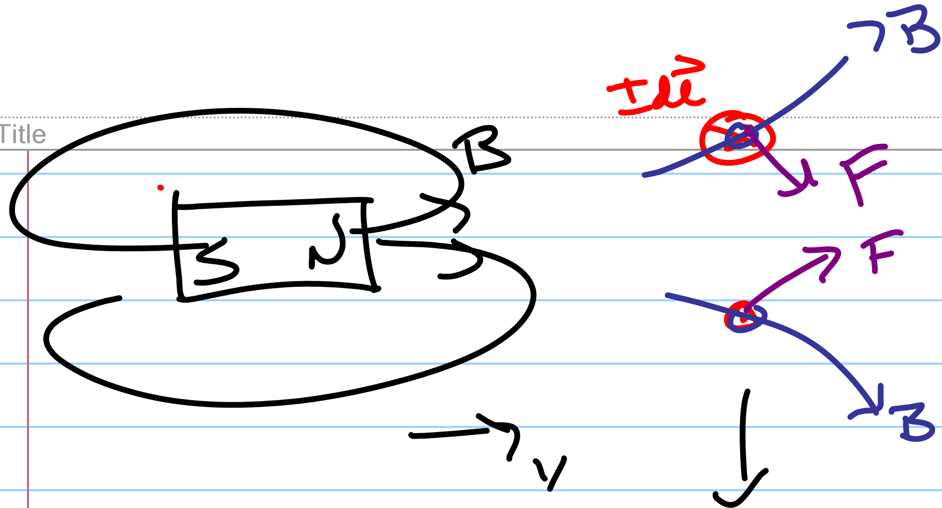
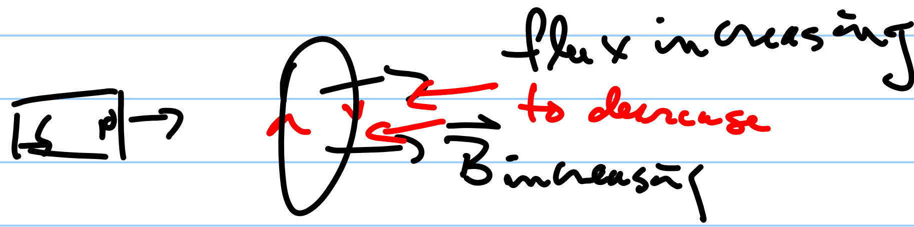
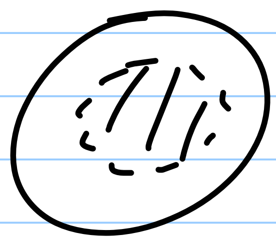


$$\mathcal{E}mf = -\frac{d\Phi_m}{dt}$$



Gauss's Law:

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{encl}}{\epsilon_0}$$



$$E\,4\pi r^2 \qquad Q_{enc} = \iiint A r^2\, r^2 \sin\theta\, d\theta\, d\phi\, dr$$

Ohm's Law

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

$$\vec{\nabla}\cdot\vec{J} = -\frac{\partial\rho}{\partial t} \quad \rightarrow \quad \oint \vec{J}\cdot d\vec{a} = -\frac{\partial Q_{enc}}{\partial t}$$

outflow of current due to loss of charge inside surface

steady state

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

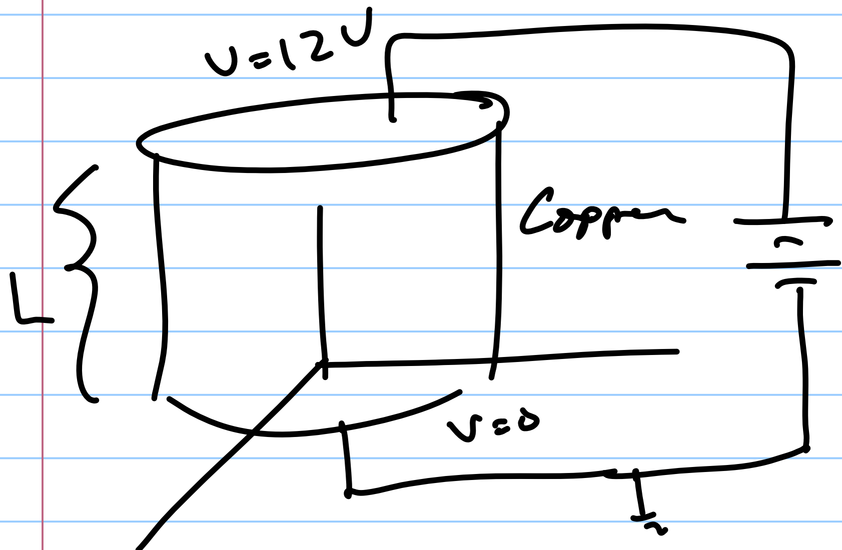
$$\vec\nabla\cdot\vec J = \vec\nabla\cdot\sigma\vec E = \sigma\vec\nabla\cdot\vec E = \phi$$

const

steady state

$$\vec E = -\vec\nabla V \qquad \sigma\nabla^2 V = 0 \qquad \boxed{\nabla^2 V = 0}$$

