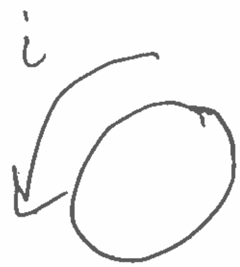
Solenoid

$N = 2000$ Turns

$L = 0.20$ m

$i = 1.0$ A ccw

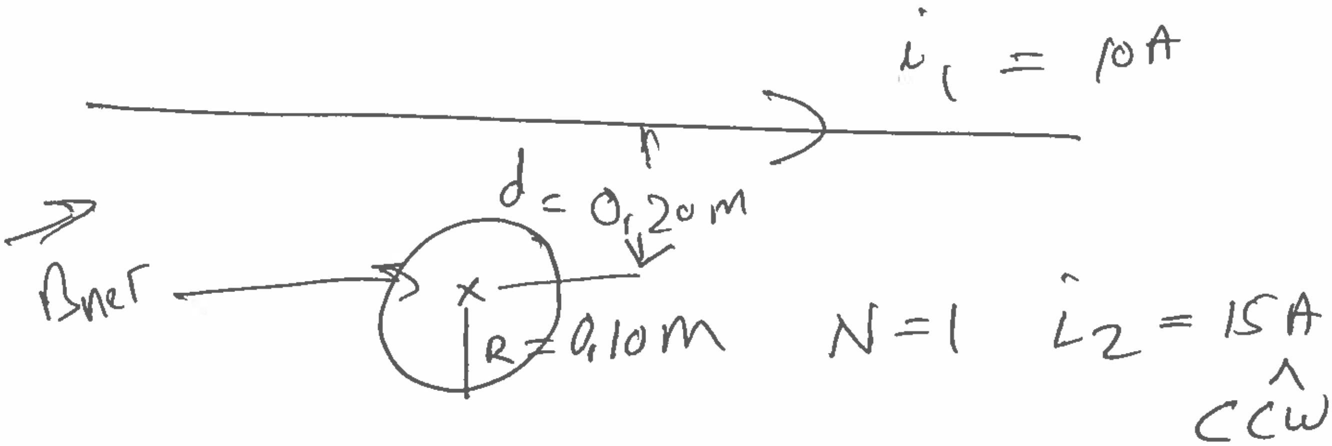


$\odot$ $\vec{B}$ out of paper

$$B_{sol} = \mu_0 \frac{N}{L} i$$

$$= 4\pi \times 10^{-7} \underbrace{\frac{(2000 \text{ Turns})}{(.20 \text{ m})}}_{10{,}000} (1.0 \text{ A})$$

$$\vec{B} = 4\pi \times 10^{-3} \text{ T } \odot$$



$$\vec{B}_{Net} = \vec{B}_{1\,wire} + \vec{B}_{2\,loop}$$

$$\vec{B}_{1\,wire} = \frac{\mu_0 i_1}{2\pi d}\,\hat{\otimes}$$

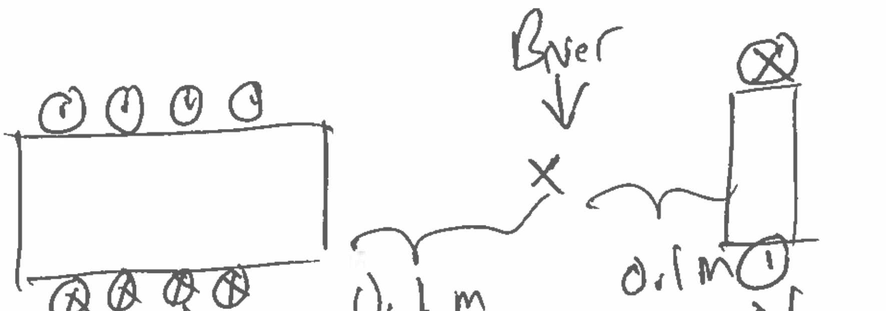
$$\vec{B}_{2\,loop} = \frac{\mu_0 i_2}{2R}\,\hat{\odot}$$

$$\vec{B}_{net} = \left(\frac{\mu_0 i_2}{2R} - \frac{\mu_0 i_1}{2\pi d}\right)\hat{\odot}$$

$$= \frac{\mu_0}{2}\left(\frac{i_2}{R} - \frac{i_1}{\pi d}\right)\hat{\odot}$$

$$\vec{B}_{net} = \frac{(4\pi \times 10^{-7}\ T\,m/A)}{2}\left(\frac{15A}{.10m} - \frac{10A}{\pi(.20m)}\right)$$

