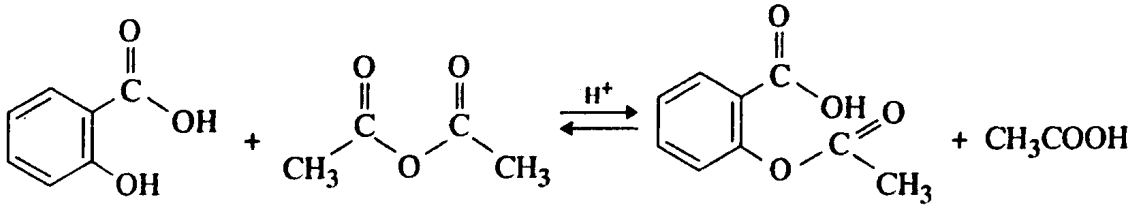
Name _____ Partner _____
Lab Section M Tu W Th F

Chemistry 130
Experiment 10: Salicylic Acid Derivatives
[Aspirin and Oil of Wintergreen]

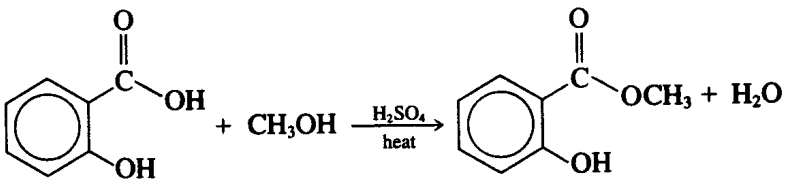
Introduction – Aspirin (acetylsalicylic acid) can be prepared by the reaction between salicylic acid and acetic anhydride. In this reaction, the *hydroxyl group* (-OH) on the benzene ring reacts with acetic anhydride to form an *ester* functional group. Thus the formation of acetylsalicylic acid is referred to as an ***esterification*** reaction. This reaction requires the presence of an acid catalyst, indicated by the H^+ above the arrow.



Salicylic acid | Acetic anhydride | Acetylsalicylic acid | Acetic acid

Esters, whether artificial or natural, are widely used as flavors and perfumes. Many of our most pleasant and familiar "fruity" and "flower" odors are due to esters. One of the most useful features of modern synthetic chemistry has been the ability of chemists to duplicate almost all naturally occurring esters. An ester is readily formed by the acid-catalyzed reaction of an organic acid [$-CO_2H$] and an alcohol [-OH]. Please note that salicylic acid (see structure above) has *both* of these functional groups. In the reaction to make aspirin, the alcohol group of salicylic acid was reacted with an acetylating reagent (the acetic anhydride).

Is it possible to react the organic acid functional group of the salicylic acid with some *other* alcohol to make an ester (which would be different from aspirin, of course)? The answer is, "Yes." One naturally occurring ester is methyl salicylate (oil of wintergreen) found in the leaves of the small creeping wintergreen shrub common to eastern North America. This ester is synthesized by means of the acid catalyzed reaction of salicylic acid and methanol.



Salicylic acid | Methanol | Methyl salicylate (Oil of wintergreen)

In this experiment we will perform both esterifications.

Procedure I: Acetysalicylic Acid (Aspirin)

1) Fill a 250 mL beaker about half full with water and place it on the hot plate. Heat the water to boiling. While the water is being heated, continue with steps 2), 3), and 4).

2) Weigh out 2.0 g. of salicyclic acid and transfer it into a DRY large test tube

Weight of Salicylic Acid _____ g.

3) Measure out 2.0 mL of acetic anhydride into a DRY 10 mL graduated cylinder and then pour the acetic anhydride into the test tube with your salicylic acid. [**CAUTION**: Acetic anhydride has a potent odor and is corrosive. Do not get any on your skin. Do not breathe the vapors. NOTE that this chemical will be found in the hood.]

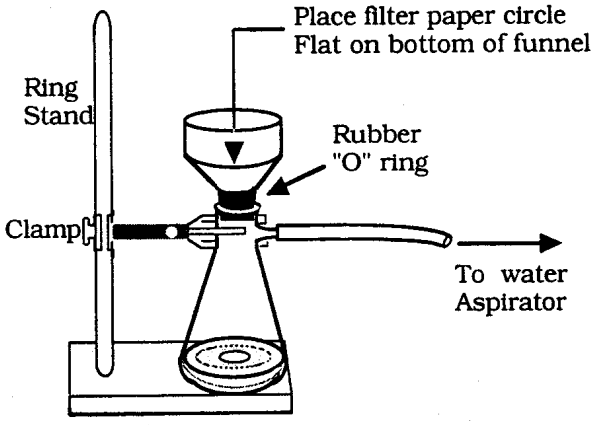
4) Add 0.4 g. of sodium acetate [CH_3CO_2Na] into the test tube and mix everything very well with a glass stirring rod. Record the appearance of this mixture:

5) Place your test tube containing your reaction mixture into the boiling water bath and simmer with occasional stirring for about 10 minutes. All of the solid should completely dissolve at some point during this heating.

