LAB 24. ELECTROMAGNETIC INDUCTION

Guiding Questions

- How are electricity and magnetism related? How do they affect each other?
- How is electromagnetic induction related to conservation of energy?

Equipment

1. Bar magnet, wire coil, sensitive galvanometer, wire leads
2. Transformer, wire leads, sensitive galvanometer, voltage source, double-pole double-throw (DPDT) switch, breadboard (optional), two LEDs of different colors (optional), resistors (optional)
3. Hand-cranked generator, bank of light bulbs, knife switch, wire leads
4. DC motor, strong magnet, wire leads, voltage source, DPDT switch (optional)
5. Cylindrical rare earth magnet, cup, copper pipe, PVC pipe (optional)

Activities

Here we look at changing magnetic fields, particularly to understand how they interact with currents in nearby conductors.

This lab consists of several stations. You may do them in any order.

1. Bar Magnet and Coil

1.1. What does the galvanometer show when you push one pole of the magnet toward the coil?

1.2 What happens when you pull the magnet away from the coil?

1.3 What happens if you move the magnet more quickly?

1.4 What happens if you hold the magnet still near the coil?

1.5. What happens when you bring the opposite pole of the magent toward the coil? What happens when you pull it away?

1.6. What happens when the leads from the coil to the galvanometer are reversed?

1.7. What happens if you use a stronger magnet?

2. DC Transformer

DC means direct current (as opposed to alternating current). This apparatus consists of two wire coils connected not by a conducting path but instead by an iron core. One coil is connected through a double pole double throw switch to a DC power source and the other is connected to a galvanometer, which measures electric current. The double pole double throw switch has two closed settings. You can verify by following the wires that the two settings send current through the coil in opposite directions. Flipping the switch reverses the current. The two LEDs are connected in the circuit in parallel in opposite directions, so that one lights when the current flows in one direction, and the other lights when the current flows in the other direction.

2.1. What happens to the galvanometer and the LEDs when you close the switch and leave it closed?

2.2. What happens to the galvanometer and the LEDs when you open the switch and leave it open?

2.3. Why is there no deflection when the switch remains closed, even though an LED lights?

2.4. What happens when you open the switch and then close it the other way, reversing the current?

2.5. What happens when you flip the current more frequently?

Leave the switch open when you are done.

3. Generator

The generator contains coils of wire that spin inside a magnetic field when you turn the crank. Think about what happens to the magnetic flux through the coils as they spin.

3.1. What happens when you close the knife switch and turn the crank?

3.2. What happens when you open the knife switch and turn the crank?

3.3. Is the crank easier or harder to turn when the switch is open? Explain why, using the principle of conservation of energy. Or Lenz's law.

4. Electric Motor

You might have to turn the motor a little to make it start. If it still does not run, check your connections.

The magnet under the coil is very brittle. Do not subject it to any physical shocks. Keep it away from all ferrous materials.

4.1. What happens to the motor rotation when you reverse the connection to the battery (or the throw of the switch)?

4.2. What happens when the you turn the magnet over?

4.3. Inspect the rotor apparatus of the motor. How does it work? (This motor does not have a spit-ring commutator.) Explainit to your instructor's satisfaction.

Disconnect the motor from the power source or open the switch when you are finished.

5. Magnet and Copper Pipe

Think about what is happening to the tube as the magnet falls through it.

The magnets are very brittle. Do not subject them to any physical shocks, such as dropping them onto a desktop or the floor.

5.1. Bring the magnet to the pipe. Is the pipe magnetic?

5.2. Postion a cup to catch the magnet as it falls from the bottom of the pipe. (It's brittle, and I want to use it in the future. Also, it is small, and you don't want to look for it.) Drop the magnet down the inside of the copper pipe. Does the magnet fall through the pipe more quickly or more slowly than it would fall outside the pipe?

5.3. Look down the pipe as the magnet falls. Does the magnet contact the pipe?

5.4. What is happening as the magnet falls inside the pipe?