AP Physics

Electromagnetic Induction and Electric Transformation

Michael Farady (along with Joseph Henry) discovered (in 1831) the phenomena of electromagnetic induction. A moving magnetic field creates a current.

Check the below web page and read about Faraday.

Faradays crowning acheivement was his law of electromagnetic induction stated;

$$\xi = -\frac{d\phi_m}{dt} = \frac{-\Delta\phi_m}{\Delta t}$$

$\phi_m = BA$ (Magnetic flux which is defined as the number of magnetic field lines passing through a given area.)

In the case of the second equation what does the delta mean??

Faradays law states that a changing magnetic flux induces a current or Emf in a conductor.

How is the magnetic flux changed?

An alternate form of Faradays law is;

$$\xi = -N\frac{\Delta\phi m}{\Delta t}$$

Where N is the number of turns of the loop of wire.
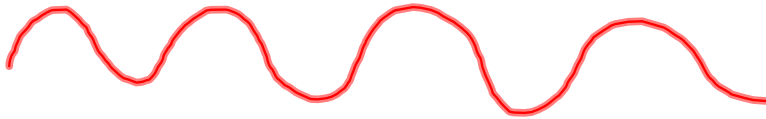
This law leads to several other useful equations;

Emf in wire moving through B;

$\xi = vLB$ = velocity Length Magnetic field

$F = q\,v\,B$

Emf produced by an electric generator;
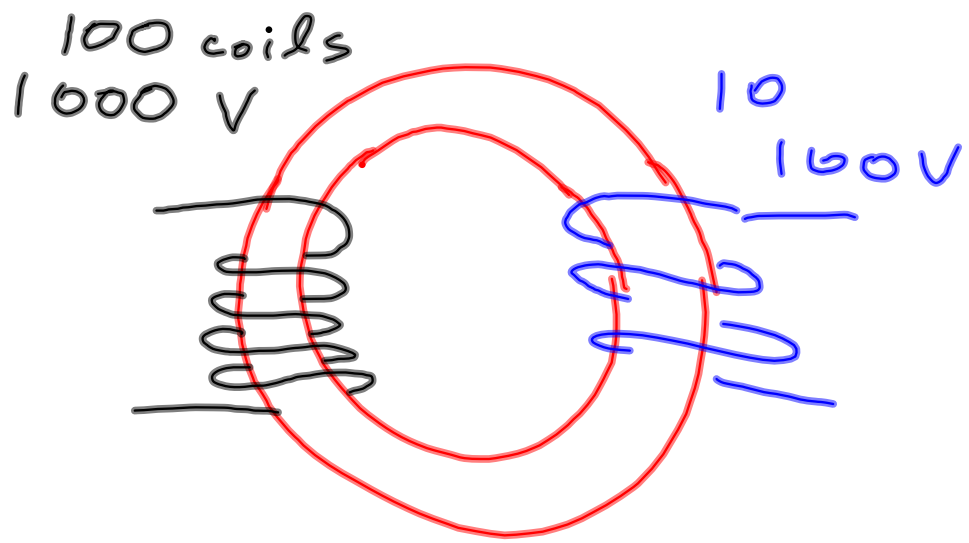
$\xi = NAB\,\omega\,\sin\,\omega$

Transformers:

$V_s/V_p = N_s/N_p$

Voltage secondary/Voltage primary =
Turns of secondary/Turns of primary

$P = IV$ so;

$I_pV_p = I_sV_s$

and $I_s/I_p = N_s/N_p$

100 coils
1000 V

10
100 V

Induced emf due to Inductance

$$\xi = -L \, \Delta I / \Delta t$$

the induced voltage in a single coil
depends on the self inductance in a single
coil and the rate of change of the current

Inductance definition

$$L = \upsilon_o \, N^2 A / L$$

Lenz'z Law: The negative sign in Faradys Law of EM Induction: WHY??

$$\xi = -N\Delta\phi m / \Delta t$$

Shows that the induced EMF opposes the change in magnetic flux which caused it.

A loop of wire with radius of .25 meters is rotated in the earths magnetic field. What is the induced emf? How many loops of wire would it take to induce an emf of 1.0 V?

A loop of wire with radius of .25 meters is rotated (at 1.0 rpm) in the earth's magnetic field. What is the induced emf? How many loops of wire would it take to induce an emf of 1.0 V?

Transformers: