# Faraday's Law

As you work through the steps in the lab procedure, record your experimental values and the results on this worksheet. Use the exact values you record for your data to make later calculations.

## EMF Due to a Moving Magnet: Observations

Advance the north pole of the magnet toward the top of the solenoid. Repeat using the south pole of the magnet. Are the signs of the induced voltages the same or reversed?

Describe the results.

After turning the solenoid coil over, are the signs of the induced voltages for this case the same or reversed?

When holding a magnet pole steadily against one end of the coil, is there a steady voltage generated?

Verify that an EMF is generated by moving the coil toward and away from a magnet (that is on the lab table). Describe the results.

## EMF Due to a Moving Magnet: Applying Faraday's Law

The Earth has a steady magnetic field of about 0.5 G ($5 \times 10^{-5}$ T) in the laboratory. Yet, in the absence of a magnet, you should have seen no induced voltage on the coil. Why is this? Relate your answer to Faraday's law.

In moving the north pole of the magnet toward the coil, will the amount of magnetic flux in the coil be increasing or decreasing? (Think about the way that field lines emanate from a pole of the magnet.)

Are the signs of the responses you recorded when advancing the magnet toward the coil what you expect from Faraday's law? Explain.

Explain the EMF observation you made when holding the magnet pole steadily against one end of the coil.

Is there a magnetic flux in the coil in this situation?

## A Moving Wire in a Magnetic Field

What is the maximum voltage amplitude you can obtain?

Try shaking the wire slowly back and forth; is the amplitude the same?

If you wanted to improve your pickup circuit to obtain larger signals, which of the following changes might help? (Select all that apply. *Note: the order of these options may be different in the WebAssign question.*)

- a larger magnetic field
- a thicker wire
- a smaller wire resistance

Why?

## Measurements with Time-Dependent Fields: Observations

### Waveform Sketches

Sketch the waveform shapes for each case using the screen template supplied and the Paint program. (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

sinusoidal waveform

triangle waveform

square waveform

Are these equivalent to the derivatives of the magnetic field waveforms?

**Triangle Wave**

Measure the voltage rise ($\Delta V$) and the elapsed time ($\Delta t$) for part of the wave from the Hall probe box.

Calculate the slope ($\Delta V/\Delta t$).

Convert this to the rate of change of magnetic field, $\frac{dB}{dt}$.

Measure the amplitude of the EMF induced in the small coil, in volts. (The amplitude is *half* the peak-to-peak value.)

**Sine Wave**

Measure the amplitude of the wave, in volts, for part of the wave from the Hall probe box.

Convert your measured amplitude to a magnetic field in T. (Do not enter units for this answer.)

Record the amplitude of the sinusoidal EMF induced in the small coil.

## Measurements with Time-Dependent Fields: Applying Faraday's Law

The small circular coil contains 50 turns. Take the average diameter to be 2.05 cm. With the rate of field change $\left(\frac{dB}{dt}\right)$, measured for the triangle wave, calculate the steady EMF predicted from Faraday's law.

Does the calculated result agree with your measured EMF?

With the amplitude of the sinusoidal field that you have just measured, calculate the predicted EMF amplitude. (You must first convert Hz to radian/s.)

Does this agree with the value you observed?

## Magnet Brake and Eddy Currents: Magnet Braking

Record your observations when the aluminum block is close to the poles.

Record your observations when the plastic block is close to the poles. Is there any difference?

## Magnet Brake and Eddy Currents: Eddy Current Propulsion

Record the effect on the magnet when the aluminum block is pulled away horizontally.

Record the effect on the magnet when the direction of the movement of the aluminum block is reversed.

Can you make a general statement about forces and the relative motion of magnets and conductors?