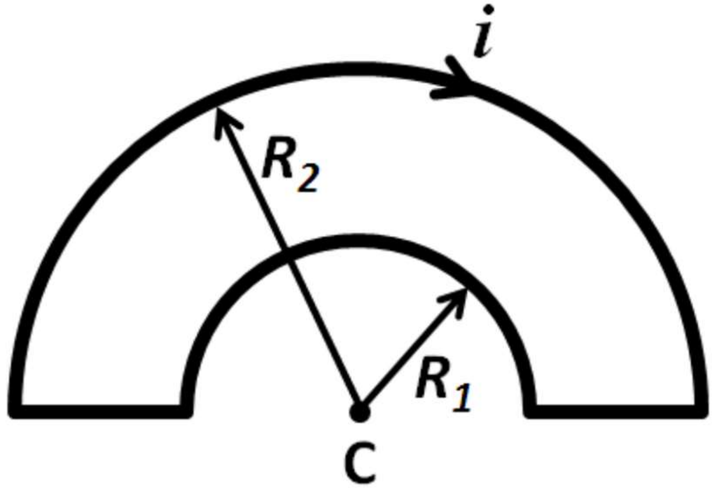
Q1 F-112-26

A current is set up in a wire loop that is formed as shown in the figure, where R_1 = 2.0 cm and R_2 = 4.0 cm. The loop carries a current of 5.0 A, as shown in the figure. What is the magnetic field at the center of the loop (C)?



A) 3.9×10^{-5} T out of the page
B) 3.9×10^{-5} T into the page
C) 1.2×10^{-4} T out of the page
D) 1.2×10^{-4} T into the page
E) 7.9×10^{-5} T into of the page

$$\vec{B} = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 + \vec{B}_4$$

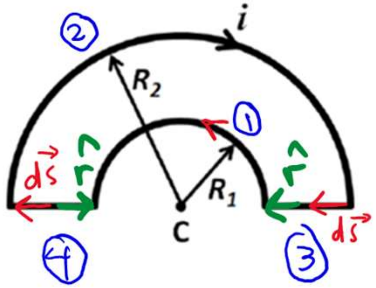
$B_3 = B_4 = 0$ because $d\vec{s} \times \hat{r} = 0$

$$B_1 = \frac{\mu_0 i \phi}{4\pi R_1} = \frac{\mu_0 i \pi}{4\pi R_1}$$ into the page

$$B_2 = \frac{\mu_0 i \pi}{4\pi R_2}$$ out of the page

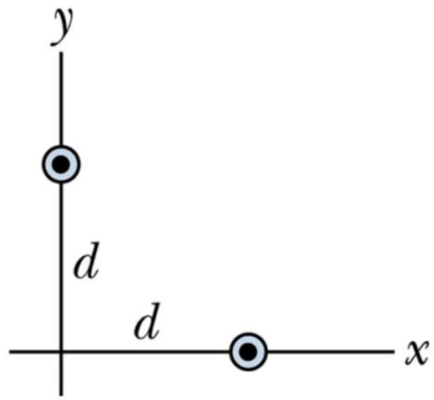
$$B = \frac{\mu_0 i}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$ out of the page

$$B = \frac{(4\pi \times 10^{-7})5}{4}\left(\frac{1}{0.02} - \frac{1}{0.04}\right) = 3.9 \times 10^{-5}\text{ T}$$ out of the page



Q2 F-112-27

Two long wires are placed in the xy plane, as shown in the figure. Each wire carries a current of 1.5 A, directed out of the page. If the distance d = 3.0 m, what is the net magnetic field due to these wires at the origin?

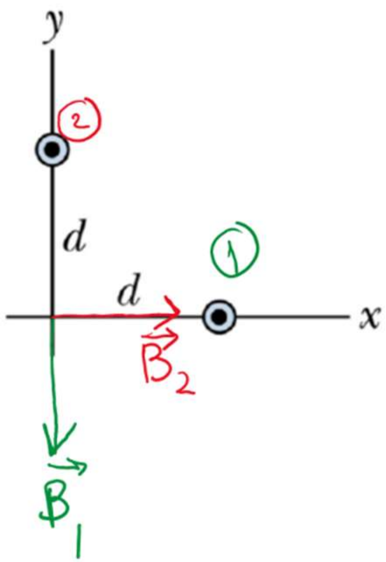


A) $(+0.10\ \mu T)\hat{\imath} + (-0.10\ \mu T)\hat{\jmath}$
B) $(+0.10\ \mu T)\hat{\imath} + (+0.10\ \mu T)\hat{\jmath}$
C) $(-0.10\ \mu T)\hat{\imath} + (-0.10\ \mu T)\hat{\jmath}$
D) $(-0.10\ \mu T)\hat{\imath} + (+0.10\ \mu T)\hat{\jmath}$
E) zero

$$B_1 = \frac{\mu_0 i}{2\pi R} = \frac{4\pi\times10^{-7}}{2\pi(3)} 1.5 = 0.1\,\mu T$$

$$B_2 = \frac{\mu_0 i}{2\pi R} = 0.1\,\mu T$$

$$\vec{B} = \vec{B}_1 + \vec{B}_2 = (0.1\hat{\imath} - 0.1\hat{\jmath})\,\mu T$$



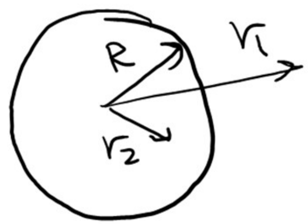
Q3 F-122-24

A long, straight, cylindrical conductor of radius R = 12.0 mm carries a current I uniformly distributed over its cross section. If the magnitude of the magnetic field produced at a distance r = 24.0 mm is 0.100 mT, then what is the magnitude of the magnetic field at a distance r = 6.00 mm?