$$\boxed{\vec{B}_{net} = 8.42 \times 10^{-5}\ T \ \odot}$$



$N_s = 1000$

$N_c = 100$

$L_s = .5M$

$i_c = 2.0A$

$R = .10M$

$i_s = 3.0A$

$\vec{B}_{Net} = \vec{B}_{sol} + \vec{B}_{coil}$

$$\vec{B}_{sol} = \mu_0 \frac{N_s}{L_s} i_s \ \widehat{Right}$$

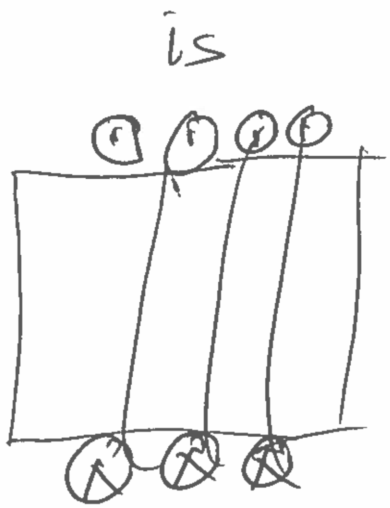
$$\vec{B}_{coil} = \frac{\mu_0 N_c i_c}{2 R_c} \ \widehat{Left}$$

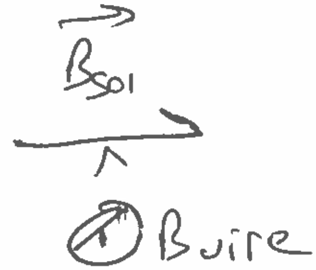
$$\vec{B}_{Net} = \left(\frac{\mu_0 N_s i_s}{L_s} - \frac{\mu_0 N_c i_c}{2 R_c} \right) \widehat{Right}$$

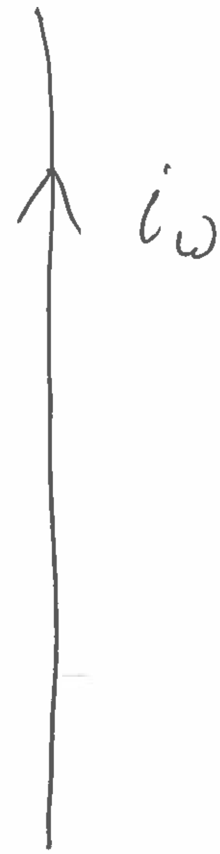
$$\vec{B}_{Net} = \left[\frac{(4\pi \times 10^{-7} \frac{TM}{A})(1000)(3.0A)}{0.5m} - \frac{(4\pi \times 10^{-7} \frac{TM}{A})(100)(2.0A)}{2(0.10m)} \right] \hat{R}$$

