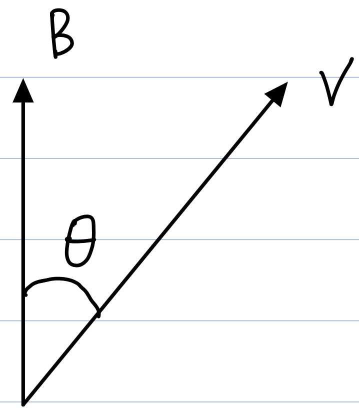
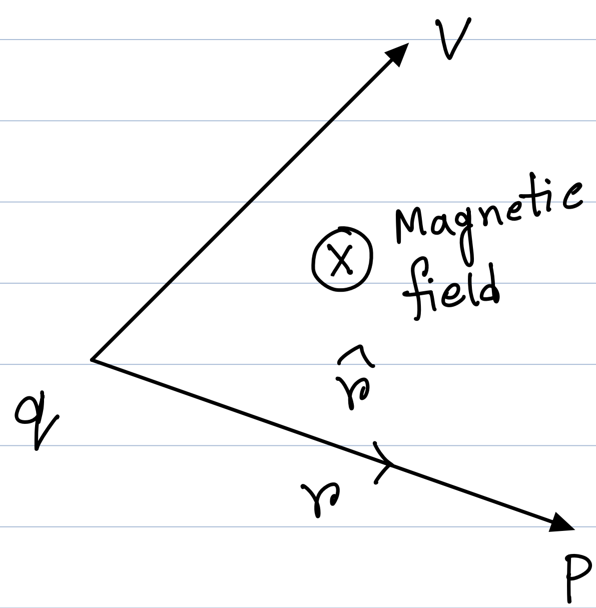
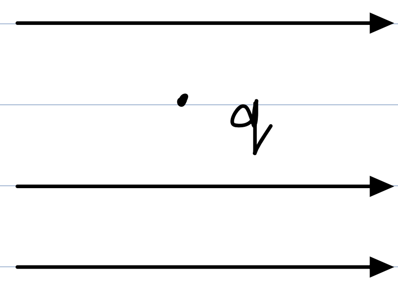
Magnetic Field Creation

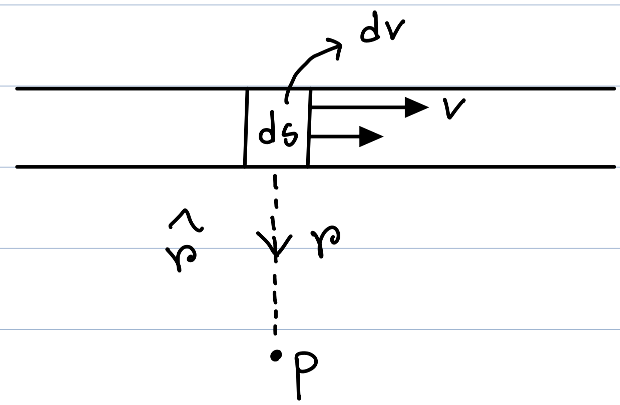






$$\vec{F} = q\vec{E}$$

$$\boxed{\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{V} \times \hat{r}}{r^2}}$$



$\dot{P}$ F

$$\vec{V} = \frac{d\vec{s}}{dt}$$

$$d\vec{B} = \frac{\mu_0}{4\pi} \times \frac{dq\,\vec{V} \times \hat{r}}{r^2}$$

$$= \frac{\mu_0}{4\pi} \times \frac{dq\,\frac{d\vec{s}}{dt} \times \hat{r}}{r^2}$$

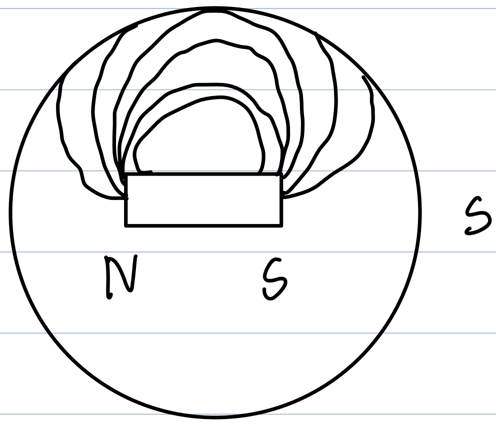
$$= \frac{\mu_0}{4\pi} \times \frac{\frac{dq}{dt}\,d\vec{s} \times \hat{r}}{r^2}$$

