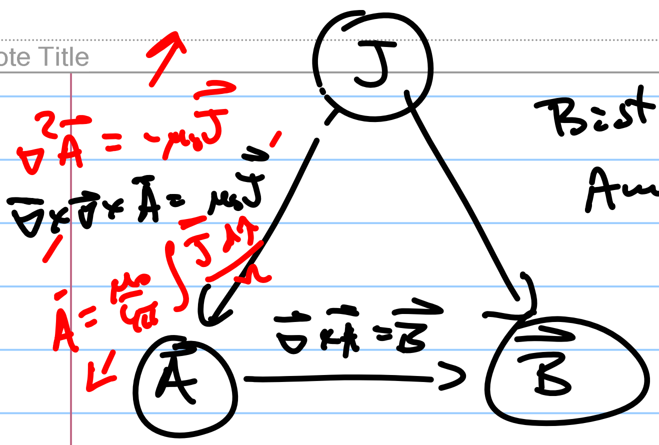


Biot Savart $B = \frac{\mu_0}{4\pi}\int \frac{I\,d\vec{l}\times\hat{r}}{r^2}$ same

Amps $\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{en}$ or $\boxed{\vec\nabla\times\vec{B} = \mu_0\vec{J}}$

$\vec{B} = \vec\nabla\times A$ $\qquad \vec\nabla\cdot\vec{A} = 0$ made up

Fundament principles $\qquad \vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$

cons energy $\Delta PE = q\Delta V$

Want $\vec{A}$ give $\vec{J}$ $\qquad \vec\nabla\times\vec{B} = \mu_0\vec{J}$

$$\vec\nabla\times\vec\nabla\times\vec{A} = \mu_0\vec{J}$$

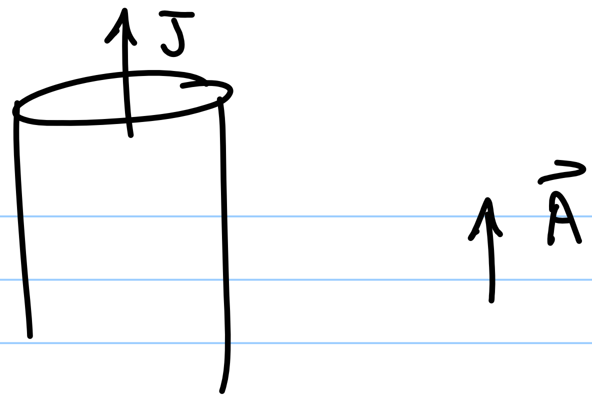
$$\vec\nabla(\underbrace{\vec\nabla\cdot\vec{A}}_{0}) - \nabla^2\vec{A} = \mu_0\vec{J}$$

