Magnetic Field of a Conducting Wire

MATERIALS LIST

- alligator clips
- galvanometer
- LabPro® or CBL 2™ interface
- masking tape
- power supply
- resistor
- support stand and buret clamp
- double-pole, double-throw switch
- TI graphing calculator with link cable
- Vernier magnetic field sensor
- voltage probe
- insulated connecting wires and bare copper wire

In this lab, you will construct a circuit with a current-carrying wire and will use a magnetic field sensor to investigate the relationship between the magnetic field and the current in the wire. You will be able to determine the magnitude and direction of the magnetic field that surrounds the wire.

SAFETY

- **Never close a circuit until it has been approved by your teacher. Never rewire or adjust any element of a closed circuit. Never work with electricity near water; be sure the floor and all work surfaces are dry.**
- **Do not attempt this exercise with any batteries, electrical devices, or magnets other than those provided by your teacher for this purpose.**
- **Wire coils may heat up rapidly during this experiment. If heating occurs, open the switch immediately and handle the equipment with a hot mitt. Allow all equipment to cool before storing it.**

PROCEDURE

Preparation

1. Read the Safety cautions for the Skills Practice Lab "Magnetic Field of a Conducting Wire" in the chapter "Magnetism."
2. Read the entire lab, and plan what steps you will take. Prepare a table with 4 columns and 7 rows. In the first row, label the columns *Trial, Current Direction,* ΔV_R *(V),* and $B_{Measured}$ *(T).* Label the second through seventh rows as *1* through *6.*

Magnetic Field Strength

3. Set up the apparatus as shown in **Figure 1.** Use 1 m of copper wire to make a square loop around the coil support pins on the galvanometer apparatus. Attach alligator clips to the ends of the wire. Label one clip *A,* and label the other *B.* Place the galvanometer apparatus so that you are facing the plane of the coil.
4. Use masking tape to mark a line on the stand of the galvanometer directly under the top of the coil. Make another tape line perpendicular to the first, as shown in **Figure 1.** The two tape segments should cross in the middle of the apparatus. On the second tape, on the side away from you, mark a point 2 cm from the center. Using this point as the center point, draw a circle with a 1 cm radius.
5. Construct a circuit that contains the power supply and a 1 Ω resistor wired in series through the middle set of posts on the switch. Place the switch so that it moves from left to right. Connect the front right post of the switch to the end of the coil marked *A,* and connect the rear right post of the switch to the end of the coil marked *B.* Now, connect the front left post of the switch to the end of the coil marked *B,* and connect the rear left post of the switch to the end of the coil marked *A.* Do not close the switch or turn on the power supply until your teacher has approved your circuit.
6. Connect the interface to the calculator with the unit-to-unit link cable. Connect the voltage probe to the CH1 port and the magnetic field sensor to the CH2 port on the interface. Set the switch on the magnetic field sensor to HIGH. Connect the voltage probe to measure the voltage across the resistor.
7. Turn on the calculator, and start the DataMate® program. Press CLEAR to reset the program.
8. Set up a support stand with a buret clamp to hold the magnetic field sensor vertically. Position the magnetic sensor securely so that the white dot is facing you and the sensor is directly above the 1 cm circle marked on the tape.