Lab: Measuring a molecule
Foundations of Science Education
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In science textbooks around the world, atoms and molecules are described as being the very building blocks of matter. This is easy to accept, perhaps, since we've been told things like this for many years of our education. Yet, it is difficult to imagine exactly what these molecules are, and exactly how big these “building blocks” must be. This lab enables you to measure a molecule for yourself.

You have at your disposal:
- a plastic plate or tray
- a 1.0 ml pipette/dropper
- a ruler
- 1% oleic acid in ethanol
- cork dust or chalk dust
- a lab partner

Some information that you might find useful:
- 1 part in every 100 of the “1% oleic acid” is actually oleic acid. This means that if you measure a volume of some of this stuff, only 0.01 times this volume is made of oleic acid molecules.
- The volume of a cylinder (even a very very very short cylinder) is the height of the cylinder times the area of the top (or bottom) of the cylinder. Or, \( V = h\pi r^2 \); where \( V \) is the volume of the cylinder, \( h \) is the height of the cylinder, \( r \) is the radius of the cylinder, and \( \pi = 3.14 \).
- The volume of a drop of something could be figured out by counting the number of drops that can come out of a known volume. For example, with a pipette you could see how many drops make up 1.0 ml (also known as 1.0 cubic centimeter). Then, each drop’s volume is equal to the 1 cubic centimeter divided by however many drops you can produce from that entire 1 cubic centimeter.
- The really neat-o-keen and important part of this whole experiment: Oleic acid has molecules that will sit on top of water, forming a layer that is only one molecule thick. It will push aside any cork dust or chalk dust that might be in its way, forming a clear ring whose radius can be measured. The ethanol that the oleic acid was originally mixed in will dissolve into the water, leaving the oleic acid layer on top of the water.

Your task:
Using the above info and some creative thinking, measure the width of a molecule of oleic acid in centimeters. To guide your thinking, remember that the volume of oleic acid that you can drop onto a surface of water is 1/100 the volume of a drop that you can produce from a dropper. This volume is equal to the volume of a cylinder whose radius you can measure, and whose thickness is equal to the thickness of one molecule.

Show how you get your answer. In addition (and just to impress yourself with the smallness of the thing that you've measured), calculate the number of oleic acid molecules that could span your thumbnail, which is about 1 cm across.

Discussion and reflection:
You can measure the size of a molecule, even though it is very very small -- so small that there is no way to create an image of the molecule itself. This isn’t because we’re dumb or because our technology isn’t good enough yet, it’s because of a fundamental limit of nature and wavelengths of light. So, molecular sizes are inferred, as are most data in science in one way or another. Is this a problem?