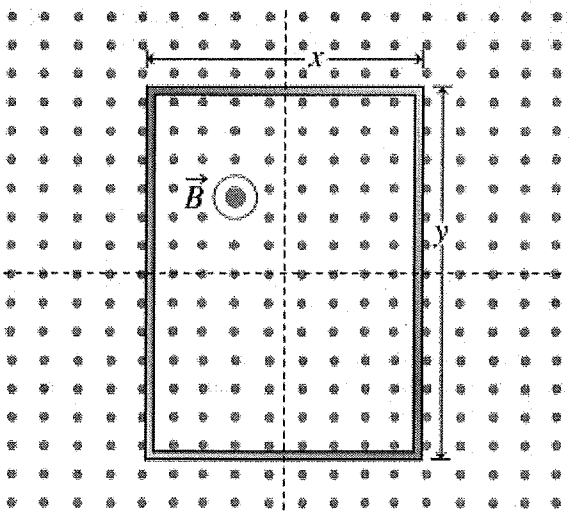
Physics 12 Section 21-2
Faraday's Law of Induction; Lenz's Law

1. Faraday determined that the amount of EMF induced in a loop depended on the rate of change of magnetic field and the rate of change of the loop area.



2. The product of the magnetic field and area of loop is known as the magnetic flux (Φ).

$$\Phi = BA\cos\theta$$

Where θ is the angle between the B field and a line orthogonal the plane of the loop area.

Magnetic flux has the unit of measure of Tm^2 or Weber (Wb).

3. The amount of induced EMF can be found using Faraday's law of induction.

Faraday's Law of Induction

$$\mathcal{E} = -N\frac{\Delta\Phi_B}{\Delta t}$$

N is the number of loops

$\Delta\Phi$ is the change in magnetic flux

The negative sign indicates the direction of the induced EMF.

4. Lenz's Law states that: an induced EMF always gives rise to a current whose magnetic field opposes that original change in flux.

Example p626: A square coil of sides 5.0cm contains 100 loops and is positioned perpendicular to a uniform 0.60T magnetic field. It is quickly pulled from the field to a region where B drops abruptly to zero. It takes 0.10s for the whole coil to reach the field free region. Find the change in magnetic flux, the EMF and current induced, how much energy is dissipated in the coil if its resistance is 100Ω, and what was the average force required?

$$\Delta\Phi = \Phi_2 - \Phi_1$$

$$\Delta\Phi = BA_2 - BA_1$$

$$\Delta\Phi = 0 - 0.60T \times (.05m)^2$$

$$\Delta\Phi = -1.5 \times 10^{-3}Wb$$

$$\mathcal{E} = \frac{-N\,\Delta\Phi}{\Delta t}$$

$$\mathcal{E} = \frac{-100 \times -1.5 \times 10^{-3}Wb}{0.10s}$$

$$\mathcal{E} = 1.5V$$

$$I = \frac{\epsilon}{R}$$

$$I = \frac{1.5\ V}{100\Omega}$$

$$I = .015A$$

$$E = Pxt$$

$$E = I^2R \times t$$

$$E = (1.5 \times 10^{-2}A)^2\ 100\Omega \times 0.10s$$

$$E = 2.3 \times 10^{-3}\ J$$

$$W = F \times d$$

$$F = \frac{W}{d}$$

$$F = \frac{2.3 \times 10^{-3}}{5.0 \times 10^{-2}}$$

$$F = 0.046N$$