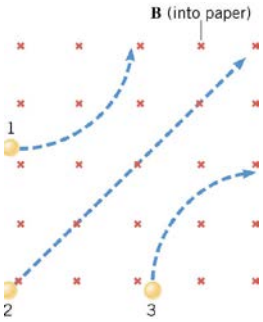
Chapter 24: Magnetic Fields & Forces
Questions & Problems

$$B_{wire} = \frac{\mu_0 I}{2\pi r} \qquad B_{loop} = \frac{\mu_0 I}{2r} \qquad B_{solenoid} = \mu_0 I \frac{N}{L} \qquad F_B = |q| vB \sin\alpha \qquad F_B = |q| vB = \frac{mv^2}{r}$$

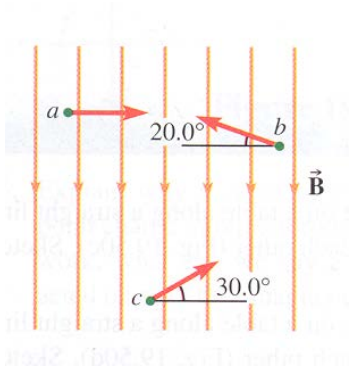
$$F_{wire} = ILB \sin\alpha \qquad F_{parallel\,wires} = \frac{\mu_0 L I_1 I_2}{2\pi d} \qquad \mu_0 = 4\pi \times 10^{-7}\ T \cdot m/A = 1.257 \times 10^{-7}\ T \cdot m/A$$

Example 23.1
A proton is moving near a long, current-carrying wire. When the proton is at the point shown in the figures below, in which direction is the force on it?

Example 23.2
Three particles move through a constant magnetic field and follow the paths shown in the figure. Determine whether each particle is positively charged, negatively charged, or neutral.

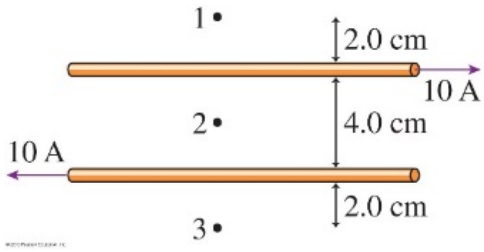


Example 23.3
Find the magnetic force (magnitude and direction) on an electron moving at a speed of 8.0×10^5 m/s for each of the directions shown in the figure below. The magnetic field has a magnitude of B = 0.40 T.



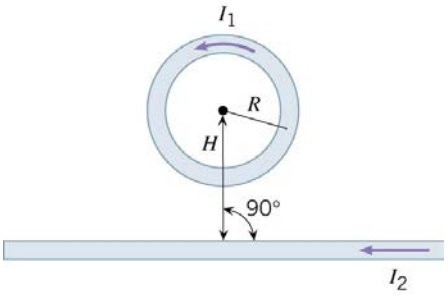
Example 23.4

What are the magnetic field strength and direction at points 1 to 3 in the figure below?



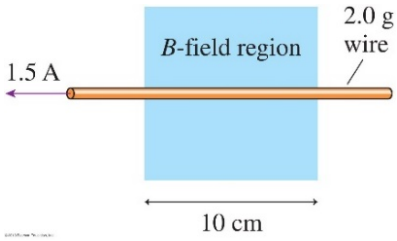
Example 23.5

A circular wire loop of wire and a long, straight wire carry currents of I_1 and I_2 (see the drawing), where $I_2 = 6.6\ I_1$. The loop and the straight wire lie in the same plane. The net magnetic field at the center of the loop is zero. Find the distance H, expressing your answer in terms of R, the radius of the loop.



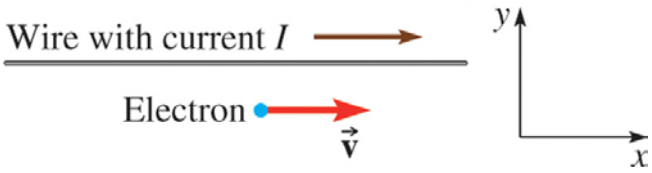
Example 23.6
A researcher would like to perform an experiment in zero magnetic field, which means that the field of the earth must be cancelled. Suppose the experiment is done inside a solenoid of diameter 1.0 m, length 4.0 m, with a total of 5000 turns of wire. The solenoid is oriented to produce a field that opposes and exactly cancels the field of the earth. What current is needed in the solenoid's wire?

Example 23.7
What magnetic field strength and direction will levitate the 2.0 g wire in the figure below?



Example 23.8

A long straight wire carries a current of 3.2 A in the positive *x*-direction. An electron, traveling at 6.8 $\times 10^6$ m/s in the positive *x*-direction, is 4.6 cm from the wire. What force acts on the electron?



Example 23.9

Two isotopes of carbon, C-12 and C-13, have masses of 19.93×10^{-27} kg and 21.59×10^{-27} kg, respectively. These two isotopes are singly ionized (+e) and each is given a speed of 6.667×10^5 m/s. The ions then enter the bending region of a mass spectrometer where the magnetic field is 0.8500 T. Determine the spatial separation between the two isotopes after they have traveled through a half-circle.