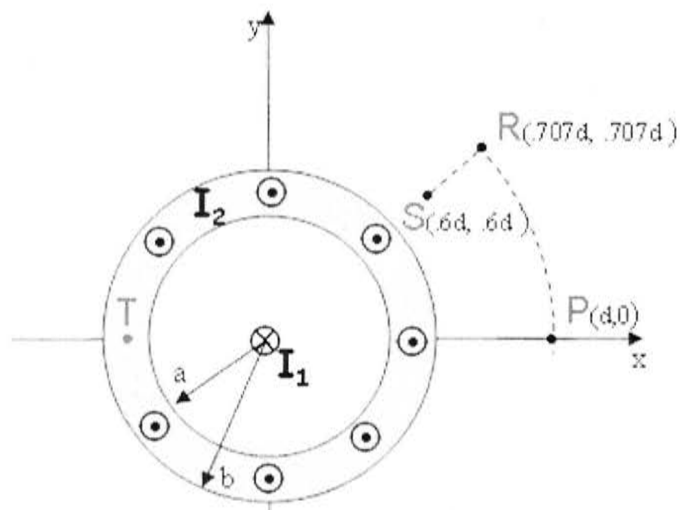
The next six questions pertain to the situation described below.

A solid cylindrical conducting shell of inner radius a = 5.6 cm and outer radius b = 7.1 cm has its axis aligned with the z-axis as shown. It carries a uniformly distributed current I_2 = 5.1 A in the positive z-direction. An inifinte conducting wire is located along the z-axis and carries a current I_1 = 3 A in the negative z-direction.



Right-hand rule shows at P B is only in y-direction, so $B_y = |B|$

1) What is $B_y(P)$, the y-component of the magnetic field at point P, located a distance d = 32 cm from the origin along the x-axis as shown?

1.31×10^{-6} T

Due to symmetry we can draw loop at 32cm

$\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{enc} \rightarrow B(2\pi d) = \mu_0(I_1 + I_2)$

$B = \frac{\mu_0(I_1+I_2)}{2\pi d} = \frac{(-3+5.1\ A)(4\pi\times10^{-7})}{2\pi(.32\ m)}$

2) What is

$$\int_P^S \vec{B}\cdot d\vec{l}$$

$B_p =$

where the integral is taken along the dotted path shown in the figure above: first from point P to point R at (x,y) = (0.707d, 0.707d), and then to point S at (x,y) = (0.6d, 0.6d).

3.30×10^{-7} T-m

section R–S gives 0 since $\vec{B}\cdot d\vec{\ell}$ gives 0

section P-R is $\frac{1}{8}$ of complete loop, so $= \frac{1}{8}\oint_{loop} \vec{B}\cdot d\ell = \frac{1}{8}\mu_0 I$

$= \frac{1}{8}(4\pi\times10^{-7})(I_1+I_2)$

$= 3.30\times10^{-7}$ T-m

3) What is $B_y(T)$, the y-component of the magnetic field at point T, located at (x,y) = (-6 cm,0), as shown?

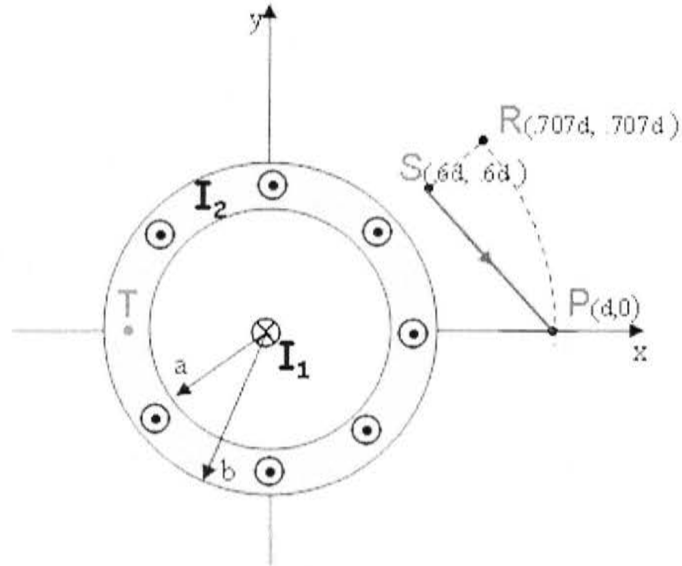
5.86×10^{-6} T

(work on next page)

