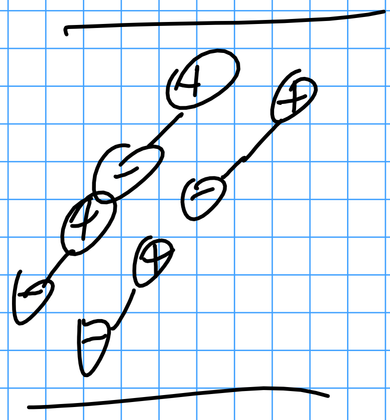
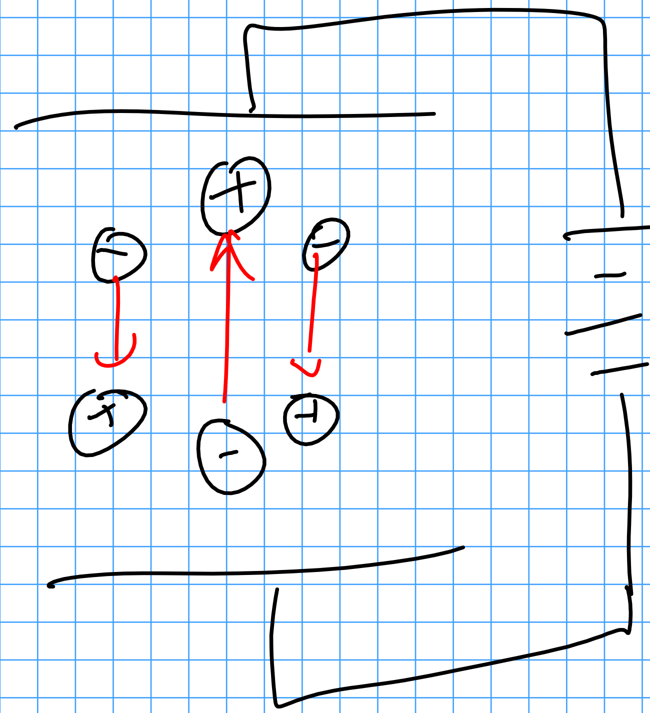
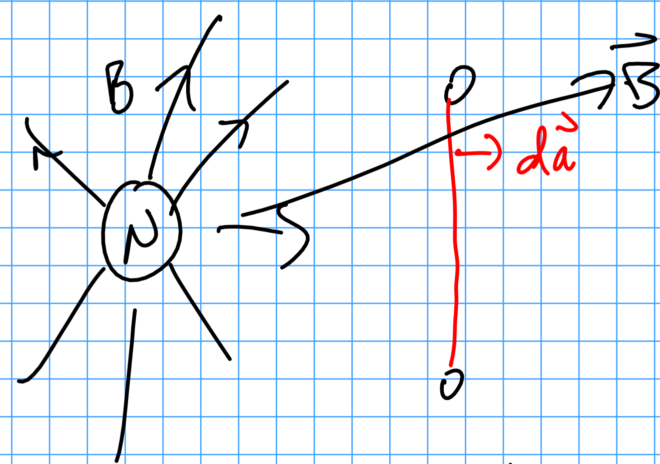
Piezoelectric



