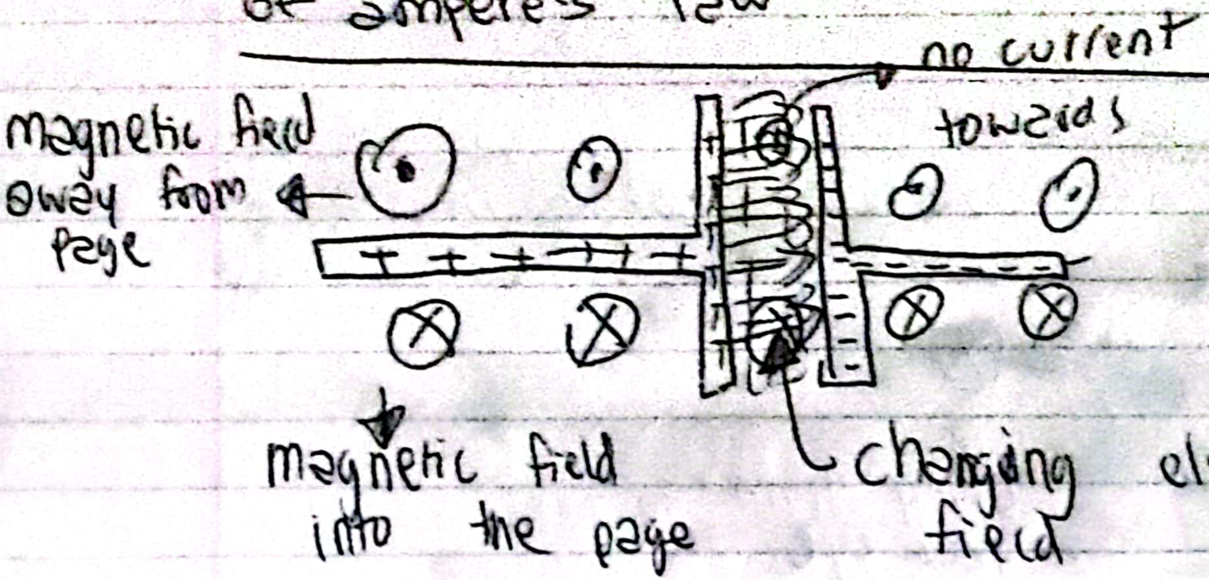
Displacement current and the general formula of ampere's law



- Inside the capacitor there is current so there is magnetic field
- In the empty space no current but change in electric field so there is magnetic field

⇒ so changing electric field produces magnetic field just like conductor

"displacement current"

$$\boxed{= I_d = \varepsilon_0 \frac{d\Phi_E}{dt}}$$ rate of change of electric flux

⇒ $\Phi = \oint \vec{E} \cdot da$ = electric flux

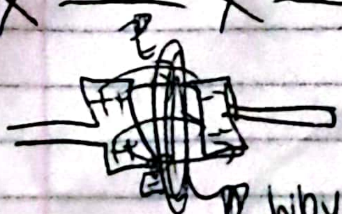
Φ has the same effect as the current in a magnetic field

maxwell's updated equation

⇒ $\oint \vec{B} \cdot d\vec{s} = \mu_0 (I + I_d)$

or, $$\oint \vec{B} \cdot d\vec{s} = \underbrace{\mu_0 I}_{\text{conduction current}} + \underbrace{\mu_0 \varepsilon_0 \frac{d\Phi_E}{dt}}_{\text{displacement current}}$$

—x—x—x—x—x—



Show $I = I_d$

⇒ why magnetic field inside

⇒ when current inside the capacitors are charging, the ~~magnetic~~ electric field between the two capacitors increase so increases magnetic field.

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q/A}{\varepsilon_0} \quad ; \quad I_d = \varepsilon_0 \frac{d\phi_E}{dt}$$

$$E = \frac{Q}{A\varepsilon_0}$$

$$I_d = \varepsilon_0 \left[\frac{d}{dt} \underbrace{\left(\vec{E} \cdot \vec{A} \right)}_{\text{electric flux}} \right]$$

$$= \varepsilon_0 \frac{d}{dt} (EA)$$

$$I_d = \varepsilon_0 A \frac{d}{dt} (E)$$

$$= \cancel{\varepsilon_0 A} \frac{d}{dt} \left(\frac{Q}{\cancel{A\varepsilon_0}} \right)$$

$$I_d = \frac{dQ}{dt} \qquad I_d = I$$