Fluid Viscosity

Part 1: Measuring Viscosity of Fluids

- **Viscosity** describes how much afluid resists flow.
- High viscosity means lots of friction between layers of fluid, so slow flow

Your 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 1-2" hole on the top (may have already been done)
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 hole 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 at the top. Record the time.
6. Do a 2nd measurement and find the average (add the 2 measurements together, then divide by 2)

Liquid	Time to flow out of bottle (Trial 1)	Time to flow out of bottle (Trial 2)	Average of the trials
Water			
Vegetable oil			
Pancake syrup		xxxxxxx	xxxxxx

7. Repeat with vegetable oil and pancake syrup (skip the 2nd trial for syrup).

- Rank the fluids from 1 (lowest viscosity, least resistance to flow) to 3 (highest viscosity, most resistance to flow).

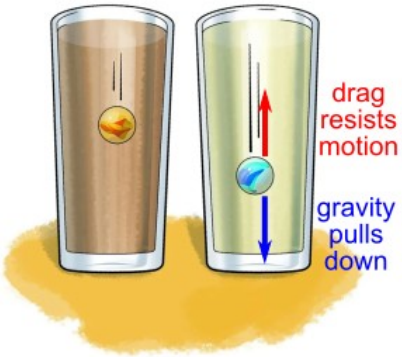
  _____ oil _____ syrup _____ water

- True or false?: Fluids with higher viscosity must be more dense.
  (recall our density experiments from last time)

Discuss: Why do you think the pin-prick holes in the bottle were necessary? How is this related to our experiments with air pressure?

Part 2: Viscous Drag

- When an object moves through a fluid, the fluid layers have to flow around it.
- Friction between the layers makes a **viscous drag** force that slows down the object. The faster an object moves, the more drag it feels.
- A more **viscous** fluid makes a higher drag force for the same speed.



You will apply a force to pull an object through different fluids against the drag force

1. Put a paper-clip into a paper bowl, with another paper bowl stacked beneath it (to make the bottom thicker.

2. Pour water into the bowl, just enough to cover the bottom and cover the paperclip.

3. Hold a magnet underneath the bottom bowl. Use only the narrow tip of the magnet to drag the paper-clip along.
   The magnet itself should not touch the fluid.

4. Try pulling the paperclip sideways at different speeds in each fluid.
When the **drag force** gets too big, it will rip the paper-clip off the magnet.

When is the drag force bigger?

when you pull fast when you pull slow

5. Try measuring how fast you can go in each fluid:
Time how long it takes you to move the paperclip back and forth across the bowl 10 times. Go as fast as you can without ripping the paper-clip off the magnet.

Liquid	Time to go back and forth 10 times
Water	
Vegetable oil	
Pancake syrup	

Which fluid allowed the paperclip to go the fastest without the drag force ripping it off the magnet?

_____

Which fluid required the slowest motion to keep the paperclip from getting ripped off?

_____

Rank the fluids in order from the one causing least drag to the one causing most drag:

1, least) _____ 2) _____ 3, most) _____

Discuss: does your ranking match what you expected from your viscosity measurements in Part 1?

6. If you have extra time:
Divide the number of back-and-forth movements you were able to make in water by the number in oil.
How many times slower did it move in oil? _____
In part 1, how many times slower did the oil flow compared to water? _____

How many times slower did the paperclip move in syrup compared to water? _____
How many times slower did the syrup flow in Part 1? _____

Discuss: What is the relationship between the two experiments (the flow speed in a viscometer and the speed of an object being pulled through the fluid by a certain force)?