Electromagnetic Induction

Motional emf: $\varepsilon = vBL$ if $\vec{v}, \vec{B}, \text{and } L \text{ are } \perp$

Magnetic flux:

$\Phi_B = BA\cos\theta$ θ is the angle between $\vec{B}$ and $\vec{A}$

The magnetic flux changes if:

- the magnetic field $\vec{B}$ changes
- the area of the coil within $\vec{B}$ changes
- the angle between $\vec{B}$ and $\vec{A}$ changes

$\Rightarrow$ the current induced in a coil arises from an induced electromotive force or emf

Faraday's law:

$\varepsilon = -N\dfrac{\Delta\Phi}{\Delta t}$ * - sign indicates that induced emf opposes the change in magnetic flux

$\Rightarrow$ the induced current is given by: $i = \dfrac{\varepsilon}{R}$

Lenz's law:

Lenz's law: an induced current has a direction such that the magnetic field due to the current opposes the change in the magnetic flux that induces the current

* if Φ is decreasing, the induced current produces a $\vec{B}$ field in the same direction as the original field (the induced magnetic field reinforces the original field)

* if Φ is increasing, the induced current produces a $\vec{B}$ field in the opposite direction as the original field (the induced magnetic field opposes the original field)

Transformers:

$$\frac{\varepsilon_2}{\varepsilon_1} = \frac{N_2}{N_1}$$

$$\frac{I_2}{I_1} = \frac{\varepsilon_1}{\varepsilon_2} = \frac{N_1}{N_2}$$