

# Magnetic Tornadoes

**Overview:** This lab is a physical model of what happens on Mercury when two magnetic fields collide and form magnetic tornadoes.

**What to Learn:** You'll get to investigate what an invisible magnetic tornado looks like when it sweeps across Mercury.

## Materials

- Two clear plastic bottles (2 liter soda bottles work best)
- Steel washer with a 3/8 inch hole
- Ruler and stopwatch
- Glitter or confetti (optional)
- Duct tape (optional)

## Experiment

1. Determine the different water conditions, such as: changing the temperature, changing the volume (height of water), adding another molecule such as oil, isopropyl alcohol, vinegar, and dish soap, adding solid pieces such as glitter, salt, sugar, or small grains. The different mixtures will give different vortex rotation speeds and different drain times. This is equivalent to changing the atmosphere on Earth and seeing how it affects weather (not magnetic) tornadoes. Write the conditions you wish to test in the data table before you start.
2. Fill one of the soda bottles with water using the data table. Set the bottle upright on the table.
3. Set the washer on top of the bottle opening. Make sure there's no cap on the bottle.
4. Invert the empty bottle over the water-filled bottle and line up the openings so they can be easily taped together. You want to tape them before they get wet with the washer between them.
5. Place the two bottles on a table and watch the water drip from the top to the lower bottle as air bubbles move from bottom to top.
6. Invert so the water is in the top bottle and circle it a couple of times to start a whirlpool in the bottle. You should see a vortex form inside as the top drains into the lower bottle. The hole in the vortex lets the air from the lower bottle flow easily into the upper bottle, so the upper drains easily.
7. When you've finished, empty your bottle and add a different solution and repeat the experiment. Fill out the data table.

## Magnetic Tornadoes Data Table

*Note: Water height is measured when all the water is in the lower container.*

[illegible]

## Reading

Mercury looks peaceful at first glance. However, when you measure the surface with scientific instruments, you'll see how the Sun blasts away any hope Mercury has of a thin atmosphere with its radiation and solar wind. Not only that, Mercury is ravaged by invisible magnetic tornadoes that start from the planet's interior magnetic field. If you've ever experienced a tornado, you know how terrifying they can be. Now imagine they are the diameter of your entire planet.

These tornadoes are different from the Earth's, which form when two weather systems smack into each other, creating instability in the atmosphere. The magnetic tornadoes on Mercury form when two magnetic fields collide. These monstrous cyclones form without warning and disappear within minutes.

Magnetic fields, like the Earth's, are invisible shields that constantly protect us from the Sun. Our Earth is constantly being bombarded with high energy particles that are deflected off the magnetosphere of our planet. Mercury's magnetic field is weak and it's constantly being blasted by solar wind, which also carries a magnetic field. When these two fields collide, the magnetic fields spiral and twist to form a magnetic tornado. (Solar wind is a stream of high energy particles from the Sun's outer atmosphere.)

## Exercises

1. Define an atmosphere.
2. What is a magnetic field?
3. Where do magnetic fields come from in planets?
4. Which planets do not have a magnetic field?

## **Answers to Exercises: Magnetic Tornadoes**

1. Define an atmosphere. (An envelope surrounding an object like a planet or a moon that is held in place by the object's gravitational field.)
2. What is a magnetic field? (A force field around a magnet.)
3. Where do magnetic fields come from in planets? (We think they originate from the molten metallic core of a planet. When the core cools off, the magnetic field disappears.)
4. Which planets do not have a magnetic field? (Venus does not because of its super-slow rotation, and Mars does not have a planet-wide magnetic field, though it does have magnetic hotspots.)