

HYPOTHESIS:

Fragrant esters are formed when carboxylic acids and alcohols react in the presence of a strong-acid catalyst.

OBJECTIVE:

To prepare a variety of esters by allowing carboxylic acids to react with alcohols in the presence of a strong-acid catalyst (a condensation reaction known as *acid-catalyzed esterification*).

MATERIALS:

hot plate or Bunsen burner, 2 large beakers, graduated cylinder, 3-4 test tubes, test-tube tongs, stirring rod, various alcohols and carboxylic acids, concentrated sulfuric acid, distilled water

CONSIDERATIONS:

1. *Be advised, we will be using extremely corrosive, concentrated sulfuric acid ($\text{H}_2\text{SO}_4(aq)$) as a catalyst in this procedure. Wear old clothes* the day of lab (or a lab coat or apron, if you have one).
2. *You must wear safety goggles at all times during the procedure.* Anyone caught not wearing goggles will receive an automatic zero for this exercise. *Wear the goggles!*
3. If you use a Bunsen burner, BE CAREFUL! You are dealing with flammable solutions.
4. Maximum group size is THREE people. Everyone must do a separate write-up (data table and equations).
5. Read the following completely before lab.

PRELAB PREPARATION:

1. Construct a data table with the following :
 - a. Column (vertical) headings should read: ALCOHOL, CARBOXYLIC ACID, ESTER SYNTHESIZED (You should be able to predict this while waiting for the ester to form.), and ODOR OF ESTER.
 - b. Include at least 6 rows (horizontal), as there should be at least six alcohol-acid combinations you may try.
Available alcohols include methyl, ethyl, amyl, and octyl. Available carboxylic acids include acetic, butyric, and salicylic. These are common names on the containers.
BUTYRIC ACID MUST BE ADDED IN THE FUME HOOD, ONLY (It's a component of B.O.).
ACETIC ACID (GLACIAL), TOO, SHOULD BE ADDED IN THE FUME HOOD (It really irritates the nose and eyes.).
You will be given IUPAC names and/or structures in lab. You may want to leave your data table blank until you get to lab.
Construct your data table so there is enough room for both the common and IUPAC names, leaving enough room for the structural formulas.
2. You do not need to write out procedures in advance. Read the following procedure before lab, however, so that you know what you are doing when you show up. (Bring this paper with you.)

PROCEDURE (for each trial):

1. Half-fill a beaker with tap water, then heat it. Adjust the heat so the water does not boil. This is a hot-water bath.
2. Using the micro-pipet supplied, add about 1 mL of a carboxylic acid (for the solid salicylic acid, measure about 1 g) and about 1 mL of an alcohol to a test tube, in combinations to be indicated in lab. Record the combination in your data table.
3. CAREFULLY add 3-5 drops of concentrated $\text{H}_2\text{SO}_4(aq)$, sulfuric acid, to the tube. Stir the mixture with a stirring rod.
4. Place the tube in the hot-water bath for 10-15 min. DO NOT ALLOW THE MIXTURE TO BOIL.
5. Prepare a cold-water bath in another beaker.
6. USING A TESTTUBE HOLDER, remove the mixture from the hot-water bath and place it in the cold water.
7. Add about 5 mL of distilled water, and note the odor by wafing the fumes toward your nose.
8. Try to relate the odor to a fruit, vegetable, animal, or something. Record observations in your data table.
9. Wash the test tube thoroughly before using it for another trial.
10. Name each ester produced (IUPAC: alcohol component first, with an *-yl* ending, followed by acid component, with an *-oate* ending) in your data table.
11. Write balanced chemical equations, using structural formulas, for each reaction.
12. When finished, CLEAN UP YOUR WORK AREA COMPLETELY. CLEAN AND DRY ALL GLASSWARE COMPLETELY, AND PUT IT BACK WHERE IT BELONGS AT THE FRONT DESK. MAKE SURE THE ENTIRE LAB, INCLUDING THE FUME HOOD, IS CLEAN BEFORE YOU LEAVE.