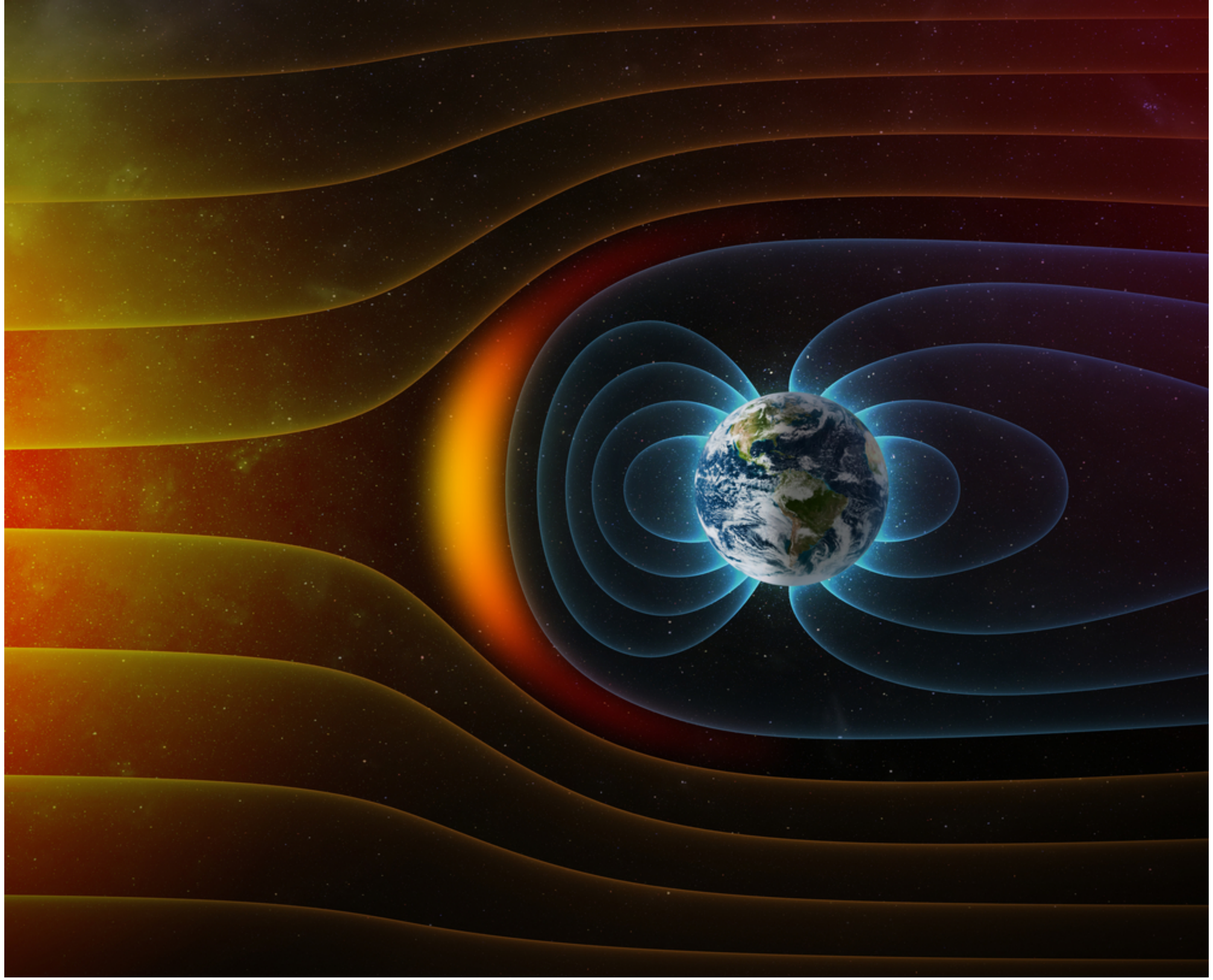
