Televsions rely upon electromagnetic fields to produce the images we see.

An electron "gun" fires electrons at the television screen. When they collide with the material on the back side of the screen, colored light is emitted, producing one pixel of the image.

Changing the strength of the magnetic field changes the degree to which the electron beam is deflected.

Magnetic domains.

Concept Quiz!

Induced magnets
• Observe the experimental evidence for EM induction.
• To understand and use Lenz’s law for induced currents.
• To learn of Faraday’s law as a new law of nature.
• To gain a qualitative understanding of electromagnetic waves.
• To analyze circuits with inductors.

Shortly after Oersted’s discovery that currents create magnetic fields, Michael Faraday (England) and Joseph Henry (US) conducted experiments to determine if magnetic fields created electrical currents...

**Faraday’s Observations:**
With the switch open, no reading on the ammeter.

When the switch is closed, the ammeter needle deflects momentarily toward the right, then returns to 0.

Steady currents in the primary produce constant magnetic fields, which result in no current in the secondary circuit.

Changing currents in the primary circuit result in changing magnetic fields, which result in induced currents in the secondary circuit.

If we move a bar magnet toward a loop of wire, the ammeter deflects to the right.

When we stop moving the magnet, the ammeter reads 0.
When we pull the magnet away from the loop, the ammeter deflects to the left. When we stop moving the magnet, the ammeter reads 0.

As the magnet moves toward the loop, the strength of the magnetic field near the loop increases. As the magnet moves away from the loop, the strength of the magnetic field near the loop decreases.

Such results are consistent with Faraday’s experiment: Changing magnetic fields lead to induced currents.

**FARADAY’s LAW**

Induced current due to changing magnetic flux.

**Potential Differences**

What causes currents to flow?

\[ E = -N \frac{d\Phi}{dt} \]

The rate of change of magnetic flux

The number of turns

**Faraday’s Law**

Just as we did with electric flux, we can think of this quantity as being related to the net number of magnetic field lines passing through the loop.
Magnetic flux is related to the strength of the magnetic field that is perpendicular to the plane of the loop. If you separate the magnetic field into components parallel and perpendicular to the loop...

Magnetic flux is given by:

\[ \Phi = \int \vec{B} \cdot d\vec{A} = B_A A \cos\theta \]

This is also the direction of the normal to the loop!

So, the Weber is the unit of magnetic flux.

A long, straight wire carries a current of 50 A. A rectangular loop of 100 turns with sides of length 5.00 cm and 20.0 cm lies in a plane with the wire at a distance of 5.00 cm from the wire. What is the magnetic flux through this loop?
Graphically, the slope of the plot of magnetic flux versus time is the negative of the instantaneous induced EMF divided by the number of turns, \( N \).

\[
E = -N \frac{d\Phi}{dt}
\]

Graphically, the slope of the line connecting the two points in the flux vs time plot is the negative of the average induced EMF divided by the number of turns, \( N \), over the time interval, \( \Delta t \).

\[
E = -N \frac{\Delta \Phi}{\Delta t}
\]

Faraday’s law tells us the average value of the EMF over the time period \( \Delta t \) in which the magnetic flux is changing.

*Note the minus sign…The induced EMF will attempt to oppose the changing magnetic flux. This result is known as Lenz’s Law.*