Diving Into Density

Background Research

Archimedes principle states that as an object goes deeper into a fluid the pressure around the object increases. When the object is at the bottom of the liquid the pressure is greater than it was at the top of the liquid. Boyle's law states that pressure and volume have an inverse relationship. Meaning, when one goes up or down the other goes in the opposite direction. The temperature and amount of the gas has to stay the same in order for this to be true.

The Vessel

The Vessel In Bottle

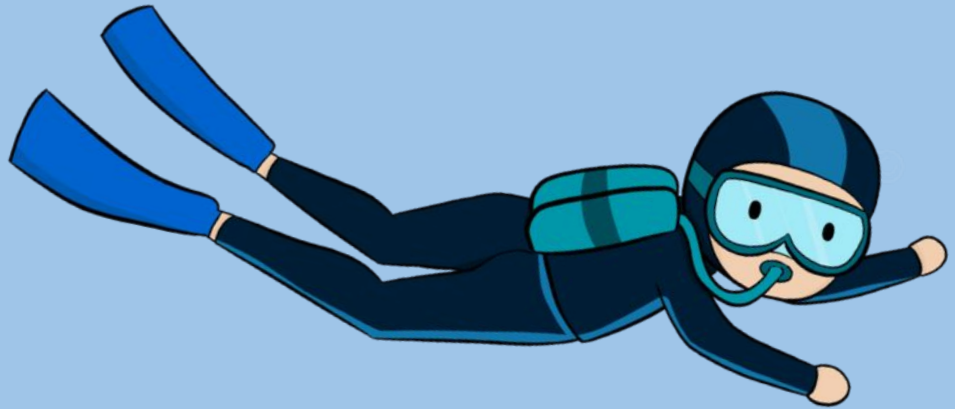
The Bottle

Question

How does viscosity affect a vessel’s movement through a liquid?

Hypothesis

If the viscosity of liquid in a bottle is changed, then a vessel will take longer to reach the bottom, because the liquid is thicker and more dense for the vessel to move through.



Variables

Independent Variables:
The liquid and the viscosity of that liquid.

Dependent Variables:
The amount of pressure needed for the vessel to move.

Controlled Variables:

- Temperature of liquid
- Amount of liquid
- The vessel's buoyancy
- Type and shape of vessel
- The bottle size
- Method of measuring

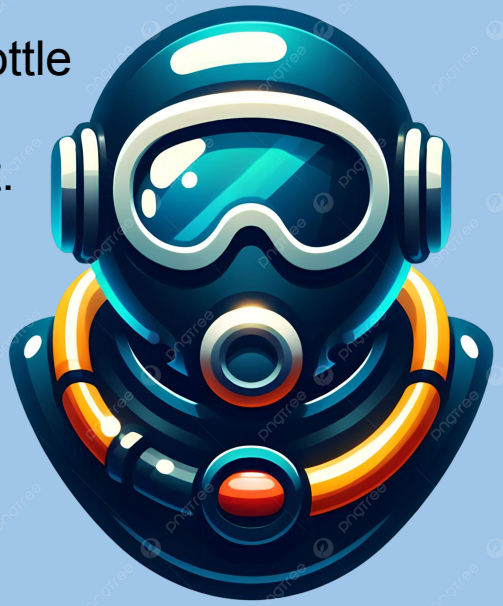
Materials

- Bottle
- Water
- Methanol
- Vegetable Oil
- Pressure Cuff
- Thermometer
- Fishing Bobbers
- Fishing Weights
- Fishing Line

Procedure

The experiment:

1. Fill 3 large bottles with the 3 liquids being used
2. Put the 3 bottles in a small closed off room and set temperature to 68’F
3. When right temperature, insert the vessels into the bottle
4. Screw on the bottle cap and put the pressure cuff on the bottle
5. Apply pressure until the vessel starts to move down
6. Record the pressure that created the downward movement.



The vessel:

