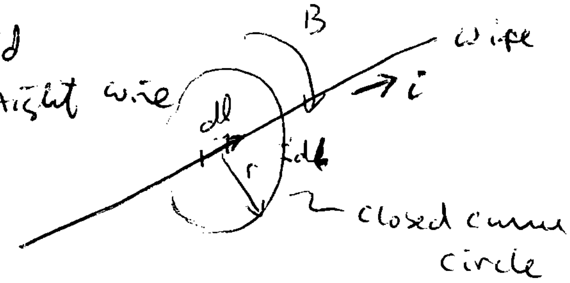
Using Ampere's Law

What is B field
around STRAIGHT wire



$$\int \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$$

Use Biot-Savart law to think about direction of B
and path along which B is CONSTANT

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

Keep your dl's STRAIGHT!

B is a fn of r only!

B goes in direction show

⟹ Put right thumb along i — fingers curl in direction of $\vec{B}$

$$\vec{B}\cdot d\vec{\ell} = B\,d\ell$$

$$\int \vec{B}\cdot d\vec{\ell} = B\int d\ell = \mu_0 i$$

$$B\,2\pi r = \mu_0 i$$

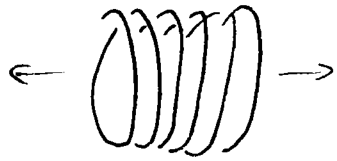
$$\boxed{B = \frac{\mu_0 i}{2\pi r}}$$

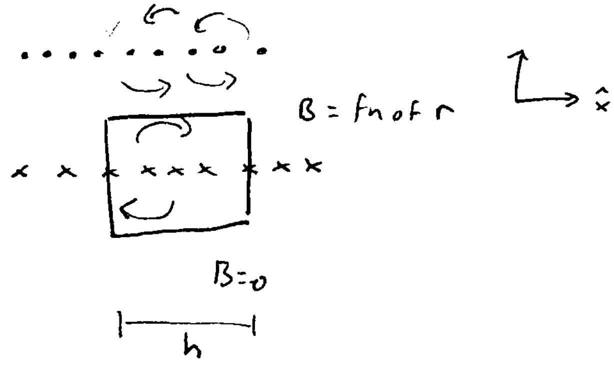
Right Hand rule
B around current
bearing wire!

~~Field of a Solenoid and a Toroid~~

~~For Magnetostatics~~
~~Plays the role of a ∥ plate capacitor~~
~~for Electrostatics~~

Field of an infinite Solenoid Tightly Packed (Slinky) n loops/unit length





Slinky

$$\int \vec{B}\cdot d\vec{l} = Bh = \mu_0 i = \mu_0 n h i$$

$$\vec{B} = \mu_0 n i \,\hat{x} \quad \text{inside}$$

$$\vec{B} = 0 \quad \text{outside}$$

~ Sometimes plays role in Magnetostatics that // plate capacitor plays in Electrostatics

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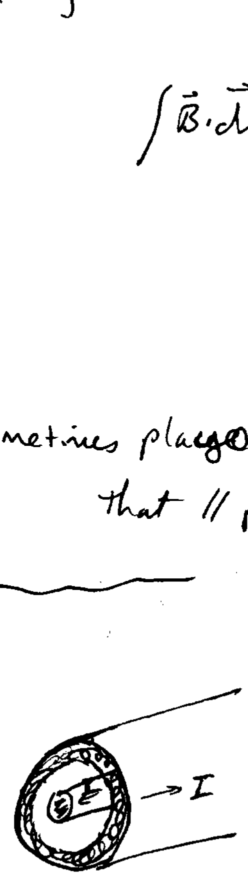
Long Coaxial Cable
Concentric conductors – each w/ i

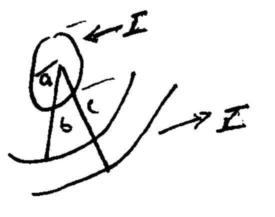


Find B $r < a$

$b > r > a$

$c > r > b$

$r > c$



Assume I is uniformly distributed throughout conductor

$r < a$

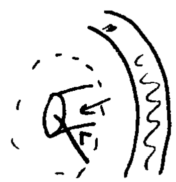
$$\int \vec{B}\cdot d\vec{l} = 2\pi r B = \mu_0 i_{encl}$$

$$i_{encl} = \frac{\pi r^2}{\pi R^2} I$$

Use thumb/fingers to get direction

$$|\vec{B}| = \frac{\mu_0}{2\pi r}\frac{\pi r^2}{\pi R^2} I = \frac{\mu_0 r I}{2\pi R^2}$$

$a < r < b$



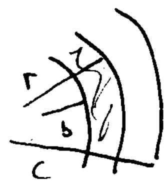
$$\int B\cdot dl = \mu_0 I_{enc}$$

$$2\pi r B = \mu_0 I$$

$$|\vec{B}| = \frac{\mu_0 I}{2\pi r}$$

$b < r < c$

$$\int B\cdot dl = 2\pi r B = \mu_0 i_{encl} = \mu_0 \left[I - \frac{I}{\pi(c^2-b^2)} \pi(r^2-b^2) \right]$$



Area current density in outer conductor is

$$\frac{I}{(\pi c^2 - \pi b^2)} = \frac{I}{\pi(c^2-b^2)}$$

$$B = \frac{\mu_0 I}{2\pi r}\left[1 - \frac{(r^2-b^2)}{(c^2-b^2)}\right]$$

Note $r = c \Rightarrow B \to 0$

$r > c$

$B = 0$ because $i_{encl} = 0$ for Amperian loop w/ $r > c$!

$$\int \vec{B}\cdot d\vec{l} = i_{encl}\mu_0$$