4) What is

$$\int_S^P \vec{B} \cdot d\vec{l}$$

where the integral is taken on the straight line path from point S to point P as shown?



T-m Since the endpoints are the same as part 2) the integral is the same but negative $= -3.30 \times 10^{-7}$ T.m

5) Suppose the magnitude of the current I_2 is now doubled. How does the magnitude of the magnetic field at (x,y) = (2.8 cm, 0) change?

a. B(2.8 cm, 0) decreases
b. B(2.8 cm, 0) increases
c. B(2.8 cm, 0) remains the same

$\int \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$ points inside radius $a = 5.6$ cm are not affected by I_2, so remains the same

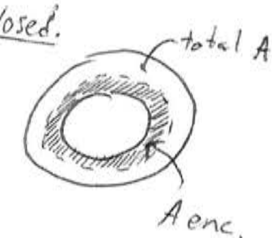
~~6) Below is some space to write notes on this problem.~~

3) $r = 6$cm

$-B(2\pi r) = \mu_0 I_{enc}$ - we need to find how much current is enclosed.

extra (-) from right-hand rule recognizing that positive current $(+\hat{z})$ will give $(-\hat{z})$ $\vec{B}$ at point T

I_2 is uniformly distributed, so $\frac{I_{enc2}}{I_2} = \frac{\text{Area enc}}{\text{Area tot}}$



$$I_{2\,enc} = I_2\left(\frac{\pi(r^2 - a^2)}{\pi(b^2 - a^2)}\right)$$

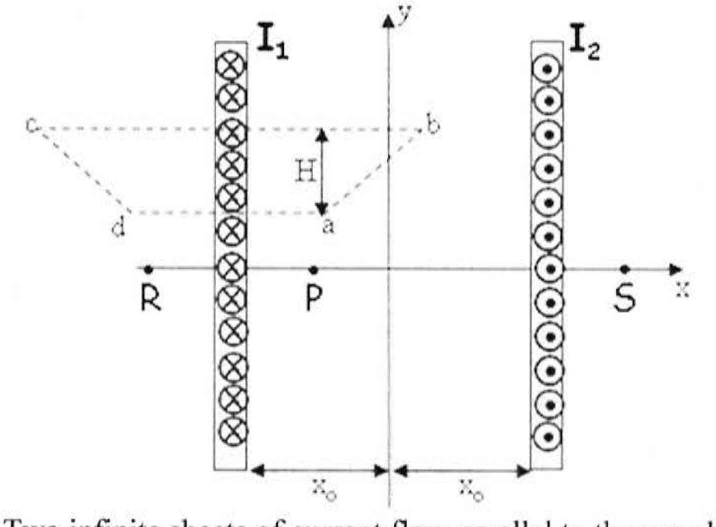
$$= (5.1\ A)\frac{(6^2 - 5.6^2)}{(7.1^2 - 5.6^2)}$$

$$= 1.24\ A$$

$$B_T = \frac{-\mu_0(I_1 + I_{2\,enc})}{2\pi r} = \frac{-\mu_0(-3 + 1.24)}{2\pi(0.06)}$$

$$B_T = +5.86 \times 10^{-6}\ T$$

The next seven questions pertain to the situation described below.