1. Tie string around the bobber
2. Clamp down the perfect amount of weights
3. Cut the string.

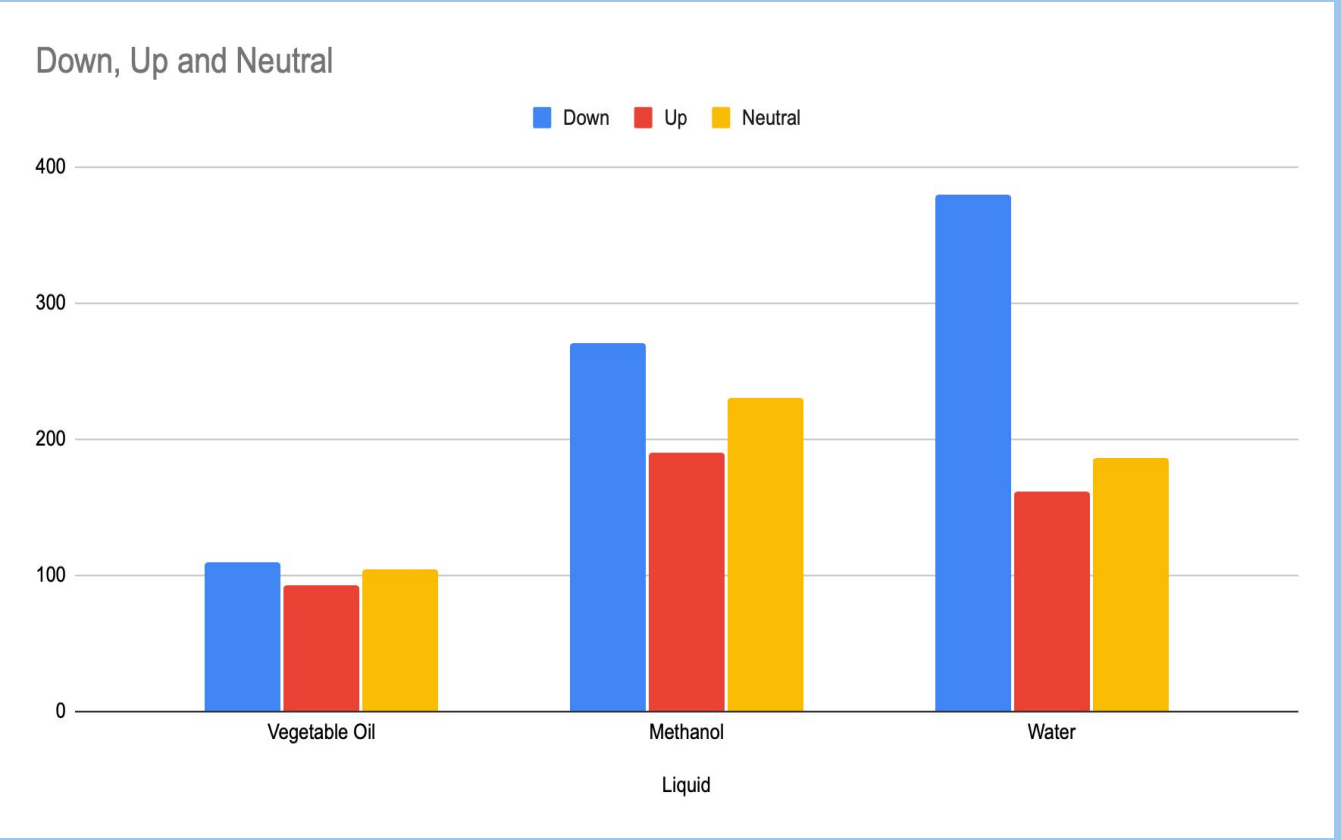
Data Table Results

- The higher the viscosity the less pressure needed to maintain neutral buoyancy.
- The liquids that are least viscous to most viscous are Methanol, Water, then Vegetable Oil.
- Buoyant Force requires more pressure to sink the vessel than it did to achieve neutral buoyancy.

	Water			Methanol			Vegetable Oil		
Test	Down	Up	Nutrial	Down	Up	Nutrial	Down	Up	Nutrial
1.	380+	162	180	240	170	185	120	90	102
2.	380+	162	186	200	182	190	116	92	104
3.	380+	162	186	210	190	198	116	92	105
4.	380+	162	186	260	190	209	110	92	100
5.	380+	165	186	230	210	222	110	92	100
6.	380+	164	180	270	230	246	113	96	105
7.	380+	158	180	280	260	269	110	96	104
8.	380+	162	182	300	260	275	110	95	104
9.	380+	160	178	340	290	310	110	96	103
10.	380+	158	177	340	320	331	112	95	104

