

# PHYSICS 122

## EXPERIMENT V: Magnetic Force Between Current-Carrying Wires

Alternate Apparatus List, Procedure and Figure, Fall 2002

62.3 Replace Apparatus list with the following:

current balance	meter, 25 amps	optical screen
spacer, 0.5 cm	compass	laser elevator block
milligram weights set	laser	level
power supply	laser beam attenuator	ruler

63.8 Replace Figure V-2 and the single line of print below it with new figure and text on page 3.

65.4 Replace entire existing < **VI. Procedure ...** > with:

### **VI. Procedure**

A. First make sure the power supply is off, then connect the circuit that you will use for the experiment as shown in Fig V-2. Again, note that the two current balance wires are in series.

Now look at the current balance, and trace the path of the current from the power supply through the upper and lower wires. You should notice that the current travels through the fixed and free wires in opposite directions, as needed.

B. Level the base of the current balance.

C. Position the knife edges so that the full length of the free wire is directly above the fixed wire. Loosen the alignment set screws on both wires and adjust the wires until they are parallel as viewed from the front of the apparatus, then tighten the alignment screws. **Do not touch or write on the front surface mirror, as this tends to degrade the silver surface.**

D. Adjust the laser and scale positions so that the laser spot falls on the center of the scale, when the 0.5 cm spacer is placed between the wires. Record this scale reading. **Note: the green filter substantially attenuates the red laser beam and causes it to be not too bright to look at on the screen as well as causes it to**

**appear smaller, enabling greater precision in taking readings. Also, for a safety reason, this green filter should be kept in the laser beam, since a weaker beam is always a safer beam. Never look directly into a laser beam, and never shine a laser beam into someone else's eyes.**

E. Remove the spacer and adjust the counterweight at the rear of the apparatus until the scale reading is the same as the reading recorded in part D above. The wires should now be spaced 0.5 cm apart. This fixes  $r$ .

F. **After having your instructor check the circuit**, and after turning the power supply voltage to zero, turn the power supply on. Then add weights to the pan in roughly 50 mg increments (50 mg, 100 mg, 150 mg ...). For each weight, adjust the current such that the reading on the scale is that recorded for the no weight, no current position. Record the balancing current corresponding to each weight. **Stop after the current reaches 15 amps.** Record the length of the parallel, current-carrying segment of the movable wire.

G. Tabulate the gravitational force in newtons, the current, and the square of the current corresponding to each weight.

H. Plot the gravitational force in newtons against the square of the current.

I. Turn off the power supply, then reverse the leads at the power supply, then repeat F, G, and H using the same graph to plot the second curve.

J. Plot the average of the two curves of H and I.

K. Measure and compute from the average curve, the slope of the force versus current-squared curve. Using this number, as well as measured values of the other needed quantities, compute  $\mu_0$ . Compare this to the accepted value,  $4\pi \times 10^{-7}$  Tesla-meter/ampere (T-m/A), or  $N/A^2$  and quote a percent error.

L. Reverse the leads on the fixed wire such that the currents are now in the same direction. Verify that the wires attract. **Caution: In order to prevent loss of alignment, press down firmly on the center of the current balance base when reversing the leads.**

In each of the 3 schematics:

1. Upper rectangle represents free wire (#1)
2. Lower rectangle represents fixed wire (#2)
3. Lines with arrow heads represent banana patch cords, with the arrows indicating current direction.

The patches:

Upper patch allows current to flow in opposite directions.

Center patch allows current to flow in opposite directions, but the current in each wire is reverse of that in the first patch.

Lower patch allows currents to flow in the same direction.

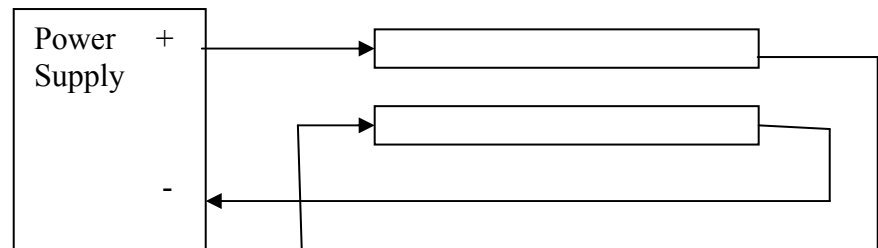
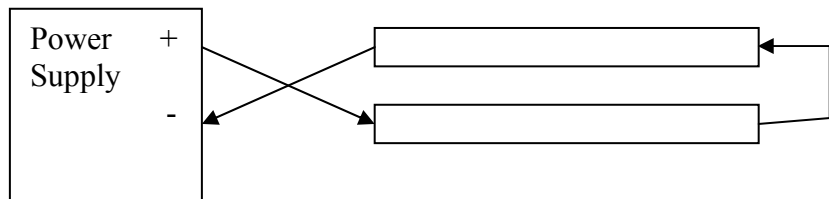
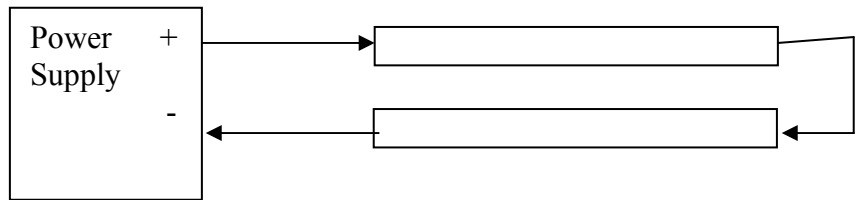


Figure V-2: Three schematic drawing of apparatus.. **Note:** At the beginning of the experiment connect the two wires in series as in the top schematic..