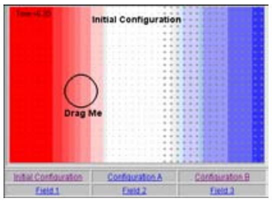
Worksheet for Exploration 29.1: Lenz's Law



Lenz's law is the part of Faraday's law that tells you in which direction the current in a loop will flow. Current flows in such a way as to oppose the change in flux. The magnetic field created by the current in the loop opposes the change in the magnetic flux through the loop's area **(position is given in meters, time is given in seconds, and magnetic field strength is given in tesla)**.

Consider the Initial Configuration. The center has a field free region and the sides have a linearly increasing magnetic field into the computer screen (blue) and out of the computer screen (red). The deeper colors represent a stronger field. Drag the loop from the white (field-free region) into the blue.

a. While you drag it, which way does the current in the loop flow? (right arrow means clockwise current; left arrow means counterclockwise current).

   Induced Current Direction=___________

b. Sketch the field that the *current in the loop* generates.
   i. This may be called the induced field.

c. In the center of the loop, does this field (created by the induced current) point into or out of the computer screen?

   Induced Field Direction at Center of loop=___________

d. So, as you drag the loop to the right, the *external field* in the loop increases in which direction? The (induced)field generated by the (induced) current points in which direction? According to Lenz's law, these two directions should be opposite.
   i. Make a note to yourself that the **change** in the external field through the loop, was pointing in the same direction as the external field.
   ii. You should think about what is happening or what should happen as you drag the loop back to the original position (see if you can predict this before you do it below).

Now, take the loop over to the far right and then move it slowly to the white region.

e. Explain why the direction of the current points the way it does.
   i. What is the direction of the initial external field pointing inside the loop? This can be drawn as a vector.

   ii. What is the change in the external field inside the loop as you move from blue into white (increase or decrease)? This is also a vector representing the change in external field inside the loop.

   iii. What is the direction of the "induced field" relative to the vector above in part ii?

f. What if you take the loop from the center to the left (into the red region)? Explain what you expect to happen and then try it.
   i. You can always consider taking three steps as in part e. What is the direction of the external field on the inside of the loop initially? What is the direction of the change in the external field? What is the direction of the induced field? Once you know the direction of the induced magnetic field inside the loop, you can find the direction of induced current.

g. Can you tell the difference between moving a loop from a blue to a white region and moving from a white region to a red region? Why or why not?

h. Try the two other configurations, Configurations A and B (where the magnetic field is hidden). Describe the magnetic field as completely as possible.
   i. For each configuration determine which way the field is pointing at various locations, and also if increasing or decreasing.

Configuration A

Configuration B

i. Once you've completed your descriptions, decide which of the magnetic fields (Fields 1, 2 or 3) matches Configuration A and Configuration B.

Check your answers to (i) by adding a loop to a field animation.