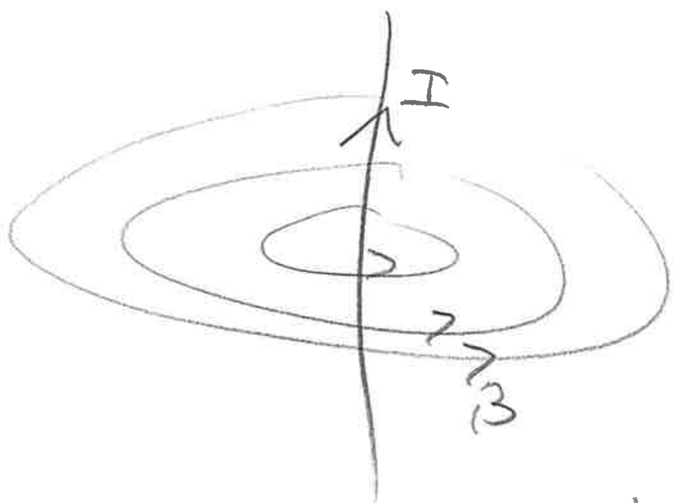
Magnetic Field from a Long, Current-Carrying wire.



- moving charges, should generate B field.

Right hand Rule (2)

- Thumb in direction of current, fingers curl in direction of magnetic field.

$$B = \frac{\mu_0 I}{2\pi r}$$ — long, straight wire

μ_0 — magnetic permeability of free space

$\mu_0 = 4\pi \times 10^{-7}$ Tm/A

Magnetic Field from wire Problem

Calculate the current running through a wire to produce a magnetic field as strong as the Earth's 5 cm away from the wire.

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

$B_{Earth} = 5 \times 10^{-5}\ T$

$r = 0.05\ m$

$\mu_0 = 4\pi \times 10^{-7}\ Tm/A$

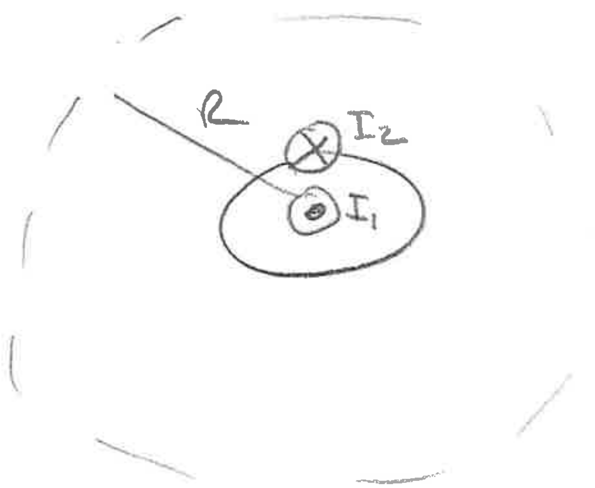
$$I = \frac{B\, 2\pi r}{\mu_0}$$

$$\boxed{I = 12.5\ A}$$

Ampere's Law

$B \cdot 2\pi r = \mu_0 I_{enc}$ — used for multiple wires

— use right hand rule (2) to determine direction of B field.



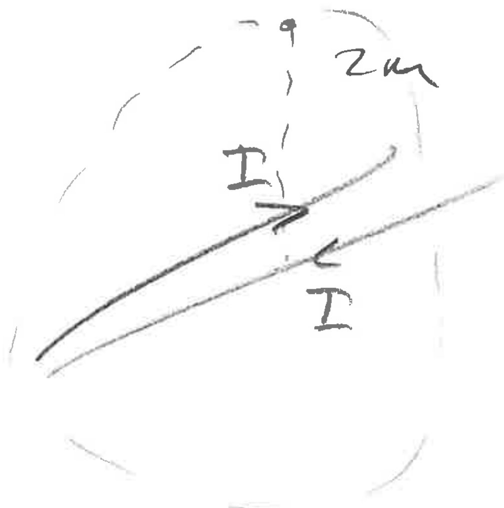
$$I_{enc} = I_1 - I_2$$

$$B = \frac{\mu_0 I_{enc}}{2\pi R}$$

smilar to Gauss's Law

Ampere's Law Problem 1

Find the $\vec{B}$ field 2 m above two parallel wires with anti-parallel currents 5A.



