Assessment

Discussion Questions

1. Why does the magnetized plug fall much slower down the tube than the unmagnetized plug?
   The magnetized plug appears to float because the moving magnet induces an electric current in the copper tube. The induced electric current creates an opposing magnetic field that slows the downward fall.

2. What is the relationship between the magnetic field of the plug, and the magnetic field induced by the current?
   The two magnetic fields oppose each other, causing the plug to slow as it falls down the tube.

3. What do you think would happen if the copper tube had a bigger diameter and the magnetized plug wasn't as close to the inside walls?
   The further away the magnetized plug is to the copper, the less affect the magnetic field will have on it, so the faster it will fall.

4. What do you predict would happen if the walls of the copper pipe were twice as thick?
   The thicker the walls of the pipe, the more the affect the magnetic field will have on the plug, so the slower it will fall.

TEACHERS GUIDE

LENZ LAW APPARATUS
ITEM # AR-105

ENERGY - MARGNETISM

The Lenz Law apparatus consists of a hollow copper tube and two plugs: one magnetized and one unmagnetized. When the unmagnetized plug is dropped through the tube, it quickly falls through accelerating due to the pull of gravity. But when the magnetized plug falls, it slowly makes its way to the bottom due to induced currents. This is the fundamental principle behind electric motors and is even the same principle used in braking for roller coasters. Viewing windows allow students to easily see the electric and magnetic force demonstration of Lenz's Law.

Materials

- Lenz Law apparatus, including copper tube, magnetized plug and an un-magnetized plug
- Stopwatch (not included)

Goals & Objectives

Students will:

- observe the current caused by an electromagnetic field interacting with a conductor that opposes the path of motion.
- experiment with and gain an understanding of Lenz's Law.

Discussion

Enrichment Activities

1. Another way to demonstrate Lenz's Law is to hang a strong magnet from a string over the surface of a conductive, but nonmagnetic material such as a pop can. Lay the pop can down on its side, and swing the magnet back and forth over top. During this, the magnet should come very close to the surface of the can, but it should not touch the surface.

2. As the magnet passes by the can, a force will develop that starts to rock the can back and forth. As the magnet swings and passes over the conductive material, the magnet's magnetic field induces an electrical current. The current in the conductor generates its own magnetic field, which according to Lenz's Law, opposes the magnetic field that caused the current.

Activities

1. Ask students to predict what would happen if you dropped two objects at the same time.

2. Hold both plugs side by side above the floor and drop them both at the same time. Ask students to describe their observations. Repeat these steps again to help clarify the concept that they will both fall at the same time.

3. Now introduce students to the copper tube with the window cut out so that they can view the inside. Ask students to predict what will happen when the plugs are dropped down the tube.

4. Drop first the unmagnetized plug and have students time how long it takes to drop to the bottom. Repeat this three times and calculate the average time it takes.

Note
It is always best to DO an experiment ahead of time to be able to best present it to the class.

5. Next drop the magnetized plug. Again, have students time how long it takes and calculate the average of three trials. Ask students to share their results with each other, and brainstorm what could have possibly caused the magnetized plug to fall more slowly.

6. Explain to students that if a magnet passes a conductive material, like a copper tube, two things will happen. First, the moving magnetic field cuts through the conductor and induces a current in the conductor. Secondly, the currents in the conductor generate their own magnetic field, which opposes the magnetic field of the magnetized plug and slows its acceleration. This directional relationship between induced magnetic field and current was discovered in 1834 by Russian physicist Heinrich Lenz. It is commonly known as Lenz's Law.