

Induction- Magnet through a Coil

Equipment list

Qty	Items	Parts Number
1	Voltage Sensor	CI-6503
1	Coil Set	SF-8616
1	Bar Magnet	
1	Pad	
2	cords	

Purpose

The purpose of this activity is to measure the induced potential difference that is generated when a magnet passes through a wire coil of conducting material.

Theory

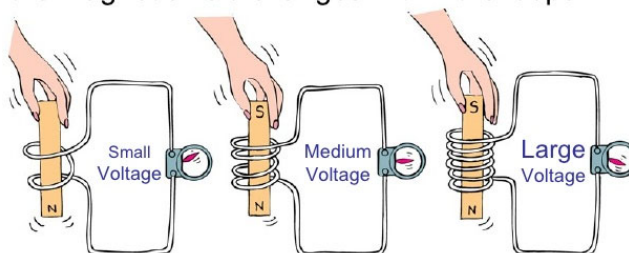
When a current passes through a wire, it generates a magnetic field in the space that surrounds the wire. It turns out that a similar yet reverse process is true as well. A changing magnetic field will generate an electric potential difference (aka; an induced electromagnetic force, \mathcal{E}) in a nearby conductor, which can in turn generate a current in that conductor. In a particular case when a magnet is passed through a conducting wire coil there is a changing magnetic flux through the coil that induces an electromagnetic force in the coil. According to Faraday's Law of Induction the induced electromagnetic force will be equal to:

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

Where N is the number of loops in the coil, and $\frac{\Delta\phi}{\Delta t}$ is the rate of change of the magnetic flux through the cross-sectional area of the coils. The negative sign indicates that the induced electromagnetic force will have the opposite orientation than the change of magnetic flux has.

Faraday's Law

The induced voltage in a coil is proportional to the product of the number of loops and rate at which the magnetic field changes within the loops.



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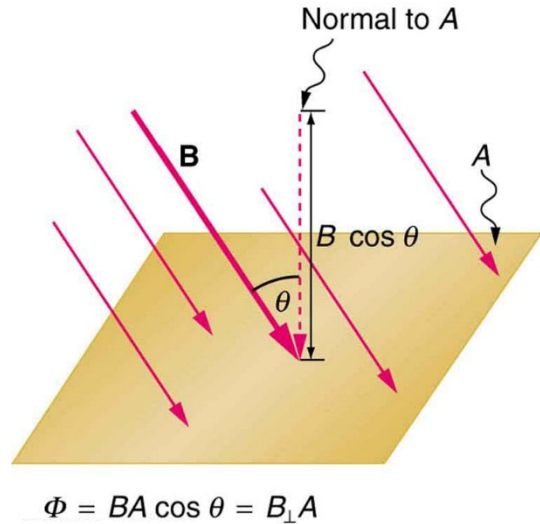
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Physics 1 (Garcia) SJSU

Magnetic flux, itself, is how much magnetic field is penetrating a surface area, and that related to the magnitude of the magnetic field, the size of the surface area, and the orientation of the magnetic field lines to the normal direction of the surface area.

$$\phi = BA \cos(\theta)$$

So changes in either the magnitude of the magnetic field, the size of the surface area, the directional orientation between the magnetic field and the surface area, or the number of loops in the coil will change the electromagnetic force induced in the wire. (The equation is usually written with the assumption that the number of loops in the coil will be constant.)



$$\mathcal{E} = -N \frac{\Delta BA \cos(\theta)}{\Delta t}$$

Setup

NOTE: During this experiment keep the magnet away from the computer, and away from your flash/thumb drives.

1. Double click on the Capstone icon to open the Capstone software.
2. In the Tool Bar, which is on the left hand side of the screen, click on the Hardware Setup icon. This will open the Hardware Setup window.
 - An image of the 850 Pasco Interface should be in the Hardware Setup window. If not, click on the Choose Interface tab. The Choose Interface window will open, select Passport: Automatically detect. Click ok.
3. On the 850 Pasco Interface image click on the Analog Ch(A), a sensor list will appear, scroll down, and select Voltage sensor. The voltage sensor icon should now be showing connected to the Analog Ch(A).
4. At the bottom center of the screen you will see that the voltage sensor is set to 20.0 Hz, change it to 200.0 Hz.
5. Close the Tool Bar.
6. In the Display Bar, on the right hand side of the screen, double click the Graph icon. This will cause a graph to appear. For the y-axis click on Select Measurements, and select Voltage (V). The computer will automatically select time (s) for the x-axis.
7. Plug in the voltage sensor to Analog Ch(A), then plug the voltage sensor's probes into one of the induction coils.

Procedure

1. Place the pad on the floor right next to your lab table.

2. Place the induction coil right at the edge of the table, right over the pad, such that the coil is vertical, and the coil itself is over the edge of the table. You will have to hold the coil so it doesn't fall.



3. Hold the magnet vertically, with its south end pointing downwards, just about one centimeter above the opening of the coil such that when you release the magnet it will fall right through the coil.

4. Near the Bottom left of the screen, click on the big red circle to start recording data, wait about one second then drop the magnet. After the magnet hits the pad, click on what is now a big red square to stop recording data.

5. Repeat Procedure steps 1 - 4, but this time with the north end of the magnet pointing downwards.

6. Shift and rescale the graph as needed so that you can clearly see the regions that show the induced EMF in the coil. Each graph should have a region where the curve is beneath the x-axis, and a region where the curve is above the x-axis.

7. For the graph with the south end facing downwards highlight the first region of the curve.

- Once the region is highlighted click on the Area Under the Curve icon that is among the icons at the top of the graph. Record the value for the area in the data table
- Now repeat for the second region.

8. Click on the Coordinate icon, which is among the icons at the top of the graph, and the coordinate tool should appear on the graph.

- Left click and hold on the coordinate tool to move it around the graph.
- Use the coordinate tool to determine the voltage value of the peak of the two regions of the graph. Record those voltage values in the data table.

9. Repeat steps 7, and 8 for the graph with the north end facing downwards.

Analysis of Induction Lab

Name _____ Group# _____

Course/Section _____

Instructor _____

Table (10 Points)

	South	North
Area of first region ($V \cdot s$)		
Area of second region ($V \cdot s$)		
First peak (V)		
Second peak (V)		

1. For each time you dropped the magnet through the coil, was the ingoing flux equal to the outgoing flux? Take the % difference of their magnitudes. (15 points)

2. Why must the flux of the two regions be the same? (15 points)

3. For both runs, the peak of the second region was larger than the first. Why is that? (15 points)

