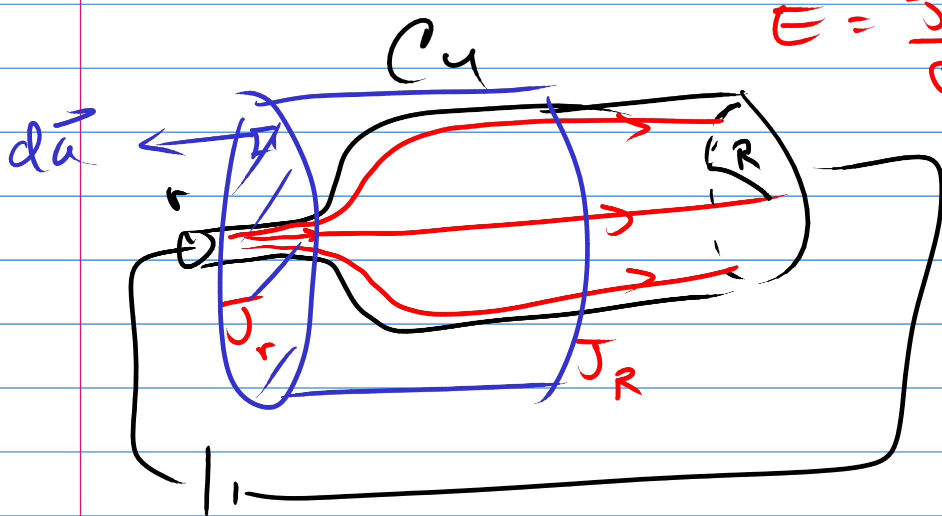
$$\vec\nabla\cdot\vec E = 0$$

$$\vec\nabla\cdot\frac{\vec J}{\sigma} = 0$$

in steady state

$$\vec E = \frac{\vec J}{\sigma}$$



Find J_r & J_R

Try $\vec\nabla\cdot\vec J = 0$

div th $\int \vec\nabla\cdot\vec J\, d\tau = \oint \vec J\cdot d\vec a$

$$\int_r \vec J_r\cdot da + \int_R \vec J_R\cdot da + \int_{\text{body}} \cancelto{0}{\vec J\cdot da}$$

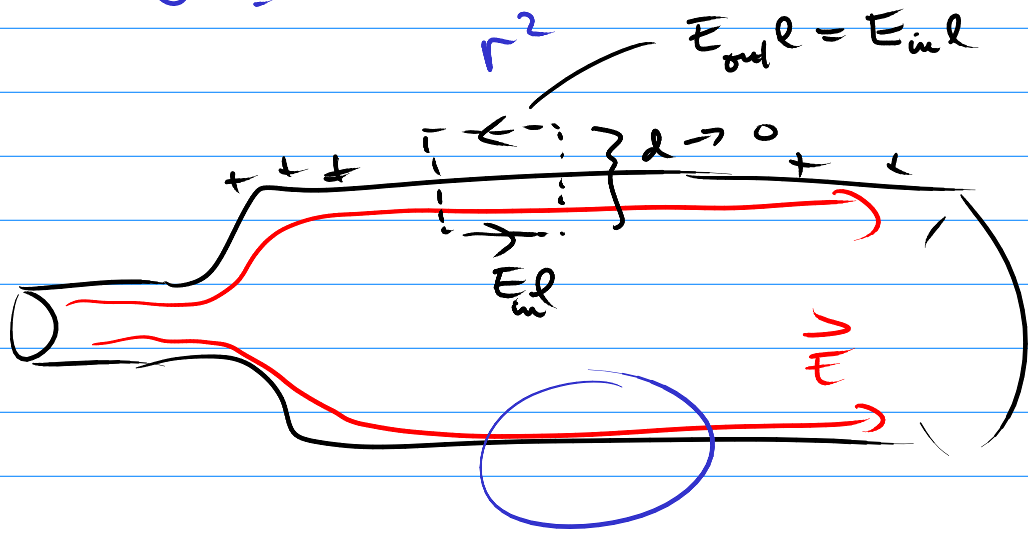
$$-J_r \pi r^2 + J_R \pi R^2 = 0$$

$$\vec{J} = \rho \vec{v}_{drift}$$

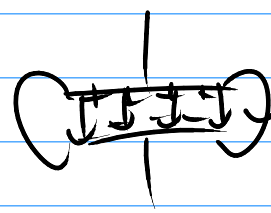
$$\cancel{\rho_r}\, v^r \pi r^2 = \cancel{\rho_R}\, v^R \pi R^2$$

