Organic Chemistry: Esters Lab

Introduction:

In order to enhance their appeal, many foods contain artificial flavorings, while many other consumer products contain artificial fragrances. The molecules that give these products their distinctive odors are called ‘esters’. Esters are produced by the reaction of alcohols with organic acids in the presence of a strong acid such as sulfuric acid, which works as a catalyst.

The generic reaction between an organic acid and an alcohol is:

RCOOH + HOR’ → RCOOR’ + H2O

where R and R’ represent carbon chains, RCOOH represents an organic acid, HOR’ represents an alcohol, and RCOOR’ represents an ester. Esters are named by using the alcohol name with the acid name after its suffix has been changed to ‘-ate’. For example, ethyl alcohol and acetic acid produce the ester ethyl acetate.

In this lab, you will prepare three types of fragrant ester molecules from their original components. You will also name these fragrances using your knowledge of organic chemistry.

Materials:

* Beaker, 400 mL
* Graduated cylinder, 10 mL
* Hot plate
* Small test tubes, 3
* The Following Alcohols:
  + Isoamyl Alcohol
  + Ethyl Alcohol
  + Octyl Alcohol
  + N-Propyl Alcohol
  + Methyl Alcohol
  + N-Amyl Alcohol
* The following organic acids:
  + Acetic Acid
  + Benzoic Acid
  + Formic Acid
  + Salicylic Acid
  + Propanoic Acid
* Sulfuric acid, Concentrated

Procedure:

1. Prepare a water bath by filling a 400 mL beaker half full with tap water. Place the beaker on a hot plate to begin heating it until it is just below boiling.
2. The first fragrance you will be making is winter green. This will require methyl alcohol and salicylic acid.
3. Obtain 2 mL of methyl alcohol and add it to a small test tube. Obtain 1.0 g of salicylic acid and add it to the test tube.
4. Carefully add 3-5 drops of concentrated sulfuric acid to the test tube.
5. Gently tap the bottom of the tube to mix the reactants in a safe manner.
6. Place the test tube in the water bath and allow it to be heated for one minute.
7. Check for any possible odor of an ester by using the ‘wafting’ method. Record your observations. If no odor is detected, allow the test tube to remain in the water bath for 5-10 more minutes.
8. Repeat steps 3-7 with your choice of organic acid and alcohol to create two more scents from the table below. If reactant is solid use 1g, if reactant is aqueous use 2 mL.

|  |  |  |
| --- | --- | --- |
| Alcohol | Organic Acid | Ester Fragrance |
| methyl alcohol | salicylic acid | wintergreen |
| isoamyl alcohol | acetic acid | banana |
| ethyl alcohol | acetic acid | fruity |
| octyl alcohol | acetic acid | citrus |
| n-propyl alcohol | acetic acid | pear |
| ethyl alcohol | benzoic acid | vanilla/flower |
| n-propyl alcohol | formic acid | apple |
| methyl alcohol | benzoic acid | flower/vanilla |
| n-propyl alcohol | benzoic acid | nutty |
| n-amyl alcohol | salicylic acid | hay/straw |
| iso-amyl | salicylic acid | straw/hay |

Questions:

1. Show the balanced reaction for the production of each of the esters that you formed in this lab.  
2. Using the directions in the introduction, name the three esters that you produced in this lab.