How big is small
Fatty Film
By Eric Muller

Estimate the length of a molecule by floating a fatty acid (oleic acid) on water.

An oleic acid molecule is a reasonably straight organic molecule only a couple of nanometers long. One end of the molecule is attracted to water (hydrophilic: the other end is repelled by water (hydrophobic). This attraction and repulsion allows the oleic acid to spread out on the water’s surface as a monolayer film that is one molecule thick.

This is a classic hands-on activity. There are many resources on-line for this lab. Go to Google and type “monolayer” “oleic acid.”

This document and some on-line videos are on my website at: www.exo.net/~emuller

Below is the teacher/example worksheet for this lab. On the back, is the student version.

Data and calculations:

1. Number of drops of isopropyl to reach 5ml in a graduated cylinder= __249____
   • Add one drop of oleic acid to the isopropyl and mix thoroughly.

2. Total number of drops in the graduated cylinder= __250__

3. Calculate the volume of a single drop from the graduated cylinder = __.020___cm\(^3\)
   Example: 5 cm\(^3\)/250 total drops = .020 cm\(^3\)/drop

4. Calculate the volume of oleic acid in the single drop = __.00008__ cm\(^3\)
   Example: 1/250 th of the solution is oleic acid so: .02 cm\(^3\) x 1/250 = .00008ml
   • Place a single drop of the isopropyl / oleic acid in the center of the tray.

5. Measure the diameter of the disk that forms = ___ 20___ cm

6. What is the radius of the disk that forms = 10 cm
   Diameter/ 2 = radius 
   Example: 20cm / 2= 10cm

7. What is the area of the disk that forms = ___ 314cm\(^2\)
   Area = \(\pi r^2\) 
   Example: 3.14 x (10cm)\(^2\) = 314cm\(^2\)

8. What is the thickness or height of the monolayer = __ 2.5x10\(^{-7}\)cm ___
   (Although the drop forms a disk, it is a cylinder….a very thin cylinder)
   Vol. of a cylinder = \(\pi r^2\) x height
   Example: .00008 cm\(^3\) = 314cm\(^2\) x height 
   Height = .00000025 cm or 2.5x10\(^{-7}\)cm

9. Convert the thickness into meters = ____ 2.5x10\(^{-9}\)m__ (remember: 1m = 100cm)

10. Also, Convert the thickness into nanometers= ___2.5___ nm
    One nanometer = 1x10\(^{-9}\) meters
    Example: 2.5 x10\(^{-9}\)m x 1 nanometer/1x10\(^{-9}\)meters = 2.5 nm

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Student Worksheet:

Data and calculations:

1. Number of drops of isopropyl to reach 5ml in a graduated cylinder = __________
   - Add one drop of oleic acid to the isopropyl and mix thoroughly.

2. Total number of drops in the graduated cylinder = ________

3. Calculate the volume of a single drop from the graduated cylinder = _______cm³

4. Calculate the volume of oleic acid in the single drop = _______cm³
   - Place a single drop of the isopropyl / oleic acid in the center of the tray.

5. Measure the diameter of the disk that forms = ________cm

6. What is the radius of the disk that forms = __________cm
   
   Diameter/2 = radius

7. What is the area of the disk that forms = ________cm²
   
   Area = π r²

8. What is the thickness or height of the monolayer = ________cm

   Volume of a cylinder = π r² x height
   (in cm³) (in cm²) (in cm)

8. Convert the thickness into meters = ______ m (remember: 1 m = 100 cm)

9. Also, Convert the thickness into nanometers = _______nm

   One nanometer = 10⁻⁹ meters