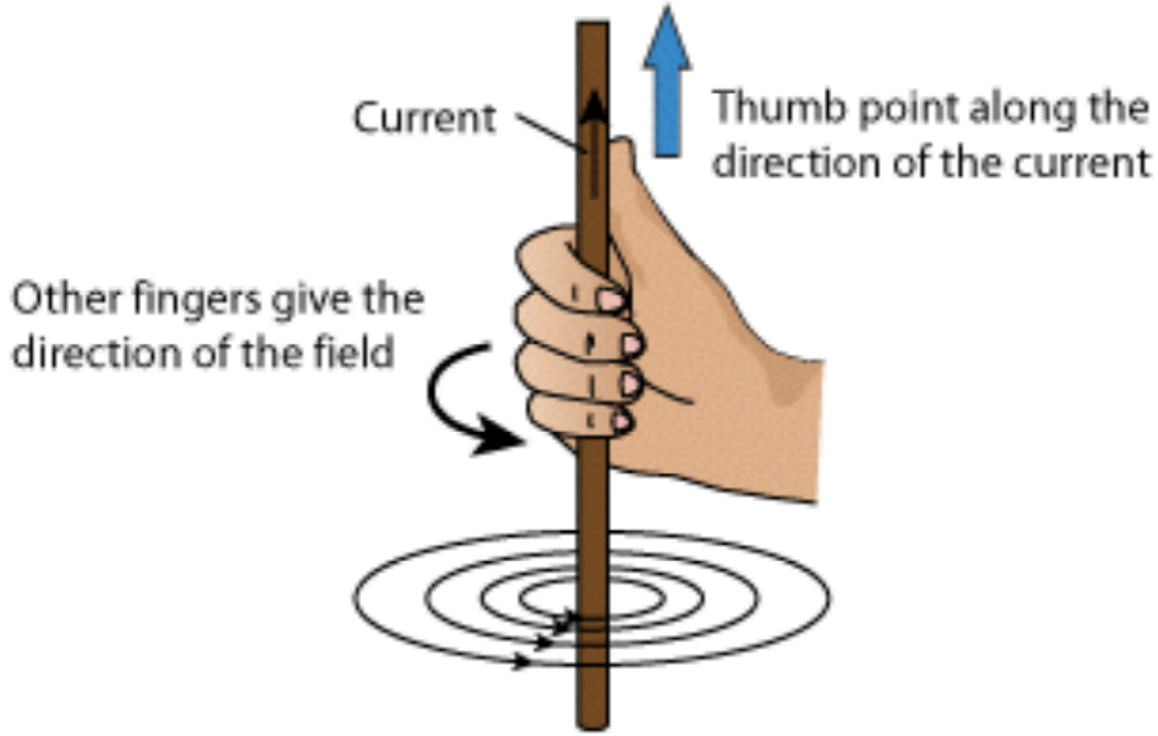
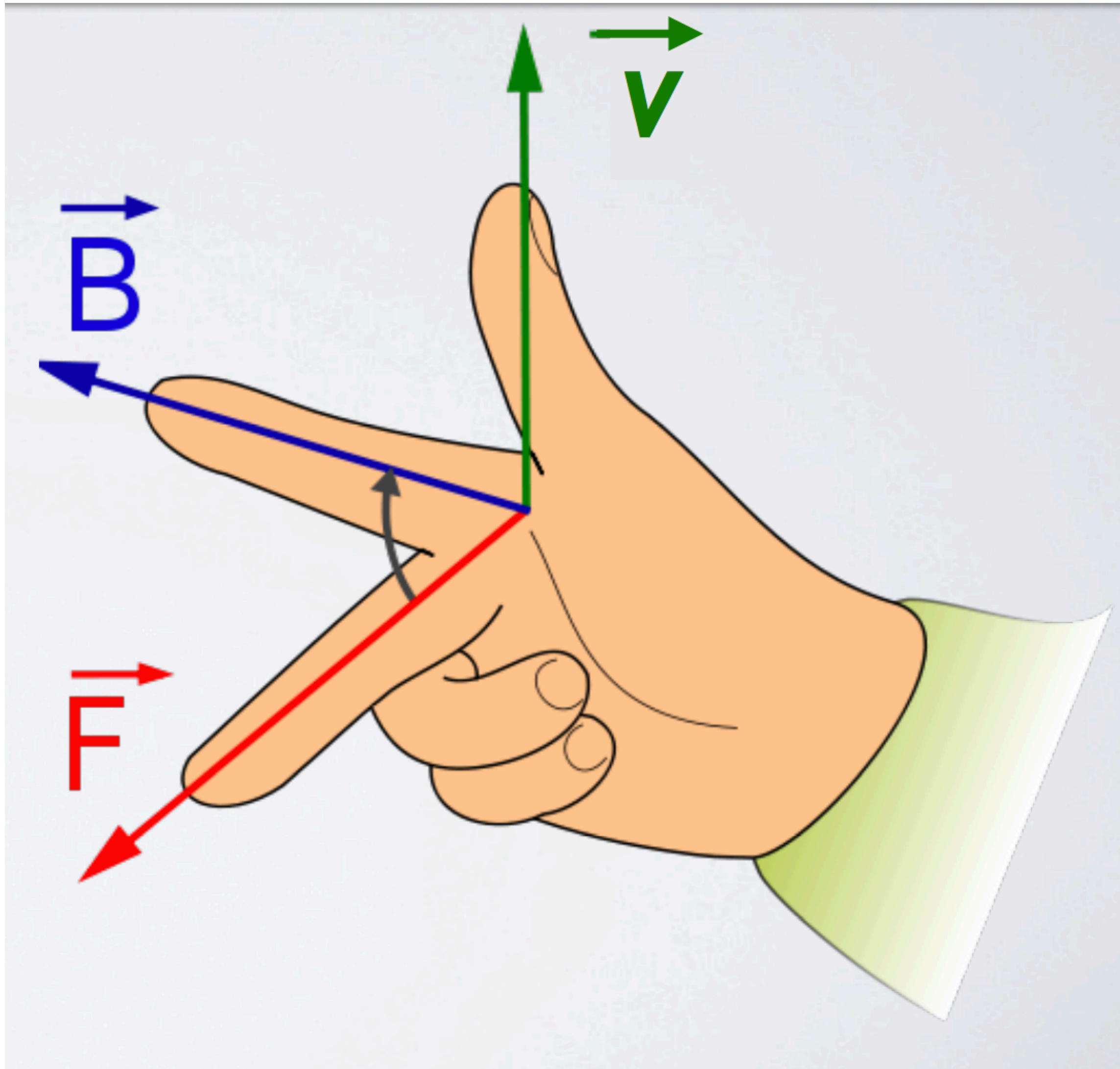
