

Magnetic Field Generated by Current in Straight Wire (3)



Consider the magnetic field $\vec{B}$ in the limit $R \rightarrow 0$.

- $B = \frac{\mu_0}{4\pi} \frac{I}{R} (\sin \theta_2 - \sin \theta_1)$
- $\sin \theta_1 = \frac{a}{\sqrt{a^2 + R^2}} = \frac{1}{\sqrt{1 + \frac{R^2}{a^2}}} \simeq 1 - \frac{1}{2} \frac{R^2}{a^2}$
- $\sin \theta_2 = \frac{2a}{\sqrt{4a^2 + R^2}} = \frac{1}{\sqrt{1 + \frac{R^2}{4a^2}}} \simeq 1 - \frac{1}{2} \frac{R^2}{4a^2}$
- $B \simeq \frac{\mu_0}{4\pi} \frac{I}{R} \left(1 - \frac{1}{2} \frac{R^2}{4a^2} - 1 + \frac{1}{2} \frac{R^2}{a^2} \right)$
 $= \frac{\mu_0 I}{4\pi} \frac{3R}{8a^2} \xrightarrow{R \rightarrow 0} 0$

