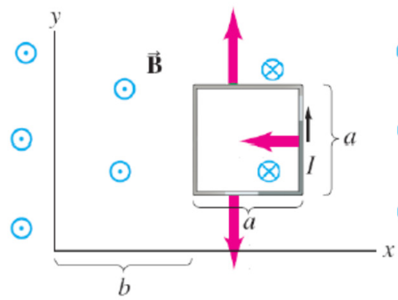
Ch. 27

74.

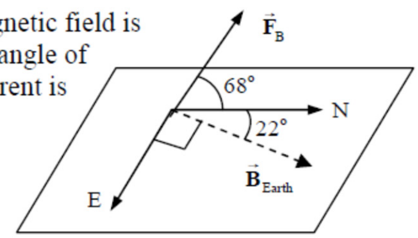
The forces on each of the two horizontal sides of the loop have the same magnitude, but opposite directions, so these forces sum to zero. The left side of the loop is located at $x = b$, where the magnetic field is zero, and therefore the force is zero. The net force is the force acting on the right side of the loop. By the right hand rule, with the current directed toward the top of the page and the magnetic field into the page, the force will point in the negative x direction with magnitude given by Eq. 27-2.



$$\vec{F} = IlB\left(-\hat{i}\right) = IaB_0\left(1-\frac{b+a}{b}\right)\hat{i} = \boxed{-\frac{Ia^2B_0}{b}\hat{i}}$$

75.

We assume that the horizontal component of the Earth's magnetic field is pointing due north. The Earth's magnetic field also has the dip angle of 22°. The angle between the magnetic field and the eastward current is 90°. Use Eq. 27-1 to calculate the magnitude of the force.



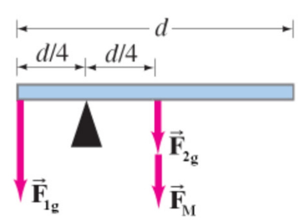
$$F = IlB\sin\theta = (330\,\text{A})(5.0\,\text{m})(5.0\times10^{-5}\,\text{T})\sin 90^\circ$$

$$= \boxed{0.083\,\text{N}}$$

Using the right hand rule with the eastward current and the Earth's magnetic field, the force on the wire is $\boxed{\text{northerly and 68° above the horizontal}}$.

76.

Since the magnetic and gravitational force along the entire rod is uniform, we consider the two forces acting at the center of mass of the rod. To be balanced, the net torque about the fulcrum must be zero. Using the usual sign convention for torques and Eq. 10-10a, we solve for the magnetic force on the rod.



$$\sum\tau = 0 = Mg\left(\tfrac{1}{4}d\right) - mg\left(\tfrac{1}{4}d\right) - F_M\left(\tfrac{1}{4}d\right) \rightarrow F_M = (M-m)g$$

We solve for the current using Eq. 27-2.

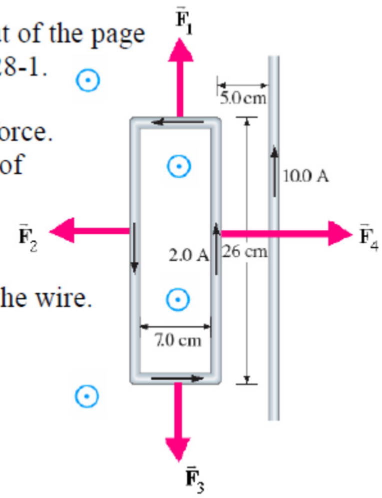
$$I = \frac{F}{lB} = \frac{(M-m)g}{dB} = \frac{(8.0m-m)g}{dB} = \boxed{\frac{7.0mg}{dB}}$$

The right hand rule indicates that the current must flow $\boxed{\text{toward the left}}$ since the magnetic field is into the page and the magnetic force is downward.

Ch. 28

56

(a) The magnetic field from the long straight wire will be out of the page in the region of the wire loop with its magnitude given by Eq. 28-1. By symmetry, the forces from the two horizontal segments are equal and opposite, therefore they do not contribute to the net force. We use Eq. 28-2 to find the force on the two vertical segments of the loop and sum the results to determine the net force. Note that the segment with the current parallel to the straight wire will be attracted to the wire, while the segment with the current flowing in the opposite direction will be repelled from the wire.



$$F_{net} = F_2 + F_4 = -\frac{\mu_0 I_1 I_2}{2\pi d_2} l + \frac{\mu_0 I_1 I_2}{2\pi d_1} l = \frac{\mu_0 I_1 I_2 l}{2\pi}\left(\frac{1}{d_1} - \frac{1}{d_2}\right)$$

$$= \frac{\left(4\pi \times 10^{-7}\ \text{Tgn/A}\right)\left(2.0\ \text{A}\right)\left(10.0\ \text{A}\right)\left(0.26\ \text{m}\right)}{2\pi}\left(\frac{1}{0.05\ \text{m}} - \frac{1}{0.12\ \text{m}}\right)$$

$$= \boxed{1.2 \times 10^{-5}\ \text{N toward the wire}}$$

(b) Since the forces on each segment lie in the same plane, the net torque on the loop is $\boxed{\text{zero}}$.