Lenz's Law Apparatus

P8-8400

INSTRUCTIONAL GUIDE

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  Neodymium magnet
  Steel slug
  Cutaway copper tube with stoppers
- Instructional Guide

Background

When a magnet is moved near a conductor, an electrical current is produced in the conductor. This is known as electromagnetic induction. The amount of current produced is proportional to the strength of the magnet and the speed that it is moving. German physicist Heinrich Lenz observed that the direction of the induced current is always such that it opposes the motion of the magnet that produced it (Lenz's Law). When an un-magnetized plug is dropped through the tube, it falls freely (except for air resistance). When a magnetized plug is dropped through the tube, a force resists its motion. Since the force is proportional to speed, the plug will fall at the speed at which the weight of the plug and the resistance force are equal in magnitude, and therefore balanced.

This phenomenon is used in some rides at amusement parks. For instance, some free-fall rides have copper plates on them. There are magnets on the cars. When the cars fall past the copper plates they are slowed down. This has the advantage that the braking system is automatic and virtually fool-proof.

One example of a national standard that the Lenz's Law Apparatus will help you attain is: Electricity and magnetism are two aspects of a single electromagnetic force. Moving electrical charges produce magnetic forces, and moving magnets produce electrical forces. These effects help students understand electric motors and generators.

Information

The Apparatus consists of a copper tube with a narrow transparent slot along its length, a cylindrical plug of magnetized Neodymium Iron Boron (NdFeB), and an un-magnetized plug of identical material, size, and weight. The purpose of the apparatus is to show that a magnetized plug falls very slowly down the tube, whereas a non-magnetized, but otherwise identical, plug falls freely through the tube. The ends of the plugs help protect the magnet against chipping.

Safety Information:

This product contains one small, but powerful neodymium magnet.

Neodymium magnets are very brittle, and if they are allowed to fly together or onto a surface attracted to a magnet, e.g. a steel cabinet, they are likely to chip or shatter on impact.

This may cause fragments to fly off and possibly cause injury to eyes. The magnet may also cause minor bruising if held in the hand near another magnet or a surface attracted to a magnet.

All magnets, especially strong ones, can cause damage to magnetic media. Keep them away from computers, TV screens, disk drives, credit cards, or similar.

Activities

To determine which of the plugs is magnetic, hold them close to a paper clip. The one that will pick it up is magnetized. (The un-magnetized plug cannot be magnetized by the magnet. It needs a much stronger field than the magnet can provide. It can only be magnetized by a strong electromagnetic coil.)

Weigh the two plugs to show that they are indeed the same weight. Drop them onto a soft surface to show that normally they will fall at the same rate. Remove the end-caps from the tube. Drop the un-magnetized plug, then the magnetized plug through the tube. Make sure the catch them with your hand or something soft. The magnetized plug will fall much more slowly through the tube and can be observed through the opening.

Have the students hold the un-magnetized plug near a piece of aluminum and then move it back and forth. Repeat this with the magnetized plug. When stationary, there is no attraction between the magnet and the aluminum, but when the magnet is moved, there is a force that resists the motion. (Just like when the plug is falling through the tube.)

Related Products

Electromagnetic Flashlight (P6-6052) Shake the Electromagnetic Flashlight 40 times and see it light up an ultra-bright LED bulb. The flashlight is perfect for backpacking, emergency kits, the kitchen drawer or just to shed some light on how magnets can be used to produce electricity.

Electromagnetic Force Demonstrator (P6-2625) The Electromagnetic Force Demonstrator is a dynamic way of showing the interaction between magnetism and electricity. Watch how the aluminum pipe travels along the track according to the direction the current is moving.

World's Simplest Motor (P8-8300) By building and observing a motor that converts electrical energy into motion, students discover and explore first-hand several key properties of electricity and magnetism.