Physics 202
Chapter 31
Oct 23, 2007

Faraday's Law

Faraday's Law

- The final step to ignite the industrial use of electromagnetism on a large scale.
- Light, toasters, cars, TVs, telephones, iPods, industrial production, ...

Faraday's Law

- "the emf induced in a circuit is directly proportional to the time rate of change of the magnetic flux through the circuit"

$$\varepsilon = -\frac{d\Phi_B}{dt}$$

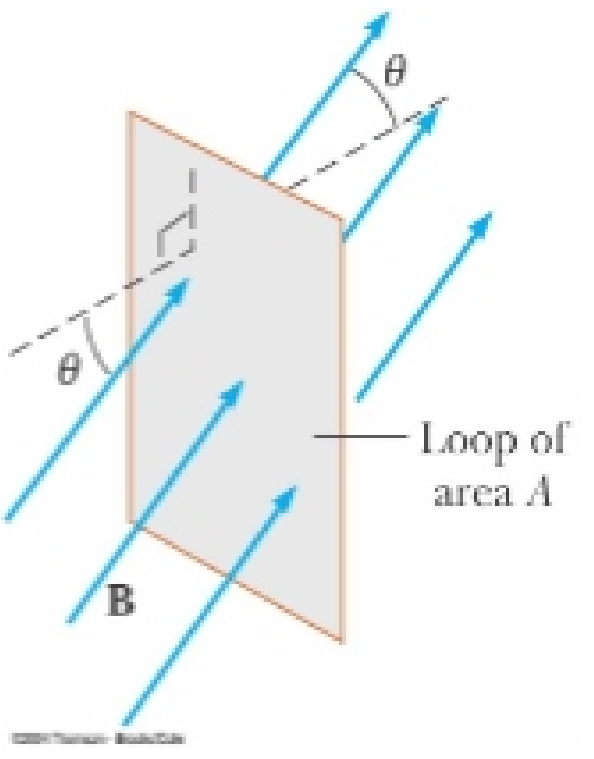
ε = induced emf,
= induced potential difference

$$\Phi_B = \int \mathbf{B} \cdot d\mathbf{A}$$

- In practice often: $\Phi_B = BA \cos\theta$
- The induced emf is then: $\varepsilon = -d/dt\,(BA\cos\theta)$

Faraday's Law – Example

- Assume a loop enclosing an area A lies in a uniform magnetic field $\mathbf{B}$
- The magnetic flux through the loop is $\Phi_B = BA\cos\theta$
- The induced emf is $\varepsilon = -d/dt\,(BA\cos\theta)$



Ways of Inducing an emf

- The magnitude of **B** can change with time
- The area enclosed by the loop can change with time
- The angle θ between **B** and the normal to the loop can change with time
- Any combination of the above can occur

Lenz's Law

- Faraday's law indicates that the induced emf and the change in flux have opposite algebraic signs

$$\varepsilon = -\frac{d\Phi_B}{dt}$$

- **Lenz's law:** *the induced current in a loop is in the direction that creates a magnetic field that opposes the change in magnetic flux through the area enclosed by the loop*