Name____

Measuring the Size of a Molecule
Dr. Slotsky Chemistry I

Introduction: Stearic Acid (STA) is a chemical found in many household products such as soap, cosmetics, and shampoo. It is a long molecule with a polar end and a nonpolar end, and forms a single-molecule layer on the surface of water. Therefore, if we can find the thickness of the STA layer, will know the 'length' of the STA molecule. We have a 1 gram/Liter solution of STA dissolved in ethyl alcohol. We will add one drop of this solution to a dish of water with pepper flakes scattered over the top. The drop will produce a 'clear' zone in the pepper, as it lowers the surface tension of the water where the STA layer forms. We can measure the diameter of this zone with a ruler and estimate its area in cm^2.

We need to know the volume of STA present in a drop of solution. We will 'calibrate' our dropper and figure out how much volume is in an average drop. Knowing the volume of a drop, we can calculate the mass of STA present in a drop of 1 g/L STA solution. Knowing the density of solid STA, we can calculate the volume of STA in cm^3 for each drop. Dividing STA volume in cm^3 by layer surface area in cm^2 gives layer height in cm. This is the size of a single STA molecule!

Part I: Calibrating your Dropper

You will be given a plastic dropper. Obtain a 3-beam scale, a plastic weighing dish, and a test tube of ethyl alcohol. One milliliter (mL) of ethyl alcohol has a mass of 0.80 grams. We need to find out how many drops it takes to make one mL.

Balance the scale with the weighing dish present. Move the grams slider over by 0.80 grams – the scale will now be unbalanced. Add drops of ethyl alcohol to the weighing dish one at a time and <u>count</u> them until the scale balances again.

1) Drops per 0.80 gram ____________drops
2) 1.00 divided by (Drops per gram) gives the volume of one drop _______mL

Name____

Part II: Finding the Area of the Single-Molecule Layer

Fill your tray with ½" to 1" of water and sprinkle the top with pepper flakes so that it is completely but lightly covered in pepper. Work quickly, before the pepper gets soggy and starts to sink!

Add a single drop of 1 g/L STA solution, using the same dropper as in Part I, to the tray. A clear spot will appear in the pepper. If the spot is not pretty much circular, repeat this step until it is.

3) Measure the diameter of the clear spot (in cm) ____________cm

4) Estimate the radius of the spot: Diameter ÷ 2 _____________cm

5) Estimate the area (in cm^2) of the clear spot: take the square of the radius and multiply it by π ______________________________cm^2

Part III: Calculating the Thickness of the Single-Molecule Layer

6) The volume of 1 drop of liquid in mL (from Line 2) _____________mL

7) The solution is 0.001 gram/mL stearic acid so multiply Line 6 by 0.001 to get grams of STA. You MAY need scientific notation: _________________g

8) The density of stearic acid is 0.85 g/cm^3. Divide Line 7 by 0.85 to get the volume of SDS added ______________________________________cm^3

9) The thickness of the single-molecule layer is the volume (Line 8) divided by the area (Line 5), in cm ____cm

10) The length of the SDS molecule, in cm, is equal to the value on Line 9. Convert this value to METERS by dividing by 100
A SDS molecule has a length of ______________________________ meters
(You **WILL** need scientific notation, this is a very small number!)