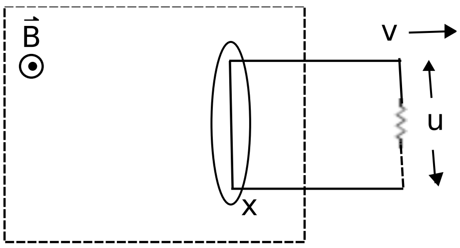
8.022 Lecture Notes Class 34 - 11/16/2006

Expt. # 1

$\vec{F_S}$ source (like battery)

$$\oint \frac{\vec{F}}{q} \cdot d\vec{l} = \oint \tfrac{F_S}{q} d\vec{l} + q \oint \vec{E} \cdot d\vec{l} = V$$
$$\oint \vec{F} \cdot dl = \oint F_S d\vec{l}$$



Let $f = \frac{F}{q}, \frac{F_s}{q} = f_s$

$$\oint \frac{\vec{F}}{q} d\vec{l} = \oint \vec{F_S} q \cdot d\vec{l} + \oint \vec{E} d\vec{l}$$
$$\oint \vec{f} d\vec{l} = \oint \vec{f_s} dl + \oint \vec{E} d\vec{l}$$

$$\oint f \cdot dl = v \cdot B \cdot h$$

$$\Phi = \lambda \cdot h \cdot B$$
$$\frac{d\Phi}{dt} = h \cdot B \cdot \tfrac{dx}{dt} = hB(-v)$$

$$\boxed{\oint f \cdot dl = -\frac{d\Phi}{dt} = V}$$

Expt # 2

Move $\vec{B}$ instead of loop
By experiment , $\varepsilon = -\frac{d\Phi}{dt}$ (voltage equal to rate of decrease of flux on loop)
By math,

$$\begin{aligned} \varepsilon = & \oint f \cdot dl \\ = & \oint f_s dl \\ = & \oint \vec{E} \cdot d\vec{l} \neq 0 \end{aligned}$$

($\varepsilon \sim V$, electromotive force)

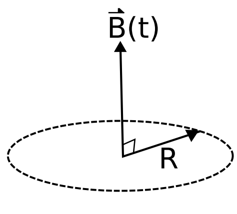
Faraday's Law (Griffiths)

$$\boxed{\oint \vec{E} \cdot d\vec{l} = -\int \frac{\partial B}{\partial t} dA}$$

get curly electric field field by moving magnetic field
Apply Stokes :

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

Find $\vec{E}$ on surface
from $\vec{B}(t)$



$$
\begin{aligned}
\oint \vec{E} = d\vec{l} = & -\int \frac{\partial B}{\partial t} dA \\
E \cdot 2\pi R = & -\frac{\partial B}{\partial t} \pi R^2 \\
E = & -\frac{\partial B}{\partial t} \frac{R}{2} \\
\vec{E} = & -\frac{\partial B}{\partial t} \frac{R}{2} \hat{\phi}
\end{aligned}
$$