Extended Experimental Investigation
Example 1

Title of Investigation: Which indigestion remedy is best at neutralising excess stomach acid?

Section A. Questioning and predicting in preparation for the investigation

State the research question
Which indigestion remedy is best at neutralising excess stomach acid?

State my hypothesis / prediction
I think that liquid indigestion remedies are more effective than solid indigestion remedies as liquid indigestion remedies react faster with the acid in the stomach compared to solid indigestion remedies.

Variables
- The variable that I will change (independent variable) is the brand of indigestion remedy used.
- The variable that I will measure (dependent variable) is the pH change after the antacid has been added to a HCl solution for a certain length of time.
- The variables that I will control (control variables) are (i) same concentration of HCl, (ii) same pH probe, (iii) equal volumes of HCl in each beaker, (iv) same time period over which measurements are taken, (iv) same laboratory temperature.

Background Information
- I studied about acids and bases in Chapter 20 of Essential Science. I also learned about neutralisation which happens when an acid and a base mix together. This is how antacids work to relieve the pain associated with indigestion.
- I also studied Chapter 1 in the textbook “Essential Science” in which I learned how to carry out an investigation including controls and variables and the importance of a fair test.
- I studied about indigestion remedies on various websites.
  www.irishhealth.com
  www.medicines.ie
  https://www.hse.ie/eng/health/az/d/dyspepsia/treating-indigestion.html
Section B. Planning and conducting the investigation

Equipment and materials needed

- Deionised water
- 5 beakers
- Retort stand
- 0.15M Hydrochloric Acid
- Stirrer/glass rod
- Mortar and pestle
- Graduated cylinder
- Safety glasses
- Variety of antacids (Rennie, Gaviscon, Bisodol, etc)
- Data Logging equipment
- pH sensor
- pH Buffers

Fair test

To make sure that this investigation is a fair test, I will add the lowest recommended dose of each brand of antacid to the hydrochloric acid.

Laboratory Safety

- I wore safety glasses at all times when carrying out this experiment to protect my eyes.
- I wore gloves to protect my hands as I was dealing with acid.
- I wore my lab coat to protect my clothes in case I spilled any chemicals.
- I took care to gently add each indigestion remedy to the HCl to avoid splashing of acid.
- I handled the pH sensor very carefully to avoid breaking it as it is a very sensitive instrument.
- I made sure that the pH sensor was always kept in deionised water when not in use.

Procedure to be followed:

1. I will place the same volume of 0.15M HCl in each beaker.
2. I will add the lowest recommended dose of each remedy to each beaker.
3. I will crush all tablets as this would occur if the tablet was being chewed.
4. I will place a pH sensor in each HCl solution.
5. I will connect the pH sensor to a datalogger and will use DataStudio to plot the graphs.
6. I will add the antacid to each beaker and record the change in pH over a period of 4 minutes.
## Section C. Processing and analysing the data

### Presentation of data in table

<table>
<thead>
<tr>
<th>Antacid</th>
<th>Run 1 Change in pH</th>
<th>Run 2 Change in pH</th>
<th>Mean Final pH</th>
<th>Mean Change in pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rennie</td>
<td>1.8 - 5.4, Change = 3.6</td>
<td>1.1 - 5.0, Change = 3.9</td>
<td>5.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Bisodol</td>
<td>1.8 - 5.2, Change = 3.4</td>
<td>1.2 - 5.3, Change = 4.1</td>
<td>5.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Gaviscon Tablets</td>
<td>1.9 - 5.3, Change = 3.4</td>
<td>1.1 - 5.3, Change = 4.2</td>
<td>5.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Gaviscon Liquid</td>
<td>1.7 - 5.7, Change = 4.0</td>
<td>1.0 - 5.6, Change = 4.6</td>
<td>5.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Milk of Magnesia</td>
<td>1.8 - 9.9, Change = 8.1</td>
<td>1.0 - 9.2, Change = 8.2</td>
<td>9.6</td>
<td>8.2</td>
</tr>
</tbody>
</table>

### Presentation of data in graph

![Graph showing the effect of different antacids on pH](image-url)
Analysis of data

- The results of the investigation showed that all the indigestion remedies studied had some level of effectiveness in neutralising the hydrochloric acid.
- The results of the investigation also showed that the brand which gave the most effective relief from acid indigestion is Milk of Magnesia, then Gaviscon liquid and then Bisodol. These indigestion mixtures reacted the fastest and raised the pH higher than the other indigestion remedies.
- Milk of Magnesia increased the pH to over 9 compared to the other antacids which increased the pH to approximately 5.3
- The investigation also shows that liquid forms of antacid are more effective. These worked more quickly and decrease the acidity to a greater extent. For example, a comparison of Gaviscon liquid versus Gaviscon tablets shows that it took less time for Gaviscon liquid to reach a higher pH.

Section D. Reflecting and reporting

Design of the experiment

- When adding the crushed tablets to the acid, it was difficult to ensure that all the powder was added to the acid. I tried to minimise the amount left behind by washing the pestle and mortar with deionised water and adding the washings to the acid.
- The indigestion powders tended to stick to the pH probe and to the sides of the beaker. I had to wash down the sides of the beaker with deionised water.
- It would be better to use a magnetic stirrer to help the antacid remedies react more easily with the acid.
- A further experiment could be carried out with the acid at body temperature to see if the same results would be obtained.

Sources of error.

- A possible source of error occurs when measuring the time at which the remedy is added to the HCl. Some of the liquid antacids are very viscous and take some time to flow into the beaker.
- Another source of error is the fact that these remedies for acid indigestion contain different ingredients and there are different recommended doses on each container (e.g. the Gaviscon liquid label indicates 10 - 20 ml and the Milk of Magnesia states 5 ml). I tried to make this test as fair as possible by adding the lowest dose recommended.
- I was unable to get all the experiments carried out on the one day so there may have been a change in room temperature and this may have affected the results.

Support of my hypothesis / prediction

- The results support my hypothesis that liquid antacid remedies are more effective than solid antacid remedies.

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https://www.folensonline.ie/home/library/programmes/essential-science/resources/