15-Phys-202

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Quiz 6

Name _____

Useful formulae and constants:

$$d\overrightarrow{B} = \frac{\mu_0}{4\pi}\frac{i\overrightarrow{ds}\times\overrightarrow{r}}{r^3} \text{ (Biot-Savart law)}$$

$$B = \frac{\mu_0 i}{2\pi R} \text{ (long straight wire)}$$

$$\mu_0 = 4\pi\times 10^{-7}\ \mathrm{T}\cdot\mathrm{m/A}$$

1. Two long parallel wires lie in an xy plane. One wire lies along the line $y = 10.0$ cm and carries a current of 6.00 A in the *positive* x direction. The other wire lies along the line $y = 5.00$ cm and carries a current of 10.0 A in the *negative* x direction. What is the resulting magnetic field $\overrightarrow{B}$ at the origin?

   Solution

   Denoting the wire that is farther away from the origin as "1", and the wire that is closer to the origin as "2", we find the magnetic field at the origin as follows:

$$\overrightarrow{B} = \overrightarrow{B}_1 + \overrightarrow{B}_2 = -\frac{\mu_0 i_1}{2\pi y_1}\hat{\mathbf{k}} + \frac{\mu_0 i_2}{2\pi y_2}\hat{\mathbf{k}} = \frac{\mu_0}{2\pi}\left(\frac{i_2}{y_2} - \frac{i_1}{y_1}\right)\hat{\mathbf{k}}$$

   where

$$\begin{aligned} i_1 &= 6.00\text{ A},\ y_1 = 10.0\times 10^{-2}\text{ m} \\ i_2 &= 10.0\text{ A},\ y_2 = 5.00\times 10^{-2}\text{ m} \end{aligned}$$

   Consequently,

$$\overrightarrow{B} = \frac{4\pi\times 10^{-7}}{2\pi\times 10^{-2}}\left(\frac{10.0}{5.00} - \frac{6.00}{10.0}\right)\hat{\mathbf{k}} = 28.0\times 10^{-6}\hat{\mathbf{k}}\ \mathrm{T} = 28.0\hat{\mathbf{k}}\ \mu\mathrm{T}$$