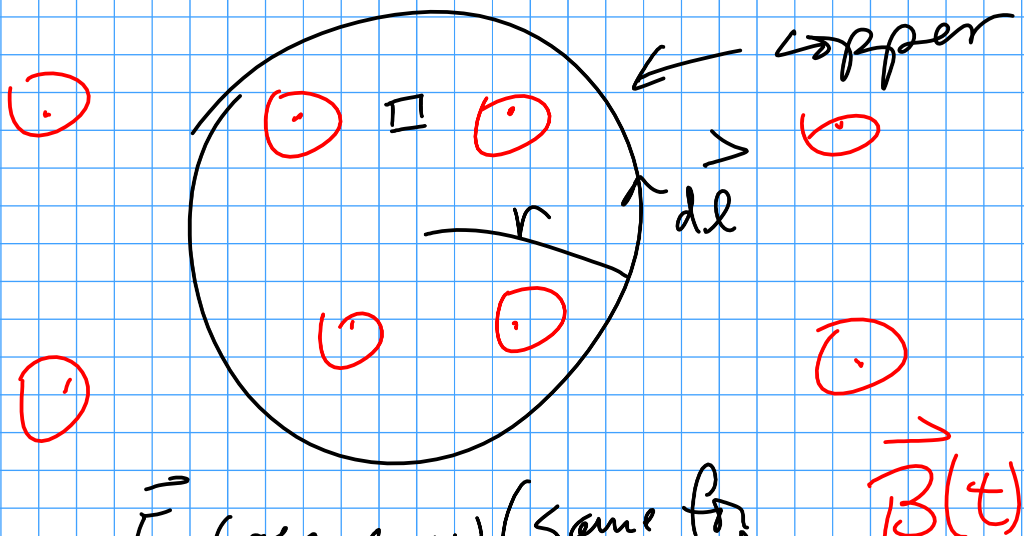
$$\mathcal{E}mf = -\frac{d\Phi_B}{dt} \qquad \oint \vec{E}\cdot d\vec{l} = -\frac{d\Phi_B}{dt}$$



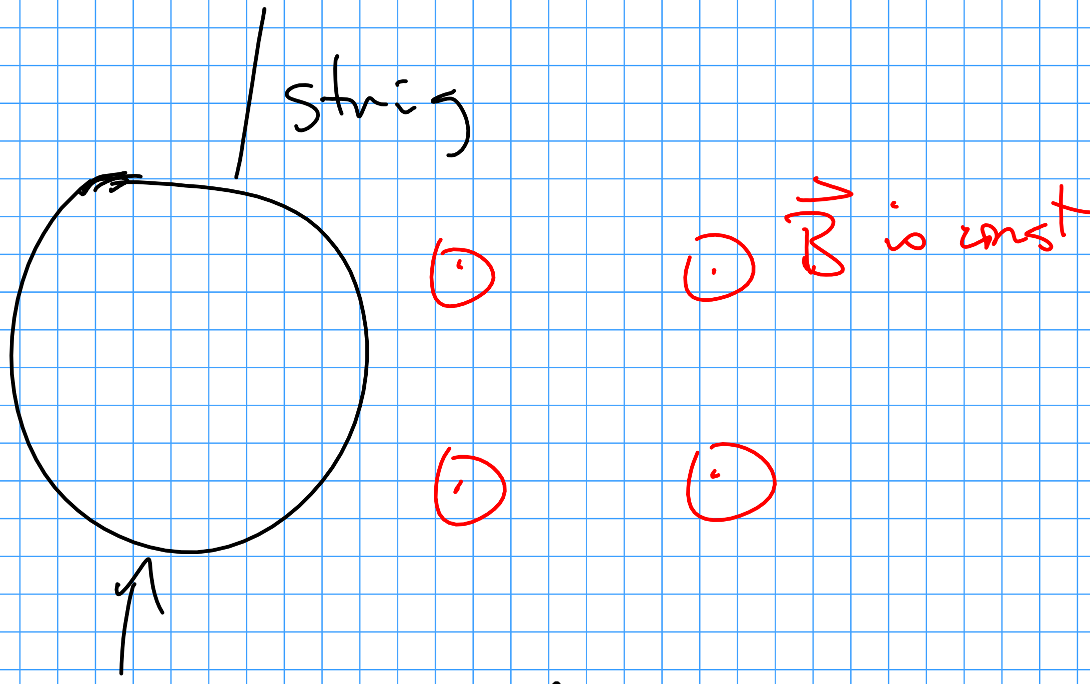
assume $\vec{E}$ goes ccw (same for all $d\vec{l}$)

