CHAPTER 8 PRACTICE PASSAGE

A current carrying wire will generate a magnetic field around the wire that varies with current in the wire, i, and the distance from the wire, r. The strength of the magnetic field generated can be calculated using the equation

$$B = \mu_0 i/2\pi r$$

Equation 1

where B is the magnitude of the magnetic field generated and μ_0 is a constant known as the permeability of free space. The direction of the magnetic field generated will always be circular around the wire.

A physics student is conducting an experiment to test the effects on charged particles of the magnetic field created by wires. Two long wires are stretched parallel to each other a distance 20 cm apart. Each wire is connected to a voltage source and a grounded point so that a current will flow through the wire. Three separate test paths are established and marked in Figure 1. The wires are fixed in place, so any forces experienced by the wires will not cause them to move.

The charged particle used in the experiment is a lightweight (mass, m) negatively charged (charge, $-q$) metal marble. For each experiment, the marble is injected along the test path with a constant initial velocity, v, which is parallel to the wires. The magnetic field created by the wires exerts a magnetic force on the marble, causing the velocity to change direction from the initial velocity direction. Because the marble rolls without slipping, frictional effects are assumed to be negligible.

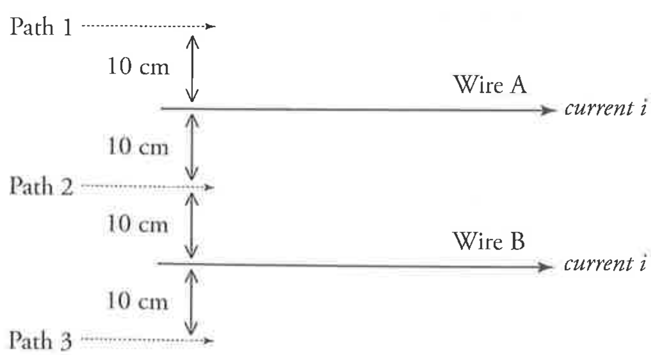

Figure 1 Complete setup for Trial 1 with the three test paths marked

In the first trial of the experiment, the student has the same voltage drop across both wires and the current, i, in both wires is going from left to right, as shown in Figure 1. The metal marble was injected along each test path, and its initial change in direction recorded in Table 1. In the second trial of the experiment, the current in Wire A remained the same, but the current in Wire B was doubled. Again, the metal marble was injected along each test path, and its initial change in direction recorded in Table 1.

Trial	Test Path	Initial Change in Direction of Marble
1	1	Up, away from Wire A (↑)
1	2	No change in direction, marble passes straight along path 2 (→)
1	3	Down, away from Wire B (↓)
2	1	Up, away from Wire A (↑)
2	2	Up, toward Wire A and away from Wire B (↑)
2	3	Down, away from Wire B (↓)

1. Which of the following best explains why the marble on Path 2 did not change direction in Trial 1 of the experiment?

A) The net magnetic force acting on the marble was zero because the net magnetic field was zero along Path 2 since the magnetic field created from Wire A was equal in magnitude and opposite in direction from the magnetic field created from Wire B.
B) The net magnetic force acting on the marble was zero because the magnetic fields created by the two wires along Path 2 resulted in forces that were an action-reaction pair.
C) The net magnetic force acting on the marble was not zero, but the magnetic fields created by the two wires resulted in forces on the marble that were parallel to the wires and kept the marble on Path 2.
D) The net magnetic force acting on the marble was not zero because the marble increased velocity as it traveled on Path 2.

2. What is the magnitude and direction of the magnetic

2. What is the magnitude and direction of the magnetic field on Path 2 in Trial 2 if $i = 6$ A?

A) magnitude is $30\mu_0/\pi$ direction is into the page
B) magnitude is $30\mu_0/\pi$ direction is out of the page
C) magnitude is $60\mu_0/\pi$ direction is into the page
D) magnitude is $60\mu_0/\pi$ direction is out of the page

3. How much work is done by the magnetic force on the marble on Path 3 in Trial 2 in terms of the variables given in the passage?

A) $qv\mu_0 i/2\pi$
B) $qv\mu_0 i/2\pi r$
C) $qv\mu_0 ir/2\pi$
D) 0

4. Assuming the same voltage drop is used for both trials of the experiment, how might the student double the current in Wire B in Trial 2?

A) Increase the resistance by a factor of 2
B) Decrease the resistance by a factor of 2
C) Increase the resistance by a factor of 4
D) Decrease the resistance by a factor of 4

5. Which of the following best describes the negative charge on the metal marble?

A) The negative charge means the electric field inside the marble points in, toward the center of the marble.
B) The negative charge means the electric field inside the marble points out, away from the center of the marble.
C) There is no electric field inside the marble since the negative charge is spread evenly on the surface of the marble.
D) There is no electric field inside the marble since conductors absorb charge and neutralize it.

6. The student wanted to conduct a Trial 3 of the experiment where the current in Wire A is the same as in Trial 1, and the current in Wire B is the same magnitude as Wire A but in the opposite direction. Predict the results of Trial 3 of the experiment.

I. The initial change in direction of the marble on Path 1 is up, away from Wire A (↑)
II. The initial change in direction of the marble on Path 2 is no change in direction (→)
III. The initial change in direction of the marble on Path 3 is up, toward Wire B (↑)

A) I only
B) I and II only
C) I and III only
D) I, II, and III

7. While recording results, the student noticed that the marble on Path 3 in Trial 2 continued in a circular path after its initial change in direction. Calculate the radius of the circular path in terms of the magnitude of the magnetic field, B, and the other variables given in the passage.

A) $|q|B/mv^2$
B) $|q|B/mv$
C) $mv^2/|q|B$
D) $mv/|q|B$