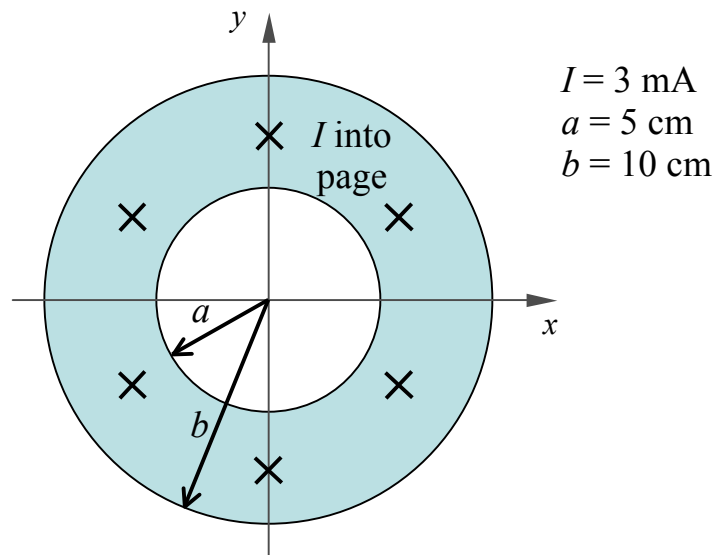


The figure shows a cylindrical metal wire with a hollow bore. The wire's inner radius is a and its outer radius is b . The wire carries a current I distributed uniformly across its cross-sectional area and flowing in the $-z$ direction (into the page).



- 1) Find the magnitude and direction of the magnetic field \mathbf{B} at the point $x=15 \text{ cm}$, $y=0$, $z=0$ [4]

$$\mathbf{B} = (\mu_0 I)/(2\pi X) \text{ down } (-y \text{ direction})$$

$$\mathbf{B} = -4 \times 10^{-9} \text{ T } \hat{y}$$

2 points for correct setup

1 point for correct numerical value

1 point for correct direction

- 2) Find the magnitude and direction of the magnetic field \mathbf{B} at the point $x=0 \text{ cm}$, $y=8 \text{ cm}$, $z=0 \text{ cm}$ [8]

Use ampere's law with $I_{\text{enc}} = I_{\text{wire}} (r^2 - a^2)/(b^2 - a^2)$

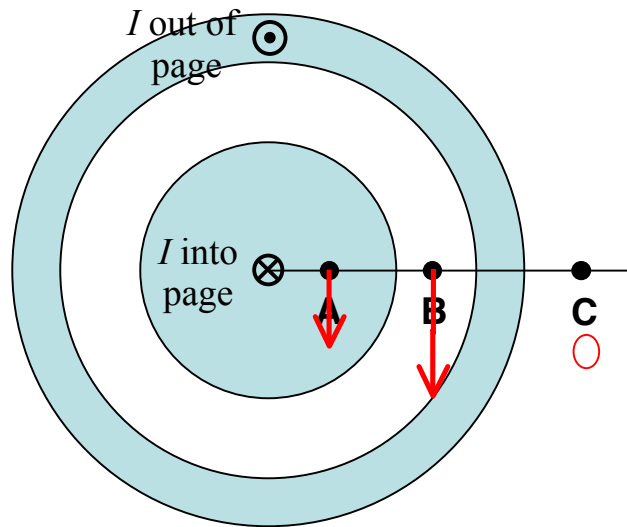
$$\mathbf{B} = +3.9 \times 10^{-9} \text{ T } \hat{x}$$

4 points for correct setup

2 points for correct numerical value

2 points for correct direction

3. A cylindrical wire of infinite length carries a total current I into the page. Surrounding it is a cylindrical conducting shell, carrying an equal current I in the opposite direction (out of the page). On the diagram provided below, draw vectors showing the direction and relative magnitude of the magnetic field at each of the indicated points **A**, **B**, and **C**. (For the magnitude, use *longer vectors* to indicate *larger B fields* ... and if the field is zero, just write “0”.) [4]



1 point for correct direction (down)

1 point for B-field at C = 0

2 points for magnitude of B-fields at A and B satisfying $|B| > |A|$

4) Calculate the magnitude of the magnetic field at the point **B** above using the following values:
[4]

- Current magnitude $I=2.5$ A
- Radius of the inner cylinder = 6 cm
- Radius of the outer shell = 10 cm
- Distance from the center to the point **B** = 8 cm

Use ampere's law with I_{enc} = current on the inner wire only

$$|B| = 6.25 \times 10^{-6} \text{ T}$$

2 points for correct setup

2 point for correct numerical value