EXPERIMENT 7
ESTIMATING THE DIAMETER OF A MOLECULE

INTRODUCTION

Oleic acid is a molecule consisting of carbon, hydrogen, and oxygen atoms. Undiluted oleic acid doesn't dissolve in water. Instead, it forms a thin film on water only one molecule thick. One drop of oleic acid will form a film large enough to cover an entire swimming pool. Therefore, we shall use oleic acid that has been diluted with alcohol so that the film produced by the oleic acid can be measured.

For you to understand the logic of the experiment, your teacher will demonstrate a method for estimating the diameter of some small lead shot. After the demonstration you will use the logic to complete the experiment.

I. PURPOSE

What is the diameter of an oleic acid molecule?

II. EQUIPMENT/MATERIALS

Petri dish	Pizza pan
Lead shot	Oleic acid, 1:500 dilution
Metric ruler	Lycopodium powder
25 ml graduated cylinder	

III. PROCEDURE

Part 1: Estimating the Diameter of Lead Shot

1. Obtain lead shot of uniform size and place enough into a petri dish to completely fill the dish with one layer of lead shot.
2. Use a metric ruler to determine the diameter of the layer of lead shot in the petri dish.
3. Pour the lead shot into a 25-ml graduated cylinder. Determine the volume of all the lead shot.
4. The area of the layer of lead shot times the height of the layer approximately equals the volume of the spheres, or volume = area x height. Determine the height of the layer of lead shot. This value is an estimate of the diameter of one of the lead shot.

Part II: Estimating the Diameter of an Oleic Acid Molecule

5. Calibrate the dropper pipet from the oleic acid solution by counting the number of drops of oleic acid required to fill a clean, 10 mL graduated cylinder to 1.00 ml.

6. Place enough water in a tray just to cover the bottom completely. Allow it to stand for about one minute.
7. Lightly sprinkle some powder on the water so that you can just barely see a film of powder on the water.
8. Place one drop of oleic acid solution on the water in the center of the tray. If you get a circular ring, measure the diameter in centimeters with a scale. If the ring is "out of round," measure several diameters and determine the average.

IV. DATA

PART I

DIAMETER OF DISH = _____ cm
VOLUME OF LEAD SHOT = _____ ml

PART II

DROPS IN 1 ML = _____
DIAMETER OF RING = _____ cm

V. CALCULATIONS

Show your work:

PART I

1. Calculate the radius of the dish. r=d/2
2. Calculate the area of the surface of lead shot. $A=\pi r^2$.
3. Calculate the height of the lead shot: h = volume / area

PART II

4. The oleic acid was diluted 1:500. Therefore, 1 ml of solution contains only 1/500 ml or .002 ml of oleic acid. To find the volume of the oleic acid in one drop of solution, divide .002 by the number of drops per 1 ml of the solution. See Procedure 5. In other words:
   Actual volume of oleic acid = .002/number of drops per ml
5. Calculate the radius of the oleic acid film ring.
6. Determine the area of the oleic acid film. Remember: πr^2 = area.

7. Determine the height of the oleic acid film, using this formula:
   Height = Volume/Area, or h = #4 / #6

   Since the height of the film is only one molecule thick, the height is an estimate of the diameter of an oleic acid molecule.

VI. QUESTIONS

1. How many oleic acid molecules could you fit side by side across the diameter of a dime?

VII. DISCUSSION OF ERROR

None

IX. REFLECTION

What is the smallest object you can see with your unaided eye? How does that relate to the size of the oleic acid molecule?