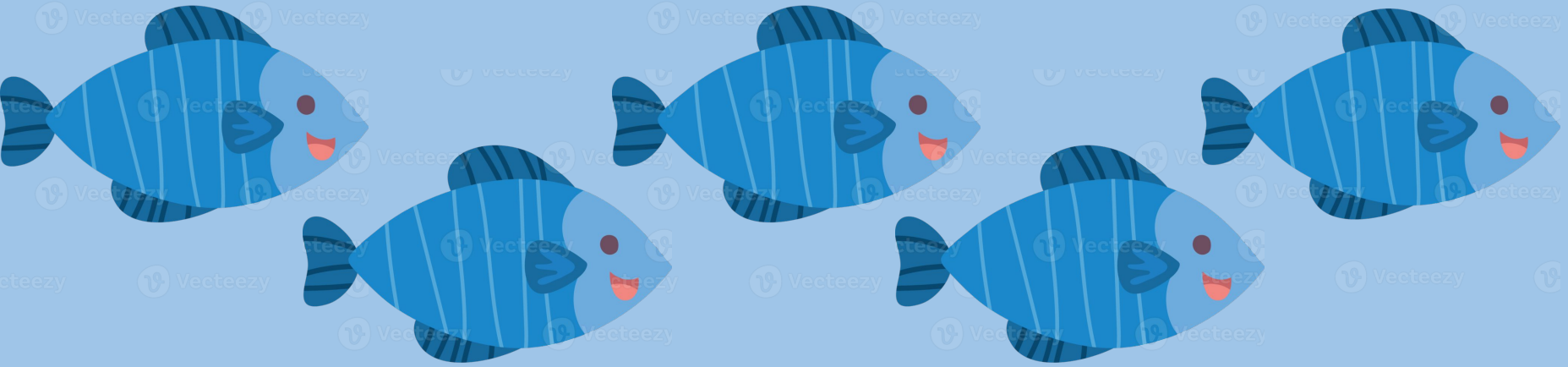
Data Graph Results

- Water took the most amount of pressure.
- Methanol was in the middle.
- Vegetable Oil took the least amount of pressure.



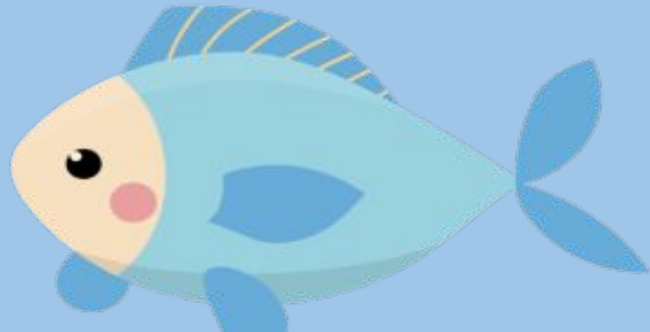
Results

According to my experiments, the amount of pressure needed for the vessel to move varied upon the viscosity of the liquid. Water took the most amount of pressure to go down with an unknown recording above 380 psi. Methanol was second, with a high of 340 psi to move down. Vegetable had the lowest amount of psi needed with only 120. I was surprised by this because I thought that if the liquid is more viscous, than it would take more pressure in order for the vessel to move.



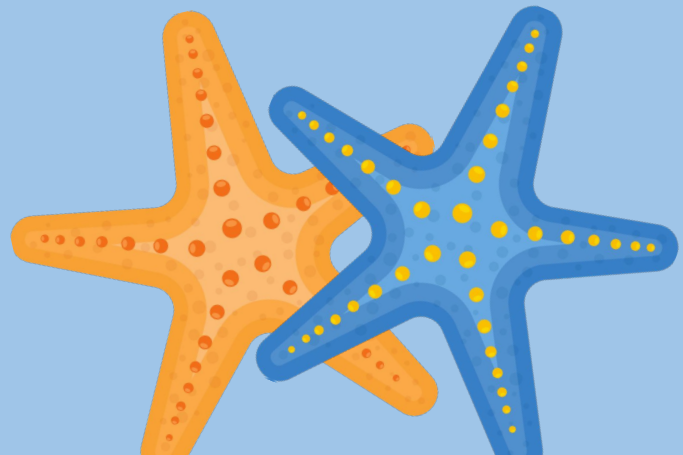
Conclusion

I found that as the viscosity of the liquid changes, the pressure needed to move the vessel through the bottle filled with that liquid also changed. Therefore my hypothesis was correct and the amount of pressure did change depending on the liquid. My experiment went according to plan but I had to use Boyle's Law for it to work. I would repeat this experiment using a container that could withstand higher pressures and a device like a compressor that could give more pressure than a blood pressure cuff. I would like to know how to measure the densities of liquids. Another thing that I wonder about is if you could use different liquids to counteract pressure. In order to understand any more though, I will have to do much more research.



Ideas For Future Research

My project and the theories behind it are important to understand for all scientists and adventurers doing underwater exploration. Further studies and interests in these theories could help develop future machines withstand the pressures of other atmospheres on this planet or elsewhere. Understanding current limitations is what will help push us to the limit and have breakthroughs in science. I would like to change the design of my vessels and study the limitations the shape of a vessel has underwater.



Resources

- Boyle's Law | Glenn Research Center | NASA
- Buoyancy: Archimedes Principle
- Center of Pressure | Glenn Research Center - NASA