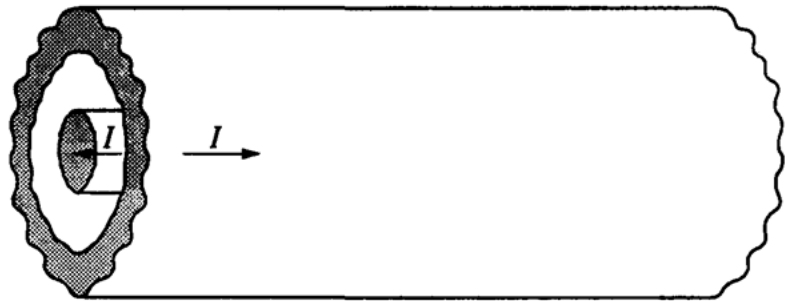


Cross Section



Coaxial Cable

1994E3. A long coaxial cable, a section of which is shown above, consists of a solid cylindrical conductor of radius a , surrounded by a hollow coaxial conductor of inner radius b and outer radius c . The two conductors each carry a uniformly distributed current I , but in opposite directions. The current is to the right in the outer cylinder and to the left in the inner cylinder. Assume $\mu = \mu_0$ for all materials in this problem.

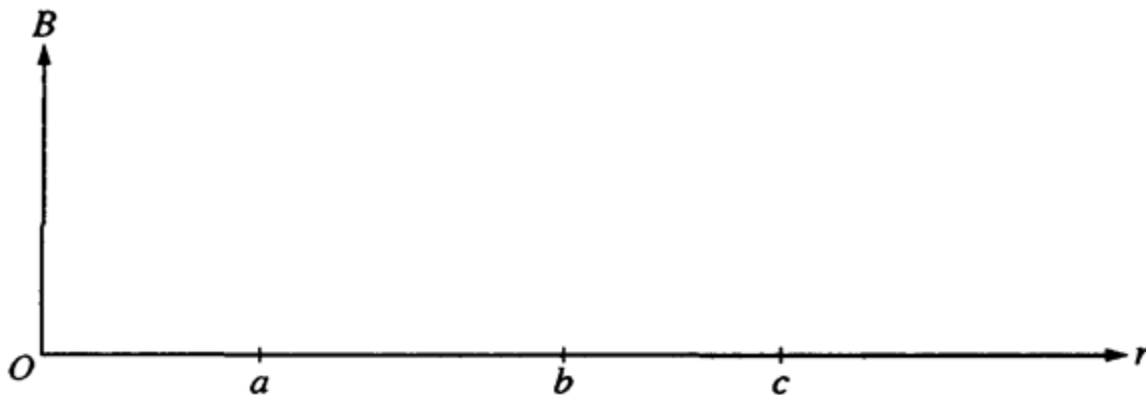
a. Use Ampere's law to determine the magnitude of the magnetic field at a distance r from the axis of the cable in each of the following cases.

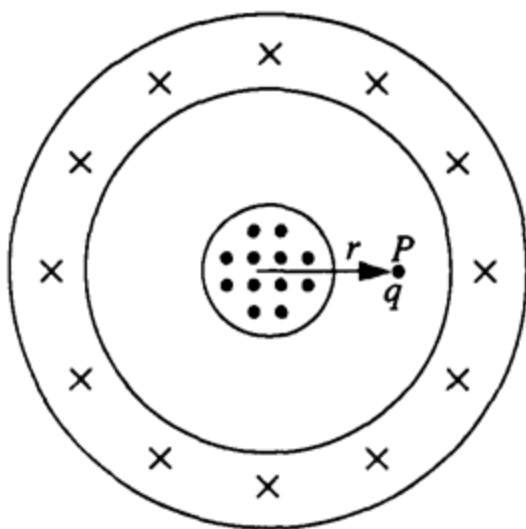
i. $0 < r < a$

ii. $a < r < b$

b. What is the magnitude of the magnetic field at a distance $r = 2c$ from the axis of the cable?

c. On the axes below, sketch the graph of the magnitude of the magnetic field B as a function of r , for all values of r . You should estimate and draw a reasonable graph for the field between b and c rather than attempting to determine an exact expression for the field in this region.





Cross Section

The coaxial cable continues to carry currents I as previously described. In the cross section above, current is directed out of the page toward the reader in the inner cylinder and into the page in the outer cylinder. Point P is located between the inner and outer cylinders, a distance r from the center. A small positive charge q is introduced into the space between the conductors so that when it is at point P its velocity v is directed out of the page, perpendicular to it, and parallel to the axis of the cable.

- d.
 - i. Determine the magnitude of the force on the charge q at point P in terms of the given quantities.
 - ii. Draw an arrow on the diagram at P to indicate the direction of the force.
- e. If the current in the outer cylinder were reversed so that it is directed out of the page, how would your answers to (d) change, if at all?