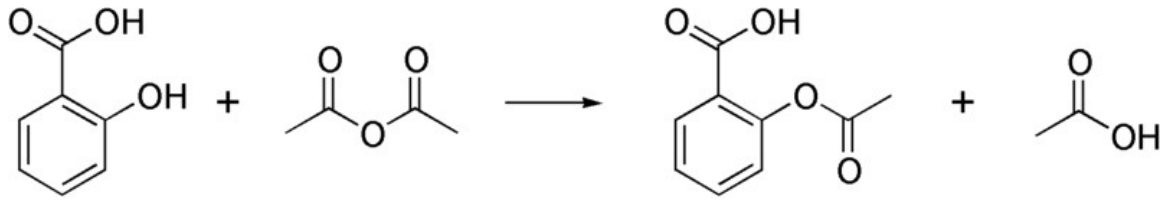
THE SYNTHESIS OF ASPIRIN: WEEK 1 of 2.

PRELAB
Complete the following Pre-lab assignment in your lab notebook prior to starting the lab.
1. Write out the synthesis reaction shown in Scheme 1 in your lab notebook.
2. Balance the reaction if needed.
3. Calculate the molecular mass of salicylic acid (A) and acetylsalicylic acid (C). ***Show your work.***
4. Calculate the theoretical yield (the amount) of acetylsalicylic acid staring with 2.98g of salicylic acid. ***Show your work.***



A B C D

Scheme 1: The synthesis of aspirin.

CAUTION! In this lab you will be handling acetic anhydride (B) and concentrated sulfuric acid. Both of these compounds are strong irritants to your skin, please handle these with care. Notify your instructor or TA to assist in cleaning up any spills.

PURPOSE
The purpose of this lab activity is to explore the chemical reaction leading to the common product aspirin, also known as acetylsalicylic acid. During this first week, of this lab activity, you will ***synthesize*** aspirin. In next week's lab you will determine the efficiency of your synthesis. During the synthesis you will also be exposed to the use of a suction filtration flask.

INTRODUCTION
As early as the time of Hippocrates (~400 BC), the compound salicylic acid (molecular mass = 138.12 g/mol) was recognized for its pain relieving properties. Salicylic acid, however, is extremely irritating to the mouth and stomach. In 1899, the Bayer Company introduced acetylsalicylic acid (molecular mass = 180.15 g/mol), a derivative of salicylic acid, which has the same pain relieving properties, but is less irritating to the stomach. Acetylsalicylic acid is better known as aspirin. Naming of organic compounds can be confusing. Aspirin is also known by the chemical name 2-acetyloxybenzoic acid.

The synthesis of acetylsalicylic acid is outlined in scheme 1 above. One mole of salicylic acid (A) is reacted with one mole of acetic anhydride (B) (molecular mass = 102.09 g/mol, density = 1.08 g/ml) using sulfuric acid (H_2SO_4) as a catalyst, to form one mole of acetylsalicylic acid (C) and one mole of acetic acid (D). Although the reaction outlined in scheme 1 appears fairly straightforward, the details of the synthesis are a bit more complicated for the following reasons: 1) acetylsalicylic acid is not very soluble in water and will precipitate out (form solid/crystals) of solution during the reaction, 2) excess of acetic anhydride must be used to make sure that all of the salicylic acids reacts, and 3) both acetic anhydride and acetic acid must be removed from the final reaction mixture before the acetylsalicylic acid can be considered for consumption, which you will ***not*** do since the glassware used is not of pharmaceutical cleanliness. Excess acetic anhydride is removed by a reaction with water to form acetic acid as shown below:

$$(CH_3CO)_2O\ (aq) + H_2O\ (l) \rightarrow 2\ CH_3CO_2H\ (aq)$$

The acetic acid formed from the primary reaction and from the reaction of acetic anhydride with water is then removed from the reaction mixture by rinsing the acetylsalicylic acid crystals with ice-cold water; acetic acid is soluble in ice-cold water, but acetylsalicylic acid is not.

In this reaction, we say that salicylic acid is the ***limiting reagent*** (reactant) and that acetic anhydride is the ***excess reagent***. The amount of acetylsalicylic acid that can be synthesized is a result of how much salicylic acid is added to the reaction mixture.

PROCEDURE (on back)

PROCEDURE:

1. Prepare a hot water bath using a hot plate and 400 mL beaker that is 1/3-filled with water. While the water is heating to the boiling point, continue with step 2 in the procedure.

2. Using the top-loading balance, weigh about 2 grams of salicylic acid and place the solid in a DRY 125 ml Erlenmeyer flask. ***Record the actual mass of the acid to 2 decimal places in your lab notebook.***

3. In a fume hood, add ~4 ml of acetic anhydride and 5 drops of **concentrated** sulfuric acid to the Erlenmeyer flask containing the salicylic acid. ***CAUTION! Both acetic anhydride and sulfuric acid are strong irritants. Both need to be handled with care. Notify your instructor or TA to assist in cleaning up any spills. Gloves are available, but are not a substitute for good lab technique.***

4. Return to your lab bench and swirl the contents of the flask for ~30 sec; all the material may not dissolve. Place the flask in the hot water bath for about ~20 minutes. While the sample is heating, continue to step 5.

5. Prepare an ice water bath using a 600 ml beaker half-filled with ice and enough water to cover the ice. Place in the ice bath 5 test tubes, each containing ~10 mL of distilled water for later use.

6. After the ~20 minutes of heating, remove the flask from the hot water bath and **slowly and carefully** add a total of 10 ml of cold distilled water to the flask in 1 ml increments with a transfer (plastic) pipette. ***NOTE: This reaction is intended to destroy unreacted acetic anhydride. Generally this reaction can be violent, but since nearly all acetic anhydride has reacted, you should not observe anything "interesting."***

7. After 10 ml of the ice-cold water has been added, cool the flask and contents in the ice water bath for 10 minutes, ***occasionally*** stirring the contents with a glass rod. The acetylsalicylic acid should begin to form crystals as it cools. ***NOTE: too much stirring with the glass rod will result is very small crystals which are more difficult to collect. Once crystals are observed, no more stirring is required.***

8. Preweigh the combined mass of a piece of filter paper and watch glass using the top-loading balance and record the combined mass in your lab notebook. Collect the crystals using suction filtration as shown in prelab. Wash crystals with ice cold water, using the other test tubes in the ice bath. Once all crystals are transferred into the filter system and are dry, carefully transfer the crystals and filter paper, without losing any aspirin, to a watch glass (use your forcepts) and place in your lab drawer to fully dry. You will weigh the aspirin next week. We will be using the synthesized aspirin in the next lab activity.

Calculations for this weeks work will be completed at the beginning of next week's lab. There is no reporting sheet for this week.

TURN IN CARBON COPIES AT THE END OF EACH LAB PERIOD!