$$\oint \vec{E}\cdot d\vec{l} = E\,2\pi r = -\frac{d}{dt}\int \vec{B}\cdot d\vec{a} = -\frac{d}{dt}B(t)\pi r^2$$

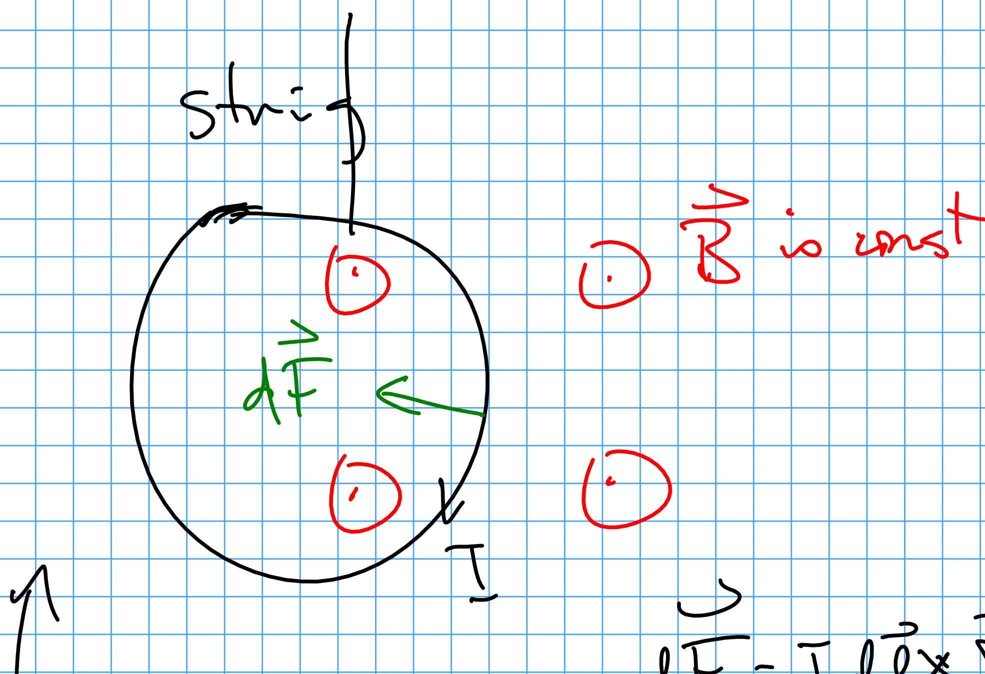
homogeneous

$$E\,2\pi r = \pi r^2(-)\frac{dB}{dt}$$

if $\frac{dB}{dt} > 0$

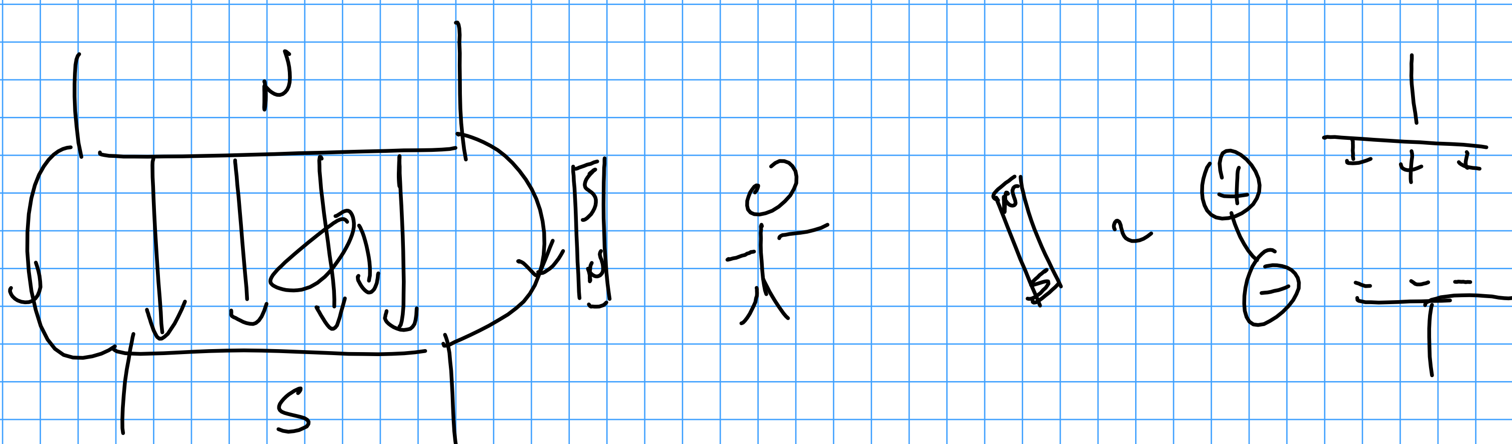


