PREPARATION OF AN ESTER
EXPERIMENT 27

PURPOSE
To synthesize an ester from a carboxylic acid and alcohol.

DEFINITIONS
Organic acid, alcohol, ester, esterification.

BACKGROUND
Did you know the aromas of bananas, strawberries, and other fruits are the result of organic chemistry? Esters account for the distinctive odors of many fruits. Many of these ester compounds have pleasant odors. You can synthesize an ester in the lab by heating a carboxylic acid in an alcohol solution containing a small amount of strong acid as a catalyst.

\[
R—\text{COOH} + R'—\text{OH} \xrightleftharpoons{H^+} R—\text{COOR'} + \text{H}_2\text{O}
\]

carboxylic acid                  alcohol                       ester                water

The acid you will use in this experiment is salicylic acid, with the structure shown below. In this experiment, you will react salicylic acid and methanol, in the presence of a strong acid catalyst, to form the ester, methyl salicyloate.

![Salicylic acid](image)

MATERIALS
salicylic acid
concentrated sulfuric acid
methanol

SAFETY
- Concentrated sulfuric acid is used to catalyze the chemical reaction. It is strongly recommended that the teacher assist during this procedure.
- Wear safety goggles.
- Alcohols are flammable liquids. Do not dispense methanol near an open flame.
- Mix chemicals only according to directions. Never add water to concentrated sulfuric acid. Never add sulfuric acid to any other concentrated acid or to an alcohol.
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PROCEDURE
1. Fill a 250 mL beaker half full with water, and heat the water to 60°C with a Bunsen burner.
2. To a small test tube, add approximately 1 g of a salicylic acid and 1 mL of methanol.
3. Add 3–5 drops of concentrated sulfuric acid to the tube and heat the tube in a water bath at 60°C for 15 minutes.
4. Turn off the burner and remove the test tube from the hot water bath. Cool the tube in a cold water bath.
5. Add 5 mL of distilled water to the tube. The ester produced in the reaction will float on the water in the tube. Note the odor of the ester by wafting the fumes toward your nose with your hand. Identify the odor produced by relating it to a familiar fruit, flower, etc.

ANALYSIS
1. State the most important safety concern in this lab and the required precaution you took.
2. What was the odor produced by the ester?
3. Write a general equation for the acid-catalyzed formation of an ester from an alcohol and a carboxylic acid, showing the structural formulas for all chemicals (see the background.)
4. Write a full structural equation for the specific esterification reaction in this experiment. It is the acid group on salicylic acid that reacts with the alcohol group on methanol. Write the name of each compound below its structural formula.
5. What was the purpose of concentrated sulfuric acid in this reaction?
6. In esterification reactions, the products are in chemical equilibrium with the reactants. Why was the reaction kept free of water during heating? (Think about Le Chatelier’s principle.)
7. Suggest one way of causing the equilibrium to shift in favor of the production of additional ester.
8. Honors: What was the most probable source of error that would lead to incorrect observations?