

SUMMARY

The goal of Chapter 33 has been to understand and apply electromagnetic induction.

GENERAL PRINCIPLES

Faraday's Law

MODEL Make simplifying assumptions.

VISUALIZE Use Lenz's law to determine the direction of the induced current.

SOLVE The induced emf is

$$\mathcal{E} = \left| \frac{d\Phi}{dt} \right|$$

Multiply by N for an N -turn coil.
The size of the induced current is $I = \mathcal{E}/R$.

ASSESS Is the result reasonable?

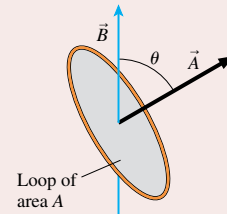
Lenz's Law

There is an induced current in a closed conducting loop if and only if the magnetic flux through the loop is changing. The direction of the induced current is such that the induced magnetic field opposes the *change* in the flux.

Magnetic flux

Magnetic flux measures the amount of magnetic field passing through a surface.

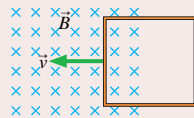
$$\Phi = \vec{A} \cdot \vec{B} = AB \cos \theta$$



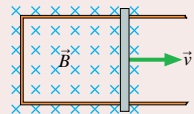
IMPORTANT CONCEPTS

Three ways to change the flux

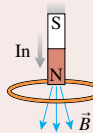
1. A loop moves into or out of a magnetic field.



2. The loop changes area or rotates.

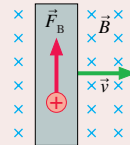


3. The magnetic field through the loop increases or decreases.

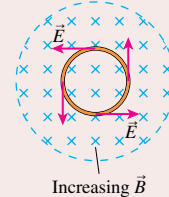


Two ways to create an induced current

1. A **motional emf** due to magnetic forces on moving charge carriers.

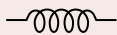


2. An induced electric field due to a changing magnetic field.



APPLICATIONS

Inductors



Solenoid inductance $L_{\text{solenoid}} = \frac{\mu_0 N^2 A}{l}$

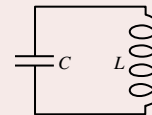
Potential difference $\Delta V_L = -L \frac{dI}{dt}$

Energy stored $U_L = \frac{1}{2} LI^2$

Magnetic energy density $u_B = \frac{1}{2\mu_0} B^2$

LC circuit

Oscillates at $\omega = \sqrt{\frac{1}{LC}}$



LR circuit

Exponential change with $\tau = \frac{L}{R}$

