Cartesian Divers

Visitors will experiment with concepts such as of buoyancy, density, and volume. The concepts of speed and velocity can be incorporated.

- Density
- Buoyancy
- Volume
- Gravity
- Pressure
- Ballast

Related exhibits: Up, Up And Away!; Hovercraft

Time: 5-10 minutes
Ages: 6 and up (with a parent) (Grades K – 8)
Staff : Supervision recommended, at least 1 teen/volunteer.
Safety issues/special notes: Make sure caps are secured tightly before squeezing the bottles. A tray may be used under the bottle(s) in case of a spill.

Materials:

- 1 or 2-liter plastic bottle filled almost to the top with water and lid
- tall cup filled almost to the top with water
- medicine dropper
- paper towels to wipe up spills
- Plastic tray (optional)
- Hex nut that fits securely on the end of the medicine dropper (optional)
- Condiment package (optional)

Preparation:

1. Test your medicine droppers by placing it in the cup of water and squeezing the bulb of the dropper to let in some water. Let go of the dropper to see if it just barely floats in the water. This will probably not happen the first time you squeeze the dropper. Continue to let water in the dropper and test until the top of the dropper just barely peeks out of the water and the tip of the dropper does not touch the bottom of the cup. Place a hex nut on the end of the dropper if additional weight is needed.
2. Empty droppers before beginning activity.
3. Fill the bottles with water.

Procedure:

1. Place the dropper (with hex nut if needed) in the water and squeeze the bulb to let in some water.
2. Carefully drop the medicine dropper into the water and tightly cap the bottle.
3. Gently squeeze the sides of the plastic bottle until the dropper moves.

continued…

Cartesian Diver continued…

4. Release the pressure on the sides of the bottle and watch what happens to the dropper.
5. Continue this several times and watch the level of liquid in the dropper.

Questions to Think About:

What happened to the size of the gas bubble in the dropper when the bottle was squeezed?
It got smaller (the volume decreased).

What happened to the water level in the dropper when the bottle was squeezed?
The water level in the dropper rose when the bottle was squeezed to occupy the volume lost by the gas.

What happened to the volume of gas in the dropper when you stopped squeezing the bottle?
The volume of gas in the dropper increased when the pressure on the bottle was released.

When you squeezed the bottle and increased the pressure inside the bottle, which changed volume more, the gas or the liquid?
The gas changed volume and density more in response to the pressure in the bottle.

Science Content:

The Cartesian diver is a dropper and the water and air inside it. By varying the volume of the air and the amount of water, the diver can be made to be either more or less dense than water. Initially, the volume of air in the dropper is adjusted so that the dropper floats with its top just at the surface of the water. It is less dense than the water. When the bottle is sealed and squeezed, pressure is exerted on the air in the diver and the gas's volume is decreased. As this happens, more water flows into the dropper to occupy the volume previously occupied by air and the mass and density of the diver increases. It will dive!

Related activities:

- Investigate variables such as: how does the amount of air in the dropper and/or in the bottle affect the dropper?
- Make a "condiment diver." Use a packet of soy sauce or duck sauce from a Chinese restaurant instead of a dropper. There is no need for a hex nut. The packet is all you need.

Related activities:

- *Boat, Fun with Bernoulli*
- Water Power – "How Science Works", J. Hann, *Readers Digest*, pg 134.
- Floating and Sinking – "How Science Works", J. Hann, *Readers Digest*, pg 138.
- Liquid Density – "How Science Works", J. Hann, *Readers Digest*, pg 140
- Rising Bottle - "Physics for Every Kid", J. VanCleave, *Wiley & Sons*, pp 59.