81. Near the Earth's poles the magnetic field is about 1 G $(1 \times 10^{-4}\,\text{T})$. Imagine a simple model in which the Earth's field is produced by a single current loop around the equator. Roughly estimate the current this loop would carry. [*Hint:* use the formula given in Problem 80.]

82. You want to get an idea of the magnitude of magnetic fields produced by overhead power lines. You estimate that the two wires are each about 30 m above the ground and are about 3 m apart. The local power company tells you that the lines operate at 10 kV and provide a maximum of 40 MW to the local area. Estimate the maximum magnetic field you might experience walking under these power lines, and compare to the Earth's field. [For an ac current, values are rms, and the magnetic field will be changing.]

83. (*a*) What value of magnetic field would make a beam of electrons, traveling to the right at a speed of 4.8×10^6 m/s, go undeflected through a region where there is a uniform electric field of 10,000 V/m pointing vertically up? (*b*) What is the direction of the magnetic field if it is known to be perpendicular to the electric field? (*c*) What is the frequency of the circular orbit of the electrons if the electric field is turned off?

84. A proton follows a spiral path through a gas in a magnetic field of 0.010 T, perpendicular to the plane of the spiral, as shown in Fig. 20–70. In two successive loops, at points P and Q, the radii are 10.0 mm and 8.5 mm, respectively. Calculate the change in the kinetic energy of the proton as it travels from P to Q.

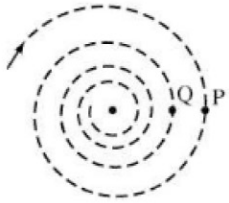

FIGURE 20–70 Problem 84.

85. A 32-cm-long solenoid, 1.8 cm in diameter, is to produce a 0.30-T magnetic field at its center. If the maximum current is 5.7 A, how many turns must the solenoid have?

86. Two long straight aluminum wires, each of diameter 0.50 mm, carry the same current but in opposite directions. They are suspended by 0.50-m-long strings as shown in Fig. 20–71. If the suspension strings make an angle of 3.0° with the vertical, what is the current in the wires?

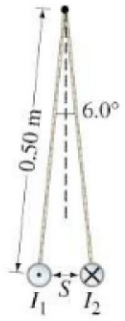

FIGURE 20–71 Problem 86.

87. An electron enters a uniform magnetic field $B = 0.23$ T at a 45° angle to $\vec{\mathbf{B}}$. Determine the radius r and pitch p (distance between loops) of the electron's helical path assuming its speed is 3.0×10^6 m/s. See Fig. 20–72.

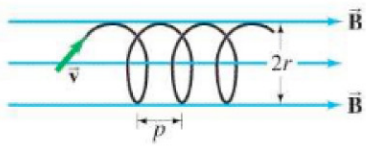

FIGURE 20–72 Problem 87.

Answers to Exercises

A: Near the poles, where the field lines are closer together.
B: Counterclockwise.
C: 0.15 N.
D: Zero.
E: Negative; the direction of the helical path would be reversed.
F: 2.0 cm.