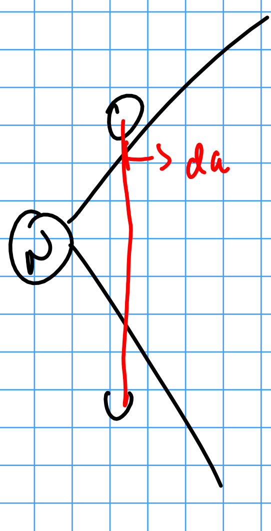


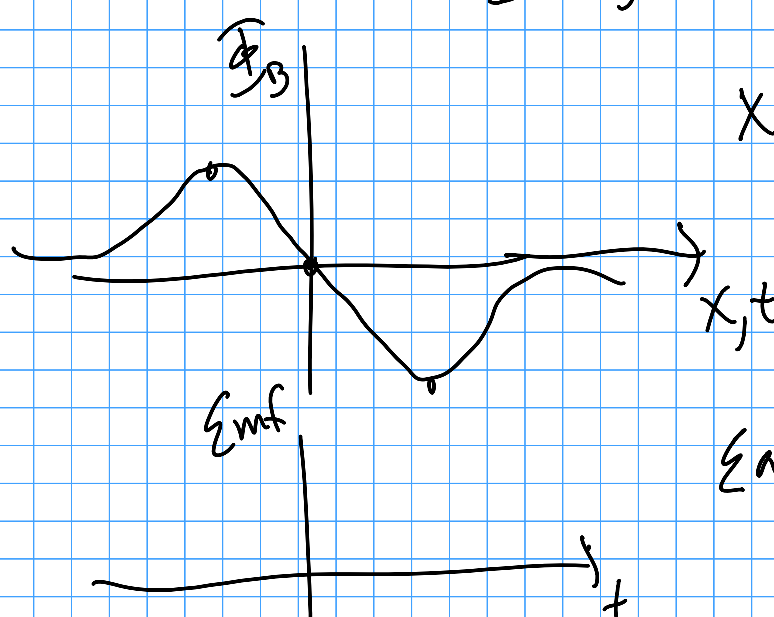
Faraday's Law

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



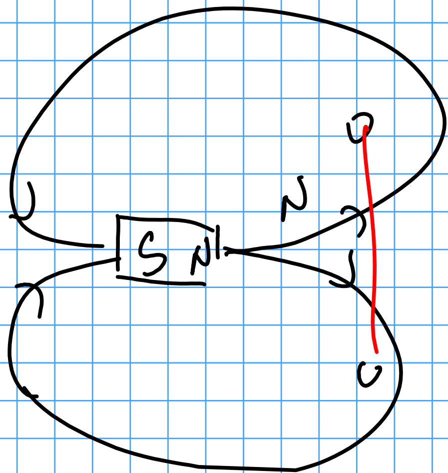
$$\Phi = \int \vec{B} \cdot d\vec{a}$$

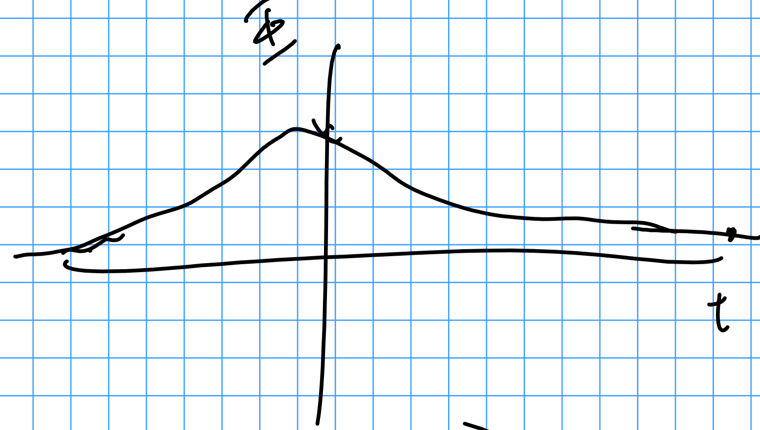


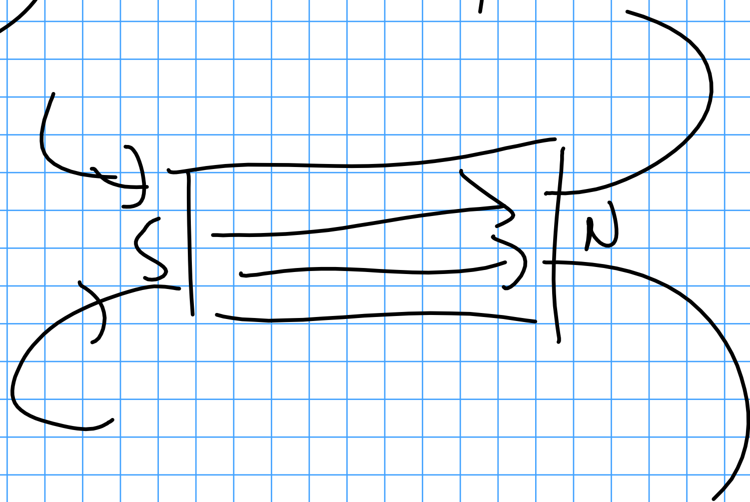


$x = vt$

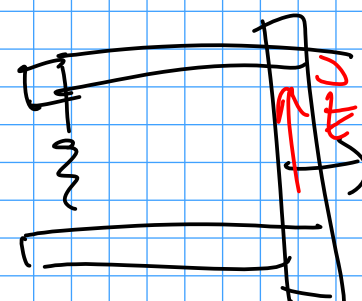
Emf is slope

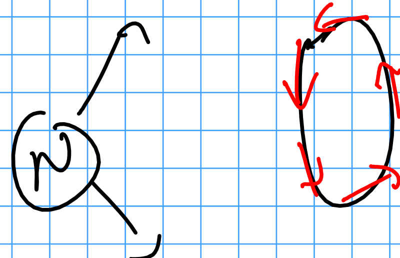






$$\mathcal{E}mf = -\frac{d\Phi_m}{dt} \Rightarrow$$





Emf

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

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

$\cancel{= 0}$ in time dep situations

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

$$\int \vec{\nabla} \times \vec{E} \cdot d\vec{a} = \int -\frac{\partial \vec{B}}{\partial t} \cdot d\vec{a}$$