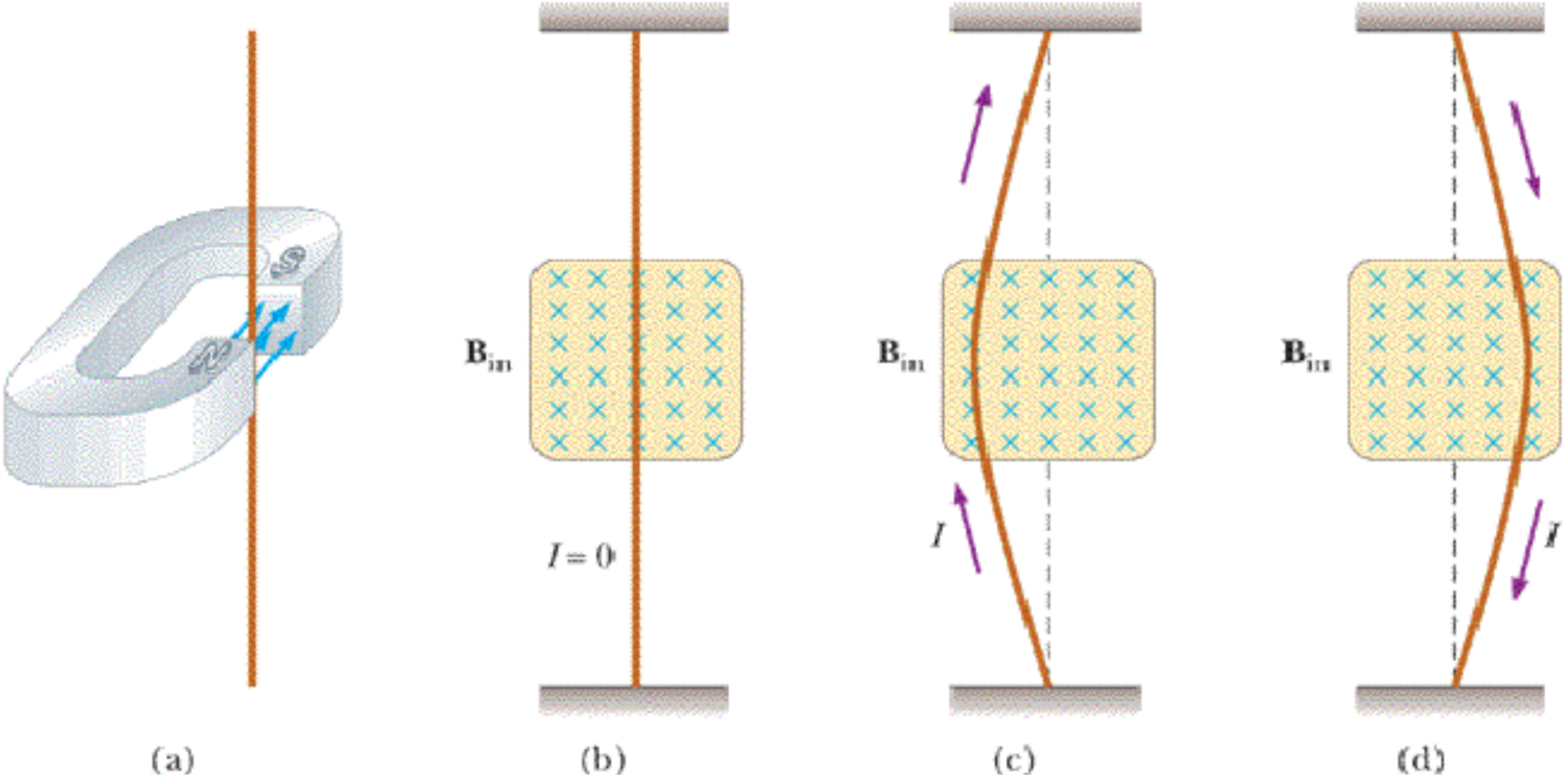


