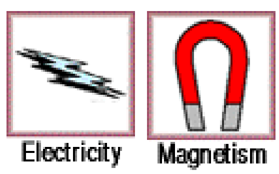
Eddy Currents

A magnet falls more slowly through a metallic tube than it does through a nonmetallic tube.



When a magnet is dropped down a metallic tube, the changing magnetic field created by the falling magnet pushes electrons in the metal tube around in circular, eddy-like currents. These eddy currents have their own magnetic field that opposes the fall of the magnet. The magnet falls dramatically slower than it does in ordinary free fall in a nonmetallic tube.

materials

- ✔ **A cow magnet or neodymium magnet.**
- ✔ **A nonmagnetic object, such as a pen or a pencil.**
- ✔ **One 3 foot (90 cm) length of aluminum, copper, or brass tubing** (do not use iron!) with an inner diameter larger than the cow magnet and with walls as thick as possible.
- ✔ **One 3 foot (90 cm) PVC** or other nonmetallic tubing.
- ✔ **Optional:** 2 thick, flat pieces of aluminum (available at hardware and home-repair stores); cardboard; masking tape; rubber bands or cord.

assembly

None required.

to do and notice

Hold the metal tube vertically. Drop the cow magnet through the tube. Then drop a nonmagnetic object, such as a pen or pencil, through the tube. Notice that the magnet takes noticeably more time to fall. Now try dropping both magnetic and nonmagnetic objects through the PVC tube.

In addition to dropping these objects through the tubes, a very simple, visible, and dramatic demonstration can be done by merely dropping the magnet between two thick, flat pieces of aluminum. The aluminum pieces should be spaced just slightly farther apart than the thickness of the magnet. A permanent spacer can easily be made with cardboard and masking tape if you don't want to hold the pieces apart each time. Rubber bands or cord can hold the pieces all together. The flat surfaces need to be only slightly wider than the width of the magnet itself. Thickness, however, is important. The effect will be seen even with thin pieces of aluminum, but a thickness of about 1/4 inch (6 mm) will produce a remarkably slow rate of fall. Allow at least a 6 inch (15 cm) fall.

what's going on?

As the magnet falls, the magnetic field around it constantly changes position. As the magnet passes through a given portion of the metal tube, this portion of the tube experiences a changing magnetic field, which induces the flow of eddy currents in an electrical conductor, such as the copper or aluminum tubing. The eddy currents create a magnetic field that exerts a force on the falling magnet. The force opposes the magnet's fall. As a result of this magnetic repulsion, the magnet falls much more slowly.

etcetera

Eddy currents are often generated in transformers and lead to power losses. To combat this, thin, laminated strips of metal are used in the construction of power transformers, rather than making the transformer out of one solid piece of metal. The thin strips are separated by insulating glue, which confines the eddy currents to the strips. This reduces the eddy currents, thus reducing the power loss.

With the new high-strength neodymium magnets, the effects of eddy currents become even more dramatic. These magnets are now available from many scientific supply companies, and the price has become relatively affordable. (An excellent source is Dowling Miner Magnetics Corp., P.O. Box 1829, Sonoma, CA 95476.)

Eddy currents are also used to dampen unwanted oscillations in many mechanical balances. Examine your school's balances to see whether they have a thin metal strip that moves between two magnets.

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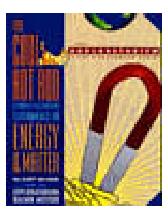

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