Activity 7: Induced Electromotive Force

Equipment	Quantity
Xplorer GLX	1
Voltage Probe	1
Coil*	1
Bar Magnet	1

*Use a coil with a few hundred turns, such as the one included with PASCO part CI-6512.

Background

When a permanent magnet passes through a coil, the changing magnetic flux induces and electromotive force (EMF) or voltage in the coil. According to Faraday's Law of Induction:

$$\varepsilon = -N\frac{d\phi}{dt}$$

where ε is the induced EMF, N is the number of turns in the coil, and $d\phi/dt$ is the rate of change of magnetic flux through the coil.

In this activity, you will drop a magnet through a coil while the GLX records and graphs the induced EMF versus Time. The area under the under the curve represents the total change in flux.

Before You Begin

Start a new experiment on the GLX.

1. Press (⌂) to go to the Home Screen.
2. Use the arrow keys to highlight the Data Files icon and press (✓) to open the Data Files screen.
3. Press (F4) to open the Files menu and press (1 pqrs) to select New File.
4. When the GLX asks if you would like to save the previous file, press (F1) to save or (F2) not to save.

Procedure

Equipment Set-Up

1. Clamp or mount the coil so that the magnet can be dropped through it.

2. Place something soft under the coil to prevent the magnet from breaking.

3. Connect the voltage probe to the coil so that it will measure the voltage across the coil.

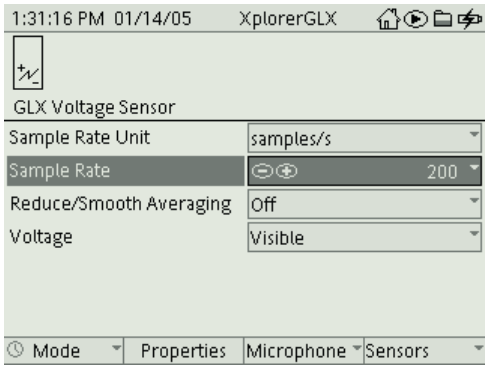
GLX Set-Up

1. Connect the voltage probe to the GLX.

a) Connect the voltage probe to the voltage port on the left side of the GLX.

b) If there are other sensors connected to the GLX, remove them.

2. Set the sampling rate to 200 Hz.



a) Press (home) to return to the Home Screen.

b) Press (F4) to open the Sensors screen.

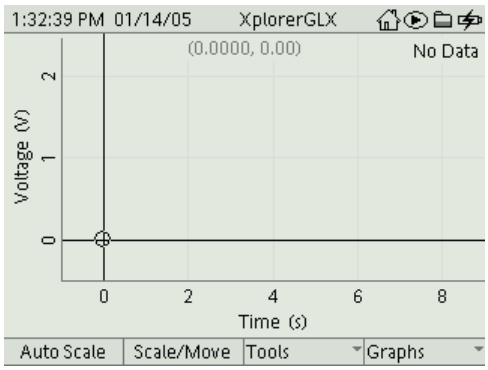
c) Press the down arrow key to highlight Sample Rate.

d) Press (+) repeatedly to set the Sample Rate to 200 Hz.

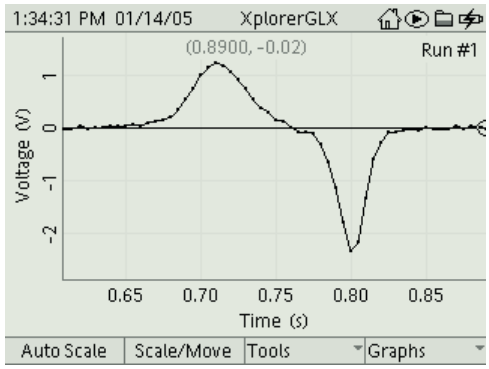
3. Open the Graph display.

a) Press (home) to return to the Home Screen.

b) Press (F1) to open the Graph display. The display will be automatically set up to graph Voltage versus Time.



Data Collection



1. Hold the magnet about 2 cm above the coil.
2. Press ▶; drop the magnet through the coil; press ▶ again.

Analysis

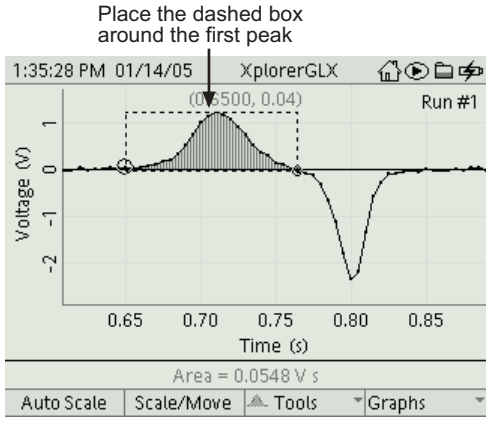
1. Scale the Graph.

a) Press F1 to automatically scale the Graph.

b) Press F2 to enter Scale mode, press F2 again to enter Move mode. Use the left and right arrow keys in both modes to zoom in on the positive and negative peaks.

See page 19 for detailed instructions on using Move and Scale modes.

2. Find the area under the first peak.



a) Press F3 to open the Tools menu; press 6mno to select the Area Tool.

b) Use the left and right arrow keys to move the right side of the dashed box to the right side of the first peak.

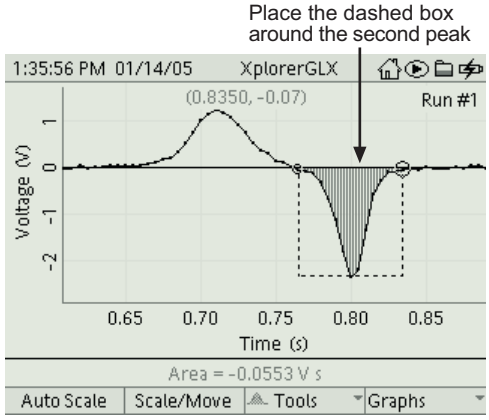
c) Press F3 then press 8abc to swap the cursor to the other side of the dashed box.

d) Use the left and right arrow keys to move the left side of the dashed box to the left side of the first peak.

See page 23 for detailed instructions on using the Area Tool.

Area under the first peak = _____ (include sign and units)

3. Find the area under the second peak.



Repeat step 2 to position the dashed box around the second peak.

Area under the second peak = _____

4. **Compare the incoming flux (area under the first peak) to the outgoing flux (area under the second peak}.**

5. **Why is the outgoing peak higher than the incoming peak?**

6. **Why are the peaks opposite in direction?**