

Induction – Magnet Through a Coil (Voltage Sensor)

Equipment List

Qty	Items	Part Numbers
1	PASCO Interface (for one sensor)	
1	Voltage Sensor	CI-6503
1	AC/DC Electronics Lab	EM-8656
1	Bar Magnet, Alnico	EM-8620
1	Pad (for stopping the bar magnet when it falls)	

Introduction

The purpose of this activity is to measure the potential difference induced in a coil of wire by a bar magnet dropping through the center of the coil. Use the Voltage Sensor to measure the induced potential. Use *DataStudio* to record and display the data.

Background

When electricity is passed through a conducting wire a magnetic field can be detected near the wire. Micheal Faraday was one of the first scientists to reverse the process. The essence of his work is decribed in the following statement:

A changing magntic field in the presence of a conductor induces a voltage in the conductor.

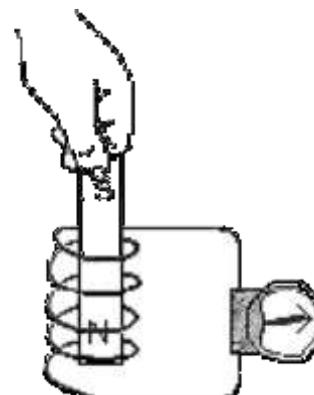
When a magnet is passed through a coil there is a changing magnetic flux through the coil that induces an Electromotive Force (EMF) in the coil. According to Faraday's Law of Induction:

$$\mathcal{E} = -N \frac{\Delta\phi}{\Delta t}$$

where \mathcal{E} is the induced EMF, N is the number of turns of wire in the coil, and $\frac{\Delta\phi}{\Delta t}$ is the rate of change of the flux through the coil.

In this activity, a plot of the EMF versus time is made and the area under the curve is found by integration. This area represents the flux since:

$$\mathcal{E}\Delta t = -N\Delta\phi$$



SAFETY REMINDER

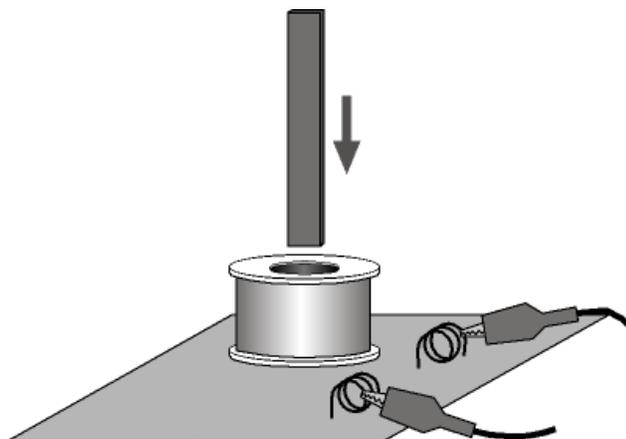
- Follow directions for using the equipment..

**THINK SAFETY
ACT SAFELY
BE SAFE!**

NOTE: During this experiment, keep the magnet away from the computer and from computer disks.

Setup

1. Set up the PASCO Interface and the computer and start *DataStudio*.
2. Connect the Voltage Sensor to the PASCO Interface
3. Create in *DataStudio* a Graph display of Voltage versus Time. The Voltage sensor is set at 200 Hz. Under “Set Sampling Options...”, set “Delayed Start” to Data Measurements when the Voltage (v) Is Above 0.050V and to “Keep data prior to start condition 0.5 Seconds. Set Automatic Stop to 0.5 seconds.
4. Attach the black wire of the Voltage Sensor lead to one component spring next to the inductor coil closest to the edge of the board on the AC/DC Electronics circuit board. Attach the other lead to the other component spring next to the coil.
5. Arrange the circuit board so the corner with the coil is beyond the edge of the table, and the bar magnet dropped through the coil can fall freely. Place a pad on the floor below. Hold the board in place with your hand as you drop the magnet(s) through the inductor.



- The bar magnet will be dropped through the coil. Make sure that the magnet does not strike the floor, or it may break.

Procedure

6. Hold the magnet so that the south end (without the groove) is about 2 cm above the coil.

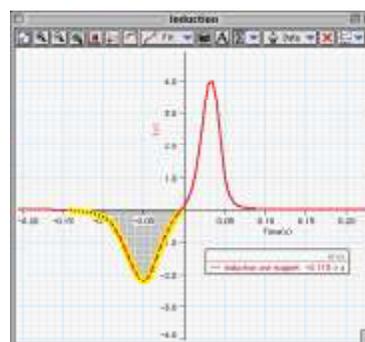
- Note: If you are using the PASCO Model EM-8620 Alnico Bar Magnet the North end is indicated by the narrow groove near one end. For the first run, hold the magnet with groove end ‘up’.

7. Click ‘Start’ in *DataStudio*. Let the magnet drop through the coil.

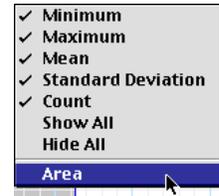
- Data recording will begin when the magnet falls through the coil and the voltage from the coil reaches 0.05 V. Data recording will end automatically after 0.5 seconds.

Analysis

- Examine the graph of the voltage versus time.
1. Rescale the Graph display to fit the data if necessary.
 2. In the Graph display, use the cursor to select a rectangle around the first peak of the voltage plot.
 3. Set up the Graph to show the area in the selected area of the curve of voltage versus time.



- In *DataStudio*, click the Statistics menu button () and select 'Area'. The value for 'Area' appears in the legend in the Graph.
- 4. Record the value of 'Area' for the left hand peak in the Lab Report section.
- 5. Repeat the process to find the area for the second peak. Record the value of 'Area' for the right hand peak.



Optional

Repeat the data recording and data analysis procedures for the following optional setups:

- Tape two bar magnets together so both south ends are together.
- Re-arrange the two bar magnets so that the south end of one is with the north end of the other.

Lab Report: Induction – Magnet Through a Coil

Name: _____

Data

Area (first peak) = _____ V*sec

Area (second peak) = _____ V*sec

Plot your graph of Voltage versus Time (indicate the area under the curve).

Questions

1. Is the incoming flux equal to the outgoing flux?
2. Why is the outgoing peak higher than the incoming peak?
3. Why are the peaks opposite in direction?