ANALYSIS OF STOMACH ANTACID TABLETS

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PURPOSE

In this experiment you will measure the amount of stomach acid consumed (or neutralized) by various antacid tablets (Maalox, Tums, Rolaids: no Pepcid or Tagamet!). If you have a favorite one, bring a package to the lab (one color only).

Inside your stomach, excess hydrochloric acid is neutralized by the antacid. Different antacids use different metal hydroxides, such as $Al(OH)_3$ or $Mg(OH)_2$. The general formula for this reaction is:

$$M(OH)_y + Y\ HCl \rightleftharpoons Y\ H_2O + M^{+y} + Y\ Cl^-$$

Additionally, some brands of antacids use calcium carbonate as a neutralizing reagent.

$$CaCO_3 + 2\ HCl\ (aq) \rightleftharpoons H_2CO_3\ (aq) + Ca^{2+}\ (aq) + 2\ Cl^-(aq)$$

The carbonic acid formed in this reaction may undergo further reaction:

$$H_2CO_3\ (aq) \rightleftharpoons H_2O\ (l) + CO_2\ (g)$$

PROCEDURE OUTLINE

This experiment will involve several steps. The first step will involve a simple reaction to determine the concentration of the NaOH that will be used in this experiment using a solid acid standard. Using the *standardized* NaOH, the next step of the lab will involve determining the concentration of the HCl. Once we have the concentration of the *standardized* HCl, we will conclude the lab by determining the amount of acid that is consumed when you use an antacid tablet. First the tablet is dissolved and an excess of acid of known concentration is added to the tablet. The solution is then briefly heated to insure that all of the antacid reacts. Finally, the remaining unreacted acid is titrated with base (NaOH) to determine the amount left over and hence, the amount that reacted with the tablet. The chemical reaction which occurs is:

$$NaOH(aq) + HCl(aq) \rightleftharpoons NaCl(aq) + H_2O(l)$$

A detailed description of the individual steps in the analysis follows. Before we get started, there are a few points on using a buret that need to be covered. Adding a solution from a buret can be a little tedious, but the errors that are technique dependent will cause errors that will propagate themselves throughout the experiment. Add material to the titration from the buret slowly and be sure to swirl the flask after adding. As you get near the endpoint of the titration, it is hard to add complete drops of solution from the buret and not to overshoot the titration endpoint. A solution for this problem is to wash the tip of the buret with a few drops of deionized (DI) water since this will add “fractional drops” of material into the titration flask. Your TA will provide some additional suggestions for proper buret use during your recitation.

While you are running the first two experimental steps (Step 2: Standardization of NaOH and Step 3: Standardization of HCl), you can prepare your antacid sample:

Step 1: Digestion of the antacid tablets

Weigh an antacid tablet and transfer it to a 250-mL Erlenmeyer flask. Label the flask ANTACID 1. Record the weight of the tablets you are going to analyze to the nearest mg in your lab notebook.

Add 50.00 mL of hydrochloric acid solution (labeled ~0.50 M) with a buret to the flask containing the tablet. Record into your lab notebook the exact volume of acid used.

If the tablet does not readily dissolve, cover the flask with a watch glass and boil gently for 5-10 minutes on a hotplate. Set it aside to cool. While the flask is cooling, weigh out another tablet of the same brand and repeat the dissolving procedure two more times. Label the flasks/samples ANTACID 2 and ANTACID 3.

Step 2: Standardization of NaOH

Label 4 125 ml Erlenmeyer flasks as KHP 1, KHP 2 ,KHP 3 and KHP 4. Obtain 4 1.5 gram samples of potassium hydrogen phthalate (KHP) and record their masses to the nearest mg. Add the samples individually to the Erlenmeyer flasks and add 30-40 mL of DI water to each flask and swirl to dissolve the solid material. While the KHP dissolves, get a buret and 100 mL of NaOH. Add about 50 mL of NaOH to the buret and record the volume of the buret by placing a card behind the meniscus to aid in reading the volume used. Add 1-2 drops of phenolphthalein to each of the KHP solutions. Begin your titration of the solution in the flask labeled KHP 1. Note that you will need to swirl the solution after adding NaOH to assure that you have noticed that any of the pink color of the phenolphthalein has cleared from the solution before you continue to add more NaOH. You should add enough NaOH so that you turn the solution a pale pink color that persists after swirling and standing for 15 seconds. If you overtitrate the solution, the color will be raspberry red, which will mean that you will get poor results that stem from this step as the error will propagate through the lab and the resulting values. Record the volume of NaOH used for KHP 1. Repeat the above procedure for KHP 2, KHP 3 and KHP 4.

Step 3: Standardization of HCl

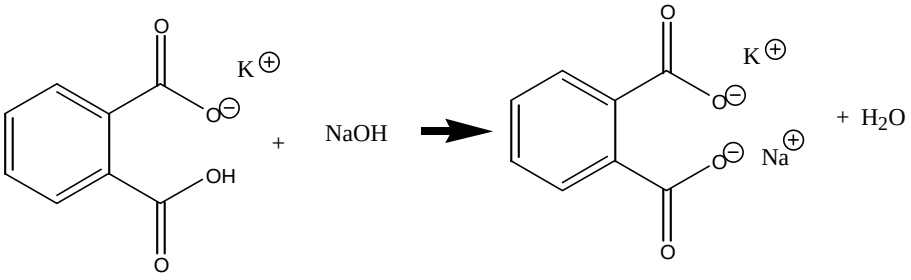
Instead of neutralizing KHP, for this step we will use a solution of HCl. Using another buret filled with HCl, you will place between 20 and 25 mL of HCl each into three separate flasks labeled HCl 1, HCl 2 and HCl 3. It is very important to record the EXACT VOLUMES of HCl placed into the flasks since the unknown variable in this part of the experiment will be the concentration of the HCl. Add 1-2 drops of phenolphthalein to each of the acid solutions and titrate each acid solution with the same concentration NaOH you used from Step 2. Record the volumes of NaOH used.

Step 4: Determination of the neutralizing ability of an antacid

Using the samples of the HCl that have been used to digest the antacid tablets, repeat the titration. Be sure that you have added phenolphthalein to the tablet solution before you start the titration with the standardized NaOH. Carefully record the volume of NaOH used for each of the three separate titrations that you performed.

CALCULATIONS FOR STEP 2

The purpose of this step is to determine the molarity of NaOH



Grams of KHP/ 204.11(molecular weight of KHP) = molarity of NaOH * volume of NaOH used

As an example: $M_1V_1 = M_2V_2$

2.3114 g/204.11 g/mol = X * 0.0243 L (remember to convert ml to liters!)

0.01132 mol KHP / 0.0234 L NaOH = 0.466 M NaOH used to neutralize the KHP

CALCULATIONS FOR STEP 3

The purpose of this step is to calculate the concentration of HCl.

Using the dilution formula: $M_1 V_1 = M_2 V_2$, solve for the unknown HCl concentration.

As an example:

M_1 (0.0247 L) = 0.466 M * 0.0275 L

M_1 = (0.466 M * 0.0275 L)/ 0.0247 L

M_1 = 0.519 M HCl