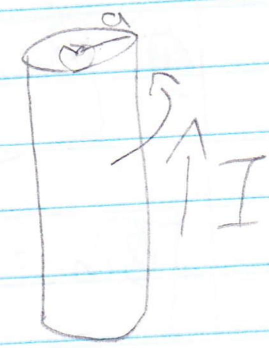
Adam

5.14 Find $\vec{B}$ in and out if

(b) I is propor to J for over outside



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{I} \times \hat{r}}{r^2}\, dl'$$

$$= \frac{\mu_0}{4\pi} I \int \frac{d\vec{l} \times \hat{r}}{r^2}$$

$$\oint B \cdot d\vec{l} = B\oint dl = B 2\pi s = \mu_0 I_{enc} = \mu_0 I$$

$$\boxed{\vec{B}_{OUT} = \frac{\mu_0 I}{2\pi s}\hat{\phi}}$$

$$\int \vec{B} \cdot d\vec{s} = 2\pi r B = \mu_0 I_{enc} \qquad I_{enc} = \frac{s}{a} I, \; s \leq a$$

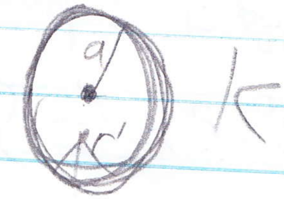
$$I_{enc} = J_s \pi s^2 = \frac{I s^2}{a^2}$$

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

$$\boxed{\vec{B}_{in} = \frac{\mu_0}{2\pi} \cdot \frac{I s}{a^2}\hat{\phi}}$$

with ~~corr~~ outside, J appro to a

ⓐ $\boxed{B_{out} = \frac{\mu_0 I}{2\pi s}}$

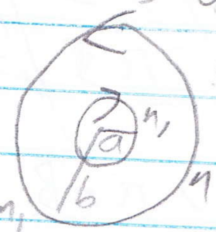


$\boxed{B_{in} = \frac{\mu_0 I s}{2\pi(a-s)}}$

at center,
$B_{in} = \frac{\mu_0 I}{2\pi(a)}$

as point approaches
a, $\lim_{s \to a} = \infty$

(5.16) Find $\vec{B}$ field
innermost, between,
and out



outside is
considered
positive for
right hand rule

(i) $s < a$

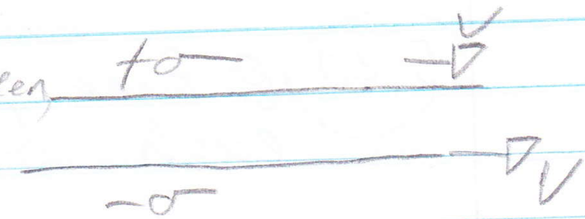
$\vec{B} = \begin{cases} \mu_0 n I \hat{z} & \text{inside} \\ \vec{0} & \text{outside} \end{cases}$

$\boxed{\vec{B}_{in} = -\mu_0 n_1 I \hat{z} + \mu_0 n_2 I \hat{z}}$

(ii) $\boxed{B_{mid} = \mu_0 n_2 I \hat{z}}$

(iii) $\boxed{\vec{0}}$ outside both solenoids

5.17 (a) Find B between, above, below



$$\vec{B}_{+\sigma} = \begin{cases} +\left(\frac{\mu_0 \sigma v}{2}\right)\hat{y} & \text{above} \\ -\frac{\mu_0 \sigma v}{2}\hat{y} & \text{below} \end{cases} \qquad K = \sigma \cdot v$$

$$\vec{B}_{-\sigma} = \begin{cases} +\frac{\mu_0 -\sigma v}{2}\hat{y} & \text{above} \\ +\frac{\mu_0 -\sigma v}{2} & \text{below} \end{cases}$$

$$\vec{B}_{mid} = -\frac{\mu_0 \sigma v}{2}\hat{y} + -\frac{\mu_0 \sigma v}{2}\hat{y} = \boxed{-\mu_0 \sigma v \hat{y}}$$

$$\vec{B}_{above} = +\frac{\mu_0 \sigma v}{2}\hat{y} - \frac{\mu_0 \sigma v}{2}\hat{y} = \boxed{0}$$

$$\vec{B}_{below} = -\frac{\mu_0 \sigma v}{2}\hat{y} + \frac{\mu_0 \sigma v}{2}\hat{y} = \boxed{\vec{0}}$$

5.19 What is simplest surface of a boundry!

Flatest surface. Any other surface will have more "field" enter but they will leave. Flat surface just has the net field.

5.20 a Find ρ of copper assuming each atom adds a e^-.

8,940 kg/m^3 density

mol mass Cu = 63.546 g/mol
0.063546 kg/mol

$$\frac{8{,}940}{0.063546} e^- = \boxed{140{,}685\ e^- = \rho}$$

b calculate e^- V in 1mm d wire carrying 1 A.

