# Physics Exploration Homework Supplement **P111-15.pdf**

## Exploring the Magnetic Field Produced from a Current Carrying Wire

In this exploration, you will investigate that a current carrying coil produces a magnetic field and how the strength of the magnetic field depends upon the magnitude of the current and number of turns per unit length. You will also investigate the type of magnetic pole that develops at the two ends of a solenoid when a current passes through the coils in a given direction.

Before you begin the exploration, answer the following questions:

(1) Explain whether a solenoid will attract paper clips if there is no current through its coils. Predict what will happen to the force between the solenoid and the paper clips if you increase the current in the coils or increased the number of turns of coil per unit length? Explain.

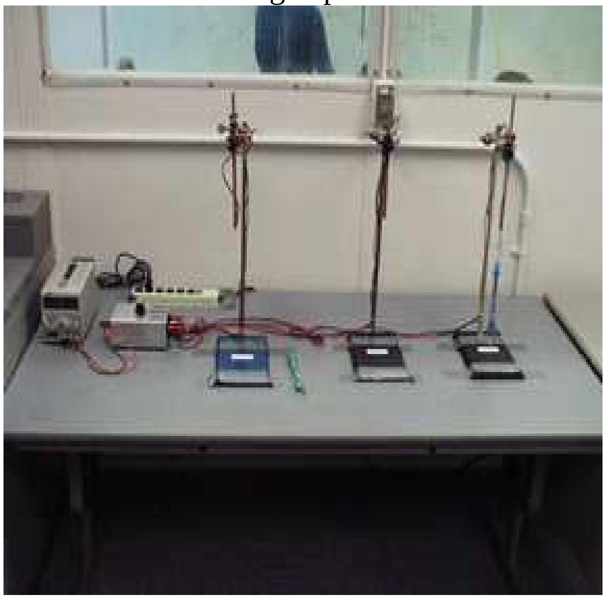
(2) A student comments: "If we change the direction of current in the solenoid coils from say, clockwise to counterclockwise, the paper clips will be attracted by the solenoid in one case and repelled in the other." Explain why you agree or disagree with the student.

(3) A student comments: "If we bring the north pole of a bar magnet close to one end of a current carrying solenoid and the bar magnet and the solenoid attract, then if I bring the south pole of the bar magnet close to the same end of the solenoid, the two will repel. This is because the solenoid is also a magnetic dipole (magnet) with north poles and sound poles at the two ends." Explain why you agree or disagree with the student.

(4) A student comments: "If we bring together the ends of two current carrying solenoids and they attract, then if we flipped the end of only one of the solenoids, the two solenoids will repel." Explain why you agree or disagree with the student.

(5) A student comments: "If we bring together the ends of two solenoids with different currents flowing through them, the one with larger current through its coils will exert a greater force on the solenoid carrying the smaller current." Explain why you agree or disagree with the student.

Now do the following explorations:



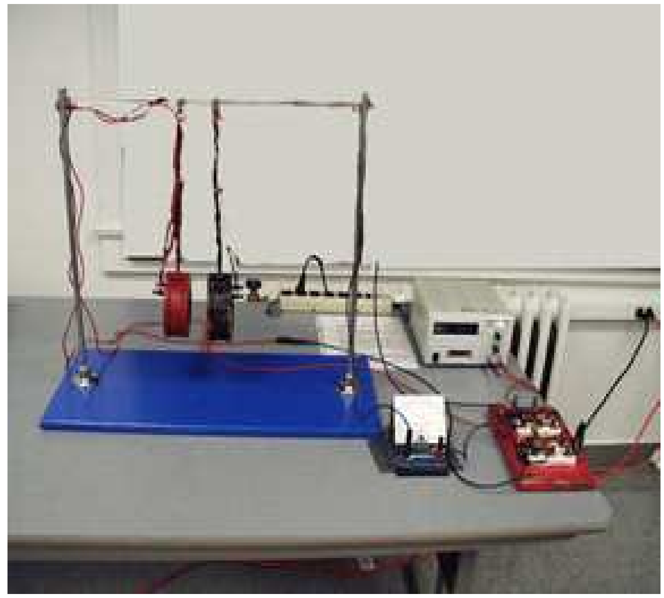


Figure 1: Set up for questions (a ) and (b).

Figure 2: Set up for question (c).

(a) You are provided three vertical solenoids with different turns per unit length, each wrapped on iron (steel) bolts (figure to the left above). The power supply (voltage source) has been adjusted so that a fixed current passes through each solenoid. We are assuming that all the solenoids have approximately the same resistance, even though the solenoid with the most turns will have a slightly higher resistance. [Notice: that as you switch between the three coils, the current reading hardly changes, implying that this assumption is true.] Take an iron hook and bring it close to one end of a solenoid. Explain why the iron hook gets attracted to it. In order to measure the magnitude of the attractive force between the hook and the solenoid, hang a spring force meter from the iron hook and observe the force reading before the hook gets dislodged. Repeat this process for all the three vertical solenoids with different number of turns. How does the number of turns per unit length affect the force that the solenoid exerts on the hook? Explain.

(b) Now bring the pole of the Magnetic Field Probe close to one end of a current carrying solenoid (from figure1 above). Do you see any attraction or repulsion? Draw a diagram showing the direction of the magnetic field lines from the solenoid, as deduced by using the magnetic field probe. Predict what would happen if you bring the magnetic field probe up to the opposite end of the current carrying solenoid. Then, bring the magnetic field probe up to the “opposite” end of the solenoid; do you observe what you predicted? Explain.

(c) Now turn on the voltage sources for the two horizontal solenoids (figure 2 above). Do you see any attraction or repulsion? Draw a diagram with magnetic field lines of the coils to show this attraction or repulsion. Now flip the switch provided to change the direction of current in one of the solenoids. (The ammeter connected to the circuit will show a deflection in the opposite direction verifying that the direction of current has changed.). What do you observe now (attraction or repulsion)? Explain. Do you think the forces that the two solenoids exert on each other are different in magnitude? Explain citing the appropriate law of physics.