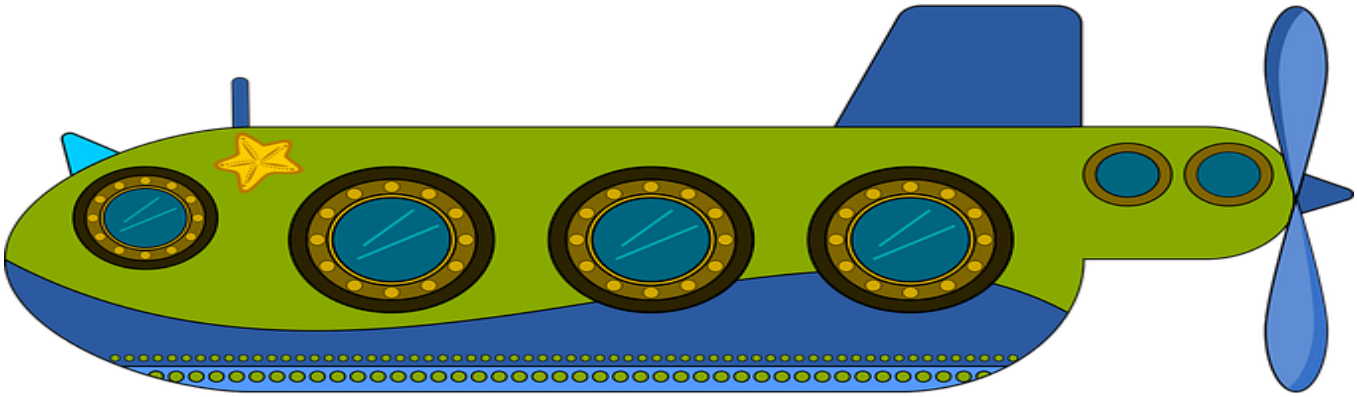


# Cartesian Diver

Aged 5-15
Length: 5 minutes

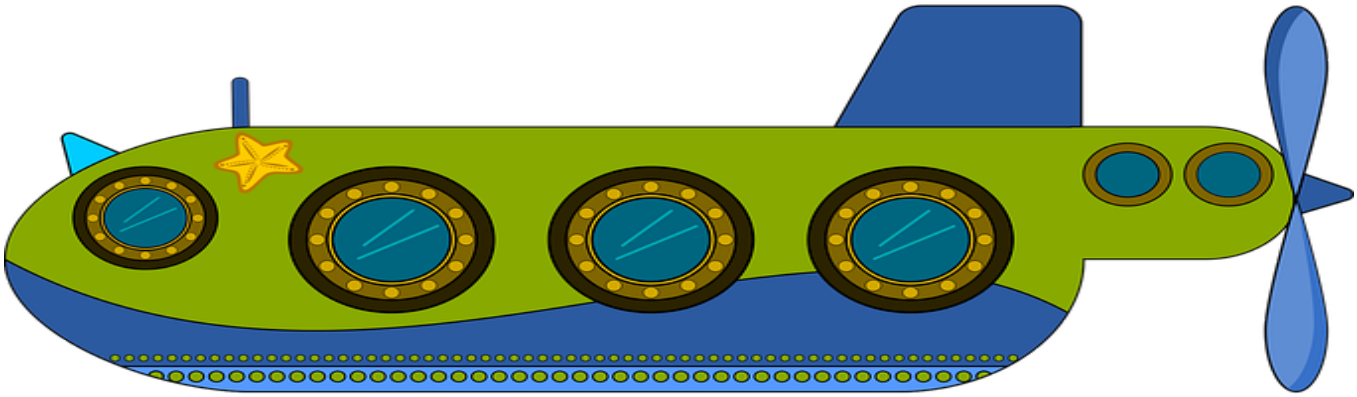
**Background**
Have you ever wondered how a submarine dives and surfaces at will? It does this by filling itself with water or air. But how does that make it sink or rise? This simple toy will help you understand the physics behind it!

**Materials**
1. Eye droppers
2. Plastic water bottle

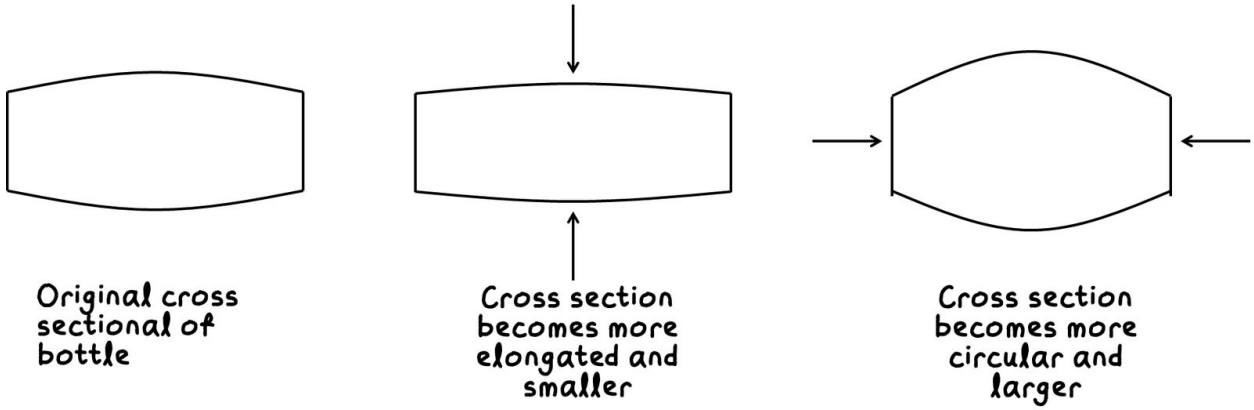
**Experiment**
1. Fill the eye dropper with enough water such that it barely floats in water.
2. Fill the plastic water bottle with water.
3. Drop the eyedropper inside the bottle.
4. Close the bottle.
5. Squeeze the bottle and watch the eyedropper sink.

The next part must be done with an elliptical water bottle like Listerine.
1. Fill another eyedropper with enough water such that it sinks to the bottom of the bottle.
2. Squeezing the bottle on the longer sides makes the floaty eyedropper sink.
3. Squeezing the bottle on the shorter sides makes the sunk eyedropper float up.

**Explanation**
Objects are pulled toward the ground by the earth. How hard the object is pulled toward the ground is determined by its weight. We can hold an object off the ground by pushing it up with a force that is larger than its weight.
When an object is underwater, the water pushes it up. The force that the water pushes on the object is called the buoyant force. How large is the buoyant force? Replace the volume of the object that is underwater with an equal volume of water. The buoyant force is equal to the weight of that volume of water.



Our eyedropper floats in water because the air inside is lighter than water. If the eyedropper were fully submerged underwater, the buoyant force would be larger than the eyedropper's weight. The water pushes the eyedropper up until it is only partially submerged. The volume underwater of the eyedropper now is pushed up by a buoyant force equal to its weight. Squeezing the bottle reduces its volume, so some water sneaks into the eyedropper, making it heavier and sink.
With an elliptical bottle however, squeezing on the shorter sides increases the volume of the bottle, so some water sneaks out of the eyedropper, making it lighter and float.




**Live or recorded?**
This should be recorded, because I want to ask the children to pause the video and think about why the second eyedropper floats up before I give them the explanation.

**Purchase link**
Eyedropper at Walmart, but they can replace it with small bottles, plastic straws, pen caps, or condiment packets too.
Can use any empty water bottle they have around. If they don't have plastic water bottles or elliptical water bottles, they can put some elastic tape on a glass bottle as a cap. Pushing and pulling on the tape would give the same effect.