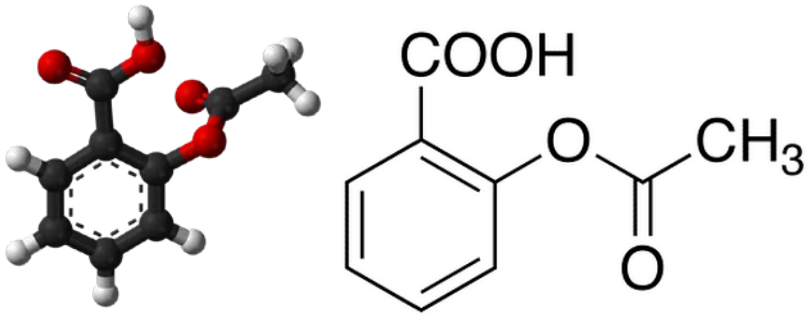
Module 7: Stoichiometry

Topic 5 Application: Synthesis of Aspirin Scientific Investigation

Introduction

Aspirin is a widely used medicinal drug. Aspirin is a naturally-occurring compound that can be derived from the bark of the willow trees. The actual compound is named acetylsalicylic acid. The willow trees use to relieve pain can be traced back to the early Native Americans. When in pain, Native Americans would chew the bark or grind it into a powder for ingestion. Of course, obtaining pain relief by grinding the bark of a willow tree is not practical in modern times. An easier solution is to produce acetylsalicylic acid in a laboratory setting. Synthesizing acetylsalicylic is more feasible and cost-effective, while producing a product of equal quality. Below you can view the chemical structure for aspirin.



Chemical Structure of Acetylsalicylic Acid, $C_9H_8O_4$

Objectives

In this scientific activity, you will:

- synthesize aspirin by reacting salicylic acid with acetic anhydride
- calculate the theoretical yield of aspirin in grams
- calculate the percent yield of the aspirin synthesis reaction

Hypothesis

Using the **Procedure and Data Collection** section below, read through the procedural information for this scientific investigation. Based on your understanding of the procedure, develop your own hypotheses which describe your expected results. Specifically, will aspirin be synthesized by reacting salicylic acid with acetic anhydride? Record these hypotheses in the **Hypothesis** section of your *Synthesis of Aspirin Scientific Investigation Report*.

Equipment and Materials

- Salicylic Acid
- Acetic Anhydride
- 85% Phosphoric Acid (concentrated)
- Gloves
- Safety Goggles
- 250 Erlenmeyer Flask
- 10 mL graduated cylinder
- 25 mL graduated cylinder
- Filter Paper
- Buchner Funnel
- Stirring Rod
- Digital Scale of Triple-beam Balance

- Watch Glass
- 1 mL Pipette
- Fume Hood
- Oven
- 2 Large Beakers (500 mL or larger)
- Distilled Water
- Ice
- Water aspirator

Procedure

It is important to follow all safety guidelines and procedures with this laboratory activity. This experiment uses salicylic acid, acetic anhydride, and phosphoric acid. Both salicylic acid and aspirin may cause irritation to your skin or eyes. Both of these compounds can be disposed of in the sink. If either of these two compounds accidentally spill, wipe them up with a wet paper towel and dispose of the towel in the trash. Acetic anhydride and phosphoric acid can cause severe burns. These chemicals must be used under a fume hood. When handling these chemicals, safety goggles and gloves must be worn at all times. If these chemicals exist in excess, the remaining chemical should be disposed of in a plastic tub of water. The water will dilute phosphoric acid and turn the acetic anhydride to vinegar. If either of these chemicals accidentally spill notify your instructor immediately.

1. Using the digital scale or triple-beam balance, measure 3.0 grams of salicylic acid. Place this acid in a 250 mL Erlenmeyer flask.
2. In the fume hood, add 6.0 mL acetic anhydride to a 10 mL graduated cylinder. Pour the contents of the graduated cylinder into the Erlenmeyer flask that contains the salicylic acid.
3. Remaining in the fume hood, carefully add 5 to 10 drops of 85% phosphoric acid. Swirl the flask to ensure that the chemicals are mixed thoroughly.
4. Still in the fume hood, fill a larger breaker with warm water at a temperature of 70-80°C. Place the Erlenmeyer flask inside of the beaker of water and let it sit for ten minutes.
5. After the ten minutes has ended, carefully add 20 mL of distilled water to the mixture using the 25 mL graduated cylinder.
6. At your laboratory station, fill a large beaker with ice and water. Remove your Erlenmeyer flask from the fume hood and place the flask in the ice bath. Allow enough time for the crystallization of your mixture. If crystallization is not occurring, use your stirring rod to scrap the sides of your Erlenmeyer flask to aid in the formation of crystals.
7. Filter the solid aspirin through a piece of pre-weighted filter paper using a Buchner funnel and water aspirator. Wash the crystals with 2-3 ml of ice cold water. The liquid is mostly water and can be allowed to drain down the sink or into an additional Erlenmeyer flask.
8. After the aspirin is washed, allow the aspirin and filter paper to air dry for 15 minutes. Record the mass of the filter paper mass.
9. Place the filter paper with aspirin on a watch glass and put into an oven at 100°C. Allow the watch glass, filter paper, and aspirin to dry in the oven for 30 minutes, or until dry.
10. Weigh the dry aspirin and filter paper, record the mass.

11. Calculate the weight of your product by subtracting the mass of the paper from the mass of the filter paper and aspirin.

Data

Use the area provided on your *Synthesis of Aspirin Scientific Investigation Report* to record any observations and data you had while you conducting the procedure.

Data Analysis

In the **Data Analysis** section of your *Synthesis of Aspirin Scientific Investigation Report*, provide the responses to the following questions:

1. Describe the appearance of your final product.
2. The molar ratio of salicylic acid to aspirin is 1:1. If you used 3.0 grams of salicylic acid in this experiment, calculate the theoretical yield of aspirin in grams.
3. What is the percent yield of your aspirin synthesis reaction?

Conclusion

Using the **Conclusion** section of your *Synthesis of Aspirin Scientific Investigation Report*, compose three to four sentences describing an overall conclusion about synthesis of aspirin. Base your conclusions on your data. Were your hypotheses true or false, how do you know? Use the data and notes that you collected from your experiment to form your conclusion. Make sure that your include information that your gained from data analysis to support your conclusion.

Experimental Sources of Error

On your *Synthesis of Aspirin Scientific Investigation Report*, provide responses to the following questions: Are there any sources of error? If so, what are they, and what could be done to minimize error?