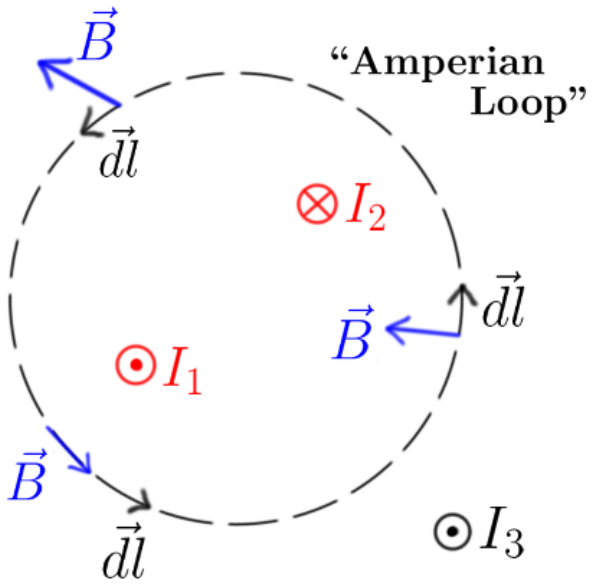
Ampere's Law

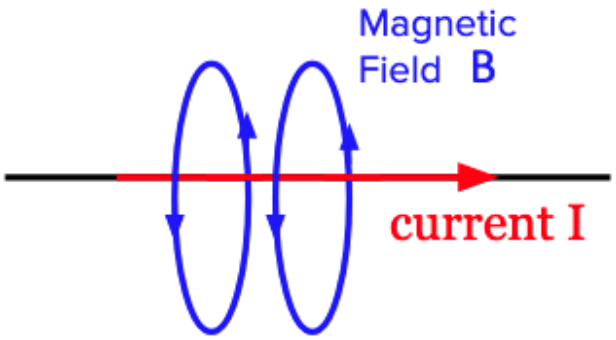
$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

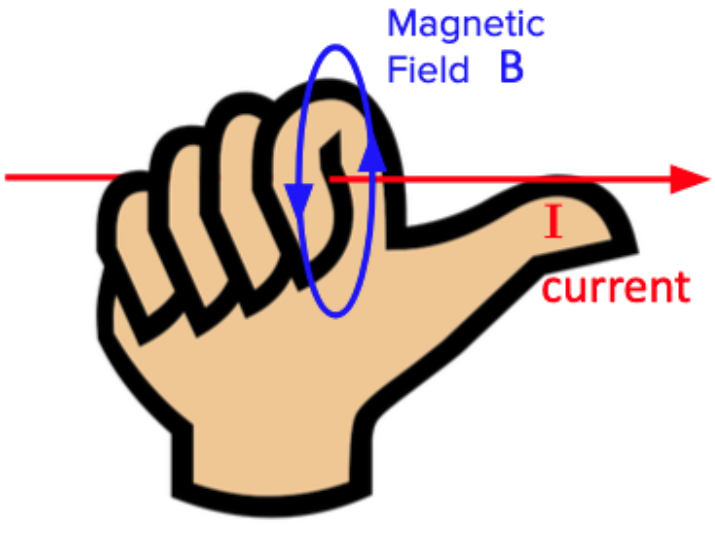
$$BL = \mu_o I_{enclosed}$$



"**Shortcut** to find **magnetic field** created by electric current"

"RHR to find direction of B field"



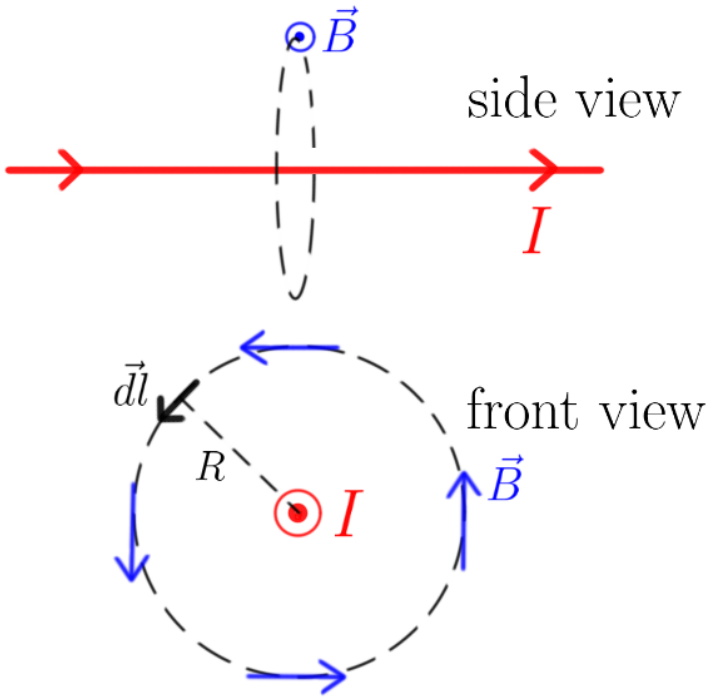


"Infinite straight wire"