$$= \left[7.5 \times 10^{-3} T - 1.2 \times 10^{-3} T \right] \hat{R}$$

$$\vec{B}_{Net} = \left[6.3 \times 10^{-3} T \right] \hat{R}$$



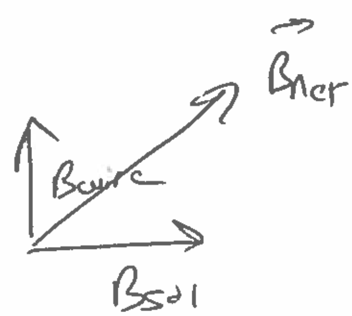




$$\vec{B}_{net} = \vec{B}_{sol}\,\hat{R} + B_{wire}\,\hat{\odot}$$

$$|\vec{B}_{net}| = \sqrt{(B_{sol})^2 + (B_{wire})^2}$$

$$\tan^{-1}\left(\frac{B_{wire}}{B_{sol}}\right)$$



Gauss's Law

$$\vec{E} \cdot \vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

Ampere's Law

$$\vec{B} \cdot \vec{L} = \mu_0 i_{enc}$$

Long Straight wire

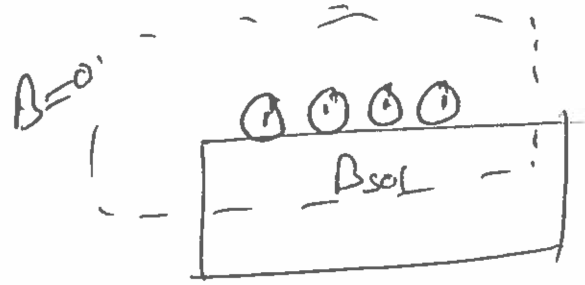
Amperian Path

$$B \, 2\pi r = \mu_0 i_{enc}$$

$$B_{wire} = \frac{\mu_0 i}{2\pi r}$$

Solenoid

$B_{sol\ outside} = 0$



N Turns

$$BL = \underbrace{BL_{Top} + BL_{Right} + BL_{Left}}_{=0} + BL_{inside}$$

$$BL = BL_{inside} = BL = \mu_0 i_{enc}$$

$$i_{enc} = Ni$$

$$BL = \mu_0 N i$$

$$B_{sol} = \frac{\mu_0 N i}{L} = \mu_0 n i$$

Magnetic Materials

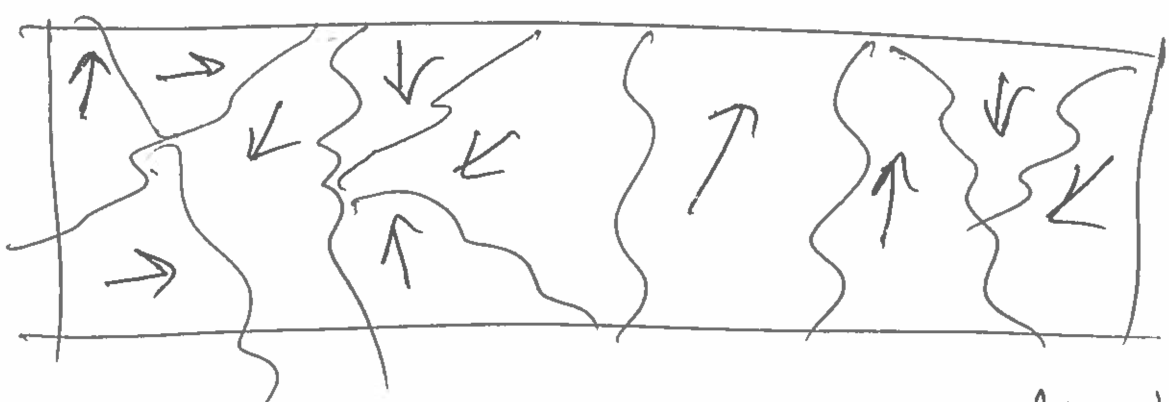
Fundamentally materials are magnetic when they have unopposed magnetic moments.

