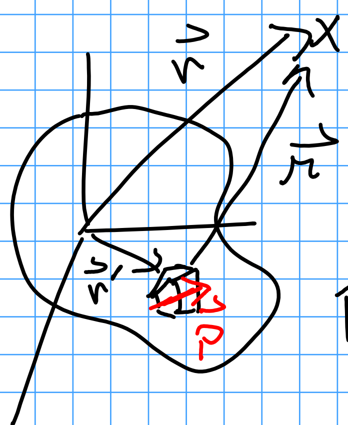
Overview of magnetism

Electric fields in matter



$p = qs$

$$V_{dipole} = \frac{1}{4\pi\epsilon_0}\frac{\hat{\boldsymbol{r}}\cdot\vec{p}}{\boldsymbol{r}^2}$$

dipole/vol

$$V = \int dV = \int \frac{1}{4\pi\epsilon_0}\frac{\hat{\boldsymbol{r}}\cdot\vec{P}\,d\tau'}{\boldsymbol{r}^2}$$

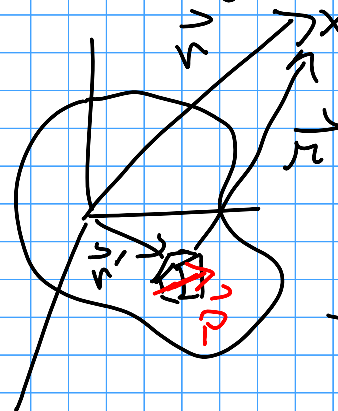
$$V = \frac{1}{4\pi\epsilon_0}\oint\frac{\sigma_b\,da'}{\boldsymbol{r}} + \frac{1}{4\pi\epsilon_0}\int\frac{\rho_b\,d\tau'}{\boldsymbol{r}}$$

$$V = \frac{1}{4\pi\epsilon_0}\int\frac{k\,dq}{\boldsymbol{r}}$$ triangle diagram

$\sigma_b = \vec{P}\cdot\hat{n}$ $\quad \rho_b = -\vec{\nabla}\cdot\vec{P}$

$$\vec{E} = -\vec{\nabla}V$$

mag fields



$\vec{m} = I\vec{a}$

$\vec{a}$

$$\vec{A}_{dipole} = \frac{\mu_0}{4\pi}\frac{\vec{m}\times\hat{\boldsymbol{r}}}{\boldsymbol{r}^2}$$ one

dipole mom / vol

$$\vec{A} = \int d\vec{A} = \int\frac{\mu_0}{4\pi}\frac{\vec{M}\times\hat{\boldsymbol{r}}}{\boldsymbol{r}^2}\,d\tau'$$

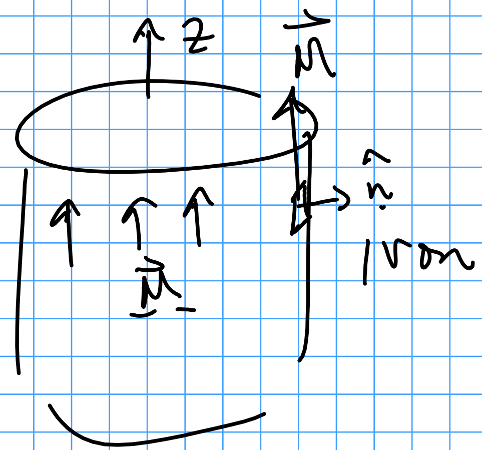
↓ vector calculus

$$\vec{A} = \frac{\mu_0}{4\pi}\int_{vol}\frac{\vec{J}_b(\vec{r}')\,d\tau'}{\boldsymbol{r}} + \frac{\mu_0}{4\pi}\oint_S\frac{K_b\,da'}{\boldsymbol{r}}$$

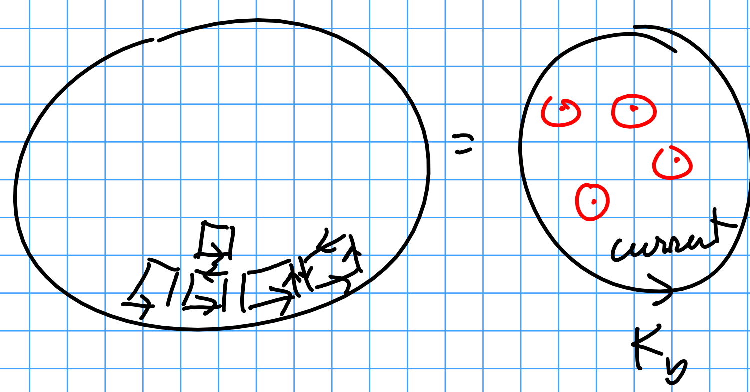
triangle diagram $\vec{A} = \frac{\mu_0}{4\pi}\int_{vol}\frac{\vec{J}(\vec{r}')\,d\tau'}{\boldsymbol{r}}$

