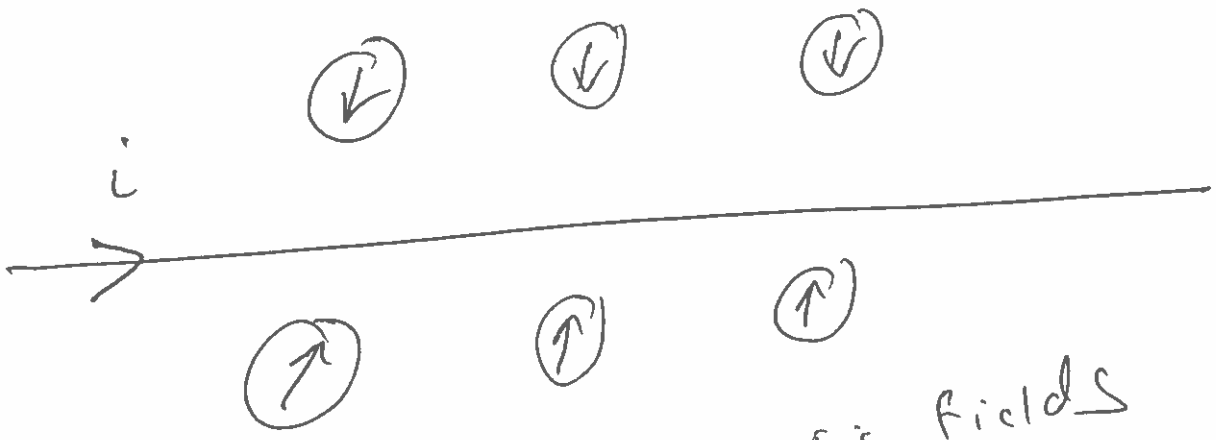
1831 - Michael Faraday



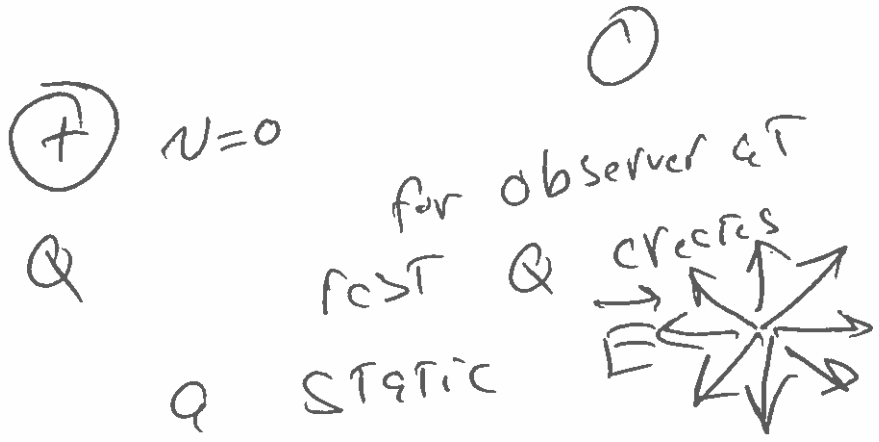
currents create magnetic fields

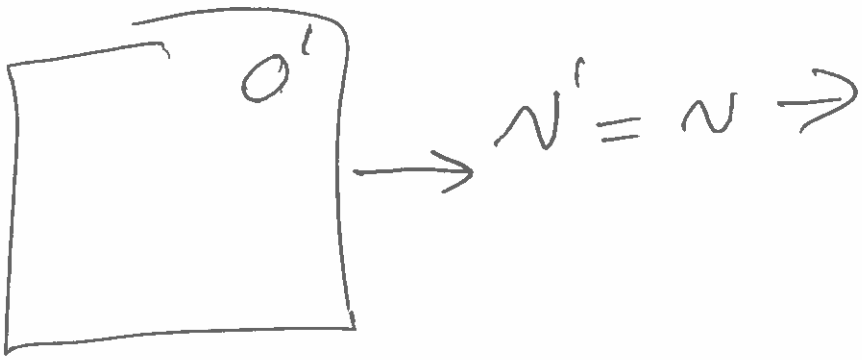
changing magnetic fields Affect electric fields (Electric fields create current)