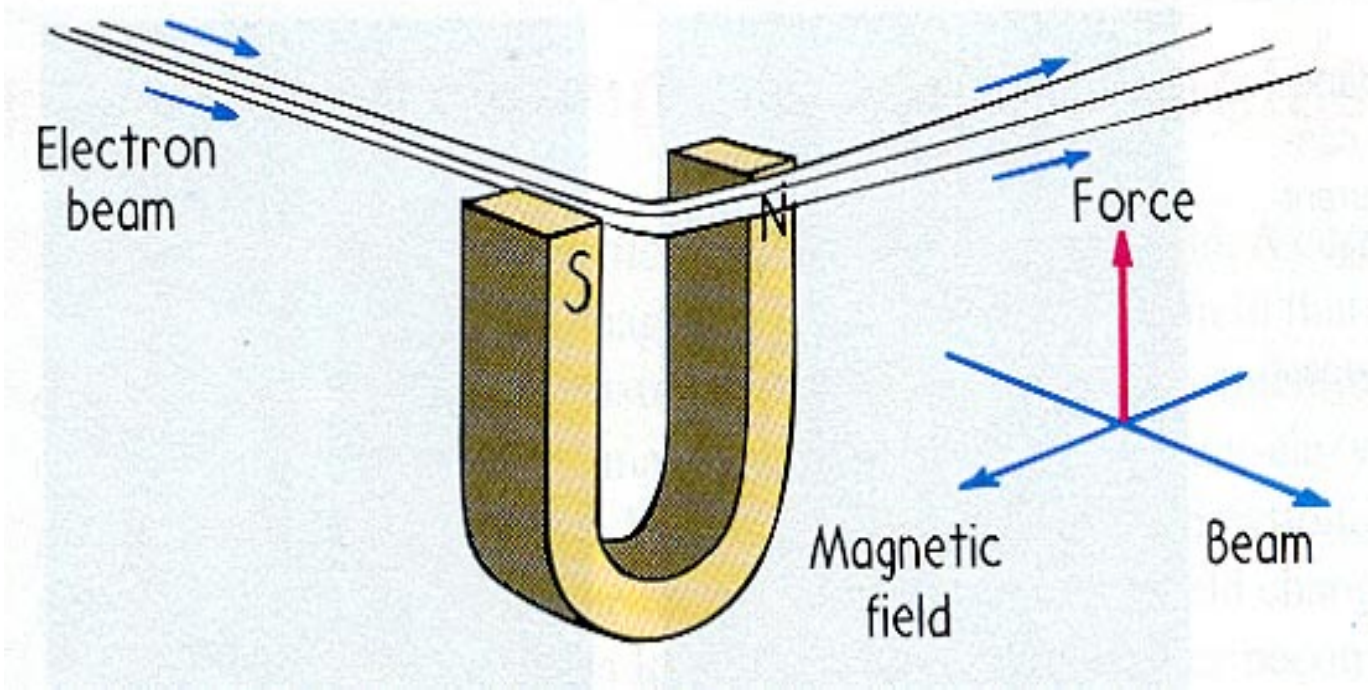
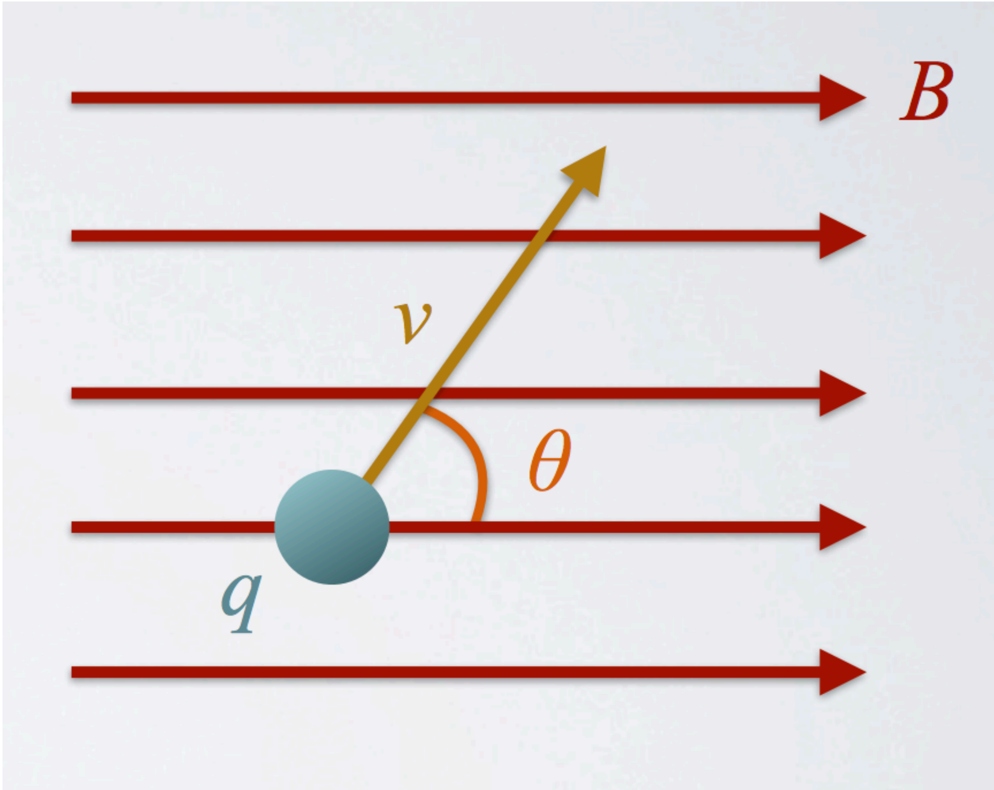


