**Antacid Titration Lab** (adapted from Robert Farber’s “Off the Shelf Chemistry”)

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**INTRODUCTION**

The stomach produces hydrochloric acid to begin the chemical breakdown [digestion] of the food that you eat. Although this acid is quite strong (pH 2-3), the stomach has a thick mucus lining that protects the stomach tissue itself from being digested by the acid. When the stomach is too full or when you have swallowed air, the acid will be forced up out of the stomach into the unprotected esophagus. The acid will react with the unprotected tissue and cause a burning sensation commonly known as "heartburn".

There are a number of over-the-counter medications called antacids. These are ***not*** strong bases. If they were bases and you used them regularly or took them in large doses, they would raise the pH of your blood. This condition, called alkalosis, would result in kidney damage. The brands of antacids sold in the drug store contain insoluble compounds that acids will react with, resulting in the acid being consumed in the reaction. The most common ingredient used is calcium carbonate [CaCO3], also known as limestone. This limestone is ground to a powder, mixed with a starch paste, and formed into a tablet. Often flavoring and coloring is added to make the tablet more palatable. Other tablets contain insoluble hydroxides that will react with hydrochloric acid.

There are also newer types of antacids that are taken before eating. These consist of a hormone [chemical messenger] that reduces the amount of acid produced by the stomach. This is not the type of antacid that we will evaluate in this lab.

**PURPOSE**

Does my antacid contain as much active ingredient as it claims?

**EQUIPMENT**

* beaker
* buret
* ring stand
* buret clamp
* stirring rod
* mortar & pestle
* 0.5 M hydrochloric acid
* Bromophenol blue OR methyl orange indicator
* several brands of antacid tablets such as TUMS, ROLAIDS, MAALOX etc. [white colored tablets are best in this lab; red or orange is the worst]

1. Complete the pre-lab calculations and check your results.

2. Clamp a buret to a ring stand. (Mr. LB will demonstrate this.) Do it *carefully*…burets are *expensive*! Put some water in the buret and make sure that it does not leak. Did you remember to close the stopcock first? Now practice dripping the water into a beaker. When you are comfortable using the buret, drain all of the water out.

3. Fill the buret about ¾ full with 0.50 M hydrochloric acid. Record the starting volume to at least 1 decimal place.

Note that burets have a 0 at the top and a 50 at the bottom. This may seem odd, because obviously a buret that is full to the top does not contain 0 ml, but the labels are done this way because burets are designed to tell you how much has been *dispensed*. Never try to fill a buret all the way up to the zero. First of all, you may accidentally overfill it (easy to do because it’s a narrow tube) and spill dangerous chemicals. Secondly, the buret does not have any lines over the zero, so if you overshoot it, you will not know your exact starting volume.

4. Crush a tablet using a CLEAN, DRY mortar and pestle. Place the crushed tablet in a CLEAN beaker and add a splash of water—just enough to make a suspension. (The tablet contains insoluble ingredients—it will not form a solution until the acid is added.) Add enough indicator solution to make your mixture moderately dark. Use either methyl red or bromophenol blue for titrating calcium carbonate. Use thymol blue if you are titrating a hydroxide.

5. Place the beaker under the buret. Begin your titration by adding acid fairly quickly. Continuously stir the mixture with a glass rod as the acid is added, or swirl if using an Erlenmeyer flask. Be careful not to splash acid out of the container, or to dribble it on your hands from the buret!

6. Continue stirring until the color remains for at least 30 seconds after the last drop of acid is added. This is the endpoint. You have already done your pre-lab calculations and figured out how much acid SHOULD be used, so you should have a pretty good idea of when you’re getting close to the endpoint. When you are within a few milliliters of the endpoint, the acid should be added dropwise and stirred until the color changes. It is difficult to describe what this will look like—experience is the only way to learn to recognize an endpoint!

7. Record the amount of acid used by this tablet. (data table is below)

8. Repeat this procedure at least three times. If you overshoot the endpoint, your trial does not count.

HOW TO FILL IN THE DATA TABLE:

* Do as many trials as you have time to complete.
* Initial reading: this is the volume displayed by the buret at the beginning. Record to two decimal places.
* Final reading: this is the volume displayed by the buret at the endpoint. Record to two decimal places
* HCl used: this is the final reading minus the initial reading. If you get a negative number here, you know you did it backwards—there’s no such thing as negative volume
* Notes: use this column to keep track of anything that happened during your titration that might help you improve your technique in future trials (e.g. overshoot, when the color change started, errors or mistakes, etc.)

**DATA**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trial | Initial reading (mL) | Final reading (mL) | HCl used (mL) | Notes |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |

**ANALYSIS**

1. Circle the 3 “HCl used” measurements that are closest to each other. We’ll call the largest of these the “high” value, the smallest the “low”, and the other one the “middle”. You’ll enter these into the website.
2. Repetition in experiments is important. Calculate the average (mean) of those three measurements.
3. Moles of HCl: You know the concentration (0.50 M) and the volume of HCl (your answer to #7 above); use them to find the moles. Don’t forget to convert mL to L first.
4. Grams of active ingredient (actual): How many grams of active ingredient must have been in the tablet to neutralize this amount of acid? It’s a stoichiometry problem—“fishbone” it.
5. Your theoretical mass of active ingredient comes from the bottle (see #2 on your prelab)
6. % yield: actual over theoretical

**DISCUSSION**

Discuss your technique—were there any errors to report? How precise were your measurements? Talk to other groups who had the same active ingredient in the same amount as you did. Did they get similar results? Why do you think they did (or didn’t do)? This should be done verbally; do not write or turn in anything.

**Now go submit your work on the website!**