

# Tornado in a Bottle



The Dimmitt Tornado,  
South of Dimmitt, Texas  
Courtesy NOAA.

“And then I was enveloped by the freight train roar...as I got to the stairs all of the front of the building blew in...like a bomb went off, just a huge explosion behind me...And then screaming wind...While I was crouched under the desk the building was breathing. You could feel the floor lift about a foot and then you could feel it drop...I thought any second this is going to drop and we are all going down to the first floor with the building on top of us. I was terrified when the building started moving, I thought I'm gonna die...”

*Bill Morgan*

*Journalist and retired Police Information Officer  
recalling the tornado that struck Lubbock, Texas on May 11, 1970,  
killing 26 people and injuring hundreds*

Did you know:

- The 1970 Lubbock tornado was classified as F-5, which is the highest a tornado can be rated
- In a typical year about 1,000 tornados will strike the United States
- The strongest tornadoes have rotating winds in excess of 250 mph
- Tornadoes can be up to one mile wide and may stay on the ground for more than 50 miles.
- Tornados can occur at any time of the year and have occurred in every state in the country
- More tornados strike the central United States than any other place in the world; which is why this area is nicknamed “tornado alley”

*Tornadoes cause an average of 70 fatalities and 1,500 injuries each year. These numbers would be much higher without NOAA's tornado warning and research programs. Nationwide tornado forecasts and urgent tornado warnings are issued by the National Weather Service and broadcast over NOAA's All Hazards Weather Radio network, which is the nation's one-stop source for weather and emergency information. NOAA's National Severe Storms Laboratory is a leader in tornado-related research, and in developing technologies such as Doppler radar to improve forecasts and warnings of tornadoes and other severe weather.*

*When you hear the word “tornado” what picture pops into your mind? For most people it is the funnel-shaped black cloud, with spiralling winds called a “vortex.” Here's how you can create your own “tornado in a bottle.”*

## What You Will Do

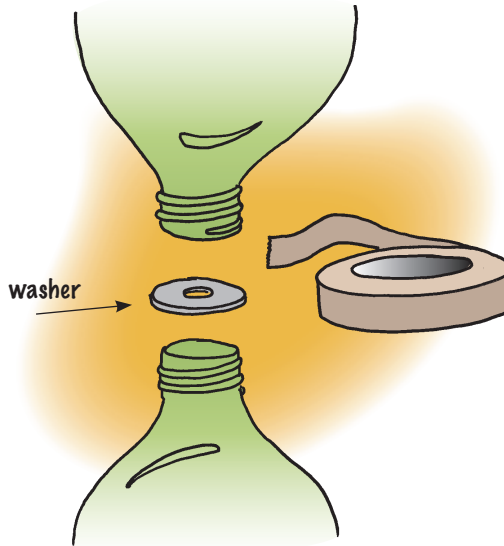
**Create a vortex similar to the wind pattern of tornados**

## What You Will Need

- Two empty two-liter plastic soda bottles
- Tornado Tube plastic connector (available from science museums, science stores, novelty stores, scientific supply companies, etc.) - OR
- Metal washer, about one inch diameter with a 3/8-inch diameter hole, and plastic electrical or duct tape
- Dishwashing detergent
- (Optional) Food coloring

## How to Do It

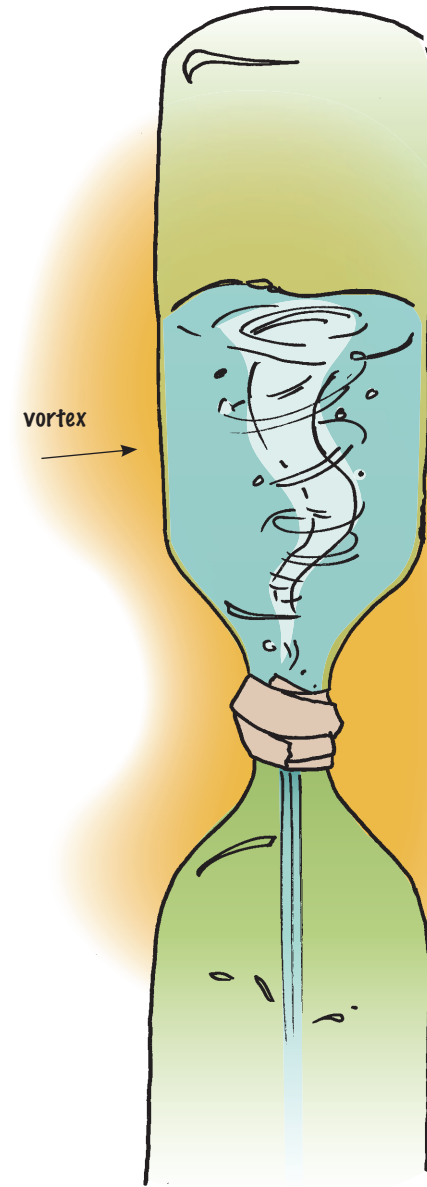
1. Fill one of the two-liter bottles about 2/3 full of water. Add three drops of dish soap and a couple of drops of food coloring to help make the vortex more visible.
2. Screw the plastic connector onto the bottle containing the water, then attach the empty bottle to the open end of the connector. Or, tape two bottles together with a flat washer between them. Use plastic electrical tape or duct tape.
3. Turn the two-bottle assembly over, and place the assembly on a table with the filled bottle on top. Watch the water slowly drip down into the lower bottle as air simultaneously bubbles up into the top bottle. The flow of water may come to a complete stop. Now, rapidly rotate the bottles in a horizontal circle a few times. Observe the formation of a