A) 0.100 mT
B) 0.050 mT
C) 0.400 mT
D) 0.200 mT
E) 0.440 mT

$$B_{out} = \frac{\mu_0 i}{2\pi r}$$

$$B_{in} = \frac{\mu_0 i}{2\pi R^2} r$$



at $r_1 = 24$ mm $> R = 12$ mm

$$B = 0.1 \text{ mT} = \frac{\mu_0 i}{2\pi r_1} \Rightarrow \frac{\mu_0 i}{2\pi} = 0.1 \times 10^{-3} r_1$$

at $r_2 = 6$ mm $< R = 12$ mm

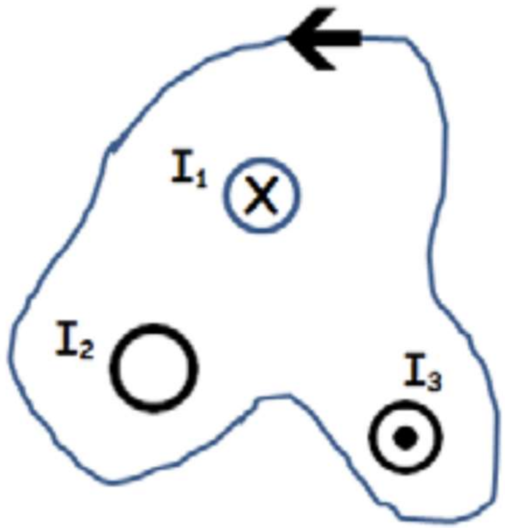
$$B = \frac{\mu_0 i}{2\pi R^2} r_2 = \frac{0.1 \times 10^{-3} r_1}{R^2} r_2 = 0.1 \times 10^{-3} \frac{(24)(6)}{(12)^2}$$

$$= 0.1 \times 10^{-3} \text{ T} = 0.1 \text{ mT}$$

Q4 F2-132-14

The figure shows cross sectional areas of three conductors that carry current through the plane of the figure. The currents have the magnitude I_1=6.0 A and I_3=2.0 A and directions as shown. If the value of the line integral $\oint \vec{B} \cdot d\vec{s}$ is +3.8 ×10^{-6} T·m, what is magnitude and direction of current I_2. The integral involves going around the path in the counterclockwise direction, as shown in the figure.

A) 7.0 A out of the page
B) 6.0 A into the page
C) 5.0 A out of the page
D) 8.0 A into the page
E) 9.0 A out of the page

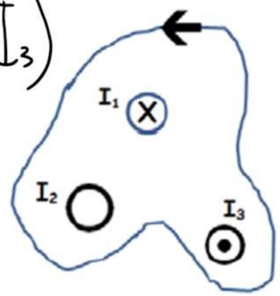


$$\oint \vec{B}\cdot d\vec{s} = \mu_0 i_{enc} = \mu_0(-I_1+I_2+I_3)$$

$$3.8\times10^{-6} = 4\pi\times10^{-7}(-6+I_2+2)$$

$$\frac{38}{4\pi} = I_2 - 4$$

$I_2 \approx +7A \Rightarrow$ out of page



Q5 F-132-15

A 1.0 m long solenoid is 10.0 cm in diameter and carries 51.9 A current to produce 0.15 Tesla magnetic field inside the solenoid (Assume solenoid to be ideal). Determine the number of turns in the solenoid.

A) 2.30×10^3
B) 3.73×10^3
C) 1.81×10^2
D) 5.33×10^6
E) 1.01×10^2

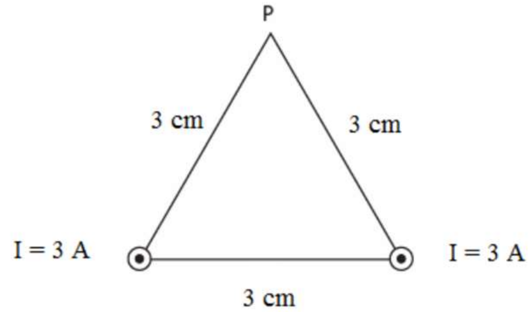
$$B = n\mu_0 i = \frac{N}{\ell}\mu_0 i$$

$$N = \frac{B\ell}{\mu_0 i} = \frac{(0.15)(1)}{4\pi\times10^{-7}(51.9)} = 2.30\times10^{3} \text{ turns}$$

Q6 F-142-24

Two long straight wires penetrate, normally, the plane of the paper at two vertices of an equilateral triangle as shown in the figure. They each carry 3.0 A, out of the page. The magnetic field at the third vertex (P) has magnitude (in T):

A) 3.5×10^{-5}
B) 2.0×10^{-4}
C) 0
D) 3.5×10^{-7}
E) 8.7×10^{-6}



$\vec{B} = \vec{B}_1 + \vec{B}_2$

$B_1 = B_2 = \frac{\mu_0 i}{2\pi R}$

$B = 2B_1 \cos 30$

$B = 2\frac{(4\pi \times 10^{-7})(3)}{2\pi(0.03)} \cos 60^\circ$

$B = 3.5 \times 10^{-5}$ T