Magnetic Field on the axis of a Circular Current Loop

\[ dB = \frac{\mu_0 i \cdot dl \cdot \sin \theta}{\pi \frac{R^2}{\theta}} \]

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\[ B = \int dB \cdot \sin \theta = \int \frac{\mu_0 i dl \cdot \sin \theta}{\pi \frac{R^2}{\theta}} \text{ for a loop ring} \]

\[ B = \int \frac{\mu_0 i dl \cdot R}{\pi \frac{R^2}{\theta}} - \int \frac{\mu_0 i R}{\pi \frac{R^2}{\theta}} dl \]

\[ B = \frac{\mu_0 i R x 2\pi R}{\pi \frac{R^2}{\theta}} = \frac{\mu_0 i R^2}{2 \left(R^2 + x^2\right)^{3/2}} \]

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important to note that the direction of flux is same on both sides of loop.

\[ B = \frac{\mu_0 i R^2}{2(R^2 + x^2)^{3/2}} \quad \text{as} \ x \to \infty \]
\[ B \to 0 \]
B at centre of circular current loop

for centre \( x = 0 \)

\[
B = \frac{\mu_0 i R^2}{2 (R^2 + x^2)^{3/2}} = \frac{\mu_0 i}{2 R}
\]

Q1) Find the value of \( x \) for which \( B \) is maximum

At centre \( B \) is maximum \( B_{\text{max}} = \frac{\mu_0 i}{2 R} \)

Q2) What happens if there are \( n \) turns in ring

Ans:

\( n \) turns means \( n \) equivalent circular rings

\[
B = \frac{\mu_0 i R^2}{2 (R^2 + x^2)^{3/2}} \times N
\]

physicswallah