incompressible fluid

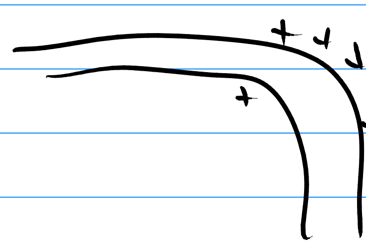
$$v^r = v^R \frac{R^2}{r^2}$$

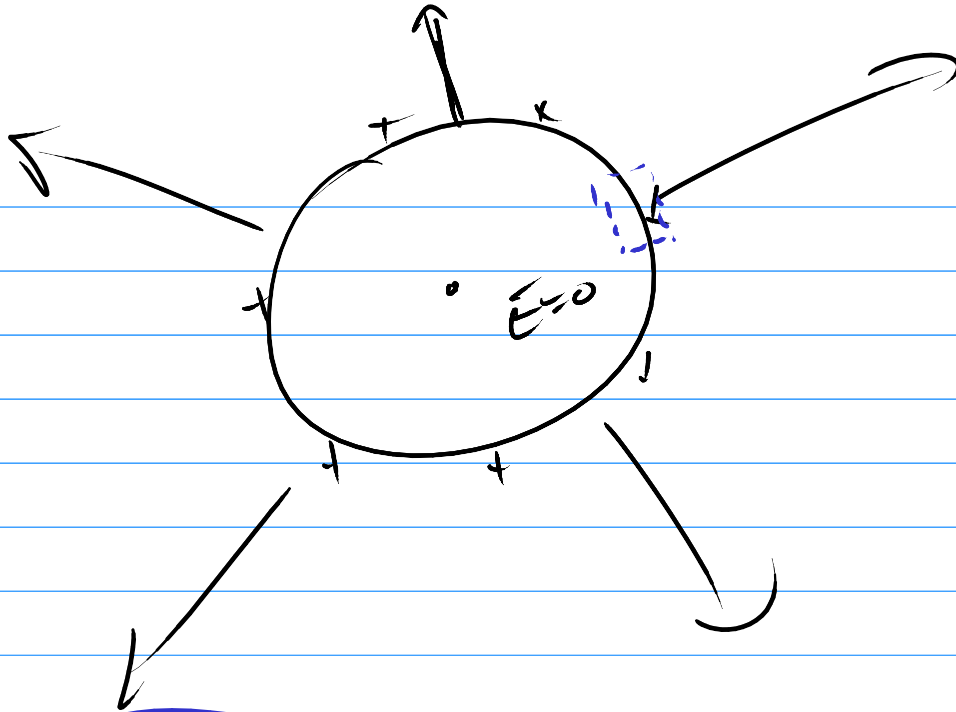


$$\vec{\nabla} \times \vec{E} = 0$$



$$\int \underbrace{\vec{\nabla} \times \vec{E}}_{=0} \cdot d\vec{a} = \oint \vec{E} \cdot d\vec{l} = 0$$



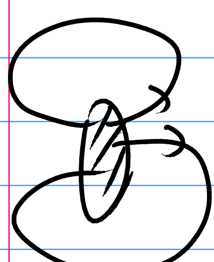


Faraday's law

$$\mathcal{E}_{mf} = -\frac{d\Phi_B}{dt}$$

$$\parallel$$

$$IR = -\frac{d}{dt}\int \vec{B}_{tot}\cdot d\vec{a}$$



$\vec{B}_{magnet}$ or $\vec{B}_{current}$ or $\vec{B}_{tot}$

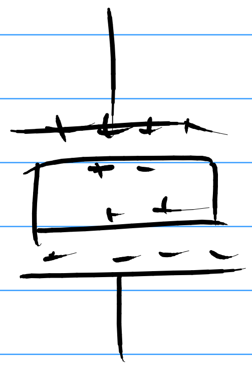
$$\vec{B}_{tot} = \vec{B}_{magnetic} + B_{wire}$$

