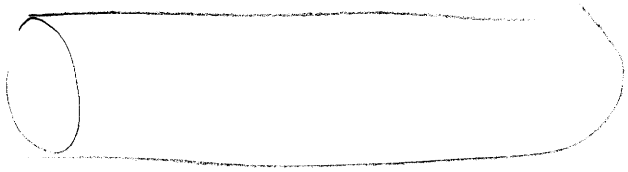
HW 11

Ch28 Q9



$B = \mu_0 I n$

(a) if diameter doubled:

$B = \mu_0 I n \rightarrow$ unaffected

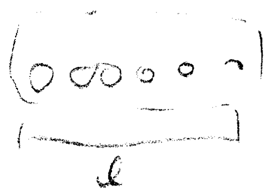
(c) length and N doubled:

oops!

$B = \mu_0 I n = \mu_0 I \frac{N}{\ell}$

$B' = \mu_0 I \frac{2N}{2\ell} = B \rightarrow$ no affect

(b) spacing doubled.



N/ℓ is halved

$B = \mu_0 I \frac{N}{\ell}$

$B' = \mu_0 I \frac{N}{2\ell} = \frac{B}{2}$ magnetic field halved

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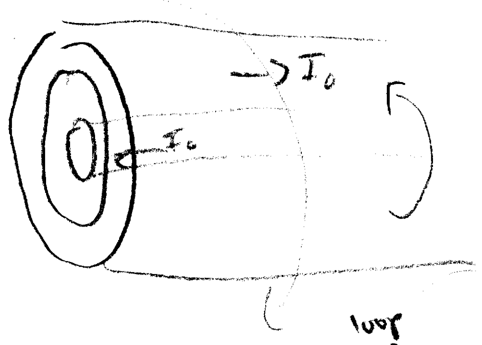
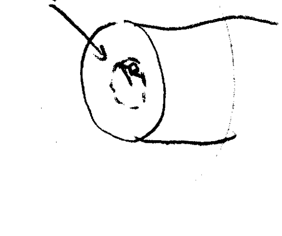
P 28-31



B either ↻ or ↺ by symmetry

This is an Ampere's law problem with nice cylindrical symmetry



(a) $R < R_1$ $\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{encl}$

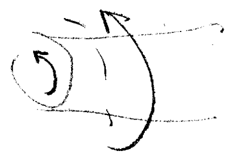
$I_{encl} = I_0$ (ratio of area)

$= I_0 \frac{\pi R^2}{\pi R_1^2} = I_0 \frac{R^2}{R_1^2}$

$B\ 2\pi R = \mu_0 I_0 \frac{R^2}{R_1^2}$

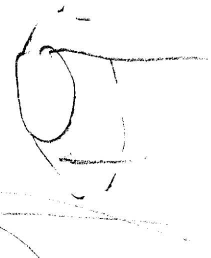
↑ circumference of loop

$$B_{R<R_1} = \frac{\mu_0}{2\pi} \frac{I_0 R}{R_1^2}$$



(b) $R_1 < R < R_2$ $\quad I_{encl} = I_0$

$$B = \frac{\mu_0 I_0}{2\pi R}$$



(c) $R_2 < R < R_3$

$I_{encl} = ?$

opp. directions

↓

$I_{enc} = I_0 - I_0$ area fraction

Area of entire outer wire $= \pi R_3^2 - \pi R_2^2$

$= \pi(R_3^2 - R_2^2)$

Area of shaded/enclosed region:

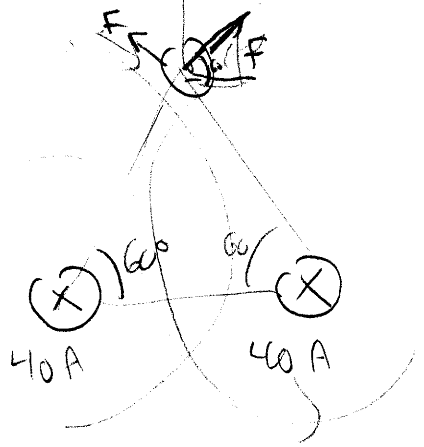
$= \pi R^2 - \pi R_2^2$

$$I_{enc} = I_0 \frac{(\pi R^2 - \pi R_2^2)}{(\pi R_3^2 - \pi R_2^2)}$$

$$2\pi R\ B = I_0 - I_0 \left(\frac{R^2 - R_2^2}{R_3^2 - R_2^2} \right)$$

$$B = \frac{I_0}{2\pi R} \left[1 - \frac{R^2 - R_2^2}{R_3^2 - R_2^2} \right]$$

28-53



equilateral triangle, so angles all 60°

$F_{mag\ up} = 2\ F_{mag} \sin 60$

$F_{mag} = ILB$ ~~sin 90~~

$= \frac{\mu_0}{2\pi} \frac{I_1 I_2}{d} l_2$ (from class, book eqn 28-2)

$F_{gravity} = mg$

$mg = 2\sin\theta\, F_{mag}$

$mg = 2 \sin 60 \frac{\mu_0}{2\pi} I \frac{40\text{ A}}{3.5\text{ cm}} l$

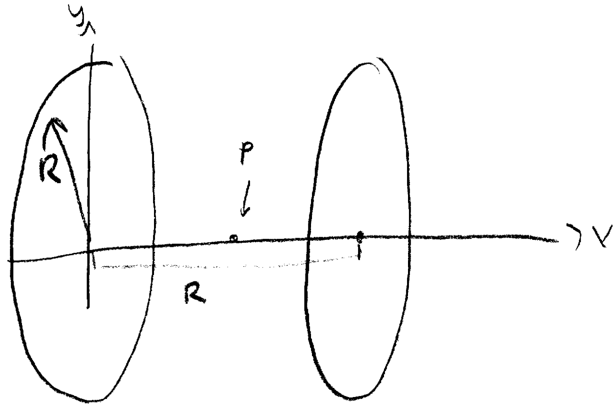
$m = \rho V = \rho l A = \rho l \pi \left(\frac{d}{2}\right)^2 I$

$g \rho \cancel{l} \frac{\pi d_{cu}^2}{4} = \cancel{2} \sin 60 \frac{\mu_0}{\cancel{2}\pi} \frac{40\text{ A}\, I}{3.5\text{ cm}} \cancel{l}$ $\quad \rho_{copper} = 8900\ \text{kg/m}^3$

$I = g\rho\pi \frac{(1\times10^{-3}\text{ m})^2}{4} \frac{\pi\,(3.5\text{ cm})}{(\sin 60)(40\text{ A})\,\mu_0}$

$I = 170\text{ A}$

28-61



B field from current loop

$B = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$

The magnetic field btwn is just sum of fields (superposition)

$$B = \frac{\mu_0 N I R^2}{2\left[R^2+x^2\right]^{3/2}} + \frac{\mu_0 N I R^2}{2\left[R^2+(x-R)^2\right]^{3/2}}$$

↖ This is the distance btwn the point and the 2nd coil

b) $$\frac{dB}{dx} = \frac{d}{dx}\left[\quad \uparrow \quad\right]$$

messy, ... but you should get zero

$$\frac{d^2B}{dx^2} = 0 \text{ as well}$$

(c) at $x = \frac{R}{2}$

$$B = \frac{\mu_0 N I R^2}{2\left[R^2+\left(\frac{R}{2}\right)^2\right]^{3/2}} + \frac{\mu_0 N I R^2}{2\left[R^2+\left(\frac{R}{2}-R\right)^2\right]^{3/2}}$$

$$= \frac{\mu_0 N I R^2}{R^3\left[\frac{5}{4}\right]^{3/2}}$$

$$= \frac{\mu_0 N I}{R\left[5/4\right]^{3/2}}$$

$$= 4.5\,mT$$

Ch25-Q18 No - ~~the~~ current is the rate of flow of charge. This is not used up. Rather, power is dissipated. The power comes from the potential difference of the battery.