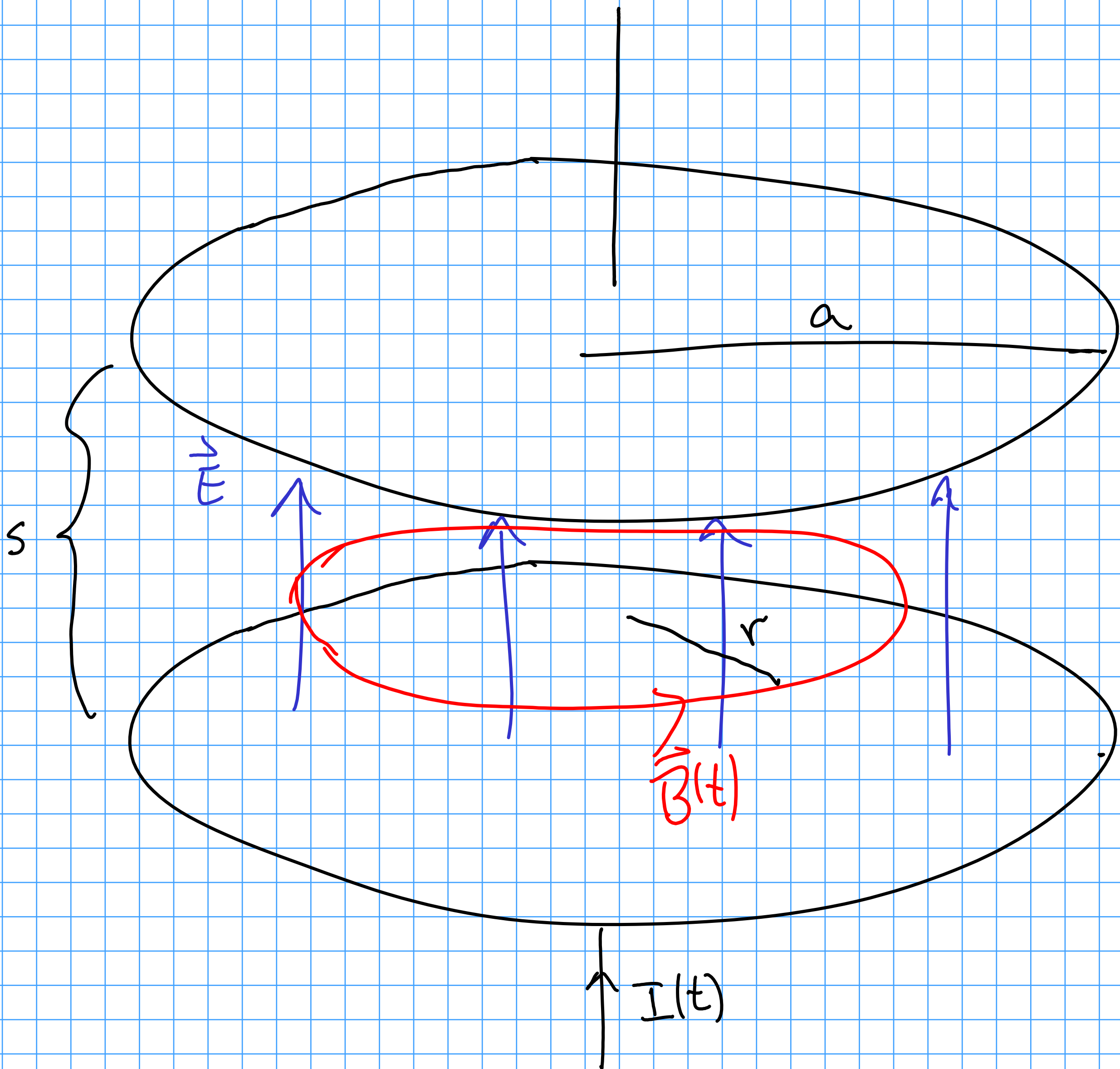
Copper loop Pendulum



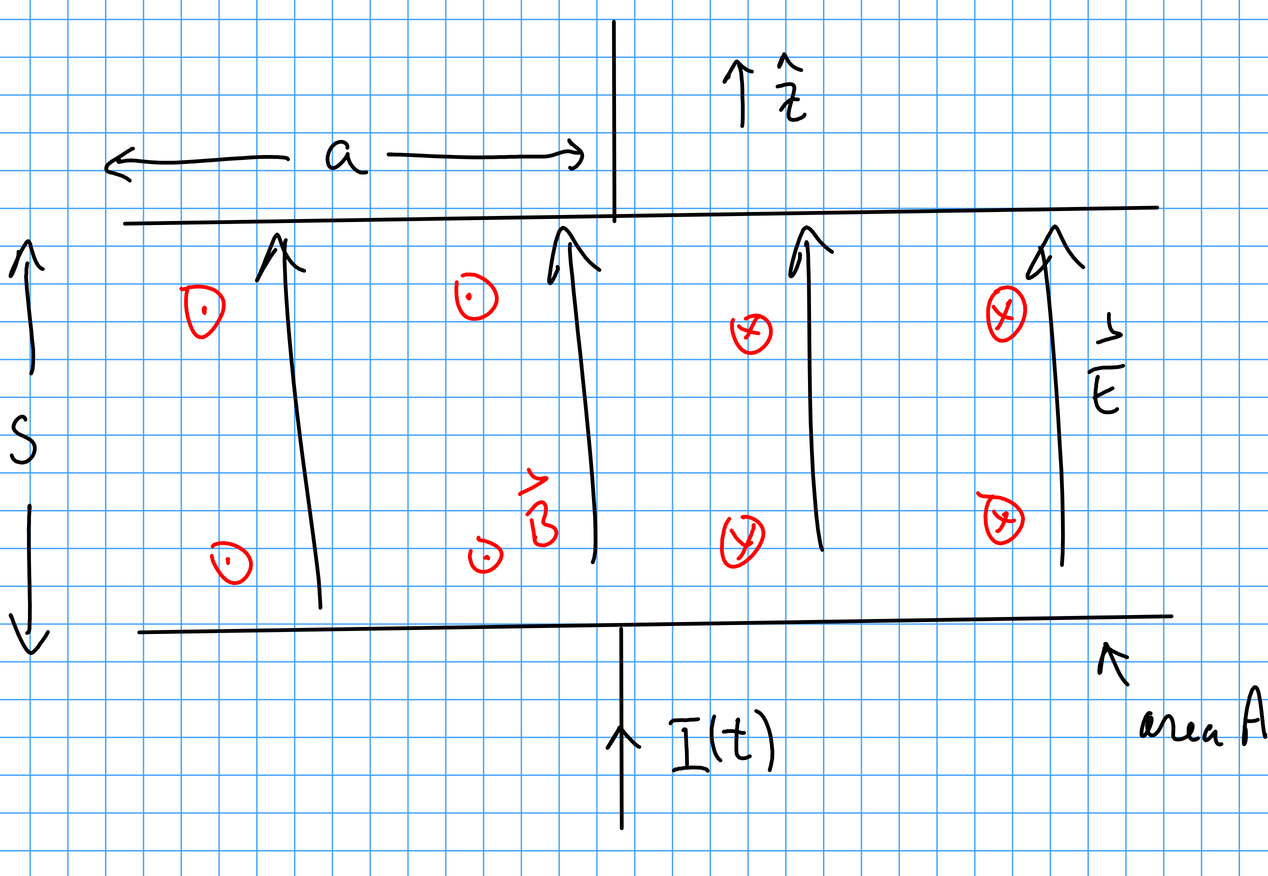
Copper loop Pendulum

$$d\vec{F} = I\, d\vec{l} \times \vec{B}$$





a
$\vec{E}$
s
r
$\vec{B}(t)$
$I(t)$



$\hat{z}$
a
s
$\vec{E}$
$\vec{B}$
area A
$I(t)$

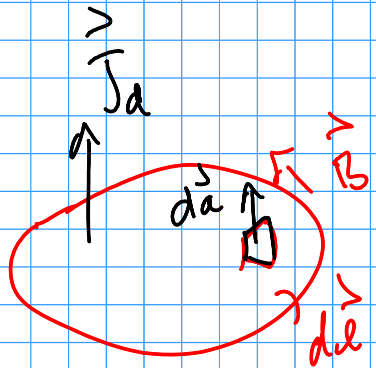
$$\vec{J}_d = \epsilon_0 \frac{\partial \vec{E}}{\partial t} \; ; \quad \vec{E} = \frac{\sigma}{\epsilon_0}\hat{z} = \frac{1}{\epsilon_0}\frac{Q}{A} \; ; \quad \frac{\partial \vec{E}}{\partial t} = \frac{1}{\epsilon_0}\frac{I(t)}{A}$$

$$\boxed{\vec{J}_D = \frac{I}{A}\hat{z}} \Rightarrow$$

$$\vec{\nabla}\times\vec{B} = \cancel{\mu_0 \vec{J}}^{\,0} + \mu_0\epsilon_0\frac{\partial \vec{E}}{\partial t}$$

stokes

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 \int \vec{J}_d \cdot d\vec{a}$$



$$B\,2\pi r = \mu_0 \int \frac{I}{A}\hat{z}\cdot da\,\hat{z} \qquad A \leftarrow \pi a^2$$

$$d\vec{a} = r\,dr\,d\varphi\,\hat{z}$$

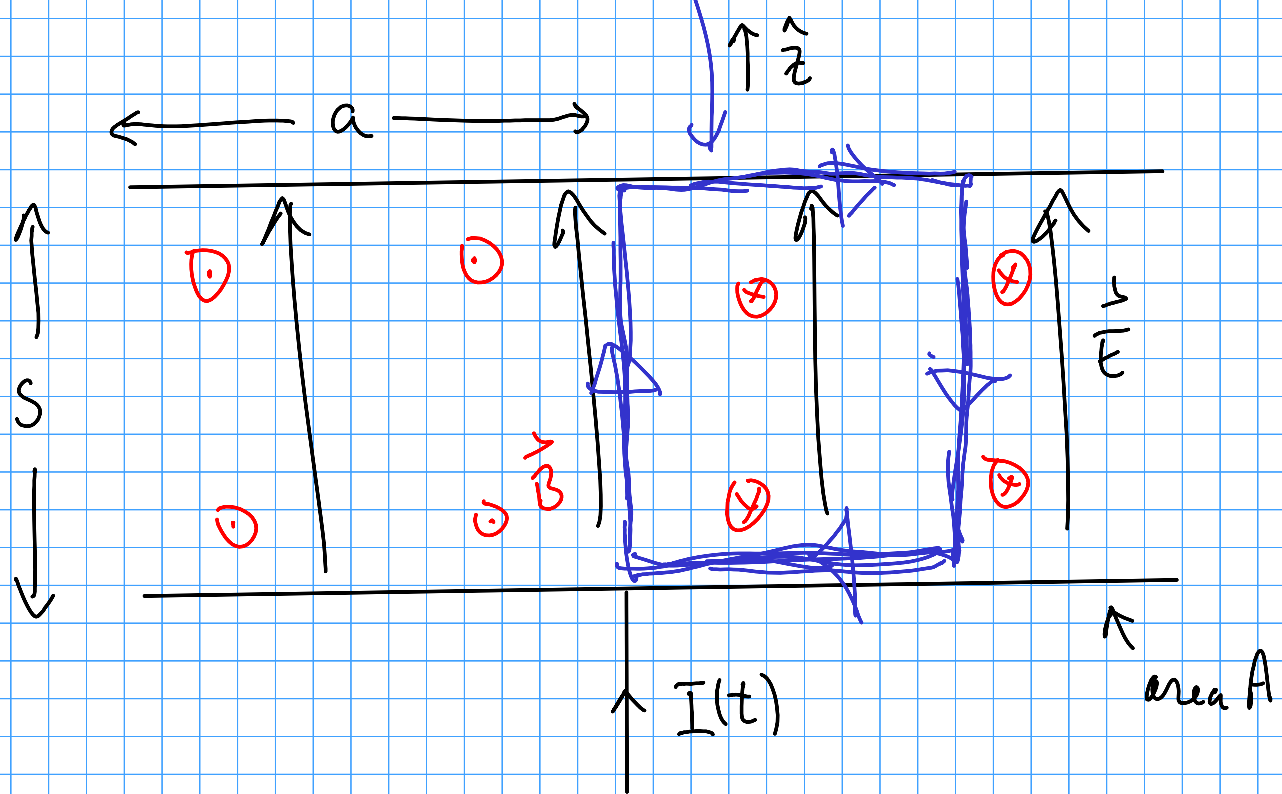
$$B\,2\pi r = \mu_0 \frac{I\,\pi r^2}{\pi a^2}$$

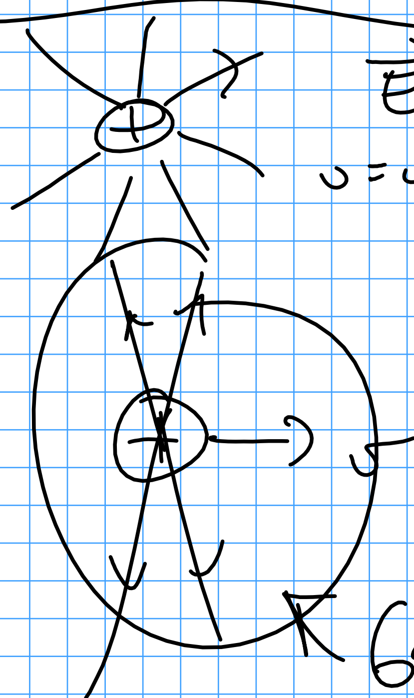
$$\vec{B} = \frac{\mu_0 I}{2\pi}\frac{r}{a^2}\hat{\varphi}$$

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

Faraday's law

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{a}$$





$$\vec{E} = \frac{kq}{r^2}\hat{r}$$

$v = 0$

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

Gaussian surface stationary