

Name _____

Section _____

Partner(s) NONE

Date _____

TITRIMETRIC ANALYSIS OF ANTACID TABLETS

PRE-LAB QUERIES

1. Predict the reaction products for the following antacids with stomach acid, HCl. Remember all neutralization reactions are double displacement reactions.

NaHCO_3 (cheap antacid)

CaCO_3 (Tums)

$\text{Mg}(\text{OH})_2$ (Milk of Magnesia)

2. What is the relative water solubility of each compound above?
3. How would you know when any of the above reactions were completed?

OBJECT

In this activity, antacid products will be analyzed by an indirect titrimetric procedure. From the analysis, the percentage of antacid in the tablet and percentage error compared to the label value will be calculated. The effectiveness of various brands will be compared.

INTRODUCTION

Antacids are compounds that act as bases to neutralize stomach acid, hydrochloric acid (~0.02M). Most antacids such as calcium carbonate and magnesium hydroxide are water insoluble and thus difficult to analyze by direct titration.

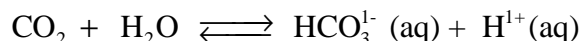
You will want to review the background on acid-base titrations covered in the CHM 101 laboratory manual or your textbook. You should know the following terms: equivalence point; end point; titrant; standard solution; and, indicator.

Because of the insolubility and any carbon dioxide production, antacids are analyzed by an

indirect method or what is known as a **back titration**. The antacid is allowed to react with a known amount of hydrochloric acid and then the excess hydrochloric acid is titrated with sodium hydroxide. The amount of acid reacted or neutralized by the antacid is determined by difference.

$$\text{moles neutralized} = \text{moles initial} - \text{moles excess}$$

If carbon dioxide is produced in the reaction of an antacid, the carbon dioxide must be removed before titration. The carbon dioxide gas can be removed by boiling, which shifts the equilibrium in the reaction below to the left.



If CO_2 is left dissolved, the H^+ produced would be titrated by sodium hydroxide.

To visualize the progress of the reaction, an indicator will be added. Thymol blue has the colors listed below at the given pH's.

pH	Color
>2	pink/red
2-8	yellow
>8	blue

Since the titration is between a strong acid and strong base (equivalence point pH of 7), the equivalence point is located in a very steep region of the titration curve. The indicator changes a little above the equivalence point, but with no appreciable error in the volume of titrant required.

To allow the comparison of the effectiveness of antacid brands, the amount of hydrochloric acid neutralized is normalized to the mass of tablet. The larger this normalized value, the more effective the antacid.

PROCEDURE

1. Into a pre-massed massing boat add one crushed antacid tablet. Determine the mass of the tablet added to the nearest 0.1 mg. Quantitatively transfer the tablet to an Erlenmeyer flask.
2. Clean two burets. Fill one with the standardized HCl and the other with standardized NaOH. Be sure to record the concentrations of the acid and base.
3. To the crushed antacid, add exactly 25 mL of standard HCl and approximately 25 mL of distilled water. Gently swirl to dissolve the antacid. Heat the solution to boiling and allow it to boil for 5 minutes to insure CO_2 loss. Allow the flask to cool before adding

- indicator and starting the titration.
4. Add 2-3 drops of thymol blue indicator to the cooled flask and titrate the excess HCl with standard NaOH. The end point is a pale blue color (yellow to blue) but will occur in the presence of suspended starch (cloudy) used as a tablet binder so careful observation is required. The blue color of thymol blue does **not** change once obtained (unlike phenolphthalein). Save the first titration of each brand as a color comparison for the endpoint. Repeat the preparation and titration on 2 additional tablets of the same brand.
 5. Analyze a different brand of antacid tablet following the procedure above.
 6. For all titrations complete the data and results table.

For each brand of antacid, calculate the percentage of antacid compound in a tablet and percentage error using the formulas below:

$$\% \text{ antacid} = \frac{\text{g antacid by titration}}{\text{g tablet}} \times 100$$

$$\% \text{ error} = \frac{\text{g antacid by titration} - \text{g antacid by label}}{\text{g antacid by label}} \times 100$$

DATA AND RESULTS

Concentration of standard HCl _____

Concentration of standard NaOH _____

DATA			
Brand:	Antacid Compound:	Amount on Label:	
	Trial 1	Trial 2	Trial 3
Mass of Massing Boat			
Mass of Massing Boat and Antacid Tablet			
Volume of HCl Added			
Volume of NaOH			
RESULTS			
Mass Antacid Tablet			
Moles HCl Initially Added			
Moles HCl Excess			
Moles HCl Neutralized			
Moles HCl Neutralized Per g Antacid Tablet			
Moles of Antacid in Tablet			
Mass of Antacid in Tablet			
% Antacid in Tablet			
% Error (compare to label amount)			

DATA			
Brand:	Antacid Compound:	Amount on Label:	
	Trial 1	Trial 2	Trial 3
Mass of Massing Boat			
Mass of Massing Boat and Antacid Tablet			
Volume of HCl Added			
Volume of NaOH			
RESULTS			
Mass Antacid Tablet			
Moles HCl Initially Added			
Moles HCl Excess			
Moles HCl Neutralized			
Moles HCl Neutralized Per g Antacid Tablet			
Moles of Antacid in Tablet			
Mass of Antacid in Tablet			
% Antacid in Tablet			
% Error (compare to label amount)			

Show all calculations on a separate sheet.

CONCLUSIONS

Discuss how the results for % antacid compare to the amount specified on the label. Using the average of the three trials, determine which brand is more effective and why. Suggest some possible sources of error in this determination and how they might affect results.

POST-LAB QUESTIONS

1. Calculate the volume (in milliliters) of stomach acid (0.020M HCl) that can be neutralized by the amount of antacid per tablet in each brand using the label amount.

2. For five different brands of antacids, complete the information below by making a trip to your local supermarket or drugstore.

#	Brand	Antacid	Amount/ Tablet	Price per 100 Tablets
1				
2				
3				
4				
5				

Explain which brand is the best purchase.

3. Why do you chew the antacid tablet and not just swallow it whole?

4. Why does boiling remove the carbon dioxide?

