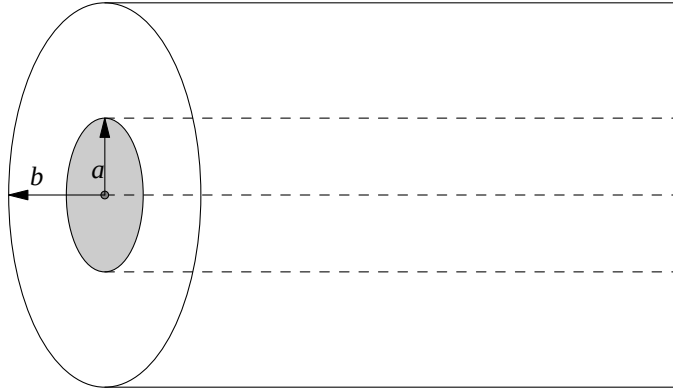
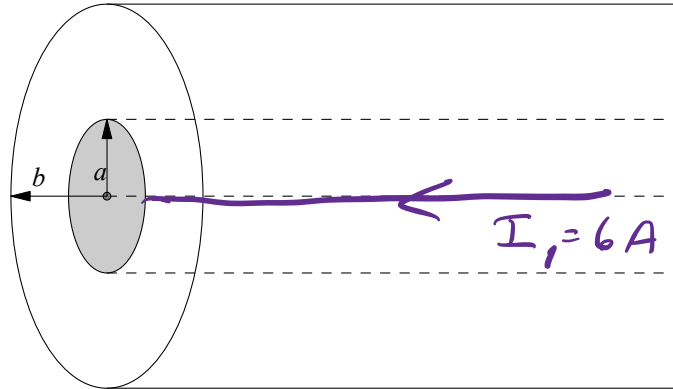


Problem 4: (30 pts.) A coaxial cable is made from a small solid conductor with radius $a = 5.0 \times 10^{-3}$ m inside a thin-walled outer conducting shell with radius $b = 0.20$ m. The inner conductor carries a current of 6.0 A to the left. Assume that the current in the inner conductor is uniformly distributed over the cross section of the conductor.



- a. (15 pts.) Use Ampere's law to find an expression for the magnitude of the magnetic field for a distance of 0.030 m from the center, (*i.e.* in the gap between the inner and outer conductors). Show your work clearly.
- b. (15 pts.) The magnitude of the magnetic field for a distance of 0.40 m from the center is 1.5×10^{-6} T. The direction of the field is the same as that you found in part (a). What is the current in the outer conductor? Give both the magnitude and the direction.

Problem 4: (30 pts.) A coaxial cable is made from a small solid conductor with radius $a = 5.0 \times 10^{-3} \text{ m}$ inside a thin-walled outer conducting shell with radius $b = 0.20 \text{ m}$. The inner conductor carries a current of 6.0 A to the left. Assume that the current in the inner conductor is uniformly distributed over the cross section of the conductor.



- a. (15 pts.) Use Ampere's law to find an expression for the magnitude of the magnetic field for a distance of 0.030 m from the center, (i.e. in the gap between the inner and outer conductors). Show your work clearly.

End view: consider a loop of radius r , where $a < r < b$, $r = 0.03 \text{ m}$.

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{\text{enclosed}}$$

$$B(2\pi r) = \mu_0 I_1$$

$$B = \frac{\mu_0 I_1}{2\pi r} = \frac{(4\pi \times 10^{-7} \text{ Tm/A})(6 \text{ A})}{2\pi (0.03 \text{ m})} = 4.0 \times 10^{-5} \text{ T}$$

- b. (15 pts.) The magnitude of the magnetic field for a distance of 0.40 m from the center is $1.5 \times 10^{-6} \text{ T}$. The direction of the field is the same as that you found in part (a). What is the current in the outer conductor? Give both the magnitude and the direction.

consider a larger loop that included both cylinders: $r = 0.40 \text{ m}$

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{\text{encl}} = \mu_0 (I_1 + I_2)$$

$$(1.5 \times 10^{-6} \text{ T})(2\pi \cdot 0.40 \text{ m}) = 4\pi \times 10^{-7} \text{ Tm/A} (I_1 + I_2)$$

$$3 \text{ A} = I_1 + I_2$$

$$\boxed{-3 \text{ A} = I_2}$$