

ESTER LAB “The smelliest lab of the year” Name: _____ Partner: _____

INTRO: When an organic acid ($\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$) and an alcohol ($\text{R}-\text{OH}$) are mixed together and heated in the presence of an acid catalyst (such as H_2SO_4), the two will react to form an ester (plus H_2O). This process is called **esterification**.

Each ester has its own unique odor, and with a discriminating nose, one can use this fact to help identify them. In this lab you will be reacting various organic acids (acetic acid & salicylic acid) with various alcohols (methanol, isopentanol, & ethanol). You will make three different esters with odors that should be familiar to you.

Procedure: GOGGLES MUST BE WORN AT ALL TIMES!

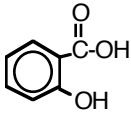
1. Get 3 test tubes, labeled: “1”, “2”, & “3”
2. **Test Tube #1:** Add 10 drops of acetic acid, 10 drops of isopentanol, and 2 drops of H_2SO_4 .
3. **Test Tube #2:** Add 1 scoop of salicylic acid, 15 drops of methanol, and 2 drops of H_2SO_4 .
4. **Test Tube #3:** Add 10 drops of acetic acid, 10 drops of ethanol, and 2 drops of H_2SO_4 .
5. Mix the contents of each test tube by the **knocking method**.
6. Place all 3 test tubes together in the warm water bath for approximately 1 minute.
7. Remove (carefully!) the test tubes from the hot water and place them in the test tube rack.
8. Note the smell of each ester by **wafting** the vapors towards your nose, one at a time. (Knocking the test tube before wafting helps!) Describe the odors in the Data Table below.
9. To clean-up, empty out your test tubes into the waste container, and place the test tubes inside the soaking bin.

| Data Table: | <u>odor</u> | <u>reactants</u> | <u>product</u> (name of ester) |
|--------------------|-------------|--------------------------------|--------------------------------|
| Test Tube #1: | | acetic acid + isopentanol ---> | |
| Test Tube #2 | | salicylic acid + methanol ---> | |
| Test Tube #3 | | acetic acid + ethanol ---> | |

Questions:

1. Why do you think you were instructed to use an electric hot plate to heat the water instead of a Bunsen burner?
2. Why do you think you were instructed to waft the odors instead of sniffing them directly?
3. What role did the H_2SO_4 play? How does it affect the esterification reaction? (see opening paragraph)
4. Why did you use warm water instead of boiling hot water?
5. Explain a) how we are able to smell certain smells in the first place (what goes on in the nose and the brain). If you are not certain of the "correct" answer, at least make up a good theory!! (Use diagrams.)

next, “draw” the structures you just smelled! (see back side)

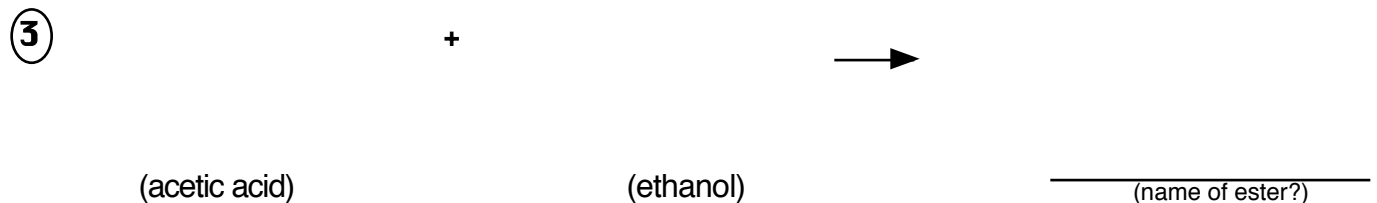
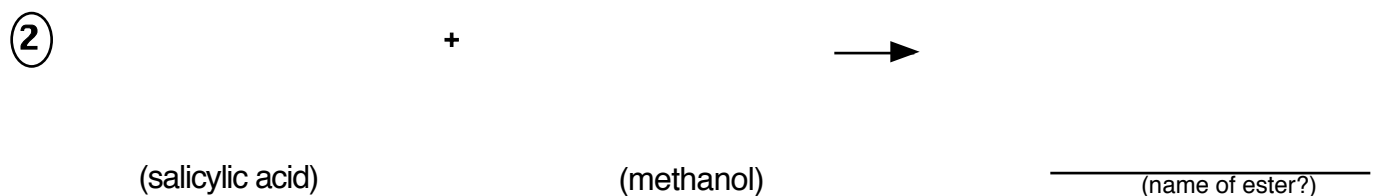
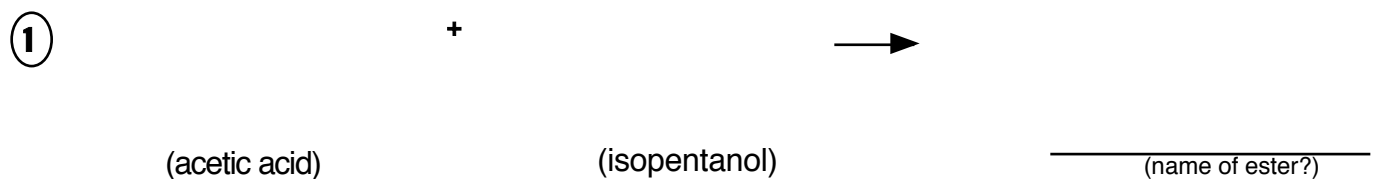
| name: | structural formula: |
|----------------|--|
| acetic acid | $\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{OH} \end{array}$ |
| salicylic acid |  |
| methanol | CH_3-OH |
| ethanol | $\text{CH}_3-\text{CH}_2-\text{OH}$ |
| isopentanol | $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{OH} \end{array}$ |

organic acids

alcohols

5. Use the structural formulas to write the equations for each of the esterification reactions:

organic acid + **alcohol** \longrightarrow **ester**



(Bonus): With 2 organic acids and 3 alcohols, there are 6 possible combinations we could have made. We only did 3 of the 6 in class (the 3 esters above). On a separate page, write the equations for the remaining 3 esterification reactions, using the structural formulas. Determine the name of the 3 esters as well!