Right Hand Grip Rule

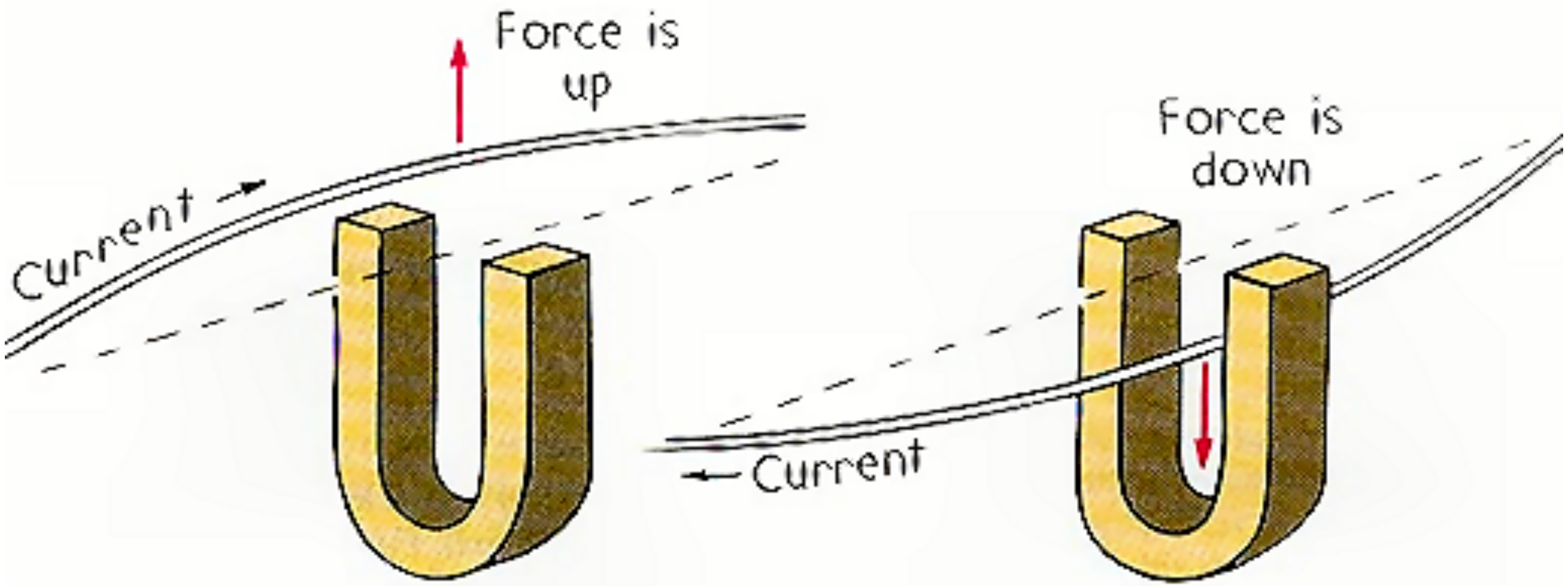


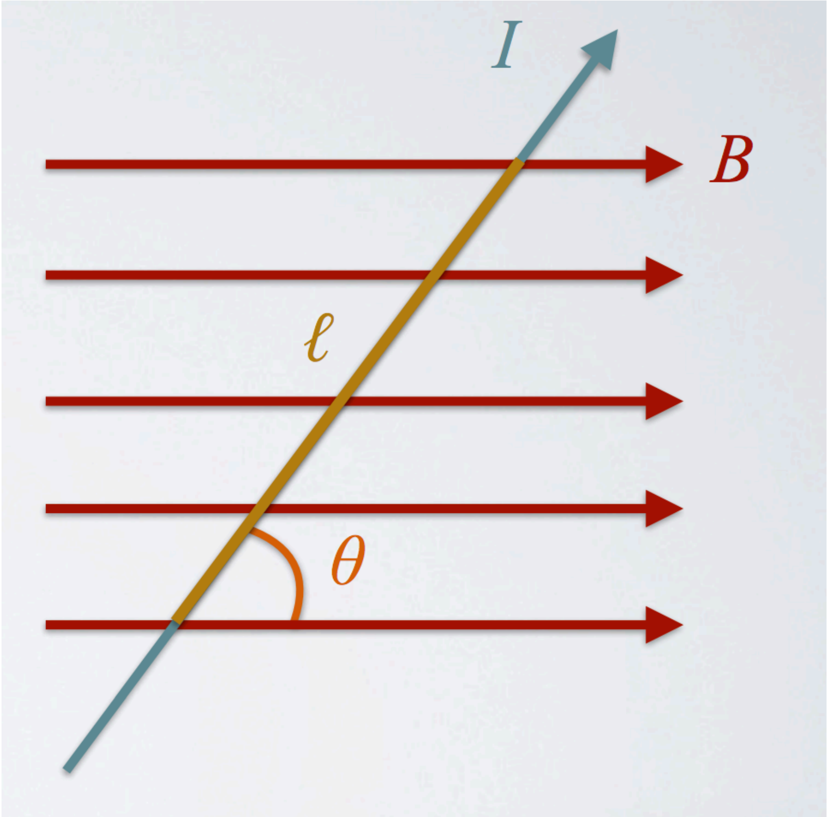


S
N
B_{in}
$I = 0$
B_{in}
I
B_{in}
I
(a)
(b)
(c)
(d)


