Cartesian Diver (Scuba Diver in a Bottle)

Materials

- Empty plastic two-liter bottle
- Original diver:
  - Drinking straw
  - Small paper clip
  - Play-dough or reusable adhesive putty
  - Thick foil (foil pan also works)
- Scissors
- Water
- Optional diver can be made with pen cap and clay

Procedure

1. Remove any labels from your bottle so you can see your diver at work.
2. Fill the bottle to the very top with water. Firmly cap the bottle so water will not spill out. Make sure to fill it to the top; otherwise, the experiment won't work.
3. Make your diver with foil to be ~1.5 inches tall.
4. Cut the straw and position it on the paper-clip as shown. Each end should be secured by the ends of the paper clip.
5. Slowly slide the straw onto the diver as shown above. The diver should look like he's wearing a scuba tank.
6. Once straw is secured, place a small piece of play-dough or putty on the diver's feet.

***Preliminary test*:** Fill a glass with water and put the diver in. This is to test to make sure it floats. If your diver doesn't float, your straw may have a hole in it. Try again with a new straw.

- Optional diver: You can also make a diver using a pen cap with play-dough at the end. It should barely float. If it sinks, take some clay away. If it floats too much, add more clay

Main Experiment:

- Carefully place the diver into the bottle and screw on the bottle cap nice and tight.
- Now for the fun part! You can make the scuba diver rise and fall at your command.
  - Squeeze the bottle hard – the diver sinks… What happens when you stop squeezing?
  - Stop squeezing and the diver rises.
  - Now try to get the diver to stop right in the middle!

How Does it Work?

When building a Cartesian diver, you're exploring three properties of air:

1. Air has weight
2. Air occupies space
3. Air exerts pressure

Basic Principle: Density

Density = Mass/Volume

An object will float in water if its density is less than the density of water.

- An object will sink in water if its density is greater than the density of water.

When you first put the diver into the bottle, why does it float? Combined density of diver + straw + paperclip + play-dough is slightly less than the density of water.

What does the straw do? A small bubble of air gets trapped in the straw when you put the diver in the bottle. When you squeeze the bottle, you increase the pressure of the water in the bottle, so water is forced up into the straw, compressing the air bubble in the straw.

What causes the diver to sink? As the air bubble gets smaller, the density of the diver increases. The diver begins to sink.

How can the diver to float back up? When you release the bottle, the pressure lessens, and the water moves back out of the straw. The air bubble in the straw returns to its original size. The diver is now less dense and can float back to the top of the bottle.

All science experiments should be conducted with adult supervision.