Two infinite sheets of current flow parallel to the y-z plane as shown. The sheets are equally spaced from the origin by $x_o = 4.2$ cm. Each sheet consists of an infinite array of wires with a density n = 18 wires/cm. Each wire in the left sheet carries a current $I_1 = 3$ A in the negative z-direction. Each wire in the right sheet carries a current $I_2 = 4.1$ A in the positive z-direction.

What is $B_x(P)$, the x-component of the magnetic field at point P, located at (x,y) = (-2.1 cm, 0)?

0 T Right-hand rule tells us that ~~the~~ fields from both sheets can only point in + or - y-direction

So $B_x = 0$ ~~on~~ everywhere

What is $B_y(P)$, the y-component of the magnetic field at point P, located at (x,y) = (-2.1 cm, 0)?

$-.00803$ T

for current/wire I
wire density n

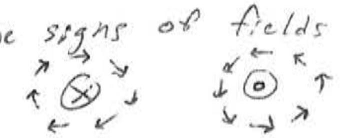
our loop equation for one side is

$B(2L) = \mu_o n L I$ (since no field in x-direction)

$B = \frac{1}{2} n I \mu_o$

use right-hand rule to determine signs of fields from both sides.

At P: $B_1 = \downarrow$ $B_2 = \downarrow$



$B_1 = \frac{1}{2}\mu_o n_1 I_1$

$B_2 = \frac{1}{2}\mu_o n_2 I_2$

$n_1 = n_2 = 1800$ wires/m

$B_p = -\frac{1}{2}\mu_o(n_1 I_1 + n_2 I_2) = -\frac{1}{2}(4\pi\times10^{-7})(1800)(3+4.1)$

$B_p = -.00803$ T

What is $B_y(R)$, the y-component of the magnetic field at point R, located at (x,y) = (-6.3 cm, 0)?

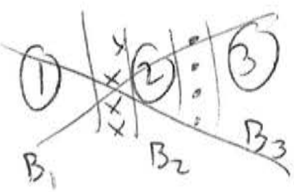
$\boxed{-.00124}$ T At R: $B_1 = \uparrow$ $B_2 = \downarrow$

$$B_r = \frac{1}{2}\mu_0 n(I_1 - I_2) = \frac{1}{2}(4\pi\times10^{-7})(1800)(3-4.1)$$

$$B_r = -.00124\ T$$

What is $\oint \vec{B} \cdot d\vec{l}$ where the integral is taken around the dotted path shown, from *a* to *b* to *c* to *d* to *a*. The path is a trapazoid with sides *ab* and *cd* having length 9.8 cm, side *ad* having length 4.7 cm, and side *bc* having length 8.5 cm. The height of the trapezoid is H = 9.6 cm.

$\boxed{-6.51\times10^{-4}}$ T-m ~~$\vec{B}\cdot d\vec{l}$ dot product means only distance in same direction as $\vec{B}$ matters so $\oint \vec{B}\cdot d\vec{l} = B$~~



The loop is closed so $\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{enc.}$

$$I_{enc} = n h I_1 = (1800)(.096)(3) = 518\ A$$

$$\oint B \cdot dl = \mu_0 I_{en} = (4\pi\times10^{-7})(518)$$

$$= -6.51\times10^{-4}\ T\cdot m$$ ← negative from right-hand rule ($\vec{B}\cdot d\vec{l}$ is negative)

What is $B_y(S)$, the y-component of the magnetic field at point S, located at (x,y) = (6.3 cm, 0)?

$\boxed{.00124}$ T At S: $B_1 = \downarrow$ $B_2 = \uparrow$

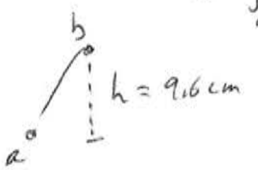
so $$B_s = \frac{1}{2}\mu_0 n(I_2 - I_1) = \frac{1}{2}(4\pi\times10^{-7})(1800)(4.1-3)$$

$$B_s = .00124\ T$$

What is $\int_{ab} \vec{B} \cdot d\vec{l}$ where the integral is taken along the dotted line shown, from a to b.