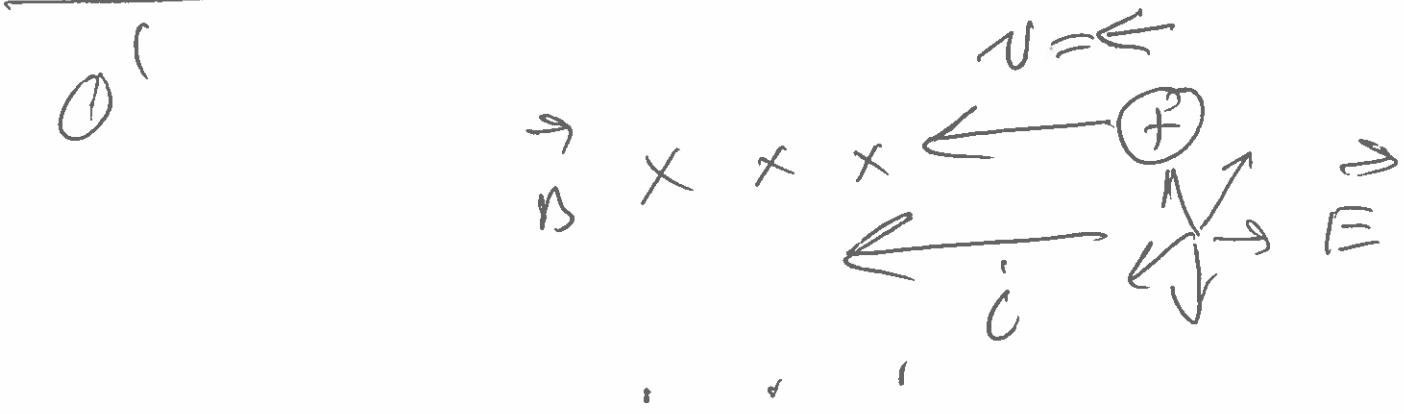
Current is the flow of charge

charges move due to Electric force. Electric force is proportional to Electric field

$$\vec{F}_E = q\vec{E}$$


v=0
for observer at
rest a creates
a static

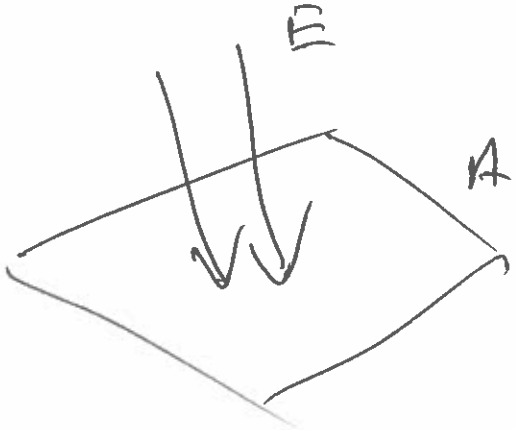

O'
v' = v


O'
v =
B
E
C

A changing Magnetic flux

creates an induced Electric field which if There is a conducting PATH creates an induced current which Therefore creates an induced magnetic field.

Flux is The amount of something passing Through a unit Area in a unit amount of time.



Electric flux

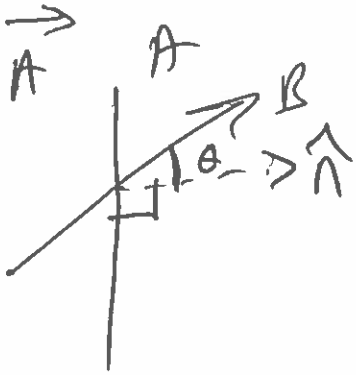
$$\Phi_E = \vec{E} \cdot \vec{A}$$

Gauss's Law

$$\vec{E} \cdot \vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

Magnetic Flux $\Phi_B = \vec{B} \cdot \vec{A}$

$$\Phi_B = BA\cos\theta$$



Flux has units $T\,m^2$ = Webbers

$$1\,Wb = 1\,T\,m^2$$

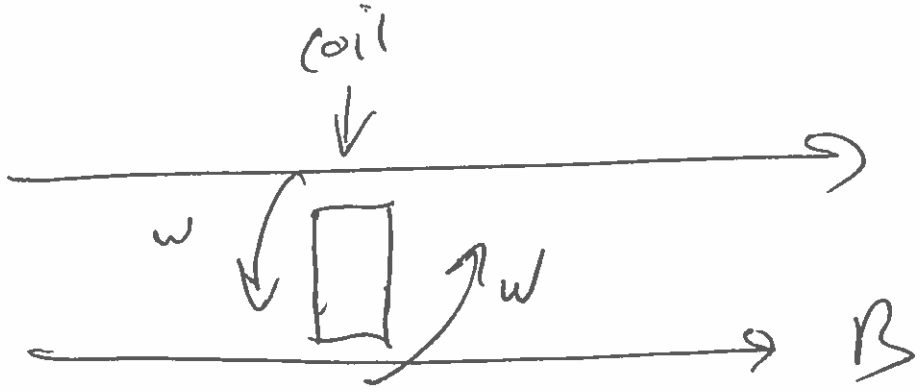
Faraday found $\Delta \Phi_B \Rightarrow E_{induced}$

How does Φ_B change?