$B_{wire} \propto I$ $\qquad$ $\vec{B}_{wire} = \vec{const}\, I$

$$IR = -\frac{d}{dt}\int \vec{B}_{magnet}\cdot d\vec{a} - \frac{d}{dt}\int \vec{const}\, I \cdot d\vec{a}$$

$$IR = -\frac{d}{dt}\Phi_B^{mag} - I\frac{d}{dt}\underbrace{\int \vec{const}\cdot d\vec{a}}_{\Phi_{self}}$$

$\sigma_b = P = \epsilon_0 \chi_e E_{tot}$



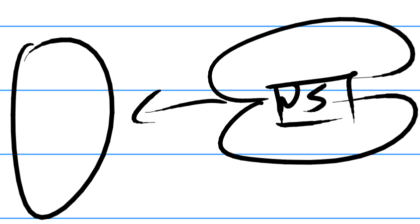
$$E_{tot} = E_{vac} + E_{dielect}$$

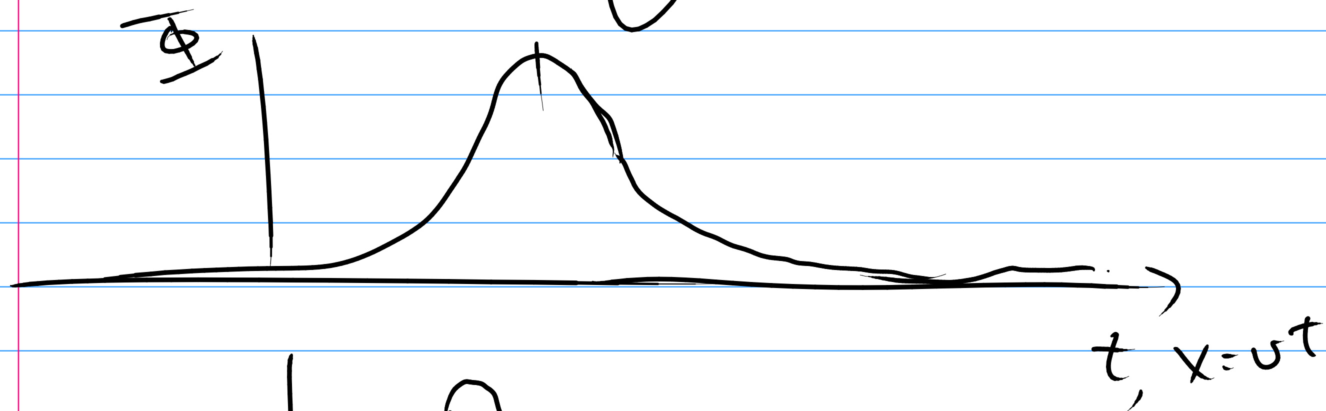
$$E_{tot} = \frac{\sigma_0}{\epsilon_0} + \frac{\sigma_b}{\epsilon_0} = \frac{\sigma_0}{\epsilon_0} + \frac{\epsilon_0\chi_e E_{tot}}{\epsilon_0}$$

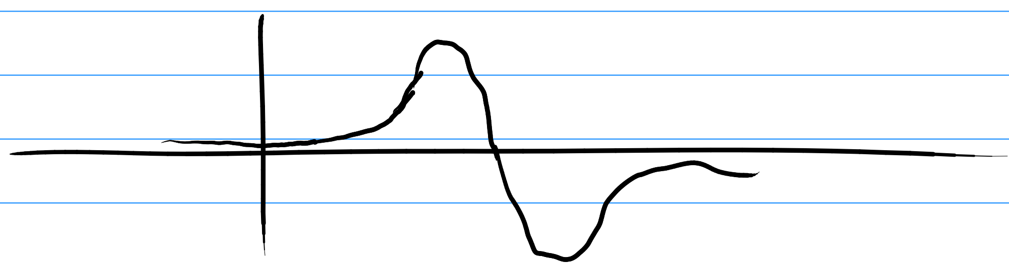
$R \to \infty$ so no I wire & no B_{wire}

$$\mathcal{E}mf = -\frac{d\Phi_m}{dt} = -\frac{d}{dt}\int \vec{B}\cdot d\vec{a}$$

$= IR$







Monopoles