

Oleic Acid Lab

Molecular Mass of Oleic Acid 282 g/mol
Density of Oleic Acid 0.89 g/ml

How **Big** is a Molecule?

or

Determining The Diameter of a Molecule Using Indirect Measurement

Theory: Oleic acid is a fatty acid found in oils (triglycerides). Like oil, Oleic acid will spread out over the surface of water in a thin layer. One drop of oleic acid will create a large oil layer. Therefore, we will add alcohol to the oleic acid to dilute the volume of oil in our drop. The alcohol will mix with water leaving the oleic acid on the surface.

Using our knowledge of measurements we can determine the thickness of the thin film formed by the Oleic acid. The volume of acid used to make the thin film should equal the thickness of the film times the area of the film created. To measure the area of the film we will use a fine powder dusting on the surface of the water, the oleic acid layer should push the dust to the sides allowing us to measure the size of the oil drop.

Purpose: Objective:

To measure the thickness of a single molecule. This gives us a "feel" for the scale of matter at the microscopic level of molecules and atoms.

In this lab, we will find the length of one oleic acid molecule by spreading a small amount over the surface of water and measuring the diameter of the circle. The oleic acid spreads itself into a one-molecule thick layer in the shape of a VERY flat cylinder.

Oleic acid layer



Water layer

If we know the volume of the drop of oleic acid and the diameter of the layer, the height of the layer (length of the molecule) can be found. Recall that the equation for the **volume of a cylinder is $\pi r^2 h$** .

Materials:

2% Oleic acid solution in alcohol by volume
Container to hold water
Thin stem dropper

10 ml graduated cylinder
Calcium Carbonate powder
Ruler

You will be measuring the thickness of a molecule, about 10^{-7} centimeters. That's small, it may even boggle your mind. But what is more mind boggling is that you can do this with a meter stick! Let's go.

Procedures:

- Using the thin stem dropper, determine the number of drops of water it takes to fill a 10 ml graduated cylinder to the 1 ml mark. Repeat this at least 3 times to get a reliable number. Record your trials in a data table and the average the number of drops.
- Obtain a sample of oleic acid. The dropper contains water, rinse the dropper with a portion of the sample, dispose of the rinse solution into the sink. Repeat a second time.
- Fill your water container at least $\frac{1}{2}$ full of water and allow the water to "rest" for a minute or more.
- Sprinkle a light dusting of Calcium carbonate powder over the water. You should be able to barely see the powder on the water.
- Using the dropper with oleic acid, gently add one drop of oleic acid to the center of the tub about 1 cm from the surface of the water. The powder should move outwards. Allow the clear layer of oleic acid to stabilize.
- Measure the diameter of the oleic acid drop. If the circle is irregular measure the diameter three times to determine the average diameter of the drop. Record each diameter and the average diameter.
- Siphon the contents of the tub into the sink and rinse the tub. Clean up your lab area, put away all the materials and start your calculations.

Guide for completing your lab report

Determining The Diameter of a Molecule

Suggested Data Tables

Trial	Number of drops In 1 ml of water
1	
2	
3	

Measurement	Diameter of Oleic Acid Layer
1	
2	
3	

Average drops/ml _____

Average diameter _____ cm

DISCUSSION

To determine the diameter of Oleic acid, I considered the oleic acid film to be a cylinder sitting on top of the water in the lab container. I used the formula for the height of a cylinder.

Show all your work in your lab report. Make sure you show all units of measurement

- 1) Use the data from Table 1 to calculate the average number of drops in 1 ml of water.
Average drops/ml _____
- 2) Use your data from Table 2 to calculate the average diameter of oil drop.
Average diameter _____ cm
- 3) Calculate the volume of pure oleic acid using these steps:
 - a) Convert drops (from calculation #1) to ml by dividing 1.0 ml by the number of drops needed to equal 1.0 ml.
 - b) Since the drop was only 2% Oleic Acid you will need to multiply that answer by 0.02. The answer is the volume of pure oleic acid expressed in ml (which, remember, are equal to cm^3)
 - c) Calculate the area of the clear surface. This is the area covered by the oleic acid. Use the diameter from calculation #2 to determine the radius (r). $A = \pi (r^2)$
 - d) Use the following equation(s) for volume to calculate the thickness of the layer of oleic acid on the water: $V = \pi (r^2) (h) = (A) (h)$

In this equation V is the volume of pure oleic acid, r = the radius of the clear acid region on the water (diameter/2), and h is the thickness you want to find. If we assume that the layer is a single molecule thick, the answer to this calculation is the size of a single molecule of oleic acid.

