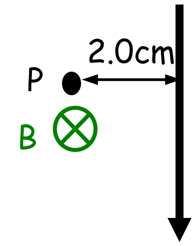
Magnetic Fields and Forces with current carrying wires
Physics 104

1. A wire carrying a current of 1.5 A is pointing straight downward as shown on the right.

   a) Calculate the magnitude of the magnetic field due to the wire at a point, P, 2.0 cm to the left of the wire as shown.

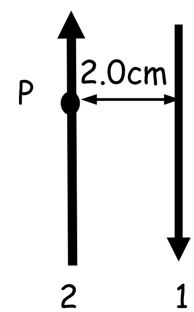


$$B=\frac{\mu_o I}{2\pi r}=\frac{(4\pi x10^{-7}Tm/A)(1.5A)}{2\pi(0.02m)}=1.5x10^{-5}T$$

   b) What is the direction of the magnetic field vector at point P? Show this on the diagram.

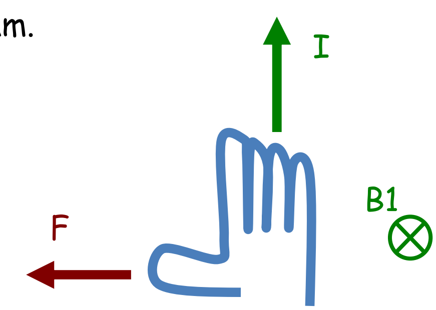
Into the page

   c) If another wire with a length of 0.75 m and a current of 3.0 A is placed through point, P, pointing straight upward, what is the magnitude of the force it experiences due to wire 1?



$$\begin{aligned} F &= ILB\sin\theta \\ &= ILB\sin 90 \\ &= ILB \\ &= (3.0A)(0.75m)(1.5x10^{-5}T) \\ &= 3.38x10^{-5}N \end{aligned}$$

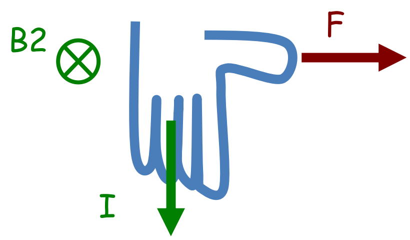
   d) What is the direction of the magnetic force on wire 2? Show this on the diagram.

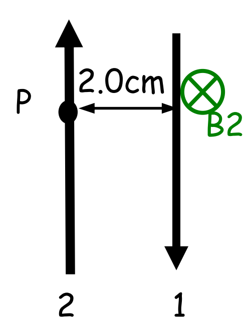


To the left

   e) Does wire 2 exert a force on wire 1? If so, what is the direction?

Yes, because wire 2 creates a B field that can exert a force on wire 1





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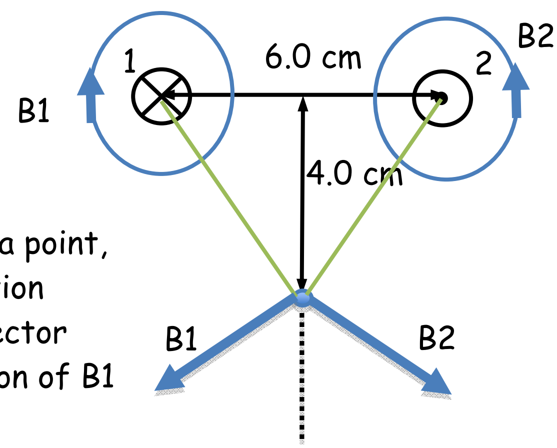
2. Two wires are carrying a current of 3.3A are separated by a distance of 6.0 cm. Wire 1 on the left is pointing into the page, and wire 2 on the right is pointing out of the page . A point, P, is 4.0 cm below the center of the two wires.

a) Sketch in a circle around each wire with an arrow showing the direction of B.



b) You know that the Magnetic field vector at a point, P, is perpendicular to r and points in the direction given by the loop you drew in A. Sketch in a vector originating at point P that points in the direction of B1 and another in the direction of B2.

c) Find the magnitude of the magnetic force due to wire 1 at point, P.

$$r = \sqrt{(3.0cm)^2 + (4.0cm)^2} = 5.0cm$$

$$B1 = \frac{\mu_o I}{2\pi r} = \frac{(4\pi x10^{-7} Tm/A)(3.3A)}{2\pi(0.05m)} = 1.32x10^{-5} T$$

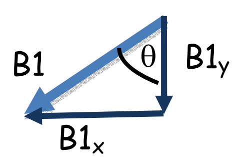
d) Find the magnitude of the magnetic force due to wire 2 at point, P.

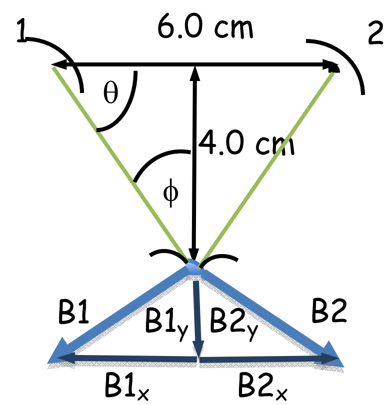
$$B2 = B1 = \frac{\mu_o I}{2\pi r} = \frac{(4\pi x10^{-7} Tm/A)(3.3A)}{2\pi(0.05m)} = 1.32x10^{-5} T$$

f) Find the angle that B1 is pointing using the geometry of the wires and point P.

$$\theta = \tan^{-1}\left(\frac{4.0}{3.0}\right) = 53.1^\circ$$

$$\phi = 90 - 53.1 = 36.9$$





g) Find the x and y components of B1 and B2.

$$B1_x = B1\cos\phi = 1.32x10^{-5} T\cos 36.9$$

$$= 1.05x10^{-5} T \text{ to the left and } B2_x \text{ is to the right}$$

$$B1_y = B1\sin\phi = 1.32x10^{-5} T\sin 36.9$$

$$= 7.9x10^{-6} T \text{ down} = B2_y$$

h) Find the magnitude and direction of the B-field at point, P, due to wire 1 and 2.

The x-components cancel each other so B_x=0

And the y-components add so $B_y = 2B1_y = 1.58x10^{-6}$ T