$$= \frac{\mu_0}{4\pi} \times \frac{i\,d\vec{s} \times \hat{r}}{r^2}$$

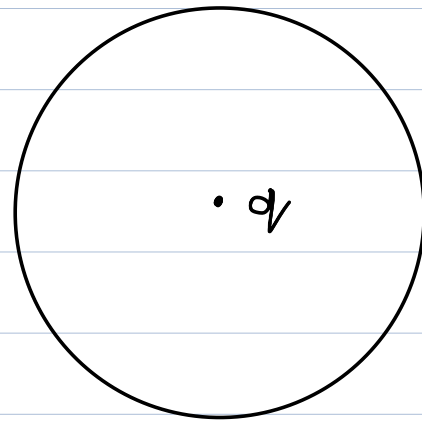
$$\Rightarrow B = \int \frac{\mu_0}{4\pi} \times \frac{i\,d\vec{s} \times \hat{r}}{r^2}$$

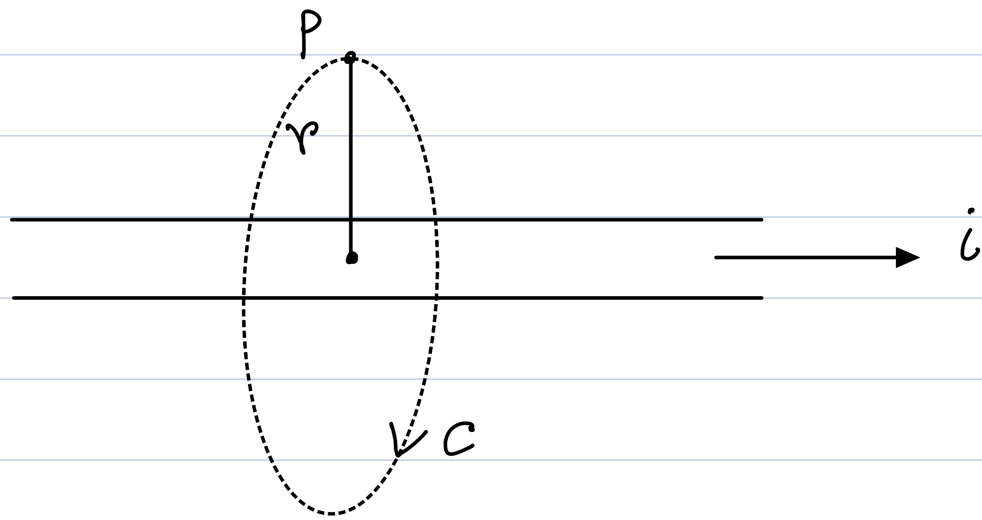
Biot Savert Law

$\varphi_B = 0$

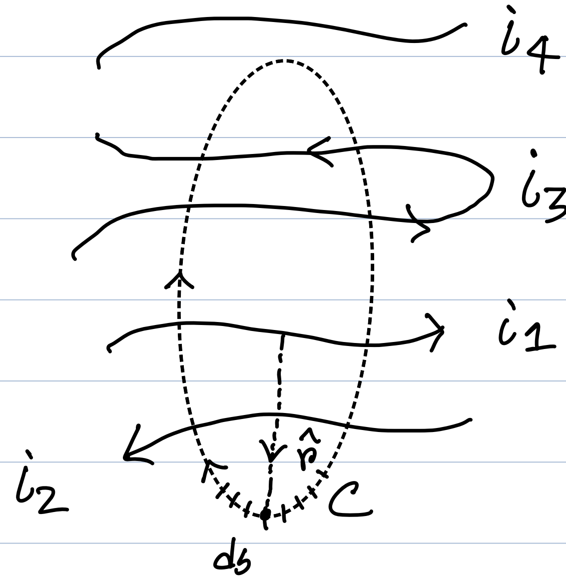


$\varphi_E = \frac{q}{\epsilon_0}$



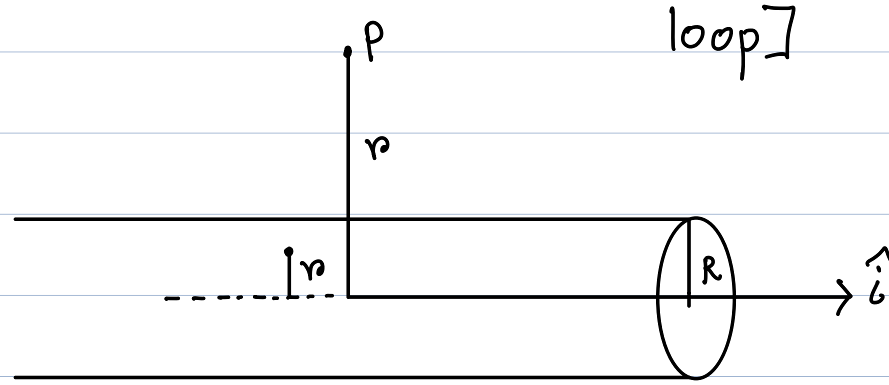


$$\int \vec{B} \cdot d\vec{s} = \mu_0 \cdot i_{enclosed}$$



$$\oint_C \vec{B}\cdot d\vec{s} = \mu_0(i_1 - i_2 + i_3 - i_3)$$
$$= \mu_0(i_1 - i_2)$$