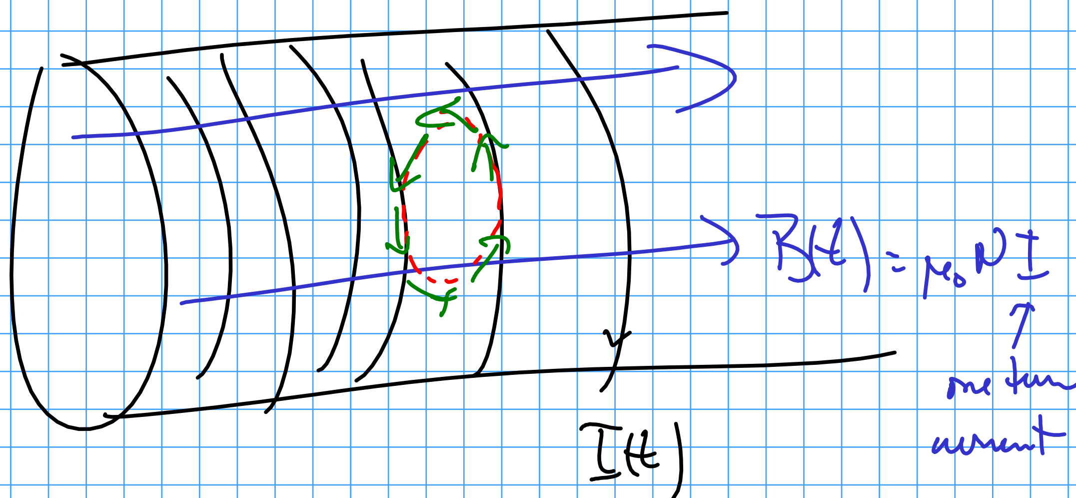
$$\boxed{\vec{\nabla} \times \vec{E} = -\frac{\partial B}{\partial t}}$$

Maxwell's Eqn

$$\vec{\nabla} \cdot \vec{E} = \rho / \epsilon_0 \qquad \vec{\nabla} \cdot \vec{B} = 0$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$$

Ex:



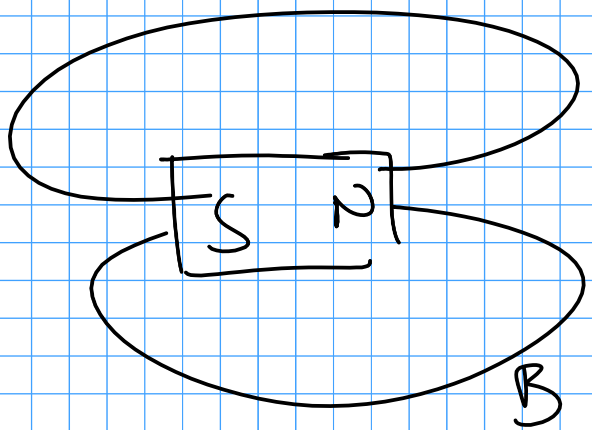
$$\mathcal{E}mf = -\frac{d\Phi_B}{dt}$$

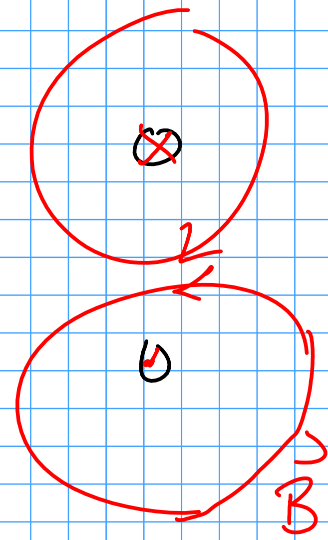
$$\Phi_B = \int \vec{B} \cdot d\vec{a} = B \underbrace{\int da}_{\pi r^2} = \mu_0 N I(t) \pi r^2$$

$$\frac{d\Phi_B}{dt} = \mu_0 N \pi r^2 \frac{dI}{dt} = \mathcal{E}mf = \oint \underbrace{\vec{E} \cdot d\vec{l}}_{E\, dl \cos\phi} = E \underbrace{\oint dl}_{2\pi r}$$

$$\mu_0 N \cancel{\pi} r^{\cancel{2}} \frac{dI}{dt} = E\, 2\cancel{\pi}\cancel{r}$$

Minus sign ⇒ Lenz's law

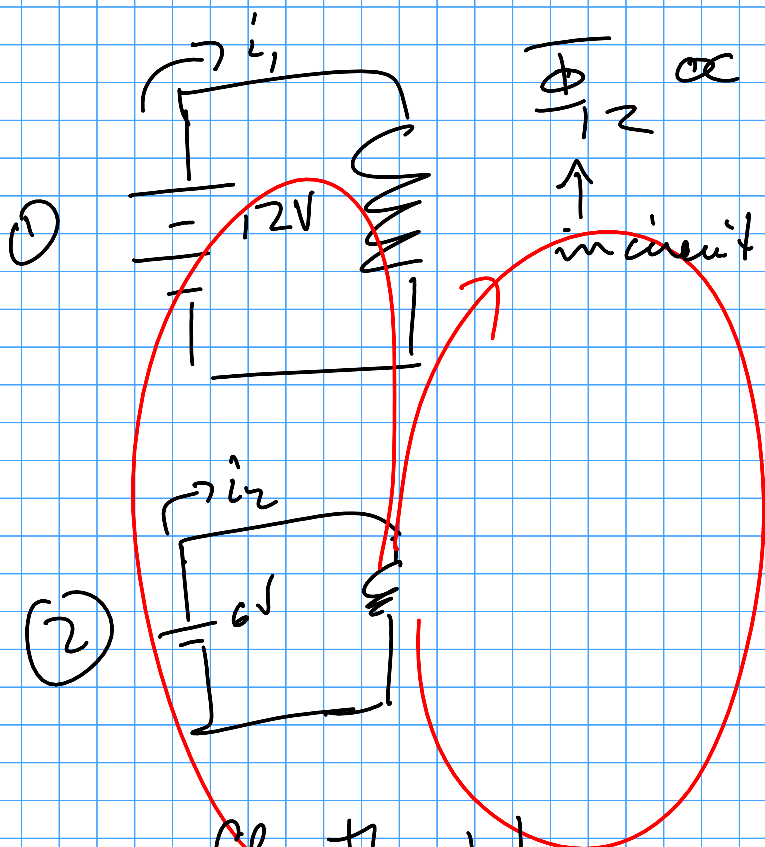




$$\mathcal{E}mf = -\frac{d}{dt}\int \vec{B}\cdot d\vec{a}$$

B_{tot}

Circuits



$\Phi_{12} \propto i_2$ $\Phi_{12} = M_{12}\, i_2$

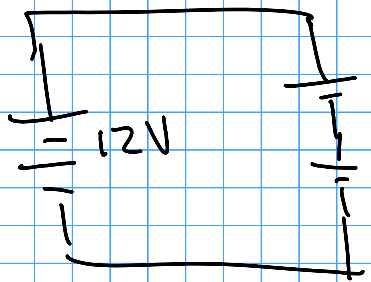
in circuit 1 due 2

geometric effects

$\Phi_{12} = N_1 \Phi$ ← flux thru 1 turn $= M_{12}\, i_2$

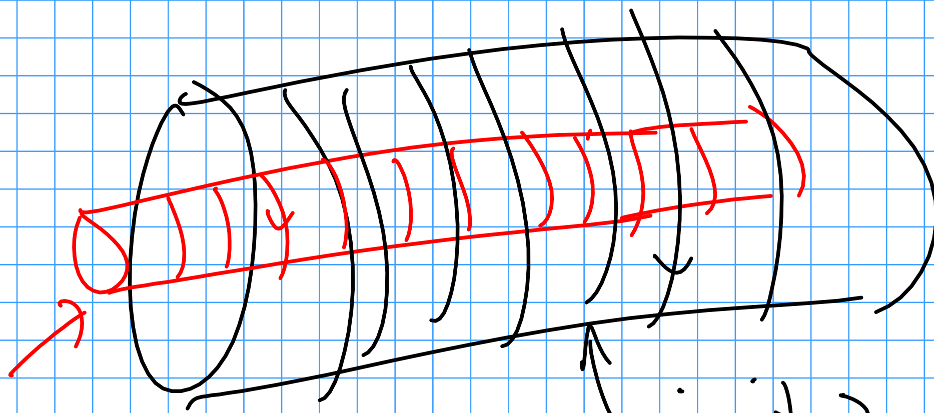
\# turns in solenoid 1

$$\mathcal{E}mf = -\frac{d\Phi_{12}}{dt} = -M_{12}\frac{di_2}{dt}$$



Emf due to circuit 2

Self inductance



How do you find M_{12}?