TITRATION: STANDARDIZATION OF A BASE AND ANALYSIS OF STOMACH ANTACID TABLETS

Teacher Notes

This experiment is designed for students working singly or in groups of two.

The overall purpose of this experiment is to determine the effectiveness of two different brands of stomach antacid tablets. The procedure, however, involves a number different processes.

Students, generally, do not prepare standard solutions in the laboratory. In response to former students asking how standard solutions were prepared, the procedure for preparing solutions by diluting a concentrated solution and from a solid solute were incorporated into this experiment. Sample calculations for each type of solution are included, but, please caution students that the examples are for different concentrations than they will need for this experiment.

A standard base solution, such as NaOH is normally standardized against a solid acid such as potassium hydrogen phthalate. Past experience has shown that most of the HCl solutions prepared by the students have a concentration between 0.09 and 0.11 M, which falls within an acceptable range for this experiment. Thus, it will be assumed that the HCl is 1.0 M and the base is standardized against the HCl. This saves time, allowing the procedure to be completed within the allotted lab period. The error introduced by this assumption is small and has little effect on the results of the antacid analysis.

The instructor should demonstrate to the class how to prepare a solution by adding water to the volumetric flask, adding the solute, shaking/swirling of the solution, and diluting to the mark on neck of the flask.

The instructor should demonstrate how to properly rinse a buret with approximately 5 mL of solution, and three rinses, and how to fill a buret. Be sure to use a small funnel on top of the buret to minimize spillage.

Demonstrate how to zero a buret and remove and air bubbles from the buret tip.

Demonstrate the proper technique for titrating an acid with a base.

The product of the HCl-NaOH tritation contains no harmful materials and can be disposed of down the drain with running water.

Stomach antacid tablets are buffered to provide a pH between 3 and 4, the approximate pH of stomach acid. There is no accurate method to titrate the antacids directly. To properly titrate antacid tablets, they must be mixed with excess acid to “overpower” the buffer and then the solution is back titrated with base to determine the amount of excess acid. In industry, the same procedure is used except that the solutions are heated to 37°C (body temperature).

Because of fillers added to the tablets, the antacid tablets, dissolved in the HCl, will not produce a clear solution.

Stomach antacid tablets are mixtures. The mass of individual tablets varies as well as the amount of active ingredient in each. The best way to compare the antacids in on a moles of acid neutralized per gram of antacid basis.

The product of the antacid-HCl-NaOH tritation contains no harmful materials and can be disposed of down the drain with running water.

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DATA AND RESULTS

Name _____ Date _____

PART I: STANDARDIZATION OF A BASE

Preparing Solutions:

Calculate the quantity of 12 M HCl needed to prepare 1000 mL of a 0.10 M solution. Show your calculations below:

$$M_1V_1 = M_2V_2$$

$$V_{12\ M} = \frac{M_{0.1\ M}V_{0.1\ M}}{M_{12\ M}}$$

$$= \frac{0.1M \times 1000\ mL}{12\ M}$$

$$= 8.33\ mL\ HCl$$

Calculate the quantity of NaOH needed to prepare 500 mL of a 0.10 M solution. Show your calculations below:

$$g_{NaOH} = \frac{M_{NaOH} \times V_{NaOH} \times W_{NaOH}}{1000}$$

$$g_{NaOH} = \frac{0.1M \times 500mL \times 40g/mol}{1000}$$

$$= 2.0\ g\ NaOH$$

Standardization of NaOH:

	Trial 1	Trial 2	Trial 3
Initial reading, HCl buret	_____ mL	_____ mL	_____ mL
Final reading, HCl buret	_____ mL	_____ mL	_____ mL
Volume HCl used	_____ mL	_____ mL	_____ mL
Initial reading, NaOH buret	_____ mL	_____ mL	_____ mL
Final reading, NaOH buret	_____ mL	_____ mL	_____ mL
Volume NaOH used	_____ mL	_____ mL	_____ mL
Molarity of NaOH	_____ M	_____ M	_____ M

Show a sample calculation for the Molarity of NaOH below:

Average Molarity of NaOH _____M

PART II: ANALYSIS OF STOMACH ANTACID TABLETS

Antacid Tablet Analysis 1:

Brand of antacid used _____

	Trial 1	Trial 2	Trial 3
Mass of crushed antacid tablet	_____ g	_____ g	_____ g
Volume of HCl used	_____ mL	_____ mL	_____ mL
Initial reading, NaOH buret	_____ mL	_____ mL	_____ mL
Final reading, NaOH buret	_____ mL	_____ mL	_____ mL
Volume NaOH used	_____ mL	_____ mL	_____ mL
Moles of HCl consumed by antacid	_____ mol	_____ mol	_____ mol
Moles of HCl consumed by 1.0 gram of antacid	_____ mol/g	_____ mol/g	_____ mol/g

Show a sample calculation of the moles of HCl consumed by the antacid tablet and the moles of HCl per gram of antacid tablet below:

Average moles of HCl consumed by 1.0 g of antacid tablet _____ mol/g

Antacid Tablet Analysis 2:

Brand of antacid used _____

	Trial 1	Trial 2	Trial 3
Mass of crushed antacid tablet	_____ g	_____ g	_____ g
Volume of HCl used	_____ mL	_____ mL	_____ mL
Initial reading, NaOH buret	_____ mL	_____ mL	_____ mL
Final reading, NaOH buret	_____ mL	_____ mL	_____ mL
Volume NaOH used	_____ mL	_____ mL	_____ mL
Moles of HCl consumed by antacid	_____ mol	_____ mol	_____ mol
Moles of HCl consumed by 1.0 gram of antacid	_____ mol/g	_____ mol/g	_____ mol/g

Show a sample calculation of the moles of HCl consumed by the antacid tablet and the moles of HCl per gram of antacid tablet below:

Average moles of HCl consumed by 1.0 g of antacid tablet _____ mol/g

QUESTIONS:

1. It was assumed that the concentration of the HCl solution was exactly 0.1 M in this experiment. How exact do you think the concentration of the HCl solution is when prepared by diluting concentrated HCl? Explain.

   The concentrationof the HCl should be close to 0.1 M (the value should be within 5%)

2. How exact do you think the concentration of the NaOH solution is? Explain.

   The concentrationof the NaOH should have the same error as that of the HCl (within 5%)

3. Why is it okay to leave the flasks wet with rinse water for the titrations?

   The water does not take part in the reaction

4. What is the chemical composition of the antacid tablet(s) that you used? (If the exact composition is not given on the label, list the active ingredients.)

   Note: Information on chemical composition of antacids are often available on company web sites.

5. If the antacid tablet did not dissolve completely in the 0.1 M HCl solution, how can you explain this?

   Fillers or inert ingredients

6. If there were variations in the weight of acid consumed for the same brand of antacid tablet, how can you explain this?

   Antacid tables are mixtures and the actual composition will vary between tablets

7. Which one of the antacid that you tested appeared to be the most effective? Can you explain the difference between them?

8. Do you think that the antacids that you tested live up to the claims of their manufacturers?