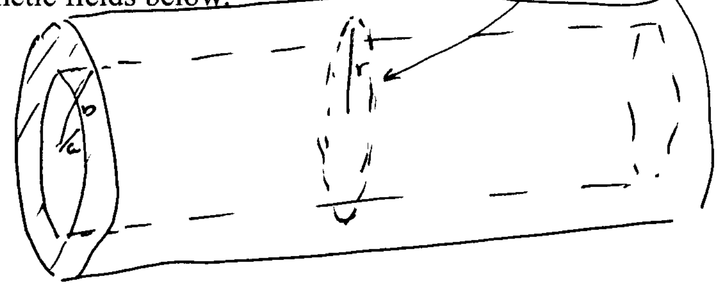
Name____________________________________ SP222 Worksheet (Quiz)

A long cylindrical shell has an inner radius *a* and an outer radius *b* and carries a current *I* parallel to the central axis. Assume that within the material of the shell the current density is uniformly distributed.

Draw and label the cylinder. Draw and label an Amperian loop that will be useful in solving one of the magnetic fields below.



$$J = \frac{I}{\pi b^2 - \pi a^2}$$

Find an expression for the magnitude of the magnetic field for $0 < r < a$.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{ENCL} = 0$$

$$\therefore \boxed{B = 0}$$

Find an expression for the magnitude of the magnetic field for $a < r < b$.

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{ENCL} = B(2\pi r)$$

$$B = \frac{\mu_0 I_{ENCL}}{2\pi r}$$

$$I_{ENCL} = J(\pi r^2 - \pi a^2) = \frac{I(r^2 - a^2)\cancel{\pi}}{(b^2 - a^2)\cancel{\pi}}$$

$$\boxed{B = \frac{\mu_0 I (r^2 - a^2)}{2\pi r (b^2 - a^2)}}$$

Find an expression for the magnitude of the magnetic field for $r > b$.

$$\oint \vec{B} \cdot d\vec{l} = B(2\pi r) = \mu_0 I_{ENCL} = \mu_0 I$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$

Extra Credit: Who was Philo T. Farnsworth?