6) After heating, pour the contents of the test tube into about 30 mL of water contained in a 125 mL Erlenmeyer flask. Swirl and agitate the mixture until the heavy liquid globules of unreacted acetic anhydride (which sink to the bottom) have completely decomposed and disappeared (this should be less that 10 minutes). A solid may already have started to form at this time.
Record your observations after pouring contents of heated tube into water:

7) Cool the flask and its contents by swirling the flask under a stream of cold water from the tap, and then placing the flask into an ice-water bath for at least 20 minutes. During this cooling time occasionally observe the ice-water bath to see if more ice is needed - the bath should always have some ice in an ice / water mixture. If the solid product (aspirin) does not form within this time period, you will need to stopper the flask and vigorously shake the flask (when the mixture begins to become milky continue shaking until the solid has precipitated). Record your observations after cooling in the ice-water bath:

8) Separate and collect the solid aspirin product by suction filtration using a small Buchner funnel. You will find one filtration set-up on each lab bench [see Figure]. Place a piece of filter paper in the bottom of the funnel. Wet the paper with water, and be sure that it lies flat and covers all the holes in the funnel (so that crystals cannot escape around the edge and under the paper). Then with the vacuum off, pour your cold slurry of crystals and liquid into the center of the paper. Apply the vacuum; and as soon as the liquid disappears from the crystals, break the vacuum to the flask by disconnecting the hose from the flask.
Rinse the flask with 15 mL of ice cold water and pour this out onto the original crystals (now on the filter paper). Reconnect the vacuum hose to the flask (which again applies the vacuum) and wait until the liquid disappears from the crystals. Repeat this washing process twice (using 15 mL portions of ice cold water). All of the crystals should now be transferred from the 125 mL flask to the filter paper. Continue to apply the vacuum to suck the crystals damp dry for about five minutes after no more liquid drops fall from the Buchner funnel stem.



9) Break the vacuum and then remove the filter paper **with the crystals by using a spatula to pry** under the edges of the filter paper. Spread the solid aspirin product out on a smooth piece of weighing paper and allow it to air dry [or place into an oven at about 75 °C. for at least 10 minutes].

10) When the aspirin is dry, weigh your product. Although fairly pure your product is not of pharmaceutical grade purity (it will still contain some unreacted salicylic acid).

Weight of Aspirin _____ g.

Appearance of your Aspirin product:

11) If you actually started with 2.00 g. of salicylic acid, you could make 2.61 g. of aspirin. Using your weight of aspirin product, what was the percentage yield for your experiment? [Divide your aspirin weight by 2.61 and multiply by 100]

Percent Yield of Your Reaction _____ %

Procedure II: Methyl Salicylate (Oil of Wintergreen)

1) Weigh out 0.25 g. of salicylic acid and transfer it into a DRY small test tube

2) Using a plastic transfer pipet, add 1.0 mL of methyl alcohol (methanol) to the test tube and stir (using a glass stirring rod) to dissolve the solid.

3) ***Carefully*** add 10 drops of sulfuric acid to the test tube; then stir with the stirring rod. Now add another 10 drops of sulfuric acid and again stir the mixture. [**CAUTION**: Sulfuric Acid is very corrosive. Do not get any on your skin. NOTE that this chemical will be found in the hood.] Record the appearance of this mixture:

4) Place your teat tube containing your reaction mixture into the boiling water bath. Stir until all of the solid dissolves and then continue heating for 10 minutes. While waiting, weigh out about 4 g. of sodium bicarbonate [$NaHCO_3$] into a 250 mL beaker, add 50 mL of water, and swirl to dissolve the solid.

5) After heating for ten minutes, pour the contents of the test tube (without cooling) into the sodium bicarbonate solution. When the fizzing subsides, stir this new mixture thoroughly and *cautiously* smell the contents of the beaker. [You "waft" your hand over the top of the beaker - to move the vapors to your nose!] Record your *visual* and *olfactory* observations: