Electric Fields Induced By Changing Magnetic Flux

Sections 21-4, 5

We know that a changing magnetic flux induces an EMF and therefore a current, i.e., there is a force causing the motion of charges.

By definition, the electric field, E, is the force acting on a charge, divided by the size of the charge, or

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

But, F = qvB, since it is caused by the induced magnetic field, B, so

$$q\vec{E} = q\vec{v} \times \vec{B}$$

$$\vec{E} = \vec{v} \times \vec{B}$$

$$E = vB\sin\theta$$

$\theta = \angle$ between $\vec{v}$ and $\vec{B}$

Generators

left wire

$\mathcal{E} = Blv$

right wire

$\mathcal{E} = Blv$

So total

$\mathcal{E} = 2Blv \sin\theta$

θ ∠ between $\vec{v}$ and $\vec{B}$

$\mathcal{E} = \cancel{2}Bl\left(\omega \cdot \frac{h}{\cancel{2}}\right) \sin\omega t$

rotate this with an angular speed ω

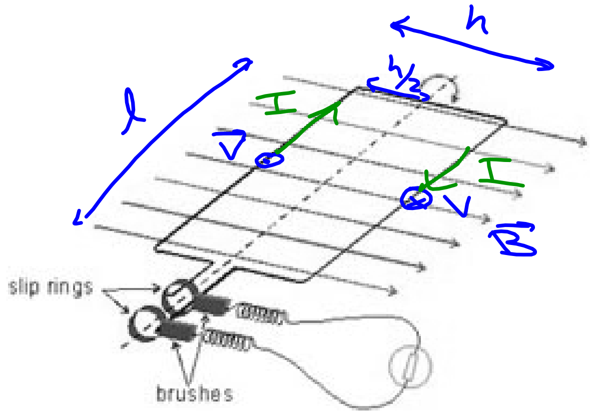
$\theta = \omega t$

$v = \omega r$

$\mathcal{E} = BA\omega \sin\omega t$

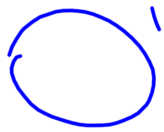
If N loops

$\mathcal{E} = NBA\omega \sin\omega t$.



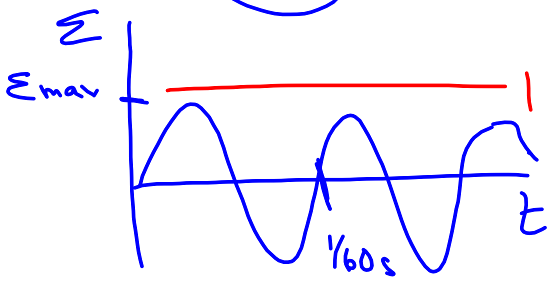
In North America

$f = 60\,Hz$



$\varepsilon = NBA\omega \sin \omega t$

$\varepsilon_{max} = NBA\omega$



$\sin \omega t$

$\sin \omega(1/60\,s) = \sin \theta$

$2\pi = \omega \cdot 1/60$

$\omega = 120\pi$

$\omega = 2\pi f$