

Vortex Tube

P1-1120



DIRECTIONS:

1. Use two identical plastic soda bottles (most sizes will work). Do not use glass bottles.
2. Fill one bottle 2/3 full with water and attach the Vortex Tube to the top.
3. Attach another (empty) bottle to the top of the Vortex Tube.
4. Quickly invert the assembly.
5. Rest the bottom bottle securely on a flat surface, and briefly rotate the top bottle in a circular motion.
6. Observe the vortex that forms as the water moves through the Vortex Tube!

WHAT'S GOING ON?

An initial small rotation causes the water molecules to move in a circle near the tube opening. The molecules are forced downward and toward the lower bottle by gravity. As the molecules approach the small opening in the tube, they move in a smaller circle. Each molecule's angular momentum* is conserved, so as its rotational radius decreases, its speed increases. (The same thing happens when a spinning ice skater pulls in her arms.)

The hole that develops in the center of the vortex allows air to move from the lower bottle to the upper one, making room for the water.

* **Angular momentum:** A quantity that depends on a rotating objects speed and rotational radius. The quantity is conserved (does not change) in a closed system.

TEACHING IDEAS:

1. Add visual interest by putting food coloring or glitter in the water.
2. Relate the bottle vortex to vortices in nature, such as tornadoes, hurricanes and smoke rings.
3. Notice that the vortex can easily rotate either way, and does not start without an initial rotation. The vortex is not influenced by the Coriolis Effect, and neither is the vortex that forms when you empty a sink. These systems are far too small to be affected by the earth's rotation.
4. Introduce the topic by challenging a student to a race. Fill two bottles 2/3 with water and cap each with a Vortex Tube. Ask the student to empty the bottle as fast as possible (without removing the Vortex Tube). Surface tension at the hole will make it quite difficult to do quickly. Students may have to shake or squeeze the bottle to get the water out. Record the student's time. To empty your bottle, invert it, hold the Vortex Tube steady in one hand, and rotate the top of the bottle in the other hand. This will create a vortex at the tube opening, allowing the water to quickly escape. This "trick" has been used to quickly empty large glass bottles that would "glug" and release water slowly. Note: This works best with smaller or more rigid bottles, whose sides are not likely to collapse when a partial vacuum forms in the bottle.

RELATED PRODUCT:

Air Cannon (P8-5700). Send fast, 6" diameter vortices across a room with this simple device.

