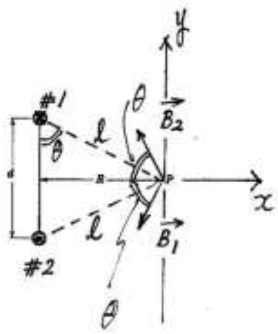
Two long wires are at a distance 'd' apart carries equal and antiparallel current 'i'. Calculate the magnetic field induction at point 'p' through distance 'R' ?

Solution



$|\overrightarrow{B_1}| = |\overrightarrow{B_2}| = \frac{\mu_0 i}{2\pi}\frac{I}{l}, where\ l = \sqrt{\left(\frac{d}{2}\right)^2 + R^2}.$

If the coordinates x and y are defined as show in figure,

$|B_{1y}| = |B_{2y}|$

$|B_x| = |B_{2x}|$

from symmetric configuration

Therefore $\begin{cases} B_y = 0 \\ B_x = -|\overrightarrow{B_1}|cos\theta - |\overrightarrow{B_2}|cos\theta = -2|\overrightarrow{B_1}|cos\theta, \dots \end{cases}$

Where $\vec{B} = \overrightarrow{B_1} + \overrightarrow{B_2}, cos\theta = \frac{d}{2l}.$

$$|\vec{B}| = |B_x| = 2x\left(\frac{\mu_0 i}{2\pi}\frac{I}{l}\right) * \frac{d}{2l} = \frac{\mu_0 i}{2\pi}\frac{d}{l^2} = \frac{\mu_0 i}{2\pi}\frac{d}{\left(\frac{d}{2}\right)^2 + R^2} = \frac{\mu_0 i}{2\pi}\frac{4d}{d^2 + 4R^2} = \frac{2\mu_0 i d}{\pi(4R^2 + d^2)}.$$