Electron beam
S
N
Force
Magnetic field
Beam

B
v
θ
q

Magnetic Forces on Current Carrying Wires

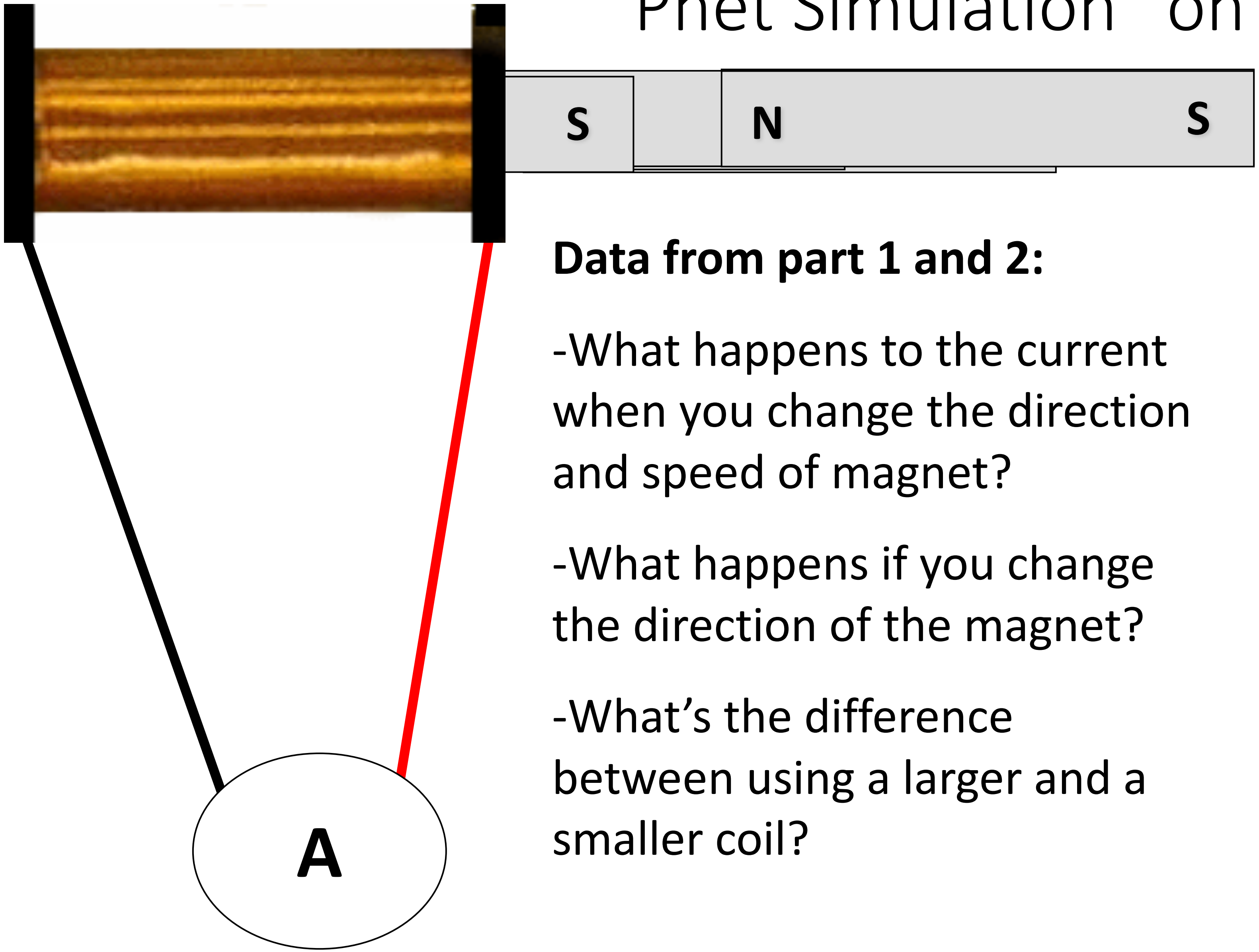




1: Solenoids

2: Look up "Faraday's Law Phet Simulation" on Google

3: Copper tube



Data from part 1 and 2:

-What happens to the current when you change the direction and speed of magnet?

