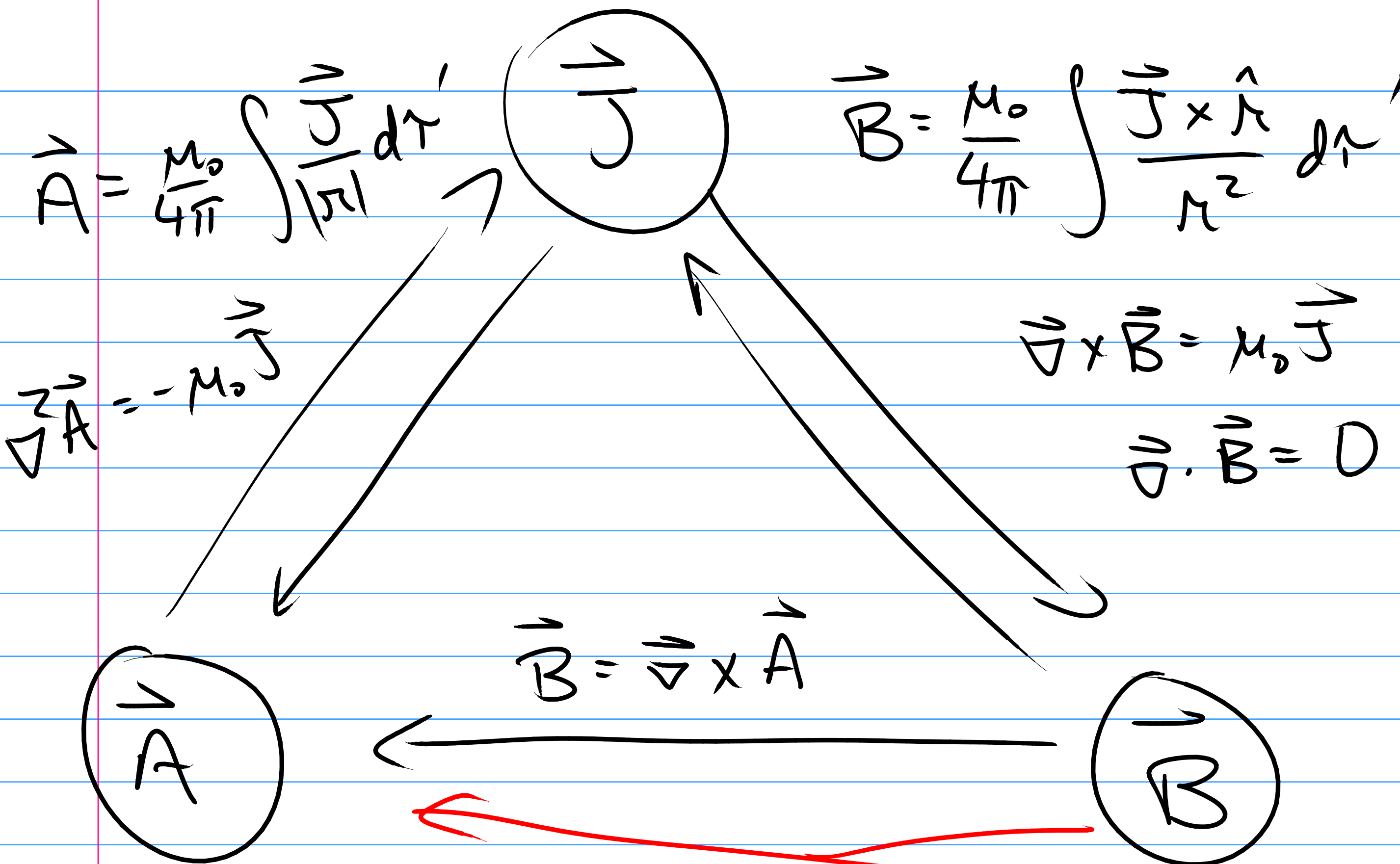
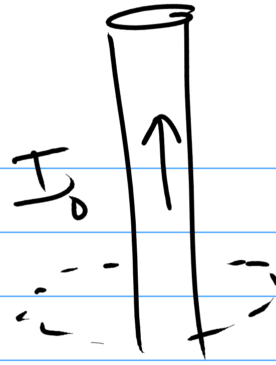


$$\left.\begin{aligned}\vec{\nabla}\times\vec{B} &= \mu_0\vec{J}\\ \vec{\nabla}\cdot\vec{B} &= 0\end{aligned}\right\}\quad \vec{B} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,d\tau'$$

$$\left.\begin{aligned}\vec{\nabla}\times\vec{A} &= \vec{B}\\ \vec{\nabla}\cdot\vec{A} &= 0\end{aligned}\right\}\quad \boxed{\vec{A} = \frac{1}{4\pi}\int \frac{\vec{B}\times\hat{\mathscr{r}}}{\mathscr{r}^2}\,d\tau'}$$

gauge choice

Ex:



