AMPERE’S LAW

A steady current is flowing parallel to the axis through an infinitely long cylindrical shell of inner radius $a$ and outer radius $b$. Each group is assigned one of the current densities given below: (In each case, $\alpha$ and $k$ are constants with appropriate units.)

(a) $|\vec{J}| = \alpha r^3$.
(b) $|\vec{J}| = \alpha \frac{\sin kr}{r}$.
(c) $|\vec{J}| = \alpha e^{kr^2}$.
(d) $|\vec{J}| = \alpha \frac{e^{kr}}{r}$.

1) For your group’s case, find the total current through a cross-section of the wire perpendicular to the axis.

2) Use Ampere’s Law and symmetry arguments to find the magnetic field at each of the three radii given below:

(a) $r_1 < a$
(b) $a < r_2 < b$
(c) $r_3 > b$

3) For $\alpha = 1$, $k = 1$, sketch the magnitude of the magnetic field as a function of $r$.

4) What units do $\alpha$ and $k$ have?