

ELECTROMAGNETIC INDUCTION

THEORY

A change in flux (area x magnetic field strength) induces an emf in a coil of wire. Physicists call the voltage an emf and give it a symbol \mathcal{E} . The emf is directly proportional to the rate of change of the magnetic flux. It also changes direction as the field does. The rate (increasing or decreasing) also affects the sign of the emf. This phenomenon is **Lenz's Law**.

With the coil and an ammeter in a closed circuit, a current (which is inversely proportional to the resistance of the coil) will flow. The magnetic field of the induced current will oppose the rate of change of the field that induces the current. For example, a mechanical action which changes a magnetic field through a closed circuit will experience a force that will try to stop it.

The right hand rule shows the relation between magnetic field direction and current direction.

Wrap the fingers of the right hand around the coil in the direction of positive current flow and emf. The thumb is a north pole.

APPARATUS

Galvanometer, ammeter, primary and secondary coils, bar magnet, aluminum rod, iron rod, connecting wires, 10,000 ohm (or greater) resistor, 1.5 Volt battery, variable power supply.

PROCEDURE

First, determine a convention for the current direction when using the galvanometer:

Refer to figure 1. Never connect a power supply directly to a galvanometer. Use the 1.5 volt battery as the power supply. Wire a 10,000 ohm resistor (3rd band orange) in series with the galvanometer and 1.5 volt battery. Current from the + of the battery goes through the resistor into the + of the galvanometer. Determine the current direction when the pointer moves to the right side. When current goes into the positive terminal, the needle moves to the

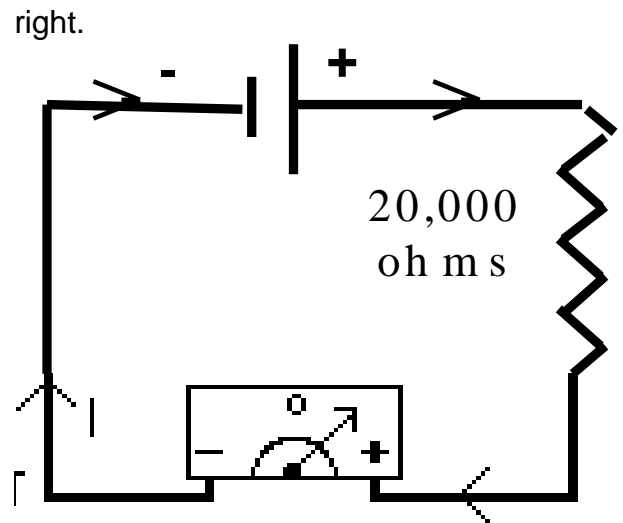


Figure 1.

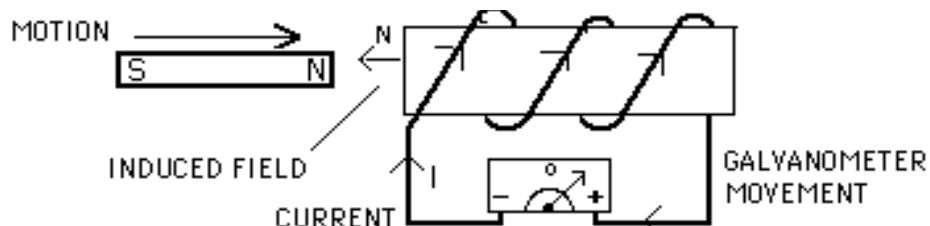


Figure 2.

Now disconnect the power supply and wire only the galvanometer directly to the secondary coil. Refer to figure 2. Determine the direction of wire wrap on the coil and note which end is connected to the positive terminal.

In each case below, record your actions and the resulting changes in current:

1. Insert the north pole of a magnet into one end of the coil and observe needle movement. Record the current direction. Remove the magnet. Record current direction. Observe the effect of speed on current.
2. Repeat (1) with the south pole.

3. Use the right hand rule to find the direction of the magnetic field for the induced current in each case above. Draw a diagram (similar to figure 2) for each case. Indicate the motion, current, and field direction by drawing arrows on these diagrams.
4. Determine if the induced field attracts or repels the magnet in each case.

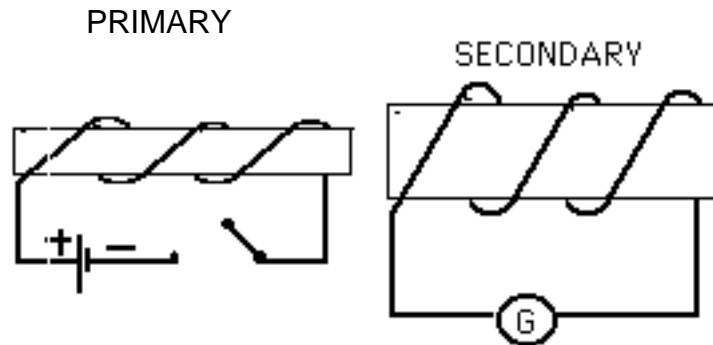


Figure 3.

5. Use a 1.5 volt battery as a power supply for this step. While the primary is inserted, disconnect it from the battery. Observe the meter for both magnitude and direction of movement. Then reconnect it and observe. Partially insert an iron rod to improve the effect.
Draw two more diagrams as in step 3.
6. **(Optional)** Connect a power supply to the primary as in figure 3. Use a current of at least 2 amperes Repeat (1) and (3) using the primary as the “magnet”.