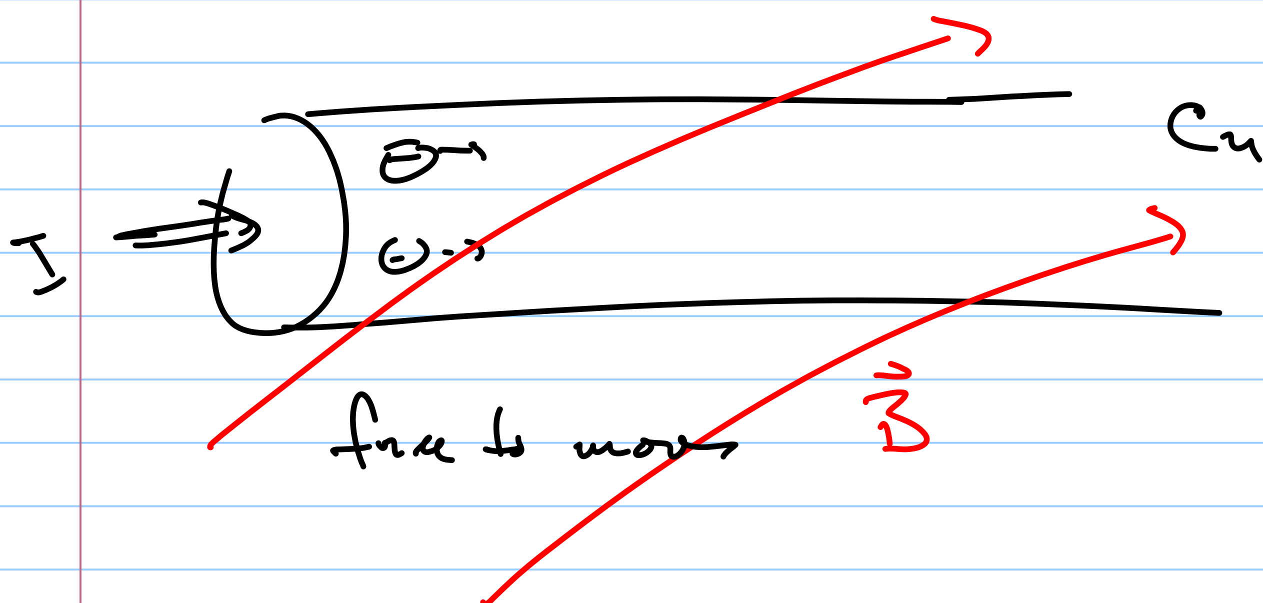
$$\boxed{\nabla^2\vec{A} = -\mu_0\vec{J}}$$

Cartesian coords

$$\nabla^2 A_x = -\mu_0 J_x$$
$$\nabla^2 A_y = -\mu_0 J_y$$
$$\nabla^2 A_z = -\mu_0 J_z$$
$$\Downarrow$$
$$A_x(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{J_x(\vec{r}')\,d\tau'}{|\vec{r}-\vec{r}'|}$$

$$\nabla^2 V = -\rho/\epsilon_0$$
$$\Downarrow$$
$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r}')\,d\tau'}{r}$$





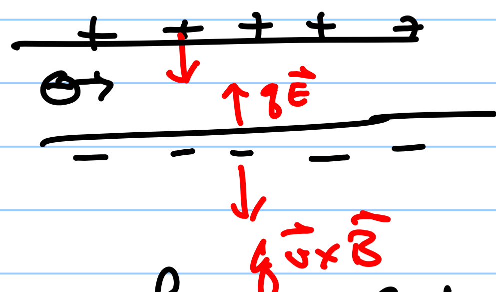
Principles: $\vec{F} = q\vec{v}\times\vec{B} + q\vec{E}$ Lorentz

$\vec{F} = m\vec{a}$ Newt laws

? Cons energy ?

Method soln: $q\vec{v}\times\vec{B}$ say B into paper
electrons move down

ok I see an $\vec{E}$ field



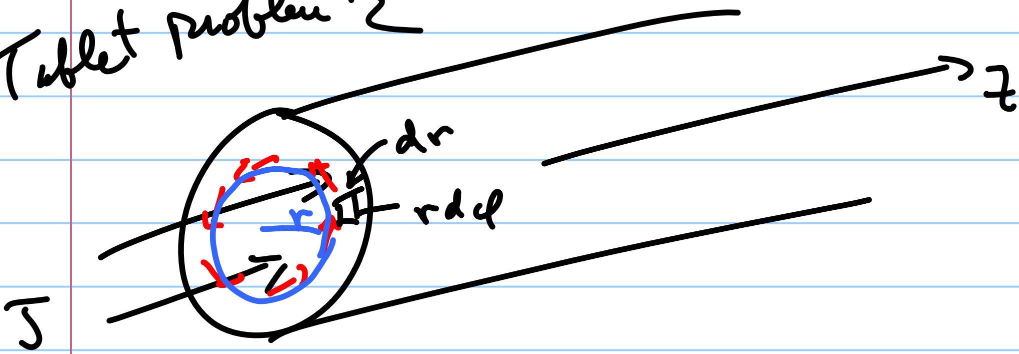
look at forces on free electrons &
transfer that to Cu lattice

$$\sum \vec{F}_{Cu} = m\vec{a} \qquad \sum \vec{F}_{\text{free electrons}} = m\vec{a}$$