$\boxed{-7.71\times10^{-4}}$ T-m $\vec{B}\cdot d\vec{l}$ dot product means only distance along direction of field matters (easier to think of than apply vectors)

so $$\int_{ab} \vec{B}\cdot d\vec{l} = Bh$$



B is same as point P since distance from wires does not matter

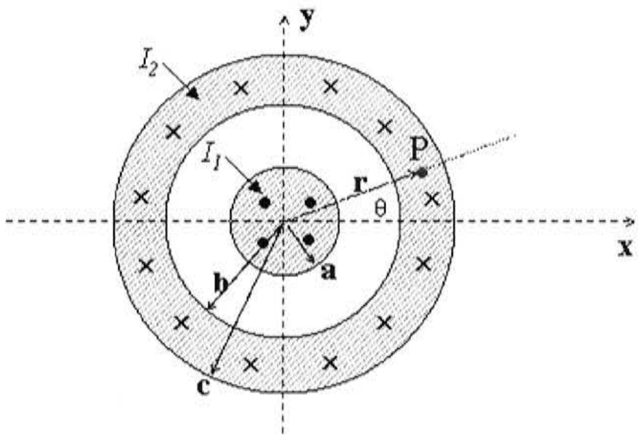
$$\int_{ab} B\cdot dl = (-.00803\ T)(.096\ m) = -7.71\times10^{-4}\ T\cdot m$$

B Cylinders

B CYLINDERS BASE

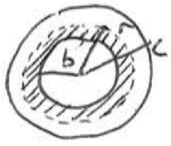
Welcome to this IE. You may navigate to any page you've seen already using the IE tab on the right.

Coaxial Cylindrical Conductors



Two very long coaxial cylindrical conductors are shown in cross-section above. The inner cylinder has radius a = 2 cm and caries a total current of I_1 = 1.2 A in the positive z-direction (pointing out of the screen). The outer cylinder has an inner radius b = 4 cm, outer radius c = 6 cm and carries a current of I_2 = 2.4 A in the negative z-direction (pointing into the screen). You may assume that the current is uniformly distributed over the cross-sectional area of the conductors. What is B_x, the x-component of the magnetic field at point P which is located at a distance r = 5 cm from the origin and makes an angle of 30° with the x-axis? B_x =

-2.4×10^{-7} T Submit Graph



Find I_2 enclosed by area radius

$$\frac{I_{2enc}}{I_2} = \frac{A_{enc}}{A} = \frac{\pi(r^2-b^2)}{\pi(c^2-b^2)}$$

$$I_{2enc} = I_2 \frac{r^2-b^2}{c^2-b^2}$$

Ampere's Law $\int \vec{B}\cdot d\vec{l} = \mu_o I_{enc}$

$$\int \vec{B}\cdot d\vec{l} = \mu_o I_{enc}$$

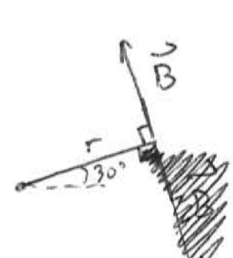
$$B(2\pi r) = \mu_o(I_1 - I_{2enc})$$

$$= \mu_o\left(I_1 - I_2 \frac{r^2-b^2}{c^2-b^2}\right)$$

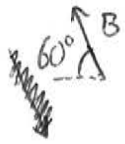
$$|B| = \frac{\mu_o}{2\pi r}\left(I_1 - I_2\frac{r^2-b^2}{c^2-b^2}\right)$$

$|B| = 4.8\times10^{-7}$ T

Now we have magnitude of B - by right hand rule this points



so



$$B_x = -|B|\cos 60^\circ$$

$$= -4.8\times10^{-7}\cos 60^\circ$$

$$\boxed{B_x = -2.4\times10^{-7}\ T}$$