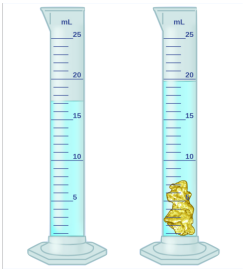
Fluid Properties: Density, Viscosity, Surface Tension



Part 1: Density of Fluids

Density is a property that tells you how relatively heavy a fluid is – how much mass it packs into a given volume.

1. Measure the density of a few objects using the same approach as last time.

(1) Use the scales provided to measure mass (in grams).
(2) Use the graduated cylinder to measure volume (in cubic centimeters, cm^3). Note the level of the water (eg: 30 mL), submerge the object, and see how much the water level goes up. A milliliter (mL) is the same volume as a cm^3. Use a straw to poke the object under water if it floats.
(3) Calculate density (mass per volume)

Try to use as much of each object as possible to get a more precise estimate.

Fill in the data sheet on the next page.

Object	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Floats on water?
Glass marble				
Lego				
Carrot				
pretzels				

2. Now measure the density of water. Measure the mass of an empty cup, then use the graduated cylinder to pour in 20cm^3 of water. Compute the mass of that amount of water. Then compute the density.

(Leave the other liquids blank for now)

Liquid	Mass of cup (g)	Mass of cup + liquid (g)	Mass of 10cm^3 of liquid	Density of liquid (g/cm^3)
Water				
Vegetable oil				
Pancake syrup				

The density of water is: _____ g/cm^3

2. Using your observations, can you hypothesize a general rule for whether an object will float or sink in a fluid?

An object will float in a fluid only if its _____ is _____ than that of the fluid.

3. Go back to step 1 and carry out the measurements to find the density of vegetable oil and pancake syrup.

4. Use your measurements above to make a prediction.
What will happen if you put the following into a cylinder together? How will they layer from bottom to top?

carrot, marble, Lego block,
piece of pretzel, water, oil, syrup

Bottom layer _____ Top layer

13. Put all the solid objects in the cylindrical bottle (use small pieces so they can pass each other). Pour in the liquids and let the objects float to where-ever they want to settle. Were you right?

Part 2: Viscosity of Fluids

The **viscosity** of a fluid describes how much the fluid resists flow. Viscosity measures friction between layers of fluid as they rub past each other.

Your group will build a simple **viscometer**, a device for measuring viscosity.

1. Place the cardboard box on its edge so that the open side faces you. Cut out a hole on the top-most side of the box. The hole should be about 2" across (wide enough to wedge in an upside-down water bottle; narrow enough that the bottle does not fall through).
2. Use a pin to poke several tiny holes around the center waist of the water bottle.
3. Use a graduated cylinder to measure 30mL of water. Pour it into the water bottle. Screw on the bottle lid with a hold in its center.
4. Place a bowl directly underneath the hole in your box.
5. Have one person flip the water bottle just as another person starts the timer. Stop the timer as soon as the stream of flowing water breaks. Record the time.

6. If you have time, do another trial and take an average.

Liquid	Time to flow out of bottle (Trial 1)	Time to flow out of bottle (Trial 2)	Average time
Water			
Vegetable oil			
Pancake syrup			

7. Repeat the experiment with vegetable oil, then pancake syryp.

Which fluid has the highest viscosity (highest friction resisting flow)?

water vegetable oil pancake syrup

Which fluid has the lowest viscosity?

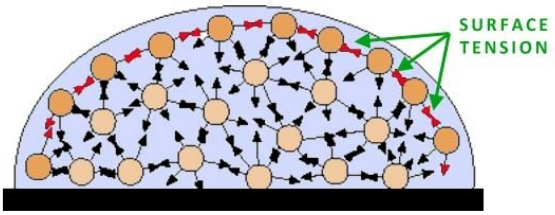
water vegetable oil pancake syrup

True or false?: Fluids with higher viscosity must be more dense

What do you think was the purpose of pricking pin-holes in your bottle?

Part 3: Surface Tension

Fluids form a 'skin' of molecules at their surface, that they try to make as small as possible. The **surface tension** of the fluid describes how much this skin resists stretching.



You will compare surface tension of different fluids

1. Pour some water into a clean
2. Put a penny flat on a plate or bowl
3. Use the dropper to slowly add water droplets one-by-one on top of the penny. Go slowly – try to add as many drops as you can without spilling over!
4. Get a number for each student and find the average.
5. Repeat the experiment with oil.

Liquid	Max drops (Student 1)	Max drops (Student 2)	Max drops (Student 3)	Max drops (Student 4)	Average # of drops
Water					
Vegetable oil					
Soapy water					

Which fluid has a higher surface tension (stronger skin)? Water or oil

5. Add a drop of dish soap to your cup of water. Repeat the experiment.

What did the soap do to the water's surface tension?

6. Pour a little milk into a clean bowl (that has not had soap in it).

7. Place several drops of one or more colors of food coloring in the center of the milk's surface.

3. Dip a Q-tip in dish soap and touch it to the center of your food coloring spot in the milk.

What happens to the food coloring?

_____

Important: if you want to try this multiple times, you will need to replace the milk and wipe the bowl thoroughly to remove any remaining soap film.

Milk contains many small balls of fat floating in water. These balls trap the even tinier molecules of food coloring so that on their own they do not spread very much. When you disrupt the surface tension of the milk with soap, you are doing the equivalent of popping a balloon. The skin of water molecules at the top pulls away from the soap spot, pulling food coloring along with it.