-What happens if you change the direction of the magnet?

-What's the difference between using a larger and a smaller coil?

Conclusion part 1 and 2: What is necessary to generate a current in some copper coils?

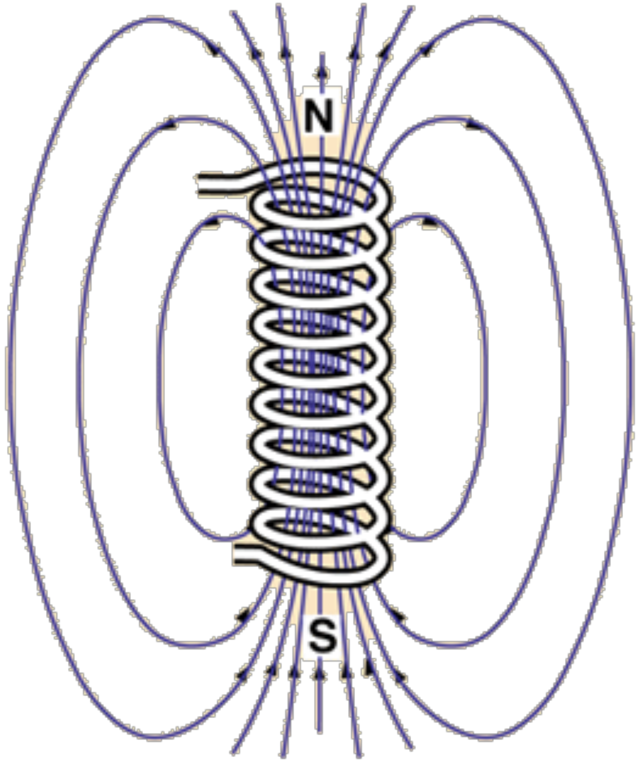
Conclusion part 3: What's causing the magnets to slow down?

