Aspirin Analysis

Strand	Molar Relationships	
Topic	Investigating stoichiometry	
Primary SOL	CH.3	The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include d) bonding types.
	CH.4	The student will investigate and understand that chemical quantities are based on molar relationships. Key concepts include a) Avogadro's principle and molar volume; b) stoichiometric relationships; c) solution concentration.
Related SOL	CH.1	The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include a) designated laboratory techniques; b) safe use of chemicals and equipment; c) proper response to emergency situations.

Background Information

In this lab, students will analyze aspirin (acetylsalicylic acid) tablets for the acetylsalicylic acid content, using a volumetric analysis technique called "titration." Not all of the mass of an aspirin tablet is acetylsalicylic acid, as there are starch binders added to hold the tablet together. Sodium hydroxide reacts with the acetylsalicylic acid but not with the starch binders, as shown in the following reaction:

$C_9H_8O_4$	+	$NaOH$	→	$NaC_9H_7O_4$	+	H_2O
acetylsalicylic acid		sodium hydroxide		sodium acetylsalicylate		water

This is an acid-base reaction in which the acetylsalicylic acid reacts with the base sodium hydroxide to produce the salt sodium acetylsalicylate and water (acid + base → salt + water).

To determine when the reaction is complete, students will use a small amount of the indicator phenolphthalein. Phenolphthalein is an indicator because it changes color when all the aspirin has been reacted. This is called the "end point" of the reaction. If one continues adding NaOH after the end point, the solution will turn dark red. You want to stop the titration when the solution is a pale pink color.

Students will use a burette to measure the volume of sodium hydroxide solution that reacts with the aspirin. With a burette, you can add small amounts of NaOH and measure the volume more accurately. This method of analysis is called "titration."

Materials

- Safety goggles
- 50-mL burettes

- Beaker
- 0.2 *M* NaOH
- Ethanol
- Variety of brands of aspirin tablets
- Phenolphthalein indicator
- 125-mL Erlenmeyer flasks

Vocabulary

molarity, molar mass, reaction, solution,

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Introduce the lab by telling students that in this method of analysis, they will use a substance, sodium hydroxide (NaOH), whose concentration they know to analyze a substance, aspirin, whose concentration they do not know.
2. Introduce or review the terms *burette, indicator, phenolphthalein, end point,* and *titration,* using the information under “Background” above. Make certain that students understand these terms and how they are used.

Procedure

Aspirin Brand A Lab Data	
Initial burette reading	
Mass of aspirin tablet	
Total volume of aspirin solution	
Final burette reading	
Volume of NaOH reacted	
Aspirin Brand B Lab Data	
Initial burette reading	
Mass of aspirin tablet	
Total volume of aspirin solution	
Final burette reading	
Volume of NaOH reacted	

1. Make a data table like the one at right.
2. Fill a 50-mL burette almost to the top with the 0.2 *M* NaOH solution. Fill the tip of the burette by draining some the NaOH into a beaker. Drain the NaOH until the level is at the zero mark. Record this initial burette reading in your data table.
3. Find and record the mass of an aspirin tablet of brand A.
4. Place the aspirin tablet into a 125-mL Erlenmeyer flask, and add 25 mL of warm water and 15 mL of ethanol to the flask. Swirl the mixture until the aspirin tablet dissolves.
5. Add two or three drops of the phenolphthalein indicator to the solution in the flask and swirl. (Without the indicator, you would not know when the reaction is complete.)
6. Place the flask on a piece of white paper, and lower the burette so that the tip is inside the neck of the flask. Slowly begin adding the NaOH solution from the burette while gently swirling the contents of the flask. With each addition of NaOH, you will see a pink color appear and then quickly fade away. When the pink color lasts for a few seconds before fading away, begin adding the NaOH drop by drop.
7. Stop adding NaOH when you see a faint pink color that remains for at least 30 seconds before fading; this is the end point of the reaction. If you add too much NaOH, the solution will turn red, and you will have gone past the end point. You will have to start over again.
8. Find and record the total volume of the aspirin solution (to be used in step 2 of the “Observations and Conclusions” below).

9. Record the level of the NaOH in the burette tube at the end point as the final burette reading.
10. Subtract the final burette reading from the initial burette reading to find the volume of NaOH that was added. This amount is the volume of NaOH that was reacted by aspirin tablet A. Record this amount.
11. Rinse out the flask, and repeat the experiment with a different brand of aspirin.

Assessment

- **Questions**
  - Comparing the amounts of NaOH reacted in the two experiments, was there much difference in the amounts of aspirin in the two brands? (The amount of NaOH relates directly to the amount of aspirin.)
- **Other**
  - Analyze the contents of various brands of aspirin and compare the results.
  - The molarity of the NaOH is known to be 0.2 M, and the mole ratio of the acetylsalicylic acid to the NaOH is 1:1. Use this known molarity of the NaOH, the volume of the NaOH reacted, and the total volume of the aspirin solution to calculate the molarity of the aspirin in the solution.
  - Knowing the mass of the aspirin tablet and given the molar mass of acetylsalicylic acid as 180 g/mol, calculate the percent acetylsalicylic acid and the percent binder in the aspirin tablet.

Extensions and Connections (for all students)

- Have students research the quality control tests that are done in industry to monitor the amount of aspirin contained in tablets. Ask students to present their research and explain the benefits of quality control tests.

Strategies for Differentiation

- Prepare the data table prior to completing the activity so students can record information in an organized manner.
- Have students input information collected on a data chart template (computer). Data entry areas should be locked so that the students cannot add information or edit anything but the areas required by the activity.
- Record the steps in the activities so students can repeat the directions multiple times throughout the activities.
- Have students highlight/color code the lab procedures in one color and the questions in another to assist in preparing for the activity.
- Have students visit industries that utilize titration, e.g., pharmaceutical, water testing, wine making.