

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, α 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 α and k have?