

20C – FRAGRANT ESTERS

INQUIRY

How does the functional group of an organic compound affect its properties?

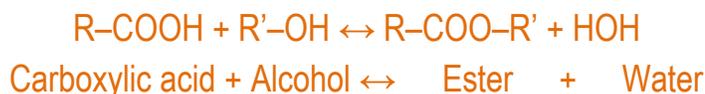
MATERIALS

- Device with SPARKvue software
- Temperature sensor
- Electrode support
- Molecular Model Set
- Beaker, 250 mL
- Test tubes, 20 mm x 150 mm (3)
- Test tube rack
- Test tube clamp
- Ring stand
- Heater stirrer
- Balance (readability: 0.01 g)
- Scoopula
- Salicylic acid (2-HOC₆H₄COOH), 0.2 g
- Methyl alcohol (CH₃OH), dropper bottle
- Ethyl alcohol (C₂H₅OH), dropper bottle
- Isoamyl alcohol ((CH₃)₂CHCH₂CH₂OH), dropper bottle
- 18M Sulfuric acid (H₂SO₄), dropper bottle
- Butanoic acid (CH₃CH₂CH₂COOH), dropper bottle
- Glacial acetic acid, (CH₃COOH), dropper bottle
- Cotton balls (3)



BACKGROUND

The physical and chemical properties of organic compounds depend largely on their functional groups. Molecules with the same functional groups will have similar physical properties and undergo the same types of chemical reactions. Therefore, it is possible to group organic compounds into families based on these functional groups. In this activity, we are looking at three types of organic functional groups: alcohols which contain an -OH functional group, carboxylic acids which contain a -COOH group, and esters which contain a R-COO-R' group. Carboxylic acid groups can be converted to ester groups through esterification. Esterification is the reaction between an organic acid (R-COOH) and an alcohol (R'-OH) to produce an ester (R-COO-R') and water. Because this reaction is reversible, maintaining an excess of alcohol and minimizing the amount of water helps increase the yield of esters.



The -OH group from carboxylic acid combines with the -H from alcohol producing a water molecule. The R'-O- group from the alcohol then attaches to the carbon on the carboxylic acid forming the ester.

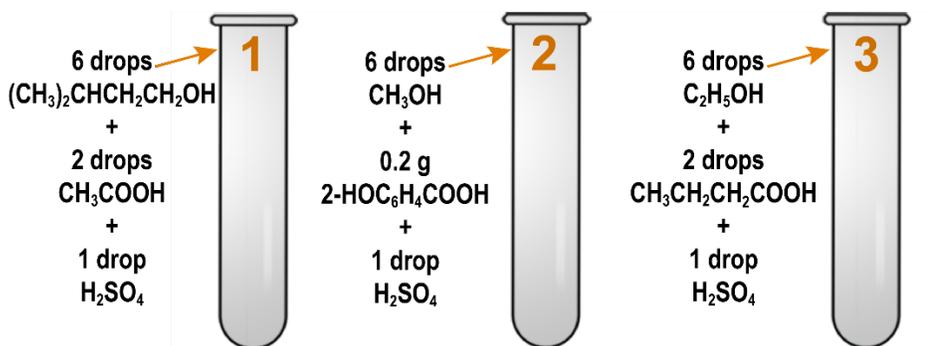
SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.
- Clean up all spills.
- Use gloves if available. Wash hands when finished.
- Keep butanoic acid and sulfuric acid in the fume hood.
- Most of the organic compounds in this lab are flammable. No open flames are permitted.

PROCEDURE

1. Open SPARKvue.
2. Open the 20C Fragrant Esters lab file in SPARKvue. Use the Bluetooth icon to connect the Temperature sensor and start collecting data.
3. Half fill the 250-mL beaker with water and place it on the heater stirrer. Set the heat to medium-high.
4. Use the electrode support to suspend the temperature sensor in the beaker.
5. Adjust the heat setting to maintain a temperature between 70 °C - 80 °C. This is your hot water bath.
6. Label three clean and dry test tubes #1 to 3. Prepare the esters according to the following.
 - Test tube #1 - add 6 drops of isoamyl alcohol, 2 drops of glacial acetic acid, and 1 drop of concentrated sulfuric acid.
 - Test tube #2 - measure and add 0.2 grams of salicylic acid (tip of the scoopula), 6 drops of methyl alcohol, and 1 drop of concentrated sulfuric acid.
 - Test tube #3 - add 6 drops of ethyl alcohol, 2 drops of butanoic acid, and 1 drop of concentrated sulfuric acid.



7. Loosely place a cotton ball in the top of each test tube.
8. Gently swirl the test tubes to mix the reactants. Set the test tubes in the ~70° C water bath. Monitor the temperature and allow the reaction to proceed for 15 minutes. While the reaction is occurring, use the Molecular Model Set to complete the steps in the Analysis on your answer sheet.
9. After 15 minutes, use a test tube clamp to remove the test tubes from the hot water bath. Set the test tubes in the test tube rack.
10. Extract the cotton plug and waft the vapor either from the test tube or the cotton plug to smell the odor of the ester produced. Record the identity of the odors in Table 1 on your answer sheet.

 **ANALYSIS** 

Complete the analysis on your answer sheet.

 **QUESTIONS** 

Answer the questions on your answer sheet.