[i_4 outside the loop]

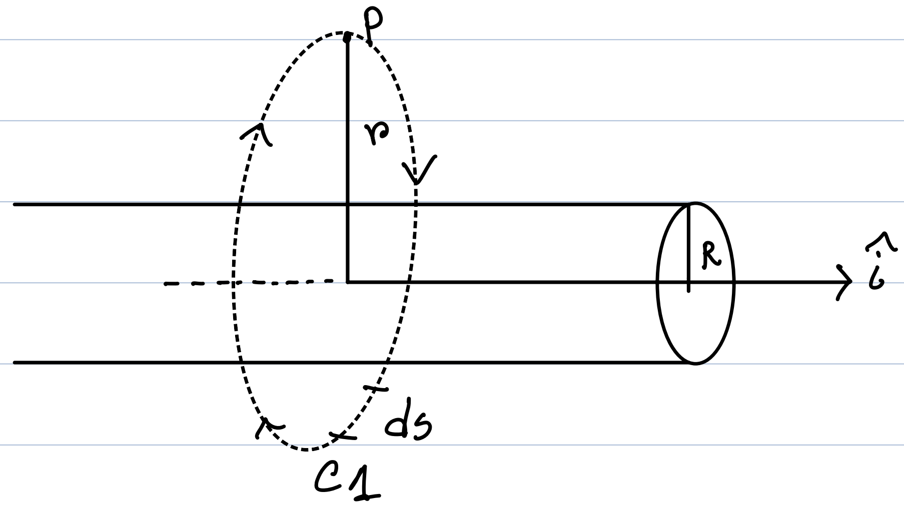


$B = ?\ ;\ r \geqslant R$

$B = ?\ ;\ r \leqslant R$

$i \propto A$

Case I:



$$\oint \vec{B} \cdot d\vec{s} = \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow \oint_C B \cdot ds = \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow B \oint ds = \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow B \cdot 2\pi r = \mu_0 \cdot i_{enclosed}$$

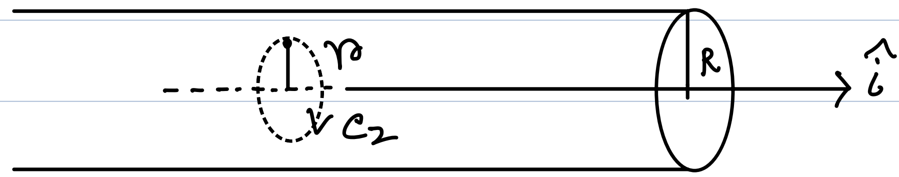
$$\therefore B = \frac{\mu_0 \cdot i_{enclosed}}{2\pi r} \; ; \; r \geqslant R$$

Case II: $r \leq R$

$$B \oint_{C_2} ds = \mu_0 \cdot i_{enclosed}$$

$$i = k\pi r^2$$

$$i_{enclosed} = k\pi r^2$$

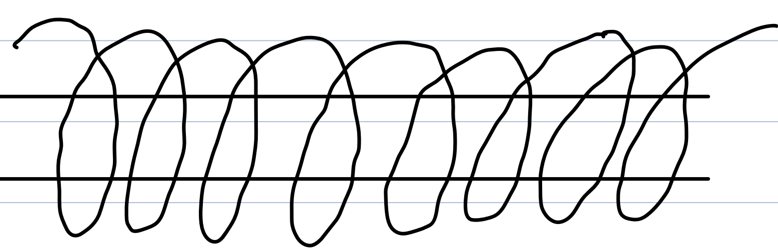


$$\Rightarrow \frac{i}{i_{enclosed}} = \frac{R^2}{r^2}$$

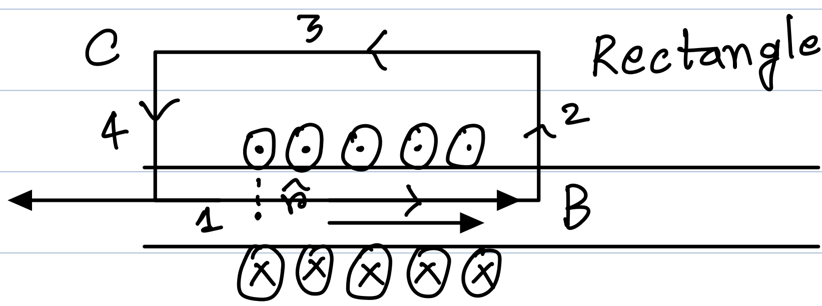
$$\Rightarrow i_{enclosed} = \frac{i r^2}{R^2}$$

