GOAL:
- Use steam distillation to isolate clove oil from cloves
- Use extraction to separate the clove oil from water
- Use TLC and 1H NMR to analyze our clove oil samples

KEY CONCEPTS:
- If a clear separation is not obtained post distillation, extraction utilizing dichloromethane (DCM) will be used to further separate eugenol from the aqueous layer. Proton nuclear magnetic resonance spectroscopy (1H NMR) and thin layer chromatography (TLC) will be used to determine the purity of eugenol isolate and identify the product obtained.
- Efficacy and efficiency of steam distillation will be evaluated based on the experiment data.
- Steam distillation is used to isolate organic compounds with high boiling points that would otherwise decompose if heated to their respective boiling points. Boiling point is the temperature at which the vapor pressure of a liquid equals the applied pressure (atmospheric pressure).
- Steam distillation requires boiling and condensing of a mixture containing a higher (eugenol) and lower boiling liquid (water).
- Eugenol and water are immiscible. Since immiscible compounds do not mix, the total vapor pressure of an immiscible system will be dependent on the individual vapor pressures of each compound and independent of the amounts of each compound present. Meaning, vapor pressures of immiscible liquids are additive.
- Thus, a mixture of eugenol and water will boil when their combined vapor pressure equals the applied pressure.
- Eugenol has a high boiling point and low vapor pressure. Similarly, water has a low boiling point and a high vapor pressure. Adding water allows for the mixture to boil much faster than if eugenol were heated by itself and makes it much easier for eugenol to phase change into a gas.

QUESTIONS
1. Theory: Which of the following statements are true about boiling and vapor pressure as related to steam distillation?
   a. The total vapor pressure of the system depends on the mole fraction of each component of the mixture (water and organic compounds).
   b. The boiling point of the system is the temperature where the vapor pressure of the system is equal to the applied pressure.
   c. The organic compounds we are trying to isolate from cloves have low vapor pressures relative to water, which means they will have higher boiling points than water.
   d. All of these are true.
   e. None of these are true.
2. Lab Techniques: If this is your first TLC plate after eluting with 2% ethyl acetate/hexanes, what should you do? What is the purpose of the co-spot, distillate spot, and clove oil spot?

3. Calculation: Cloves are approximately 17% eugenol by weight. Calculate the theoretical mass of eugenol that can be recovered from the cloves you weighed and percent recovery for your experiment based on this mass. Do not use the values from the Achieve questions to calculate these numbers!