funnel shaped vortex as the top bottle drains much more quickly. You can make the vortex with a single bottle by twirling the bottle and holding it over a water basin or the ground to drain, but you lose the water and have to refill the bottle each time you use it. Now you know how to use a liquid tornado to quickly empty a large bottle!

## What's Happening

When the water is not rotating, surface tension creates a skin-like layer of water across the small hole in the center of the connector or washer. If the top bottle is almost full, the weight of the water is sufficient to push out a bulge in this surface to form a large drop, which then drips into the lower bottle. As water drops into the lower bottle, the pressure in the lower bottle increases



until air bubbles are forced into the upper bottle. The pressure of the water's weight at the surface of the connector or washer decreases as the water level in the upper bottle drops. When the water level and pressure decrease enough, the water surface can hold back the water and stop the flow completely.

When you rotate the bottles in a horizontal circle, the water in the upper bottle starts rotating as well. As the water rotates, forces called *centripetal forces* pull the water toward the center of the bottle. At the same time, gravity pulls the water toward the drain hole. As the water drains into the lower bottle, a vortex forms. As water particles at the outside of the bottle move toward the hole, the speed of the particles increases and the centripetal forces increase. The slope of the water shows where centripetal forces are increasing. So at the bottom of the vortex, the slope of the water is steeper because the centripetal forces are increasing as the water moves with higher speeds and in smaller circles. The water drains smoothly and rapidly because the hole in the vortex allows air from the lower bottle to flow easily into the upper bottle.

There are many examples of vortices in nature, including whirlpools, hurricanes, the Great Red Spot on Jupiter, sunspots, and spiral galaxies (such as our own galaxy, the Milky Way). Keep in mind that while the spiralling motion makes many vortices look similar, they occur for many different reasons. The vortex in your "bottle

### Tune In to NOAA Weather Radio

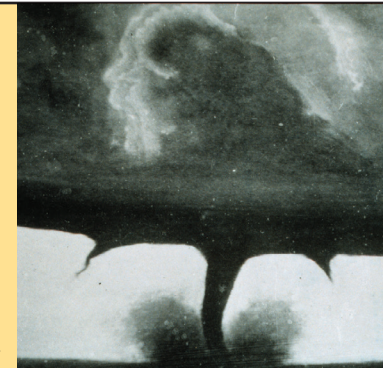
NOAA Weather Radio (NWR) broadcasts local weather forecasts 24 hours a day from local offices of the National Weather Service. NWR is an All-Hazards program that broadcasts warnings and information about emergencies that include:

- natural events such as tornadoes, hurricanes, floods, and earthquakes;
- technological accidents such as chemical spills, oil spills, nuclear accidents; industrial emergencies, shipping accidents, or train derailments;
- AMBER alerts; and
- terrorist attacks

NWR broadcasts cannot be heard on a simple AM/FM radio receiver, but the Weather Band is built into many automobile radios, walk-

tornado" is caused by horizontal spin (provided by you) and gravity. But a real tornado in the atmosphere is caused by a combination of wind shear, changes in atmospheric pressure, and centrifugal force.

By the way, tornadoes in the atmosphere happen on a relatively small scale (compared to the size of the whole atmosphere). This means that tornadoes may rotate clockwise or counterclockwise, regardless of where they are on Earth; just like your bottle tornado can be made to rotate in either direction.



Oldest known photo of a tornado. August 28, 1884, Howard, South Dakota. Courtesy NOAA.

ie-talkies, marine radios, and other receivers. Prices for Weather Radio receivers start at about \$20. Some receivers have a built in alarm that is turned on by a special tone sent from NWR during an emergency to signal that information is being broadcast about a life-threatening situation.

For more information about NOAA Weather Radio, visit <http://www.weather.gov/nwr/>

### Want to Do More?

Find out more about tornadoes at NOAA's Tornadoes Web page, <http://www.noaa.gov/tornadoes.html>. You may also want to visit the Tornado Project's Web site, <http://www.tornadoproject.com/>.

Portions of this activity are adapted from an Exploratorium Science Snack (<http://www.exploratorium.edu/snacks/>).