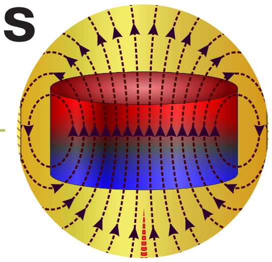
Investigating Interactions Between Electric and Magnetic Fields



A Carolina Essentials™ Activity

Student Worksheet

Overview

A major concept in physics is the relationship between electricity and magnetism. Everyday devices such as electric motors and generators apply the concept routinely. This activity is an investigation of relationship between electrical conductors and magnetic fields.

You will gather time data for a neodymium magnet falling through copper, aluminum, and PVC pipes. As a magnet falls through a conductor, the magnetic field created by the induced current generates opposing fields. You will measure the result of the opposing fields with time data.

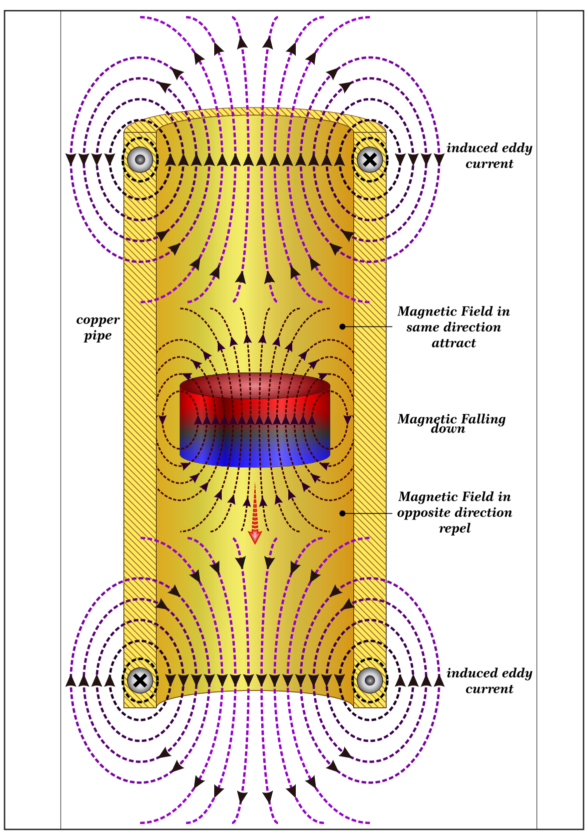
Both Faraday's law of electromagnetic induction and Lenz's law explain how a changing magnetic field induces a current in an electrical conductor. Lenz's law explains that the induced current works in the opposite direction of the changing magnetic field that created the current, which in turn supports the law of conservation of energy.

Phenomenon

Observe the 3 nuts as they fall. When do they hit the bottom? What can you infer about the velocity of the washers?

Essential Question

How do electric and magnetic fields interact?



SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS

2–5 neodymium round magnets, $^{1}/_{2} \times {}^{1}/_{4}$ in

Stopwatch or smartphone timer

Copper pipe (same length as the aluminum foil tube × $^{1}/_{2}$ in outside diameter)

Aluminum foil tube (at least half a roll)

PVC pipe (same length as the aluminum foil tube × $^{1}/_{2}$ in outside diameter)

Support stand

Utility clamp

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Activity Objectives

1. Conduct an investigation to gather data for a magnet interacting with 3 different materials.
2. Use data to explain the interaction of magnetic and electric fields.

Safety and Disposal

The neodymium magnets are strong. Keep your fingers and hands from between the magnet and other magnetically attractive bodies.

Activity Procedures

1. Place a pipe in the clamp attached to the support stand. The bottom edge of the pipe or tube should be 15 to 20 cm above the base of the support stand.
2. Add a cushion made from a folded towel, paper towels, bubble wrap, or foam packing material directly under the pipe or tube.
3. Place a magnet at the top edge of the pipe or tube.
4. Drop the magnet down the center of the tube.
5. Measure the time, in seconds, it takes for the magnet to fall the length of the tube.
6. Repeat the procedure for a total of 5 trials.
7. Experiment with additional numbers of magnets, recording the number of magnets used and the time in seconds.
8. Complete the same procedure for the other 2 pipes.
9. Your teacher may make a class data table to record all group data.

Data and Observations

Construct a data table for 5 trials on each of the 3 types of pipe material.

Data Table

Time for 1 magnet to fall(s)

Trial	Aluminum	Copper	PVC
1			
2			
3			
4			
5			
Additional Magnets			

Average the total time for the magnet to fall over the 5 trials for each type of pipe.

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Analysis and Discussion

1. Which type of pipe or tube interacted most strongly with the magnet? What evidence supports your claim?

2. Which type of pipe or tube interacted the least with the magnet? What evidence supports your claim?

3. Explain which pipes or tube are most likely electrical conductors. What evidence supports your claim?

4. Explain whether the number of magnets made a difference in the time.

5. Using your data as evidence, explain the interaction between electric and magnetic forces.

6. Using the same materials, how could this experiment be modified to collect additional data to support the claim you made in item 4?