$\vec{B} = \vec{\nabla}\times\vec{A}$ { inside / outside } matter

$\vec{K}_b = \vec{M} \times \hat{n}$ $\quad$ $\vec{J}_b = \vec{\nabla} \times \vec{M}$



Solenoid



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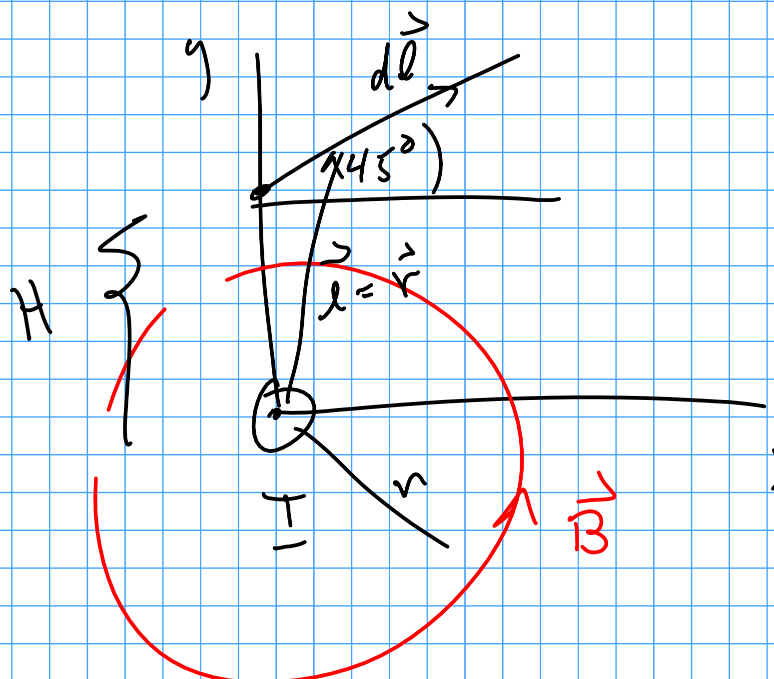


$\vec{B} \cdot d\vec{l}$

$y = ax + b = x + H \Rightarrow dy = dx$

$b = H$

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

$d\vec{l} = dx\,\hat{x} + dy\,\hat{y}$

$dy = dx$

$d\vec{l} = dx\,\hat{x} + dx\,\hat{y}$

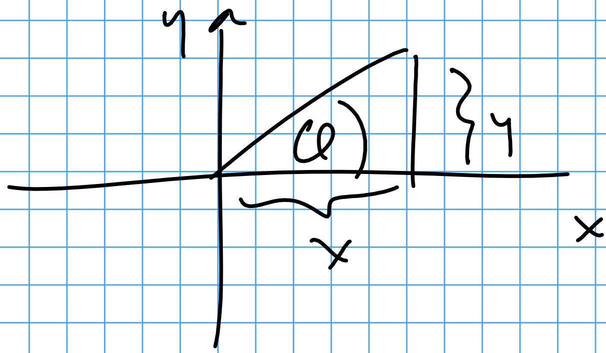
$\vec{B} = \frac{\mu_0 I}{2\pi r}\hat{\varphi}$

