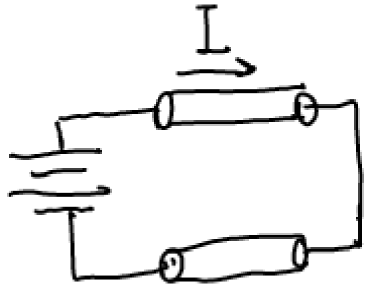
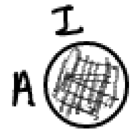
Magnetic Fields

$Q \rightarrow \vec{E}$

$I \rightarrow \vec{B}$





$J = \frac{I}{A}$

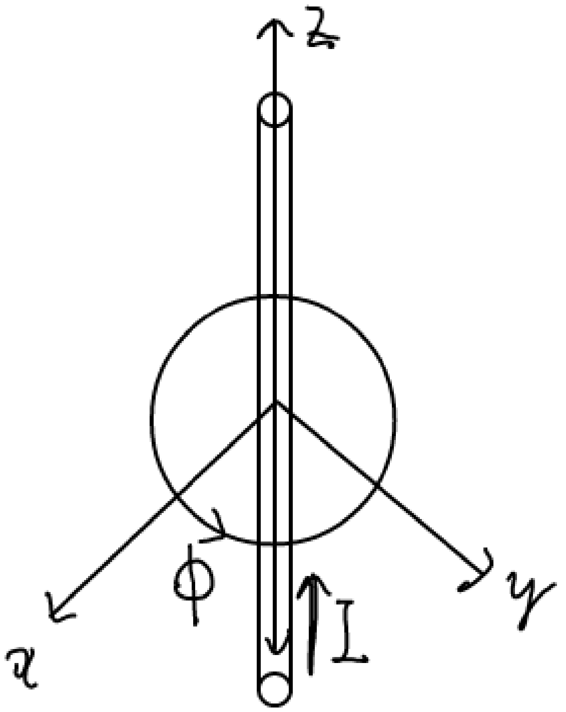
$J = I/L$

$$\boxed{\begin{array}{l}\text{Current Density} \\ J = \frac{I}{A} \quad \text{Amp}/m^2\end{array}}$$

$$\boxed{\begin{array}{l}\text{Surface Current Density} \\ J = I/L \quad \text{Amp}/m\end{array}}$$

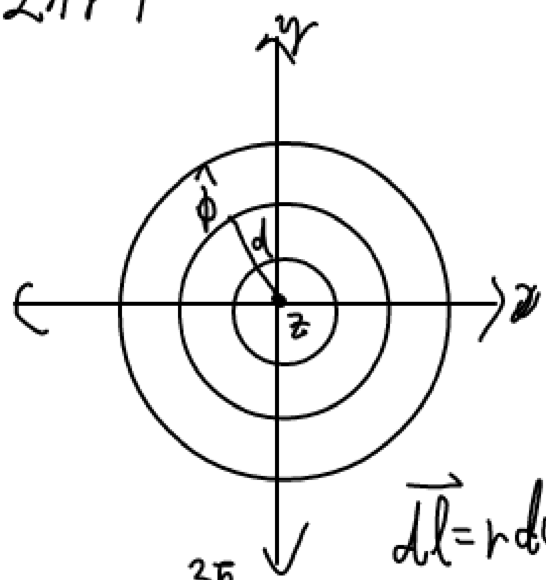
Line Integral

$$\int \underbrace{\vec{A}}_{\text{field}} \cdot \vec{dl} = \lim_{\Delta L \to 0} \sum_{i=1}^{n} \vec{A} \cdot \vec{\Delta L}$$



$$\vec{B}(r) = \frac{\mu_0 I}{2\pi r} \hat{\phi}$$

$\Longrightarrow$

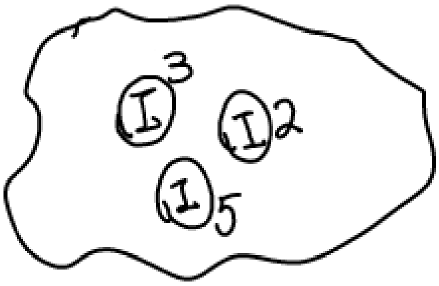


$\vec{dl} = r\, d\phi\, \hat{\phi}$

$$\int_C \vec{B} \cdot \vec{dl} = \frac{\mu_0 I}{2\pi d} \oint \hat{\phi} \cdot r\, d\phi\, \hat{\phi} = \frac{\mu_0 I \cancel{d}}{2\pi \cancel{d}} \int_0^{2\pi} d\phi = \mu_0 I$$

$$\boxed{\oint \vec{B}\cdot\vec{dl} = \mu_0 I}$$ for all closed paths

Ampère's Law



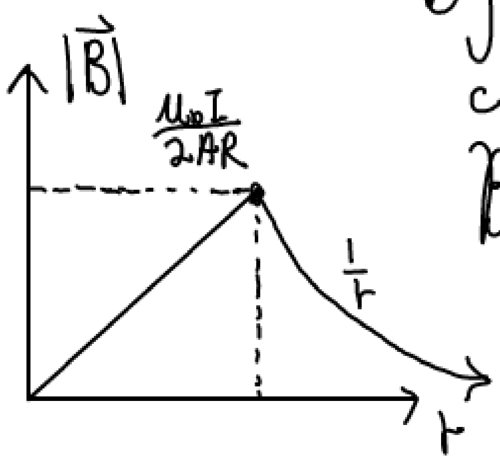
$$\oint \vec{B}\cdot\vec{dl} = \mu_0(3+2+5)$$
$$= \mu_0(10)$$

$J = I/A$

$$\oint_C \vec{B}\cdot\vec{dl} = \mu_0 I_{\text{inside } C}$$
$$= \mu_0 I_{\text{inside } C_1}$$
$$= \mu_0 J A_{C_1}$$
$$\oint_C \vec{B}\cdot\vec{dl} = \mu_0 \frac{I}{A} A_{C_1}$$

$$B \oint_C \hat{\phi}\cdot r\,d\phi\,\hat{\phi} = \mu_0 \frac{I}{A} A_{C_1}$$

$$B \oint_{\phi=0}^{2\pi} r\,d\phi = \mu_0 \frac{I}{A} A_{C_1}$$



$$B\,\cancel{r}\,2\cancel{\pi} = \mu_0 \frac{I}{A}\cancel{\pi} r^{\cancel{2}}$$
$$B = \frac{\mu_0 I r}{2A} = \frac{\mu_0 I r}{2\pi R^2}$$