Weird Science: Cartesian Divers

You'll Need:

- Clear plastic bottle with cap
- 1 disposable pipet
- 1 metal nut (5/16")
- Squid Fishing lure (optional)
- Water
- Cup

Some things sink and some float, but what about things that do both?! Can you think of one object that both sinks and floats, moves up and down in the water?

Scuba divers, submarines, fish—all of these rise and sink in the water! How?!

Let's start by thinking, "What makes an object float?" Take a moment and think.

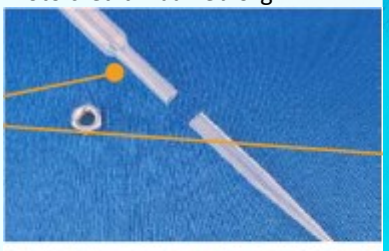
Floating & Sinking:

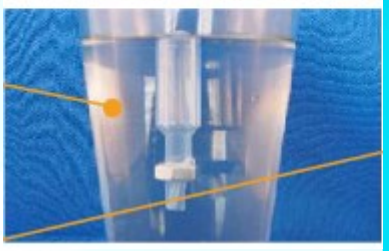
Objects float or sink depending on their **density**—or how heavy they are compared to their size. A plastic spoon will float because it is light compared to it's size. A metal spoon will sink because it is heavy compared to its size. In order for an object to float, it has to **displace its weight in water**. You may have observed displacement when you climb into a bathtub. When you put something in water it moves aside water to make space, which is why the water in the bathtub get's higher—you shoved it to the sides! An ancient Greek scientist named Archimedes observed this. He realized that in order for an object to float it has to displace it's weight (or more). He wrote a principle that says: an object in water will experience an upward (buoyant) force equal to the weight of water it displaces (moves). Dense but small objects (like rocks) don't displace enough water to create a big enough buoyant force to support their weight, while dense but large objects (like boats) displace enough water to float!

We can build a device that seems magical called a **Cartesian Diver** to show this!

Build A Cartesian Diver:

Photo credit: naaweb.org





1. Cut off a tip of a plastic pipette leaving about 1/2" of stem. Slide your metal nut onto the stem. It shouldn't fall off.
2. Fill a cup with water. Gently lower the pipet into the cup of water. Squeeze the top to slowly remove air. Experiment with how much air to leave inside. The top of the pipet should just stick out of the water. This mean's it's neutrally buoyant.
3. Fill your bottle of water **all the way to the top.** There should be no air left in the bottle.
4. Place the pipette in the bottle of water. Twist the cap on the top of the bottle to seal it.

Experiment

1. Squeeze the sides of the bottle gently. What happens? What happens if you squeeze just a little compared to a lot? What happens when you release the bottle?

You should see your pipet (Diver) move down when you squeeze and pop back up when you release! Can you get it to hover in the middle of the bottle? Why do you think this happens? Think about what you know about density and buoyancy!

Think about what's inside your pipet—an air bubble! What happens to that air when you squeeze the full bottle of water? When the bottle is squeezed it puts pressure on the water in the bottle. The water can't escape, so it pushes against the tiny air bubble, making it get smaller. As the bubble gets smaller the diver fills up with more water meaning it changes density, loses buoyancy and then sinks! When you let go of the bottle you release the pressure causing the bubble to get bigger again, changing the buoyancy and letting it rise!

Expand your experiment, what happens if you add and dissolve salt in your water? Does the bubble in the diver have to be bigger or smaller?

Decorate:

If you want you can stretch a squid fishing lure over the pipet to make a little sea creature! Color the sides of your bottle with sharpies to create a little ocean scene!