$\hat{\varphi} = -\sin\varphi\,\hat{x} + \cos\varphi\,\hat{y}$

$\hat{\varphi}\cdot\hat{\varphi} = \sin^2\varphi + \cos^2\varphi = 1$

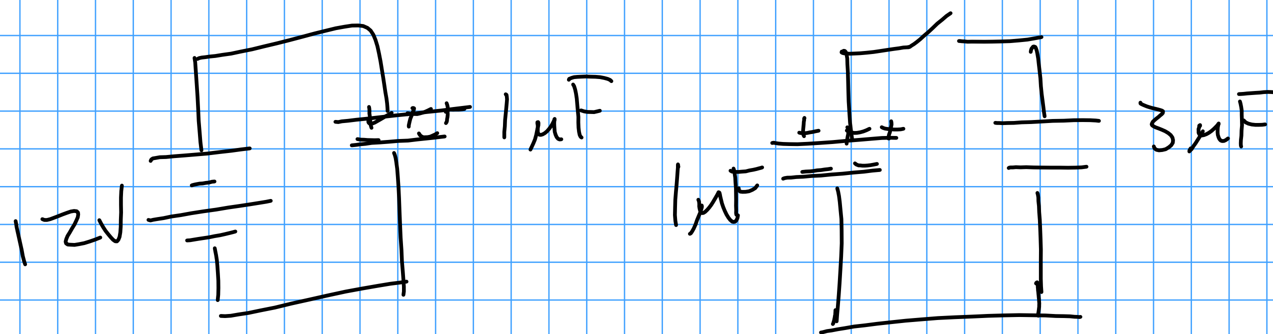
$\int \vec{B}\cdot d\vec{l} = \int \frac{\mu_0 I}{2\pi\sqrt{x^2+y^2}}(-\sin\varphi\,\hat{x} + \cos\varphi\,\hat{y})\cdot(dx\,\hat{x} + dx\,\hat{y})$

variable of integration is x. As x varies θ varies



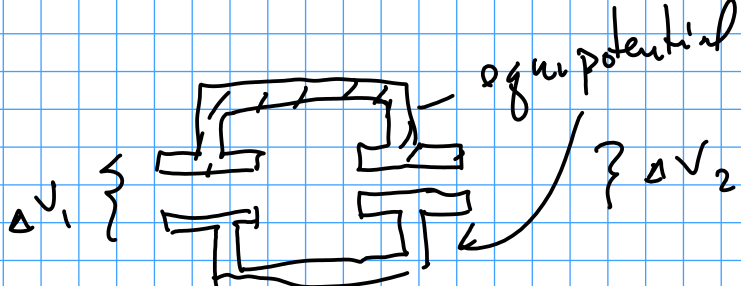
$$\cos\theta = \frac{x}{\sqrt{x^2+y^2}}$$

$$\sin\theta = \frac{y}{\sqrt{x^2+y^2}}$$



Cons charge, defn of cap $C = \frac{Q}{V}$

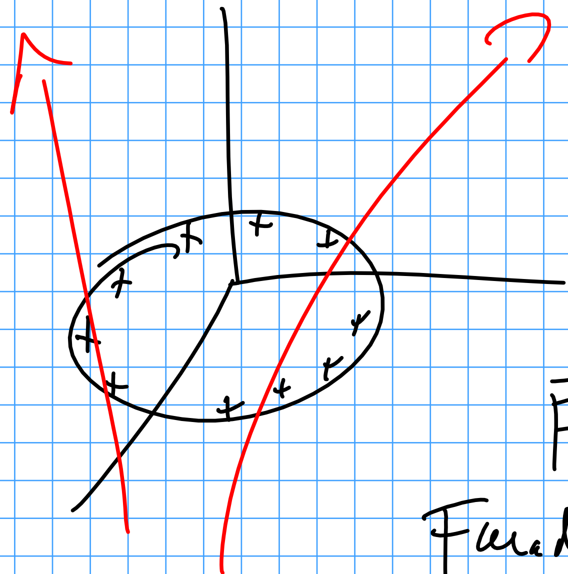
$$Q_{in} = CV = (10^{-6}\,F)(12\,V) = Q_f = Q_{f,1} + Q_{f,2}$$



$$(10^{-6})(12) = 10^{-6}\,F\,V_{f1} + 3\times10^{-6}\,F\,V_{f,2}$$

$$V_{F,1} = V_{F,2}$$

2 eqn
2 unks



$\vec{B}(x,y,z,t)$ given

ring of charge

$$\vec{F} = q\vec{v}\times\vec{B} + q\vec{E} = m\vec{a}$$

Faradays law $\quad \mathcal{E}mf = -\frac{d\Phi_B}{dt}$

Outline cal: choose dq

$$d\vec{F} = dq\,\vec{v}\times\vec{B} + q\vec{E}$$

$$dq = \lambda R\, d\varphi$$

Check: $B(x,y\,z,t) \to B(x,y\,z)$ get rid of $\vec{E}$