Laplace's Eqn



$\nabla^2 V = 0$ solve with bndy cond to find V Then get $\vec E = -\vec\nabla V$

$\vec J = \sigma\vec E$ know J

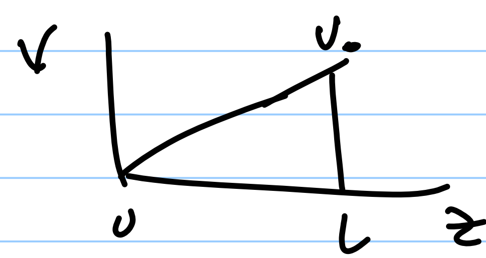
$$\nabla^2 V = 0 \qquad \frac{1}{s}\frac{\partial}{\partial s}\left(\cancel{s\frac{\partial V}{\partial s}}^{\,0}\right) + \cancel{\frac{1}{s^2}\frac{\partial^2 V}{\partial\phi^2}}^{\,0} + \frac{\partial^2 V}{\partial z^2} = 0$$

$$V = S(s)\,\Phi(\varphi)\,Z_1(z)$$

const

$$V(s) = \phi \qquad V(\varphi) = \phi$$

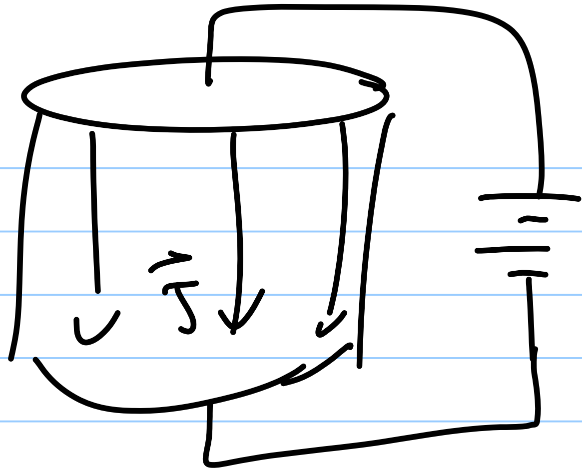
$$\frac{\partial^2 Z_1}{\partial z^2} = 0 \qquad Z_1 = Az + B$$

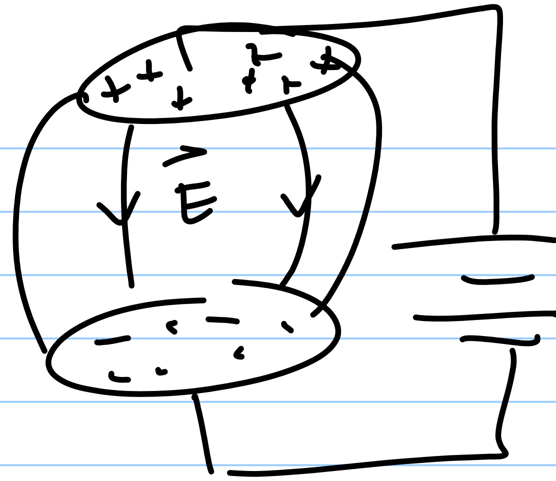


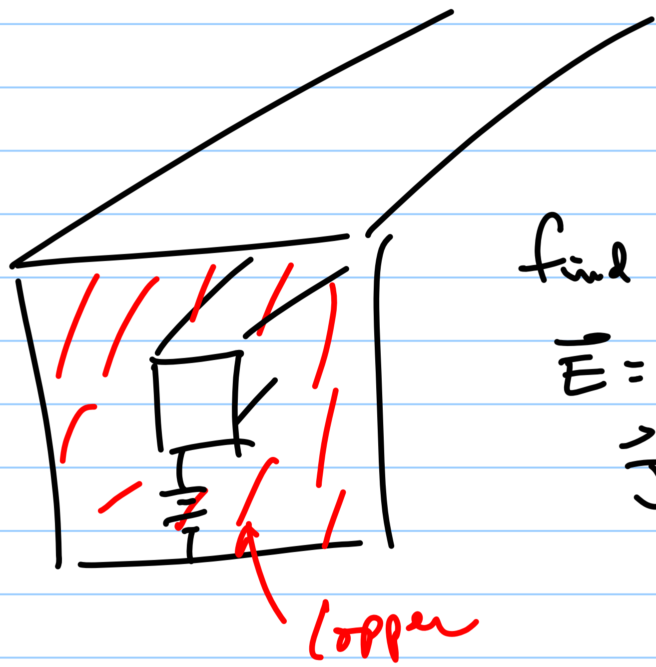
$\vec E = -\vec\nabla Z_1 = \text{const}$

$\vec J$ is const

$\vec{J} \propto \vec{E}$







find V using Relaxation method

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

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