Investigating Magnetic Fields

Teacher Notes

Introduction

Using a voltage probe it is easy to investigate magnetic fields. When a wire cuts across a magnetic field a voltage is induced between the ends of the wire. This is because the electrons in the wire are forced to move one way, the effect being that of a current driven by a voltage. If the wire takes the form of a coil, the voltages across all the individual coils add up, so inducing a much bigger voltage between the ends of the wire or coil. In general terms V α Number of turns and rate of change of field.

In this activity a magnet is dropped through a coil of wire and the voltage produced is recorded by the voltage probe and analysed by the TI-Nspire.

Resources

There is an TI-Nspire document, eminduction.tns to accompany this activity.

The activity

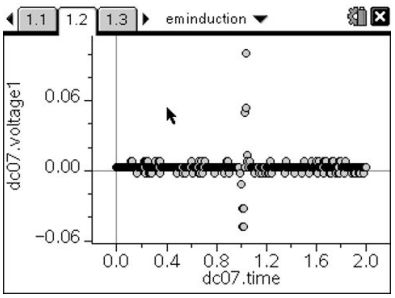
Wrap a coil of insulated wire around a plastic tube such as a thermometer case. If a magnet is dropped down the tube the magnetic field will cut the coil. The more turns there are the more field is cut, so typically 30 turns will induce a readable voltage.

Students can investigate how the number of turns and the speed of the magnet will affect the induced voltage.

Step 1

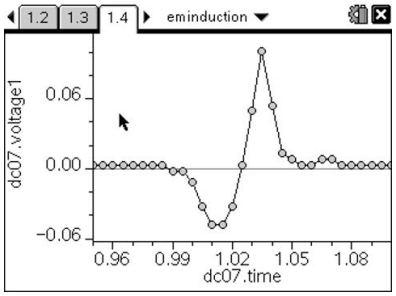
1. Connect the Vernier voltage probe to the TI-Nspire handheld, using the EasyLink adaptor.
2. Select Data & Statistics and tab to *ok*.
3. Connect the ends of the voltage probe to the ends of the coil.
4. Press *menu* and select *Experiment/Set Up Collection/Time Graph*. Enter a *Time Between Samples* of .005 seconds and *Experiment Length* of 2 seconds.
5. Press *tab* to *OK*, then press *enter*.
6. Press *menu*, then *Sensors/Zero.*
7. Press enter to start collecting data and then drop the magnet down the tube.

The screen shown on the right is a typical result. Notice the spike in voltage corresponding to the magnet passing through the coil.



Step 2

Press *menu* and *Window/Zoom/Zoom – In* to select the region around the spike**.**

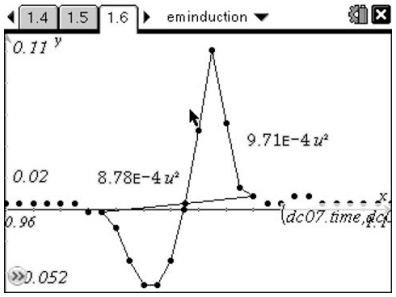


Describe what is going on. Why is the induced voltage on exit bigger than the induced voltage on entry?

Step 3

Now calculate the area under the two parts of the spike. To do this you will first need to insert a Graphs & Geometry page and plot the points again using a scatter plot. To do this:

1. Press the *Home* key, select Graphs and press *enter*
2. Press menu, select Graph Type/Scatter Plot and press *enter*
3. Plot the points again.



Now you can construct a polygon around all the points which make up the entry spike and do the same for the exit spike.
The area of the two spikes can be calculayed by pressing *menu* and choosing *Measurements/Area.*

Are the two areas nearly the same? Why is this?