Currents opposite, $I_{enc} = 0$

$B = 0$

Ampere's Law Problem 2

Find the $\vec{B}$ field 2m above two parallel wires with parallel currents of 5A

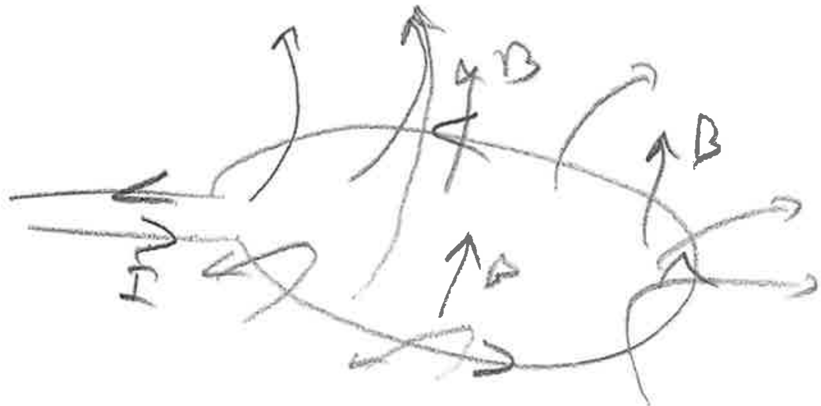
$$B \cdot 2\pi R = \mu_0 I_{enc}$$

$$B = \frac{\mu_0 (2I)}{\cancel{2}\pi R}$$

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

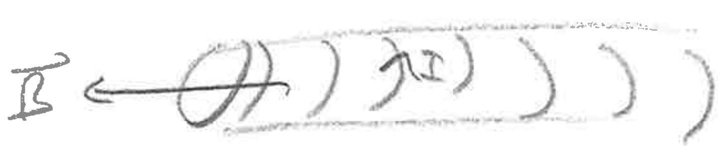
$$\boxed{B = 1\times10^{-6}\ T}$$ right

Loop of wire



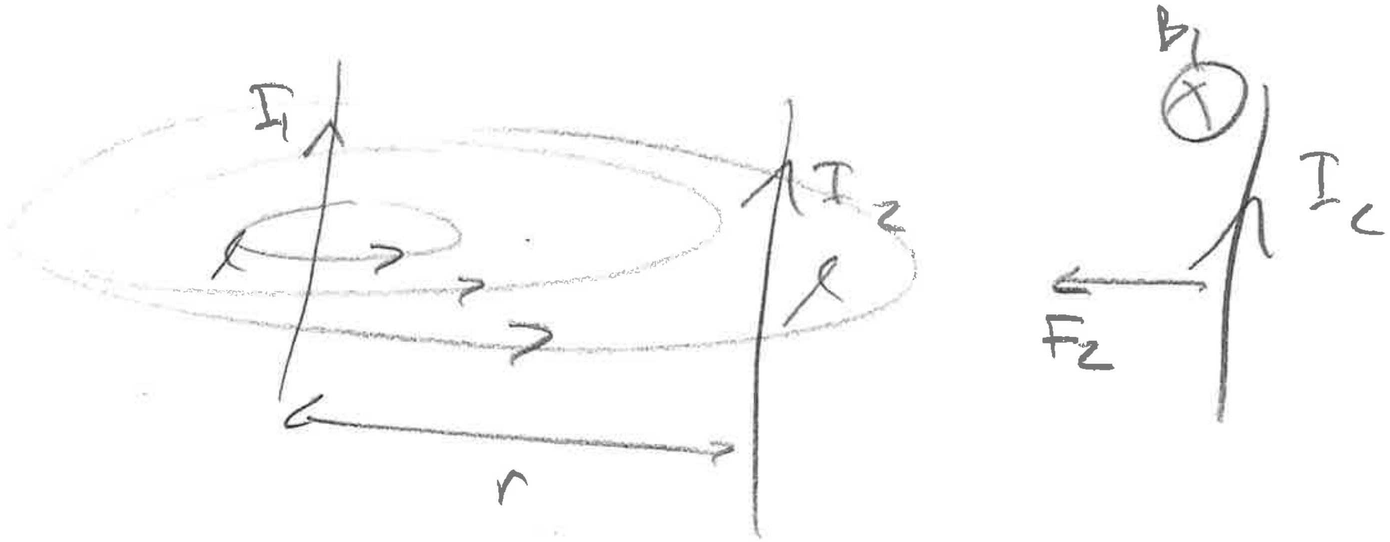
$$B = \frac{\mu_0 I}{2R}$$ (center of loop)

Solenoid



$$B = \frac{\mu_0 N I}{L} \qquad \frac{N}{L} = n$$

Magnetic Force between Current-Carrying Conductors



Force on wire 2 from wire 1's $\vec{B}$ field.

$$F_2 = I_2 l B_1 \qquad \sin\theta = 1$$

$$B_1 = \frac{\mu_0 I_1}{2\pi r}$$

$$F_2 = \frac{I_2 l \mu_0 I_1}{2\pi r}$$

$$\frac{F_2}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$ – force per unit length of wire.