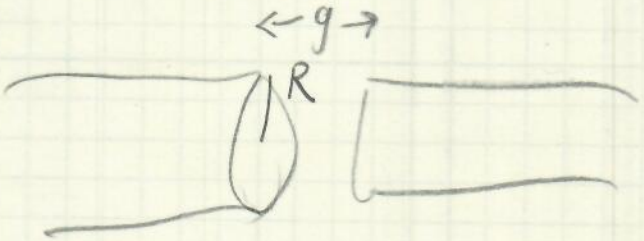
Problem 8.2



$\vec{E}(t) = It/A\epsilon_0 \hat{z}$

$\vec{B}(t) = \frac{\mu_0 r I}{2\pi R^2} \hat{\phi}$

$\vec{S} = -\hat{r} \frac{I^2 r t}{2\pi R^2 \pi R^2 \epsilon_0}$

$u = \frac{1}{2}\epsilon_0 \frac{I^2 t^2}{A^2 \epsilon_0^2} + \frac{1}{2\mu_0} \frac{\mu_0^2 r^2 I^2}{4\pi^2 R^4}$

$\int \nabla \cdot \vec{S} = -\frac{\partial u}{\partial t} d\tau$

$\int \vec{S} \cdot d\vec{a} = -\frac{d}{dt} \int u \, d\tau$

$\frac{du}{dt} = \frac{\epsilon_0 I^2 t}{A^2 \epsilon_0^2}$ ... so not a function of r

$\int \frac{du}{dt} d\tau = \tau \frac{du}{dt} = \frac{I^2 t}{A^2 \epsilon_0} Ag = \frac{I^2 t}{A\epsilon_0} g$

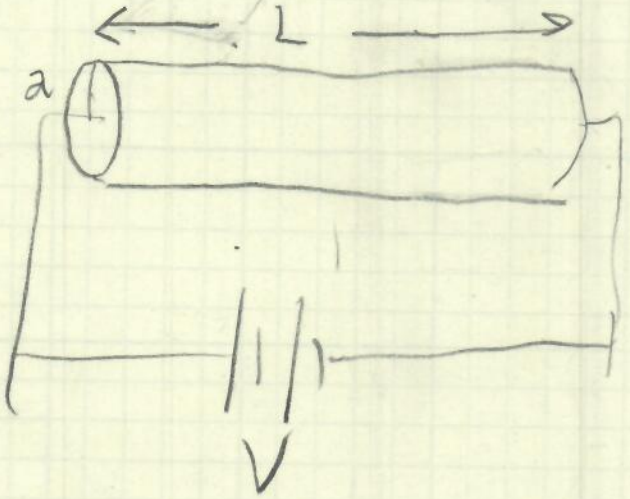
$\int \vec{S} \cdot d\vec{a} = \int_0^{2\pi} d\phi \int_0^g dz \frac{r I^2 r t}{2\pi R^2 \pi R^2 \epsilon_0}$

$d\vec{a} = dx\,dz\,\hat{y}$
$dr\,d\phi\,\hat{r}$
$r\,dr\,d\phi\,\hat{\phi}$
$dz\,d\phi\,\hat{r}$
$r\,dz\,d\phi\,\hat{r}$

But $r = R$

$\int d\phi \int dz \frac{I^2 t}{2\pi^2 R^2 \epsilon_0} = \frac{I^2 t \, 2\pi g}{2\pi^2 R^2 \epsilon_0}$

$= \frac{I^2 t g}{\pi R^2 \epsilon_0}$ ✓



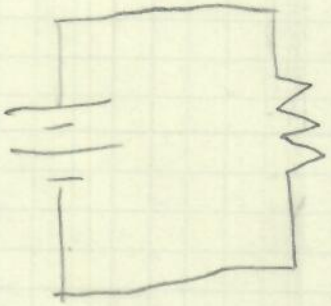
$$E = \frac{V}{L}\,\hat{z}$$

$$B = \frac{\mu_0 I}{2\pi a}\,\hat{\phi}$$

$$S = \frac{1}{\mu}\vec{E}\times\vec{B}$$

$$S = \frac{V I}{L\,2\pi a}$$

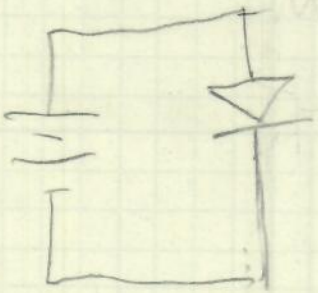
$$\int \vec{S}\cdot d\vec{a} = 2\pi a L S = IV$$



$$P = I^2 R$$

$$V = IR$$

$$P = IV$$



$$I = I_0\left(e^{+\frac{qV}{kT}} - 1\right)$$

$$\Delta W = q\,\Delta V$$

$$\frac{dW}{dt} = \frac{dq}{dt}\Delta V = I\,\Delta V$$

General Result