I. Introduction

(summarize the introduction and add more information to your prelab)

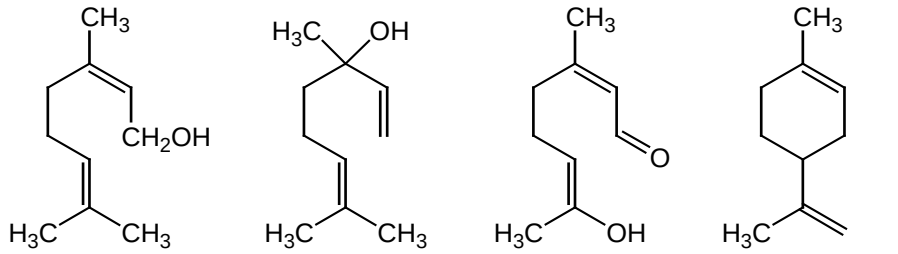
Steam distillation is used to separate slightly volatile water-insoluble substances from nonvolatile materials. It is especially useful in cases where a relatively small amount of nonvolatile material is available. It is important to remember that the principle of steam distillation applies only if the organic substance is insoluble in water and has a boiling point much higher than 100°C. it is especially useful in extracting substances that may decompose if distilled at much higher temperature.

To illustrate the principle behind steam distillation, consider a mixture of bromobenzene (BP 156°C) and water (100°C). Each component of this mixture exerts its own vapor pressure independent of the other with the total vapor pressure equal to the sum of the individual vapor pressures. One can therefore write the equation: $P_{total} = p°_{water} + p°_{bromobenzene}$, where $p°_{water}$ and $p°_{bromobenzene}$ are the independent vapor pressures, respectively. Since the total pressure must equal atmospheric pressure at a temperature below the boiling point of either pure substance the mixture must distil at this lower temperature. For example, at 95°C, bromobenzene exerts a vapor pressure of 120 mm Hg while water's vapor pressure is 640 mm Hg. Hence, we have

$$\begin{aligned} P_{total} &= p°_{water} + p°_{bromobenzene} \\ &= 640 \text{ mm Hg} + 120 \text{ mm Hg} \\ &= 760 \text{ mm Hg.} \end{aligned}$$

The above equations imply that bromobenzene and water will distill together at 95°C since the mixture of water and bromobenzene will exert a vapor pressure equal to the atmospheric pressure at this temperature. Thus, the mixture boils at a temperature lower than the boiling point of either bromobenzene or water.

Essential oils are substances that give the characteristic odor and flavor of plants, flowers and fruits. They are high boiling liquids that are insoluble in water and thus are usually isolated from the plant material by steam distillation. An essential oil is not a pure chemical compound but a mixture of several types of organic compounds. The most prominent components of these mixtures are the so-called monoterpenes, some of which are shown below:



Geranoil rose oil | **Linalool** oil of ilang-ilang | **Citral** lemon grass oil | **Limonene** oil of citrus fruits

II. Objectives

(just copy these objectives to your prelab)

a. To recognize and assemble a steam distillation setup,
b. To compare stem distillation with simple distillation as a separation method,
c. To use steam distillation in the separation of slightly volatile substances from those which are nonvolatile, and
d. To isolate essential oils from fresh plant material and gain experience in the chemical laboratory manipulation of fresh plant material.

III. Procedure

(make a flowchart/ schematic diagram)

Please bring the following for each group:

Oranges or ponkan (citrus fruits)
Knife or cutter
Distilled water
Ice (bring enough for condenser)
Vial
Tissue paper, matches, wire gauze

Steam Distillation

a. Obtain the rind of any citrus fruit (orange or ponkan) and weigh about 200 grams fresh finely sliced rind of the fruit.
b. Mix the sample with distilled water in the sample flask. Add enough water such that the flask is about 2/3 full.
c. Assemble the rest of the setup; check all connections for tightness.
d. Heat the sample flask.
e. Collect about 200mL of distillate into a 250mL separatory funnel.
f. Record all observations.

Separation of the essential oil from the steam distillate.

a. If a distinct oily layer separates from the aqueous layer of the steam distillate, drain the aqueous layer slowly out of the separatory funnel. If the oily layer is not distinct or if some oil droplets are dispersed in the distillate, salting out may be necessary. Place a spatula of sodium chloride into the separatory funnel and gently shake or swirl the contents. Let stand to allow the oil layer to separate then proceed with drawing out the aqueous layer.
b. Transfer the remaining oily layer into a previously weighed clean vial using a dry dropper.
c. Determine the weight of the oil.
d. Record all observations.
e. Label the vial properly, indicating the source, group number and date.

IV. Data and Results

(Provide a table for your observations)