1) $\vec{B}$ changes Gets Larger or Smaller

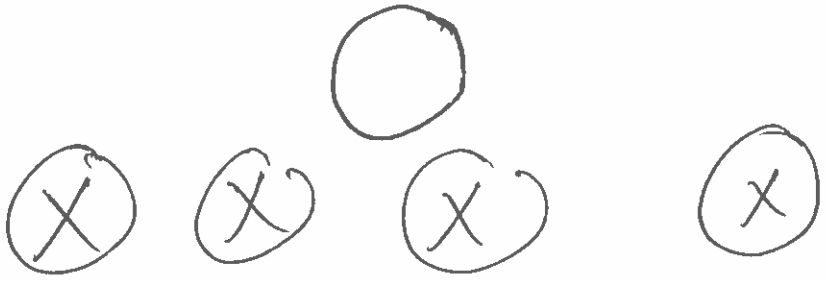
2) Area changes again Gets larger or Smaller

3) orientation between $\vec{A}$ and $\vec{B}$ changes



Lenz's Law says a magnetic field induced due to a changing magnetic flux will be directed to oppose the change in magnetic flux.

$$B = \frac{\mu_0 i}{2\pi r}$$



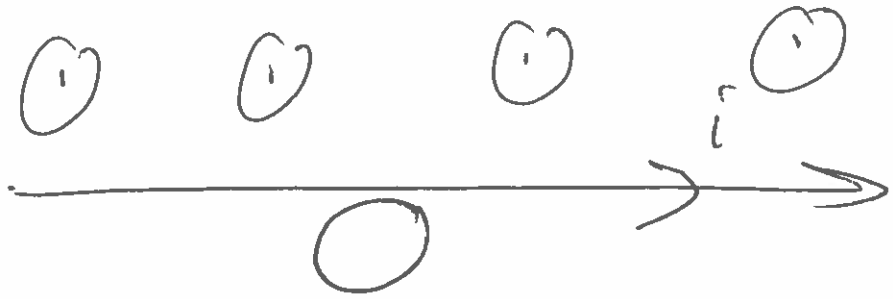
if i is constant $\Rightarrow$ No $\Delta\Phi_B \Rightarrow$ No induced current

LET i increase over time $\Rightarrow$ B increases

B increases $\Rightarrow$ Φ_B increases

Φ_B increase $B_{induced}$ must point out of paper

So i_{induce} MUST flow counter-clockwise!

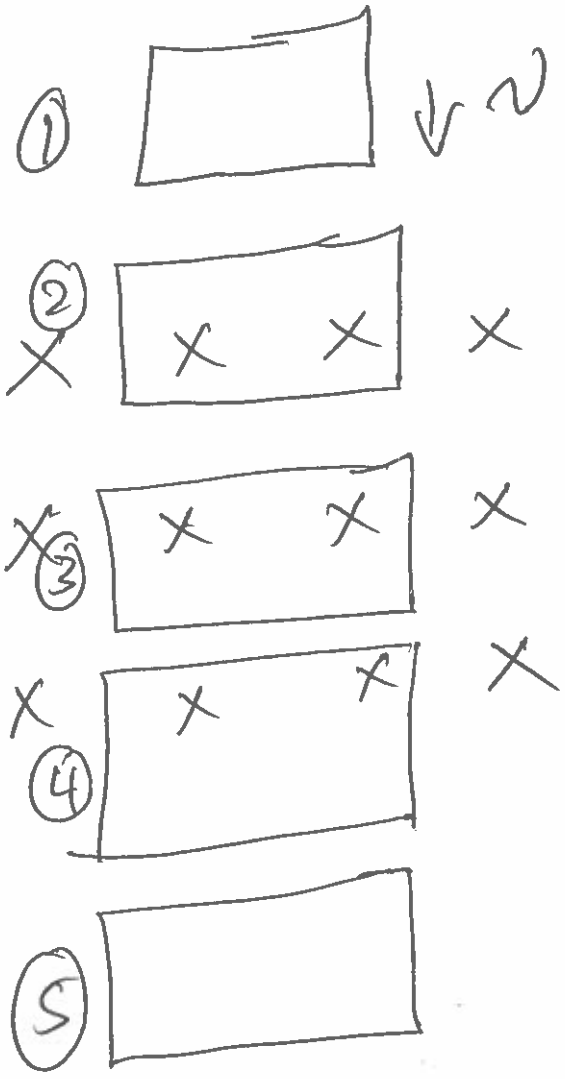


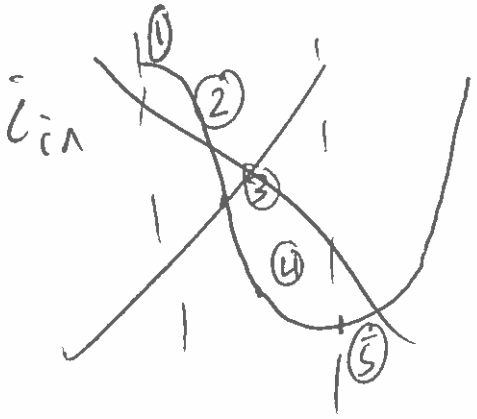
i decreases over time $\Rightarrow$ B decreases

Φ_B is decreasing $B_{induced}$ MUST oppose the change $\Rightarrow$ $B_{induced}$ MUST go into paper (Add to decreasing B field)

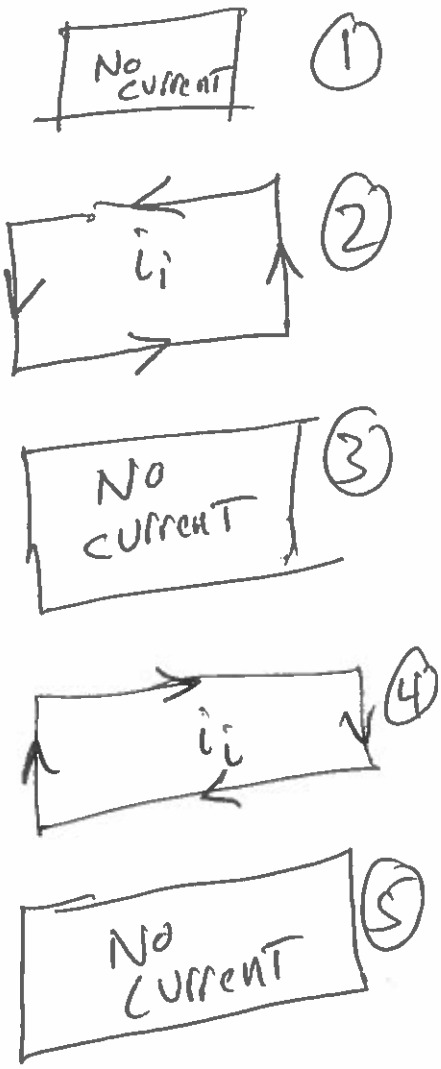
So $i_{induced}$ MUST be clockwise!

Uniform Magnetic field





$\vec{B}$



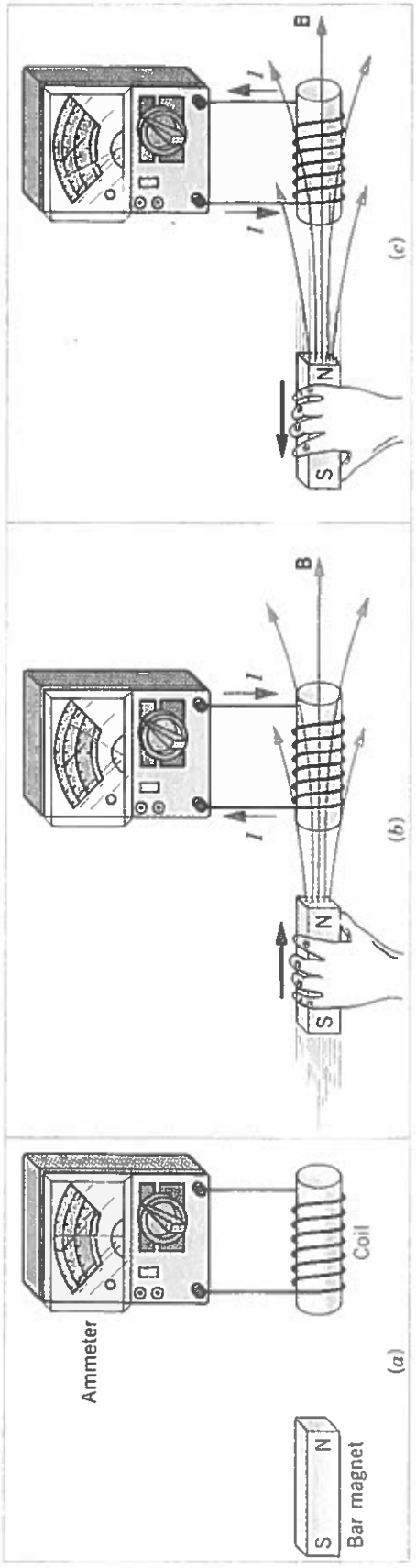


FIGURE 22.1 a, b, c