∞ wire carrying current I_0 with radius a

$$\oint \vec{B}\cdot d\vec{l} = B\,2\pi r = \mu_0 I_0 \Rightarrow \boxed{\vec{B} = \frac{\mu_0 I_0}{2\pi r}\hat{\varphi}}$$

$$\vec{A} = \underset{0}{\underset{\shortparallel}{A_r}}\,\hat{r} + \underset{0}{\underset{\shortparallel}{A_\varphi}}\,\hat{\varphi} + A_z\hat{z} \qquad \vec{J} = J_0\hat{z}$$

$\vec{A}$ & $\vec{J}$ are in same direction

$$\boxed{\vec{A} = A_z(r)\,\hat{z}} \qquad \vec{\nabla}\times\vec{A} = \vec{B}$$

cylindrical coords

$$\vec{\nabla}\times\vec{A} = \vec{\nabla}\times\left[\overset{0}{\overset{\shortparallel}{A_\varphi}}\hat{\varphi} + \overset{0}{\overset{\shortparallel}{A_r}}\hat{r} + A_z\hat{z}\right]$$

$$= \left[\frac{1}{r}\underset{0}{\underset{\shortparallel}{\frac{\partial A_z}{\partial \varphi}}} - \frac{\partial \overset{0}{\overset{\shortparallel}{A_\varphi}}}{\partial z}\right]\hat{r} + \left[\frac{\partial \overset{0}{\overset{\shortparallel}{A_r}}}{\partial z} - \frac{\partial A_z}{\partial r}\right]\hat{\varphi} + \frac{1}{r}\left[\frac{\partial}{\partial r}(r\overset{0}{\overset{\shortparallel}{A_\varphi}}) - \frac{\partial \overset{0}{\overset{\shortparallel}{A_r}}}{\partial \varphi}\right]\hat{z}$$

$$\vec{\nabla}\times\vec{A} = -\frac{dA_z}{dr}\hat{\varphi} = \vec{B} = \frac{\mu_0 I_0}{2\pi r}\hat{\varphi}$$

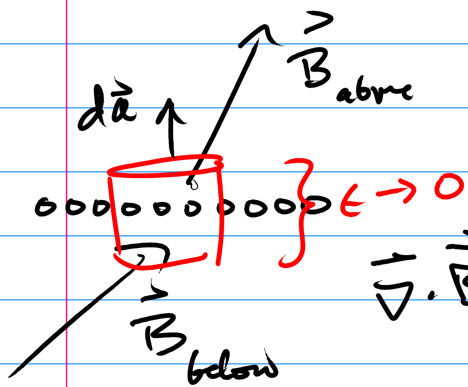
$$\frac{dA_z}{\cancel{dr}} = -\frac{\mu_0 I_0}{2\pi r}dr \qquad A_z = -\frac{\mu_0 I_0}{2\pi}\overbrace{\int_a^r \frac{dr}{r}}^{\ln(r/a)}$$

Cylindrical coords

$$\vec{\nabla}\cdot\vec{A} = \frac{1}{r}\frac{\partial}{\partial r}\underset{=0}{(rA_r)} + \frac{1}{r}\frac{\partial \overset{=0}{A_\varphi}}{\partial \varphi} + \cancelto{0}{\frac{\partial A_z}{\partial z}} = 0$$