$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

$$B(2\pi R) = \mu_o I$$

$$B = \frac{\mu_o I}{2\pi R}$$



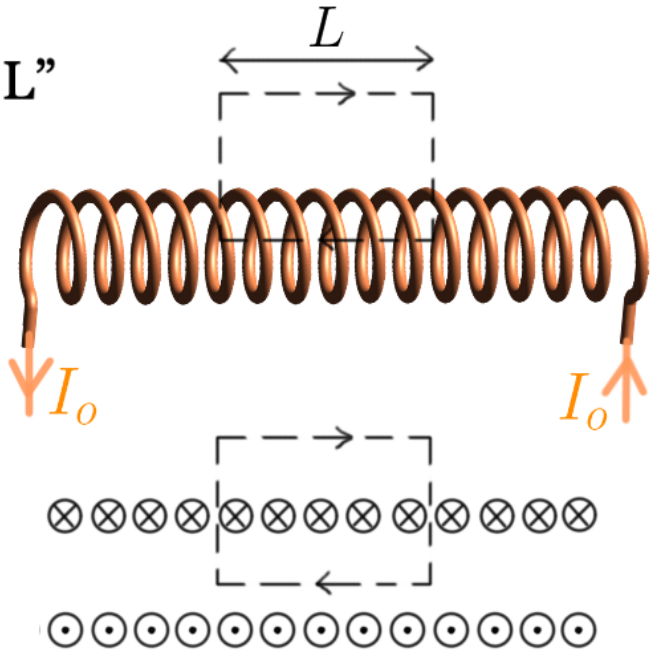
"Solenoid w/ N loops per length L"

$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

$$BL = \mu_o (NI)$$

$$B = \mu_o \frac{N}{L} I$$

$$B = \mu_o n I$$

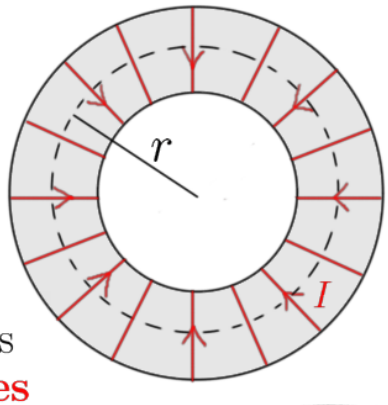


"Toroid with N total windings"

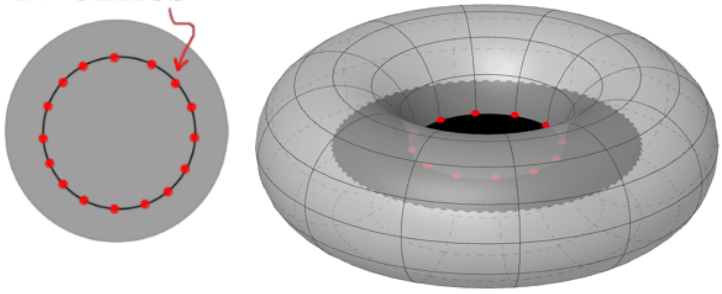
$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

$$B(2\pi r) = \mu_o (NI)$$

$$B = \frac{\mu_o NI}{2\pi r}$$



Current pierces **area N times**

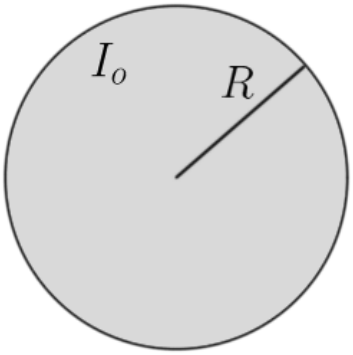


"Solid wire carrying uniform current I_o"

$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

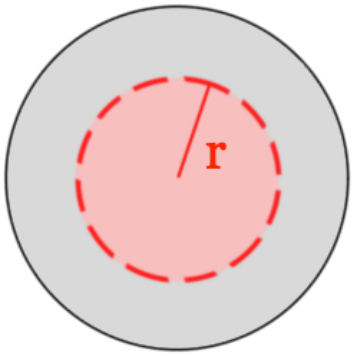
$$J = \frac{I}{A}$$

$$I = JA$$



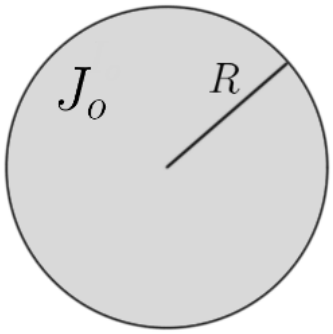
$$B(2\pi r) = \mu_o \frac{I_o}{\pi R^2}(\pi r^2) \quad \text{if r < R}$$

$$B(2\pi r) = \mu_o I_o \quad \text{if r > R}$$



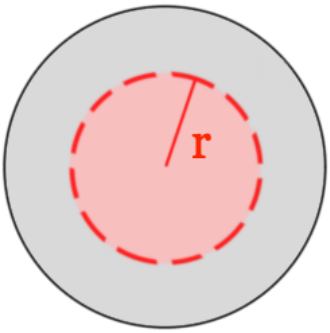
"Solid wire carrying uniform current density J_o"

