Esters

Background

Organic compounds known as acids and alcohols react to form another type of organic compound called an ester. Esters frequently produce a recognizable and often pleasant fragrance. Esters are responsible for many fruit flavors, such as apple, pineapple, pear, and banana. However, esters are not always aromatic in the chemical sense—they might not contain a benzene ring.

Question

How do an acid and an alcohol combine to produce a compound with different characteristics? Can the presence of the new compound formed be detected by its odor?

Objectives

- Prepare an ester from an alcohol and an acid.
- Detect the results of the reaction by the odor of the product.

Materials

- medium-size test tube
- test-tube holder
- 250-mL beaker
- 10-mL graduated cylinder
- water
- hot plate
- ring stand
- thermometer
- salicylic acid (1.0 g)
- amyl alcohol (2 mL)
- concentrated sulfuric acid
  (1 mL to be added by teacher)

Safety Precautions

Procedure

1. Read the procedure and safety information, and complete the lab form.
2. Add about 150 mL of water to the beaker, and heat it on the hot plate to 70°C.
3. Place approximately 1 g of salicylic acid in a test tube. Does this material have an odor? See the illustration for the proper way to detect odors in the laboratory.
4. Add 2 mL of amyl alcohol to the test tube. Before adding it, check to see if this compound has an odor. If so, try to remember what it smells like.
5. Ask your teacher to carefully add 1 mL of concentrated sulfuric acid. WARNING: Sulfuric acid is caustic. Avoid all contact. Do not inhale fumes.
6. Place the test tube in the hot water, and leave it untouched for about 12 to 15 minutes.
7. Remove the tube from the hot water using a test tube holder, and allow it to cool. Check to see if you can detect a new aroma.
LAB (continued)

The proper way to detect odors

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<tr>
<th>WARNING: When checking an odor, waft the vapor toward your face gently.</th>
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Analyze Your Data

1. Identify  What did you smell after the reaction was complete?

2. Infer  Look closely at the surface of the liquid in the test tube. Do you see any small droplets of an oily substance? What do you think it is?

Conclude and Apply

1. Predict  What esters would form if amyl alcohol were replaced by the following alcohols: methyl, ethyl, propyl, and isobutyl?

2. Predict  Look at the equation for the reaction below. One product is given. What do you think is the second product formed in this reaction? Explain.

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\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{CH}_3\text{CO}_2\text{H} \rightarrow \text{CH}_3\text{CO}_2\text{CH}_3 + ?
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3. Design an Experiment  How might you modify the experiment to produce a different ester?

Communicate Your Data

Poster  Make a poster showing the reaction that took place. Use the poster to explain the formation of esters to students from another class.