$$\Rightarrow B \cdot 2\pi r = \frac{\mu_0 i r^2}{R^2}$$

$$\Rightarrow B = \frac{\mu_0 i r}{2\pi r \cdot R^2} \; ; \quad r \leq R$$



Rectangle Loop



$$\vec{B} = i\, d\vec{s} \times \vec{r}$$

$$\oint_C \vec{B} \cdot d\vec{s} = \mu_0 \cdot i_{enclosed}$$

$$- \int_3 B\,ds = 0$$

$$\Rightarrow \int_1 \vec{B} \cdot d\vec{s} + \cancel{\int_2 \vec{B} \cdot d\vec{s}}^{\,0} + \cancel{\int_3 \vec{B} \cdot d\vec{s}}^{\,0} + \cancel{\int_4 \vec{B} \cdot d\vec{s}}^{\,0}$$

$<90°$

$$= \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow \int_1 \vec{B} \cdot d\vec{s} = \mu_0 \cdot i_{enclosed}$$

$\vec{C} = \vec{A} \times \vec{B}$

$\vec{C} \perp \vec{A}$

$\vec{C} \perp \vec{B}$

$$\Rightarrow B \int_1 d\vec{s} = \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow B \cdot L = \mu_0 \cdot i_{enclosed}$$

$L \rightarrow N$

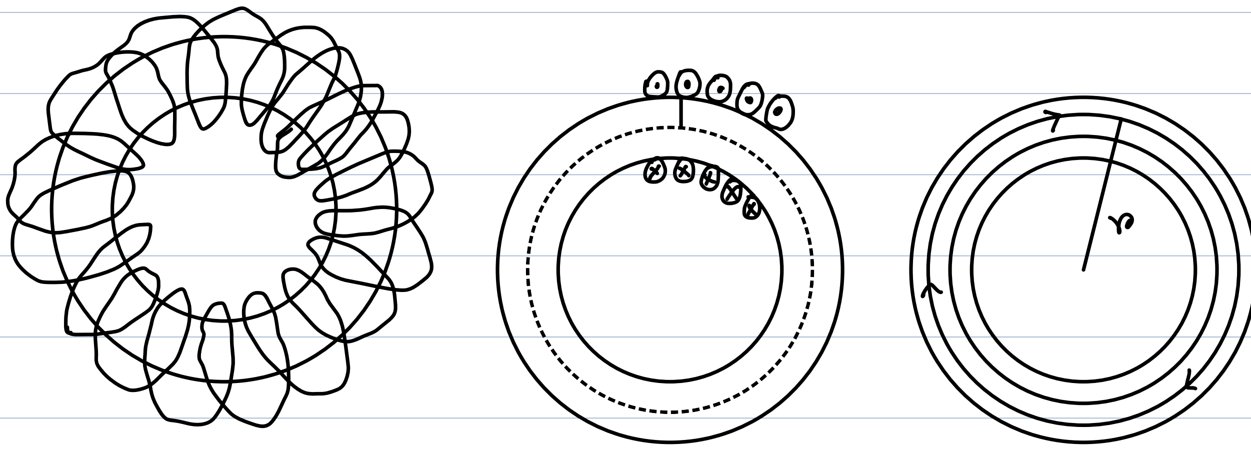
$1 \rightarrow \frac{N}{L}$

$$\Rightarrow B \cdot L = \mu_0 \cdot N \cdot i_{enclosed}$$

$$\therefore B = \frac{\mu_0 \cdot N \cdot i_{enclosed}}{L}$$

$$B = \mu_0 \cdot N \cdot i\ enclosed$$

[Unit Length]



$$\oint_C \vec{B}\cdot d\vec{s} = \mu_0 \cdot i_{enclosed}$$

$$\Rightarrow B \oint_C ds = \mu_0 \cdot N \cdot i_{enclosed}$$

$$\Rightarrow B \cdot 2\pi r = \mu_0 \cdot N \cdot i_{enclosed}$$

$$\therefore B = \frac{\mu_0 \cdot N \cdot i_{enclosed}}{2\pi r}$$