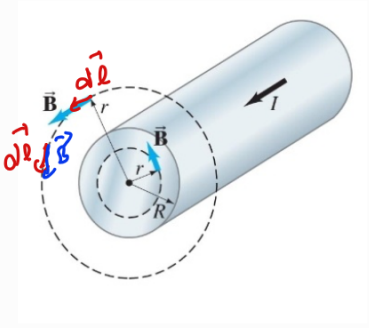
Chapter 28 : Ampere's Law

Example 28.6



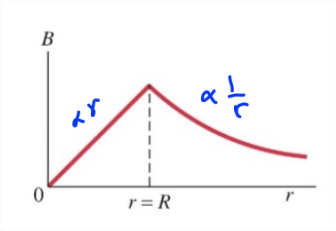
a) $B(r) = ?$ when $r > R$. $\quad \oint \vec{B}\cdot d\vec{l} = \mu_0 I_{enc}$

Since $\vec{B} \parallel d\vec{l}$, we have $\oint B\,dl = B\oint dl = \mu_0 I$

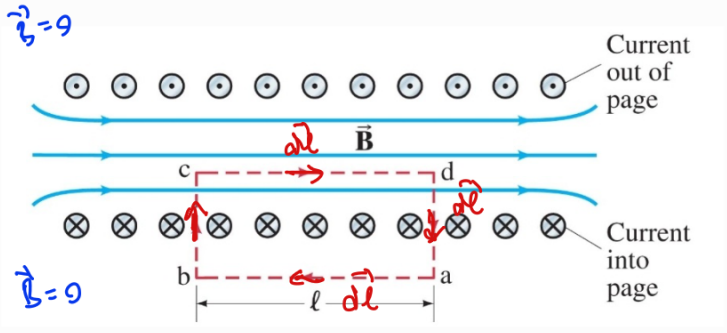
$B\,2\pi r = \mu_0 I \Rightarrow B(r) = \mu_0 I / 2\pi r$

b) $B(r) = ?$ when $r < R$. $\quad I_{enc} = I \dfrac{\pi r^2}{\pi R^2}$

$\oint \vec{B}\cdot d\vec{l} = B\,2\pi r = \mu_0 I_{enc} = \mu_0 I \dfrac{r^2}{R^2} \Rightarrow B(r) = \dfrac{\mu_0 I r}{2\pi R^2}$



Magnetic Field inside solenoid :



$\oint \vec{B}\cdot d\vec{l} = B\int_c^d dl = B\,\ell = \mu_0 I_{enc} = \mu_0 N I$

$B = \mu_0 I (N/\ell) = \mu_0 I n$ ($n = N/\ell$)

$\oint \vec{B}\cdot d\vec{l} = \int_a^b \vec{B}\cdot d\vec{l} + \int_b^c \vec{B}\cdot d\vec{l} + \int_c^d \vec{B}\cdot d\vec{l} + \int_d^a \vec{B}\cdot d\vec{l}$

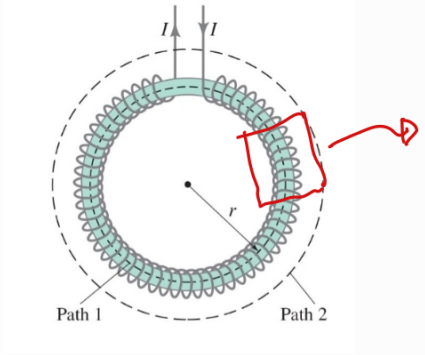
($B = 0$) ($\vec{B} \perp d\vec{l}$) ($\vec{B} \perp d\vec{l}$)

$\int_c^d \vec{B}\cdot d\vec{l} = B\int_c^d dl$

Example 28.9

$B = \mu_0 I n \Rightarrow B = (4\pi \times 10^{-7}\ T\,m/A)(400/0.1\ m)(2.0\ A) = 1.0 \times 10^{-2}\ T$

Magnetic Field due to a Toroid :



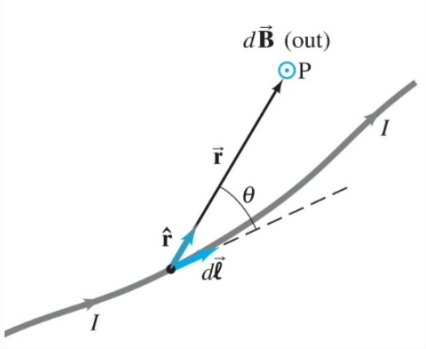
* $B(r)$ inside the toroid :

$B\oint dl = \mu_0 I N$ → number of turns

$B\,2\pi r = \mu_0 N I \Rightarrow B(r) = \dfrac{\mu_0 N I}{2\pi r}$

* B outside : 0

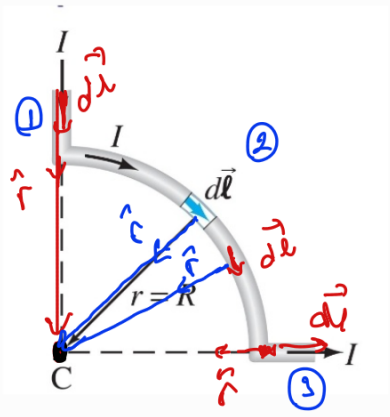
Biot - Savart Law



$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d\vec{\ell} \times \hat{r}}{r^2}$$

$$\vec{B} = \int d\vec{B}$$

Example 28.13



consider segment ①: $d\vec{\ell} \parallel \hat{r} \Rightarrow d\vec{B} = 0$

consider segment ③: $d\vec{\ell} \times \hat{r} = 0 \Rightarrow d\vec{B} = 0$

consider segment ②: $d\vec{\ell} \perp \hat{r} \Rightarrow d\vec{\ell} \times \hat{r} = d\ell$

$$dB = \frac{\mu_0 I}{4\pi} \frac{d\ell}{R^2} \Rightarrow B = \int dB = \frac{\mu_0 I}{4\pi R^2} \int d\ell \quad \frac{2\pi R}{4}$$

$$B = \frac{\mu_0 I}{8R}$$