Bndry conditions

sheet of current



$\vec{\nabla}\cdot\vec{B} = 0$

or $nI_0 \frac{\text{amps}}{m}$

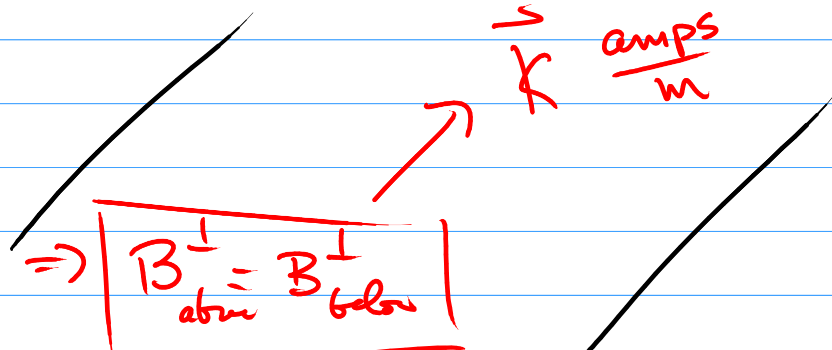
$\approx$

$\vec{K} \frac{\text{amps}}{m}$

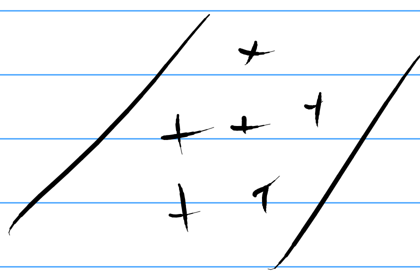
$$\int \vec{\nabla}\cdot\vec{B}\, d\tau = \oint \vec{B}\cdot d\vec{a} = 0$$

$$\underbrace{\int \vec{B}\cdot d\vec{a}}_{\text{top can}} + \underbrace{\int \vec{B}\cdot d\vec{a}}_{\text{bottom can}} =$$

$$B^{\perp}_{above} A - B^{\perp}_{below} A = 0 \Rightarrow \boxed{B^{\perp}_{above} = B^{\perp}_{below}}$$



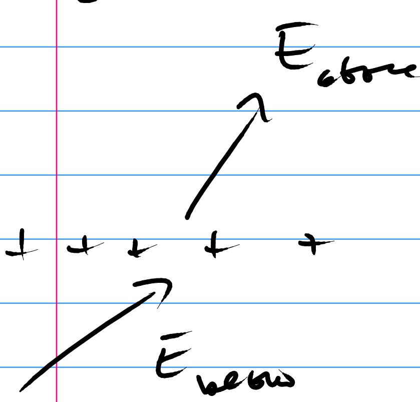
Electrostatics



$$\int \vec{\nabla}\cdot\vec{B}\, d\tau = \oint \vec{B}\cdot d\vec{a} = 0$$

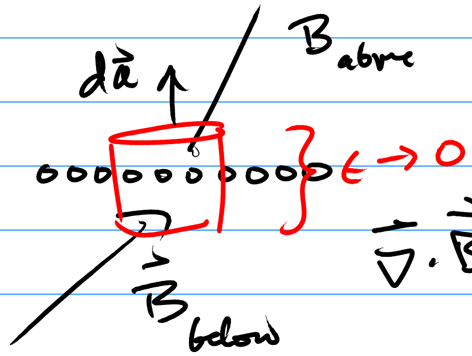
$$\int \vec{\nabla}\cdot\vec{E}\, d\tau = \oint \vec{E}\cdot d\vec{a}$$

$$\int \frac{\rho}{\epsilon_0} d\tau = \frac{Q_{enc}}{\epsilon_0}$$



$$\vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0$$

$$\vec{\nabla}\times\vec{E} = 0$$



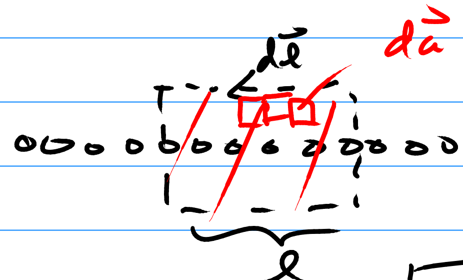
$\vec{\nabla}\cdot\vec{B}=0$

Parallel component of $\vec{B}$

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

Stokes

$$\int \underbrace{\vec{\nabla}\times\vec{B}}_{\mu_0 \vec{J}}\cdot d\vec{a}=\oint \vec{B}\cdot d\vec{\ell}$$



$$\int \mu_0 \underset{\substack{\shortparallel \\ \frac{\text{Amps}}{m^2}}}{\vec{J}}\cdot d\vec{a}=\mu_0\underbrace{\int \vec{J}\cdot d\vec{a}}_{I}=\boxed{\mu_0 n I_0 \cancel{\ell}=B^{\shortparallel}_{above}\cancel{\ell}-B^{\shortparallel}_{below}\cancel{\ell}}$$