** The student thinks his hypothesis was off and that just because something is more expensive, doesn't mean it's better. Still, the BTB was a good indicator and was liable to tell when a pill was neutralized by the acid. Some errors occurred during the experiment such as the number of drops and the method for mixing the vinegar to the solution. Some students accidentally added more or less drops than they wrote down/tallied. Also, since four different students were in a group, some may have shaken, stirred or used a different method to mix the solution.

**Significance:** Students can relate this to previous indicator labs that used BTB as well. This relates to talks of bases, acids and neutrals we've had.