$$\oint \vec{B} \cdot d\vec{l} = \mu_o I_{enclosed}$$



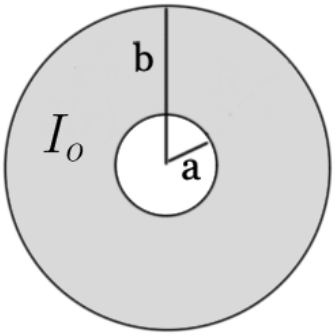
$$B(2\pi r) = \mu_o J_o(\pi r^2) \quad \text{if r < R}$$

$$B(2\pi r) = \mu_o J_o(\pi R^2) \quad \text{if r > R}$$



"Hollow wire with uniform current I_o"

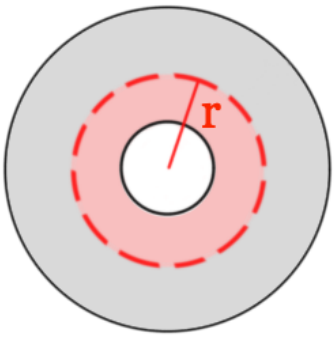
$$\oint \vec{B} \cdot d\vec{l} = \mu_o I_{enclosed}$$



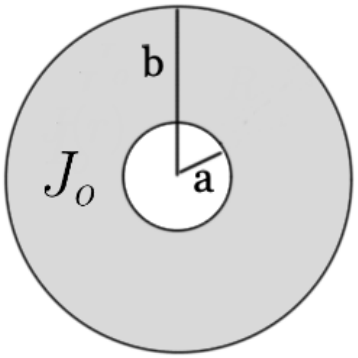
$$B(2\pi r) = \mu_o(0) \quad \text{if r < a}$$

$$B(2\pi r) = \mu_o\left(\frac{I_o}{\pi b^2 - \pi a^2}\right)(\pi r^2 - \pi a^2) \quad \text{if a < r < b}$$

$$B(2\pi r) = \mu_o I_o \quad \text{if r > b}$$



"Hollow wire with uniform current density J_o"

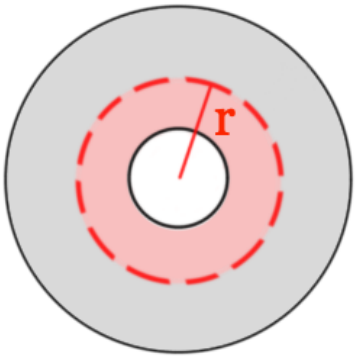


$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

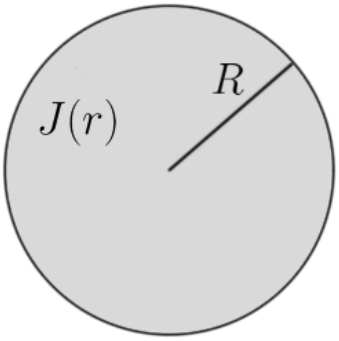
$B(2\pi r) = \mu_o(0)$ if r < a

$B(2\pi r) = \mu_o J_o(\pi r^2 - \pi a^2)$ if a < r < b

$B(2\pi r) = \mu_o J_o(\pi b^2 - \pi a^2)$ if r > b



"Solid wire carrying non-uniform current density J(r)"



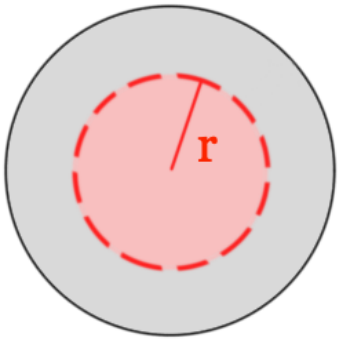
$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

$$I = \int J(r)\, dA$$

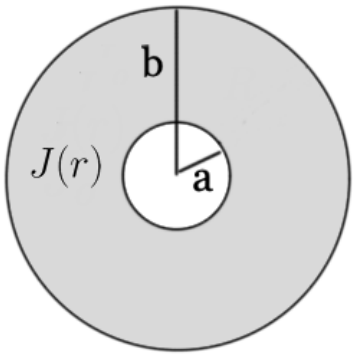
$$dA = 2\pi r dr$$

$B(2\pi r) = \mu_o \int_0^r J(r) 2\pi r dr$ if r < R

$B(2\pi r) = \mu_o \int_0^R J(r) 2\pi r dr$ if r > R



"Hollow wire with non-uniform current density J(r)"



$$\oint \vec{B} \cdot \vec{dl} = \mu_o I_{enclosed}$$

$B(2\pi r) = \mu_o(0)$ if r < a

$B(2\pi r) = \mu_o \int_a^r J(r) 2\pi r dr$ if a < r < b

$B(2\pi r) = \mu_o \int_a^b J(r) 2\pi r dr$ if r > b