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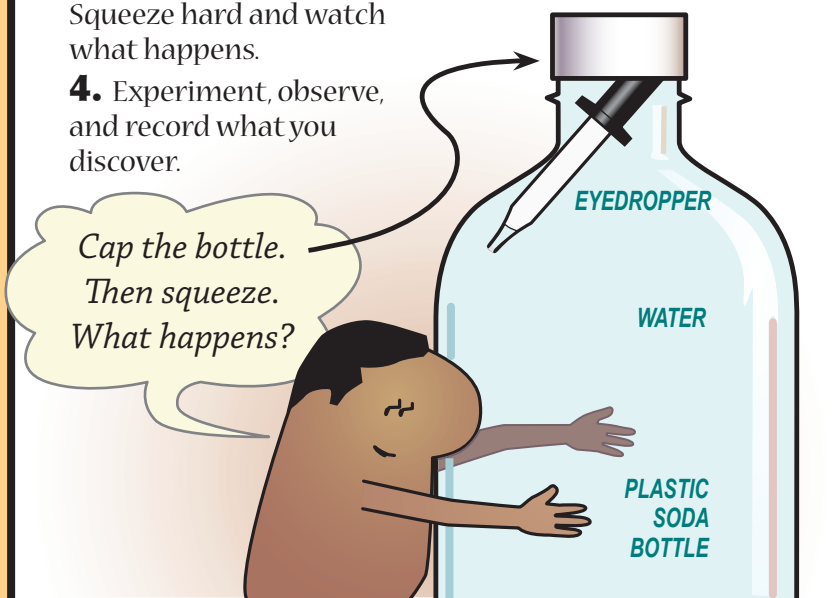
This TOPS Idea is taken from an original series of black-and-white line masters, adapted to stand alone as an independent mini-lesson. Please purchase our original book to get the whole in-depth program.

cartesian diver

...adapted from **DIVING INTO PRESSURE and BUOYANCY #200** by TOPS Learning Systems

Challenge: Can you sink an empty eyedropper without touching it?

1. Fill a plastic soda bottle to the top with water.
2. Float an air-filled glass eyedropper as shown.
3. Cap tightly—you've just made a **Cartesian Diver**. Squeeze hard and watch what happens.
4. Experiment, observe, and record what you discover.



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OBJECTIVE

To discover relationships between pressure, air volume, density, water displacement and buoyancy in a floating eyedropper.

TEACHING NOTES / ANSWERS

Copy the activity above for each student or lab group.

Steps 3-4. As I gradually squeeze the bottle, water rises higher inside the dropper. First it swings into a vertical floating position, then hovers and finally sinks. As I gradually release my grip this process reverses. See evaluation section for explanation.

BACKGROUND

- **pressure:** A force distributed over an area that acts equally in all directions, and increases with depth.
- **compressibility:** If you squeeze both air and water, only air compresses to a significantly smaller volume.
- **density:** How much mass (stuff) a substance contains per unit volume.
- **displacement:** The volume of water pushed aside when you immerse an object.
- **buoyancy:** An upward push on objects immersed in water, equal to the weight of the water displaced.

EVALUATION

Q: How does your Cartesian Diver work?

A: Squeezing the bottle increases water pressure on the diver, shrinks its compressible air inside to a smaller volume, increases its average density, decreases its water displacement. It thus decreases its buoyancy until it sinks, hovering first at neutral buoyancy (the density of water), and finally sinking to the bottom.

MATERIALS

- A 2-liter plastic beverage bottle with airtight lid.
- Water.
- An eyedropper with a glass barrel. The rubber bulb must be airtight. *Test in advance: Droppers must sink when you apply pressure to the bottle. If they are too buoyant, squeeze out a little air (draw in a little water), so they will sink with less pressure.*
- Paper towels or sponge to mop spills.

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