$\vec{J} = \rho \vec{u}$ $\quad \vec{J} = \frac{I}{A}$

$$\frac{1}{\pi (0.001)^2} = 140{,}685\ \vec{u}$$

$318310 = 140685 \vec{u}$

$\boxed{2.26\ m/s = \vec{u}}$

We can use telegraphs because those rely on the signal of e^- moving and not moving, which travels faster.

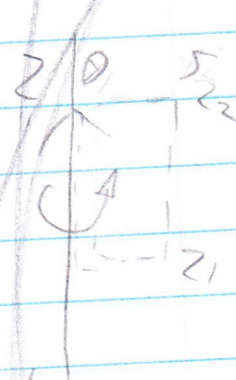
(5.23) Find ~~magnet~~ $\vec{A}$ of finite wire carrying current I.

$$\vec{A} = \frac{\mu_0 I}{4\pi}\int \frac{I}{\pi} \, dl' = \frac{\mu_0 I}{4\pi}\int_{z_1}^{z_2} \frac{dz}{\sqrt{x^2+y^2}} = \boxed{\frac{\mu_0 I(z_2-z_1)}{4\pi\sqrt{x^2+y^2}}}$$

$\pi = \sqrt{x^2+y^2}$, cylindrical , $= \boxed{\frac{\mu_0 I(z_2-z_1)}{4\pi s}}$

looks good

(5.26) ⓐ By whatever means you can think of, find $\vec{A}$ a distance s from an ∞ straight wire carrying current I. check $\nabla \cdot A = 0$ and $\nabla \times \vec{A} = \vec{B}$



$\oint \vec{A} \cdot d\vec{l} = \int \vec{B} \cdot d\vec{a} = \mu_0 \pi I (s z')$

$= A(2s + 2z_1)$

$A(2s + 2z_1) = \mu_0 \pi I (s z')$ $\quad s >> z'$

$A = \frac{\mu_0 \pi I (s z')}{2s + 2z_1} \Rightarrow A = \frac{\mu_0 \pi I}{2s}\hat{\phi}$

$\nabla \cdot A = \frac{\partial}{\partial \phi}\left(\frac{\mu_0 \pi I \sin\theta}{2s}\right)\frac{1}{s\sin\theta} = 0$ ✓

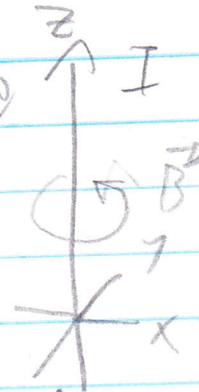
$\nabla \times \vec{A} =$

$$\nabla \times \vec{A} = \frac{1}{s}\left(\frac{\partial A_z}{\partial s} - \frac{\partial A_\phi}{\partial z}\right)\hat{s} + \left(\frac{\partial A_s}{\partial z} - \frac{\partial A_z}{\partial s}\right)\hat{\phi}$$

$$+ \frac{1}{s}\left(\frac{\partial (s A_\phi)}{\partial s} - \frac{\partial A_s}{\partial \phi}\right)\hat{z}$$

$$= \frac{1}{s}\left(\frac{\partial}{\partial s}\left(\frac{\mu_0 I n}{2}\right) - 0\right)$$

5.26 ⓐ



$\vec{B} = \nabla \times \vec{A}$

$\vec{A} \neq \vec{B}$

$\vec{A} = \hat{\phi}$

$\nabla \times (6(\rho, \phi, z)\, \hat{\phi})$

$\vec{A} = A(\rho, \phi, z)\, \hat{z}$

$\vec{B} = \frac{\mu_0 I}{2\pi\rho}\, \hat{\phi} = \frac{1}{\rho}\left(\frac{\partial A_\rho}{\partial z}\right.$

$\vec{A} = A(\rho)\, \hat{z}$

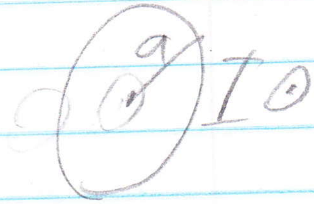
$\vec{B} = \left.\frac{\partial A_z}{\partial \rho}\right)\hat{\phi}$

$$\boxed{\vec{A} = \frac{-\mu_0 I}{2\pi} \ln(\rho)\, \hat{z}}$$

$-\frac{\partial A}{\partial \rho} = \frac{\mu_0 I}{2\pi\rho}$

ⓑ $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$

$B_{in} = \frac{\mu_0}{2\pi} \cdot \frac{I\rho}{a^2}\hat{\phi} = \nabla \times \vec{A}$



$= -\frac{\partial A_z}{\partial \rho}$

$$\boxed{A = \frac{-\mu_0}{4\pi} \cdot \frac{I\rho^2}{a^2}\, \hat{z}}$$