Cartesian Diver	Grade 8: Fluids Understanding Matter and Energy

Lesson Plan

Safety Notes: Parental supervision and help is always encouraged!

Description

Students will learn about buoyancy and density while completing the Cartesian Diver experiment.

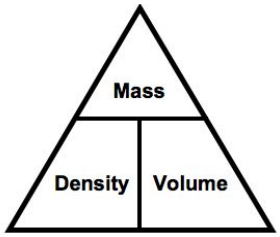
Materials

- A plastic bottle with sealable lid (1L or 2L pop bottle)
- A straw (alternative: pen cap)
- Paper Clips (or other small weights)
- An elastic (alternative: paper clip)
- Water

Note: if using a pen cap, make sure there are no holes on the top. If it does, cover holes with tape or clay.

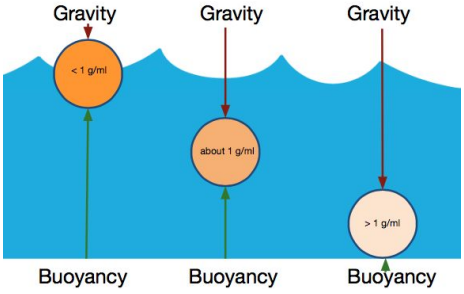
Science Background

This activity demonstrates multiple scientific concepts.



Density = Mass ÷ Volume
Mass = Density × Volume
Volume = Mass ÷ Density

1. **Density** – everything that has mass has density. Density is determined by dividing an object's mass (weight) by its volume (the amount of space an object takes up). The density triangle on the side of the page demonstrates how scientists can determine something's density, mass or volume, if provided the other two variables. In general, solids are more dense than liquids because their particles are closer together. Liquids are more dense than gases because their particles are closer together. This is why it is very difficult to compress a liquid compared to a gas.
2. **Buoyancy** – the ability for an item to float or sink in a fluid. We can figure out if an object will float or sink based on its density compared to the density of the fluid it is placed in. An object that is less dense than the fluid will float and is positively buoyant (left on diagram). An object that is more dense will sink and is negatively buoyant (right on diagram). An object with the same density will float somewhere in the middle of the fluid, this is called neutral buoyancy (middle of diagram).



Activity Procedure

1. Make the diver by folding the straw in half and tightly wrap the elastic around the open ends so they are squished together. (Alternatively, you can use a paperclip to pinch the ends together)
2. Drop the diver into water to see if it floats or sinks.
3. It should float right now. Hook a paperclip to the elastic to add some weight.
4. Drop the diver back in the water to see if it floats or sinks.
5. Repeat steps 3 + 4 until the diver sinks. If it sinks remove one paperclip. The diver is now ready because it is 'neutrally buoyant'.
6. Place the diver with the paper clips into a bottle.
7. Fill the bottle with water and put the cap on. TIP – Use cold water to fill the bottle. When the water warms, it will increase the pressure in the bottle making it easier to cause the diver to drop. Try to fill the bottle so that there are no air bubbles.
8. Squeeze the bottle to make the diver drop to the bottom of the bottle.
9. If the diver doesn't dive, it is too buoyant and needs more paper clips.

CHALLENGE: Try the activity with different liquids or different variations of water (salt water, sugar water, warm water). Does this change anything?

Debrief

Now you might be wondering why your diver was able to "dive" when the bottle was squished since the density and the buoyancy of the diver and the water did not change… or did it? Remember that there is air in your straw (or pen lid) and that air is less dense than water. When you squeezed the bottle pressure inside the bottle increased. Since water (liquid) cannot be compressed and air (gas) can, the air that is in the straw (or pen lid) is compressed. Because the density of the air has now increased (as the gas particles squish together), the diver now has negative buoyancy and begins to sink.

Thank you for participating in our at home science experiment for buoyancy!

Buoyancy | Grade 8: Understanding Matter and Energy

1. What is density?

2. Complete the following chart for the objects placed in water:

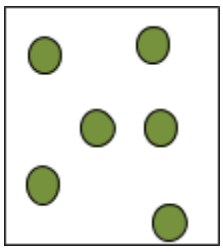
Density of Object	Where will it settle? (Sink to bottom or middle, float)	Buoyancy (positive, negative, neutral)	Example
More than water			
Same as water			
Less than water			

3.
   a. Draw positive, negative and neutrally buoyant objects into the beaker.
   b. Label the objects as positive, negative and neutrally buoyant.

4. Why does the Cartesian Diver sink when the bottle is squeezed?

5. Draw in the molecules to show how compressing a gas changes density. Use the word bank to complete the statements about this compression.

Uncompressed



Compressed

Word Bank

Increased Decreased Stayed the same

The volume of the container _____.

The mass of the gas _____.

The density of the gas _____.

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Buoyancy | Grade 8: Understanding Matter and Energy

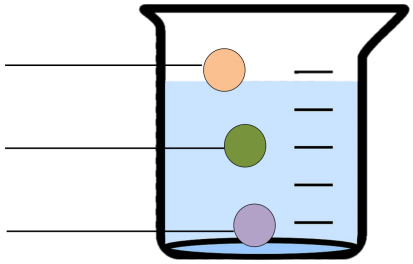
1. What is density?

2. Complete the following chart for the objects placed in water:

Density of Object	Where will it settle? (Sink to bottom or middle, float)	Buoyancy (positive, negative, neutral)	Example
More than water	Sink to bottom	Negative	Rock/Crab
Same as water	Suspended in middle	Neutral	Fish
Less than water	Float to top	Positive	Boat/duck

3.

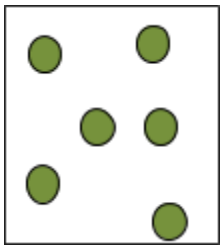
a. Draw positive, negative and neutrally buoyant objects into the beaker.
b. Label the objects as positive, negative and neutrally buoyant.



4. Why does the Cartesian Diver sink when the bottle is squeezed?
Squeezing the bottle compresses the air inside the straw, allowing water to fill the space previously occupied by the air. Water is denser than air, making the diver sink.

5. Draw in the molecules to show how compressing a gas changes density. Use the word bank to complete the statements about this compression.

Uncompressed



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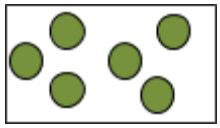

Word Bank
Increased Decreased Stayed the same

The volume of the container decreased.

The mass of the gas stayed the same.

The density of the gas increased.

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