3.) Check $\quad I \to 0 \quad F \to 0$

$\qquad\qquad\quad B \to 0 \quad F \to 0$

Tablet problem 2



$$\vec{J} = \frac{A}{r}\hat{z}$$

Fund Principles: $\quad$ Biot Savart

$\qquad\qquad\qquad\quad$ Ampere's

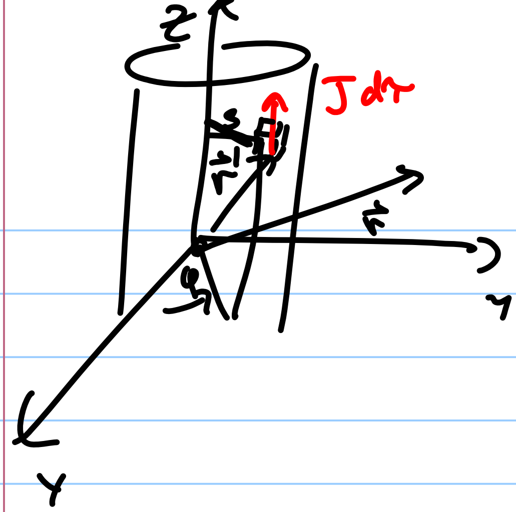
Outline $\quad \oint \vec{B}\cdot d\vec{l} = \mu_0 I_{encl}$

$$\int |\vec{B}||d\vec{l}|\underbrace{\cos\theta}_{1} = B\,2\pi r = \mu_0 \int \vec{J}\cdot d\vec{a}$$

$$\int \vec{J}\cdot d\vec{a} = \int \frac{A}{r}\hat{z}\cdot r\,d\phi\,dr\,\hat{z} = \int \frac{A}{\cancel{r}}\cancel{r}\,d\phi\,dr$$

$$= \mu_0 A \int_0^r \int_0^{2\pi} d\phi\,dr = \mu_0 A \cancel{2\pi} r = B\,\cancel{2\pi r}$$

Biot Savart: $\quad \vec{B} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\,d\tau \times \hat{\mathscr{r}}}{\mathscr{r}^2}$



$$d\tau = s'\,d\varphi'\,ds'\,dz'$$

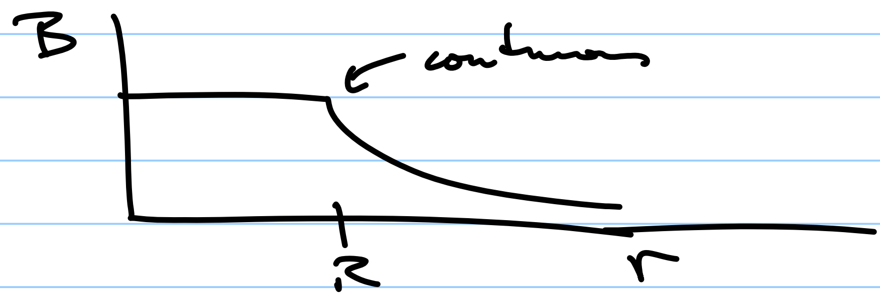
$$\vec{\mathscr{r}} = \vec{r} - \vec{r}\,'$$

$$\vec{r} = x\,\hat{x} + y\,\hat{y} + z\,\hat{z}$$

$$\vec{r}\,' = s'\cos\varphi'\,\hat{x} + s'\sin\varphi'\,\hat{y} + z'\,\hat{z}$$

limits $\varphi: 0 \to 2\pi$ $\quad s: 0 \to R$ $\quad z: -\infty, \infty$

Check: Biot Savart must = Amperes



$J \to 0$ $\quad B \to 0$