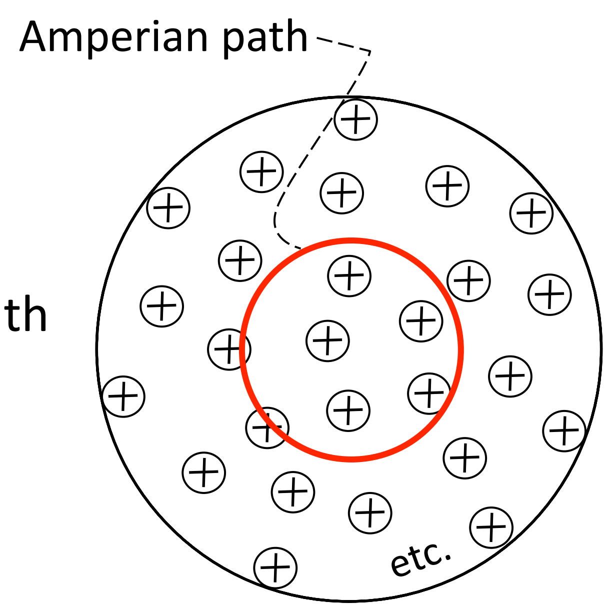
Problem 30.34



a.) A sketch approximately representing the uniformly distributed charge flow is shown. Moving a distance *r* units from the center, where *r* < *R*, allows us to draw in the Amperian path (in red) as shown on the sketch. With that, and noticing that we'll need to determine the fraction of total current passing through the Amperian path due to the *other* 99 wires, Ampere's Law yields:

$$\oint \vec{B} \bullet d\vec{l} = \mu_o i_{thru}$$

$$\Rightarrow \quad B\oint dl = \mu_o \left[\left(\frac{\pi r^2}{\pi R^2} \right) (99 i_o) \right]$$

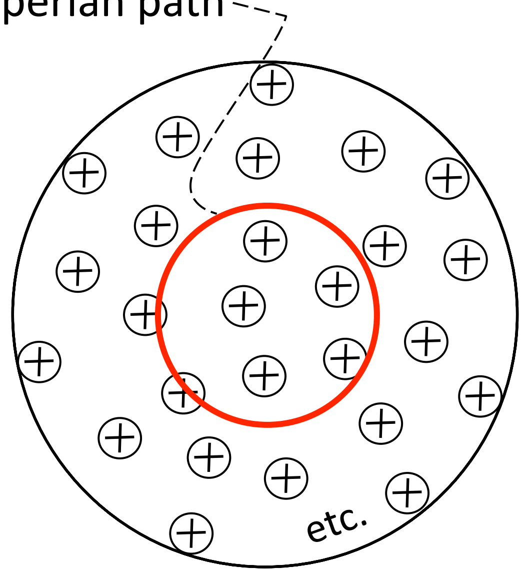
$$\Rightarrow \quad B(2\pi r) = \mu_o \left(\frac{99 r^2}{R^2} i_o \right)$$

$$\Rightarrow \quad (B_{at\ r=.2})(2\pi(.002\ m)) = (4\pi x 10^{-7}\ T \bullet m/A) \left(\frac{99(.002\ m)^2}{(.005\ m)^2} (2\ A) \right)$$

$$\Rightarrow \quad B_{at\ r=.2} = 3.17 x 10^{-3}\ T$$

Problem 30.34

Amperian path



The magnetic force on a current carrying wire at r = .200m will, therefore, be:

$$\left|\vec{F}\right| = i\left|\vec{L}x\vec{B}_{r=.2}\right|$$

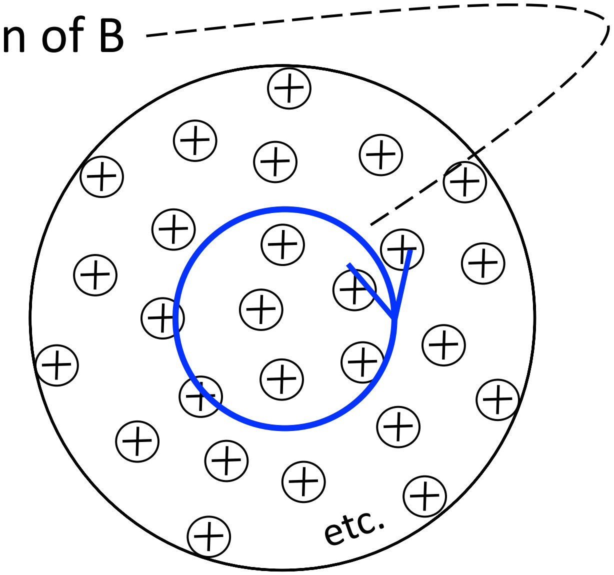
$$= iLB\sin 90^o$$

$$\Rightarrow \frac{\left|\vec{F}\right|}{L} = iB_{\text{at } r=.2}$$

$$= (2.00\text{ A})(3.17x10^{-3}\text{ T})$$

$$= 6.34x10^{-3}\text{ N/m}$$

direction of B



b.) Given the direction of current flow and using the right-thumb rule, the magnetic field direction is found to circle clockwise around the cylinder (see sketch). Using the right-hand rule on $i\vec{L}x\vec{B}$, the direction of the force is found to be *toward the center* of the bundle.

c.) At the edge, the Amperian path would include more wires, which mean the B-fld is bigger at the outer edge, which means the force on a wire at the outer edge would be bigger.