$\vec{\mu} =$ 

$\vec{\mu} = Ni\vec{A}$

Magnetic domains

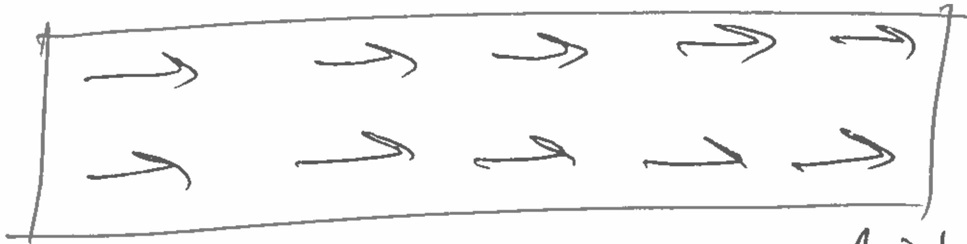
Bar of Iron



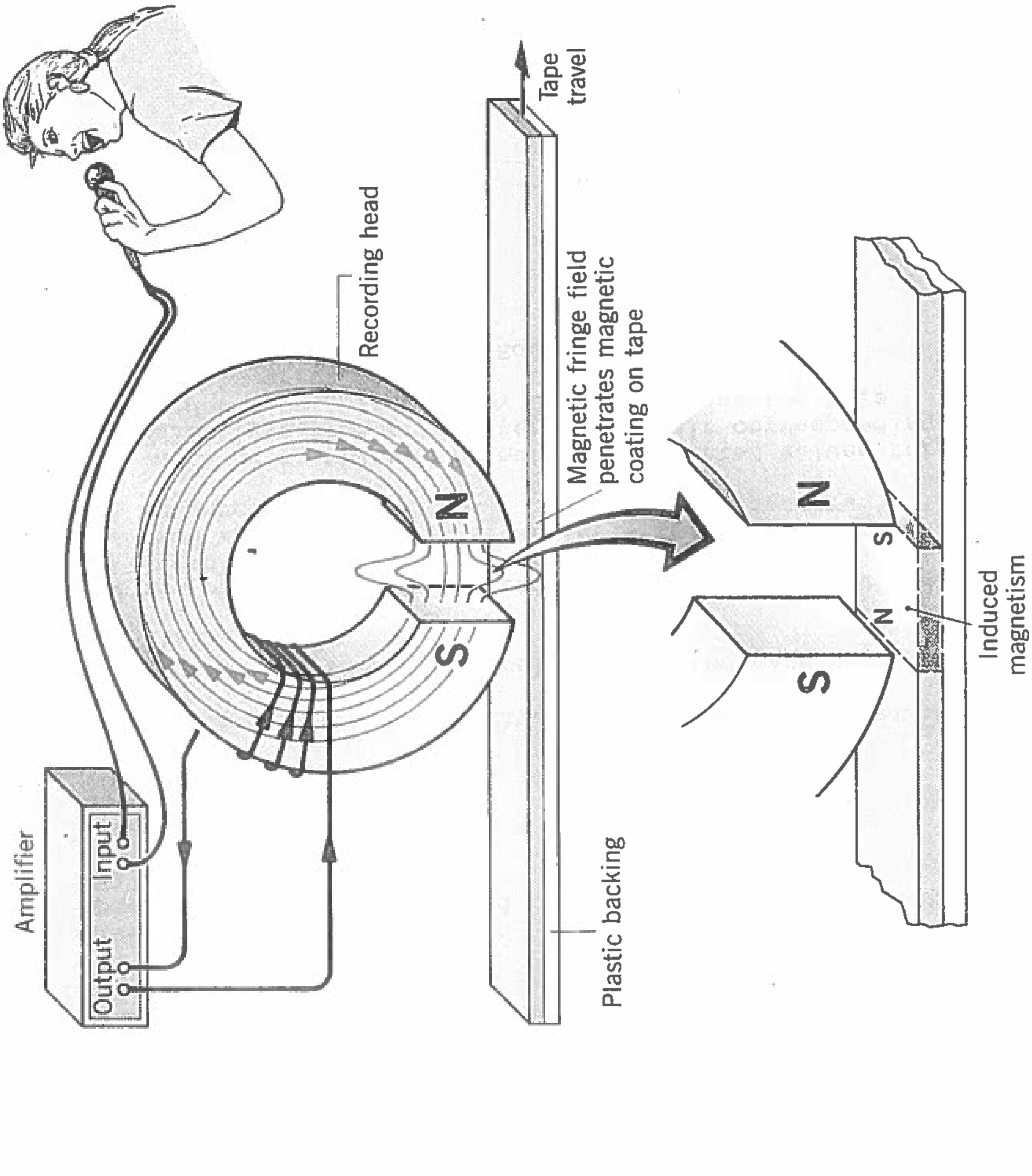
Magnetic moments randomly distributed

The net magnetization ~ 0

But apply an external magnetic field and they will align!



After External Magnetic field Applied => Net Magnetized object.


Amplifier
Output
Input
Recording head
Tape
travel
Magnetic fringe field
penetrates magnetic
coating on tape
N
S
Plastic backing
N
S
S
N
Induced
magnetism

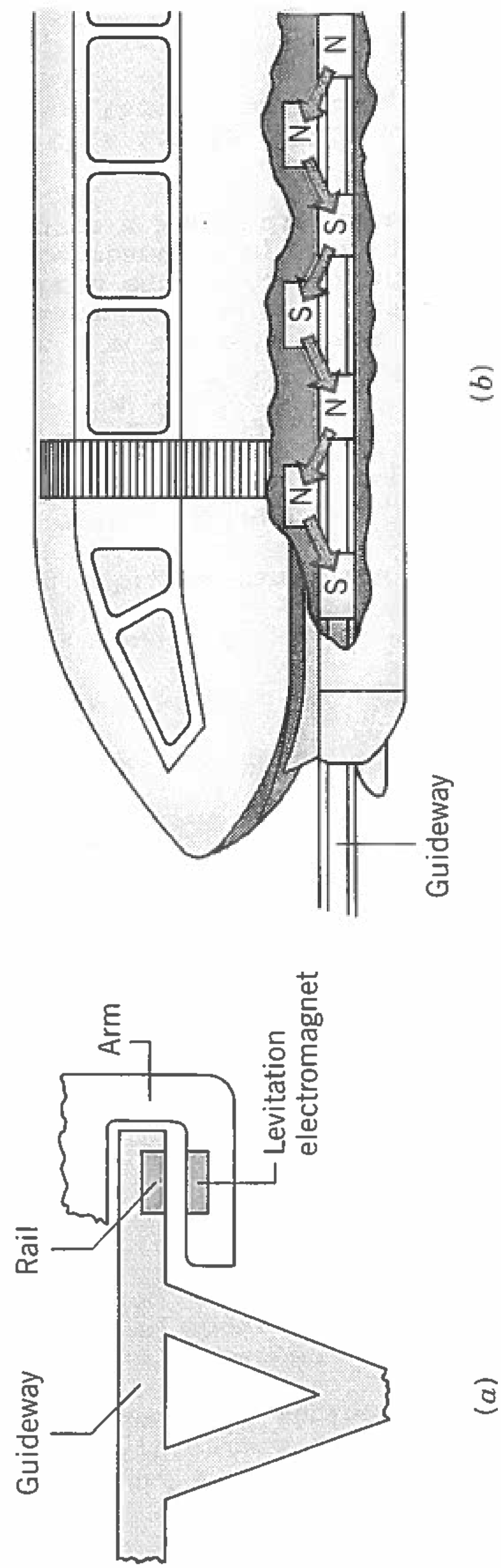


FIGURE 21.36 a, b