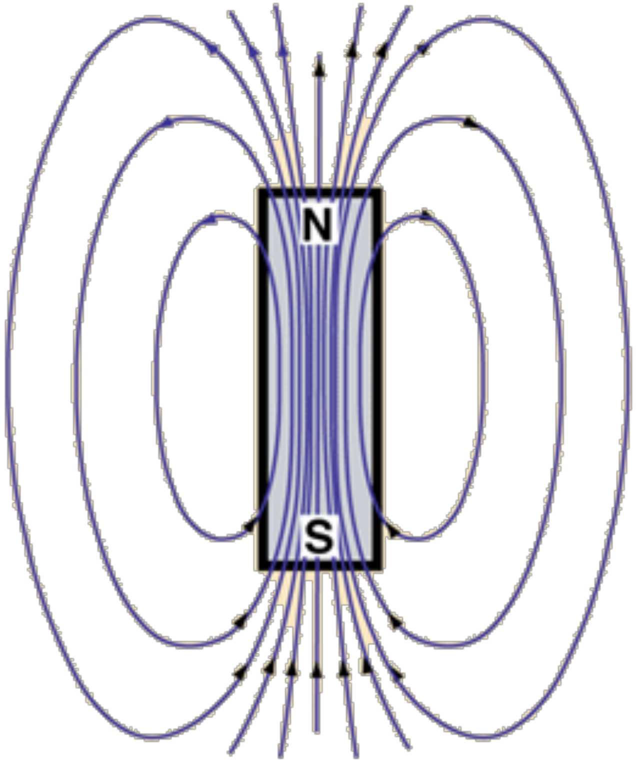
What causes the can to explode and the quarter to shrink?

https://www.youtube.com/watch?v=AXOa66-k9MA

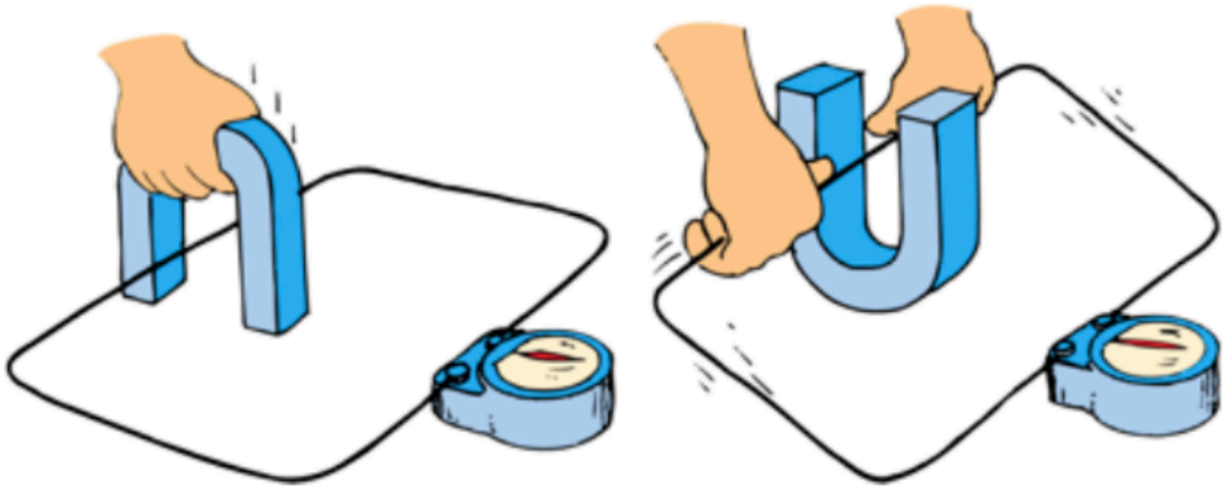
Right hand rule to find Magnetic Field in a solenoid or electromagnet

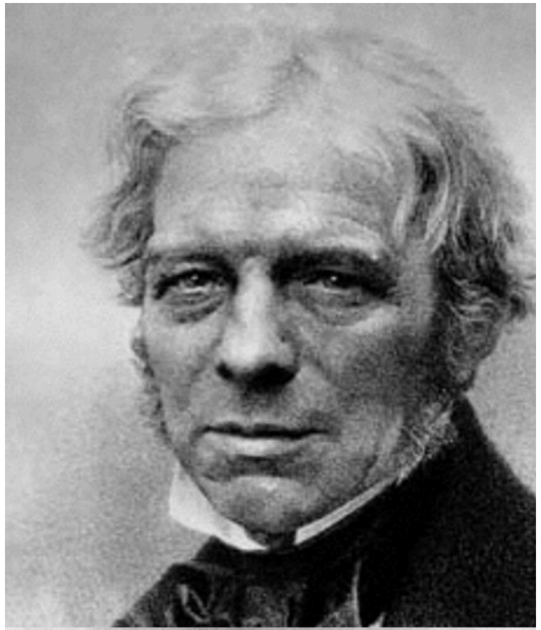
1. Point your thumb in the direction of the current
2. The magnetic field points in the direction the rest of your fingers curve toward (upward)
3. Because the field lines leave the top end of solenoid, the top end is the **N**orth pole and the bottom end is the **S**outh pole

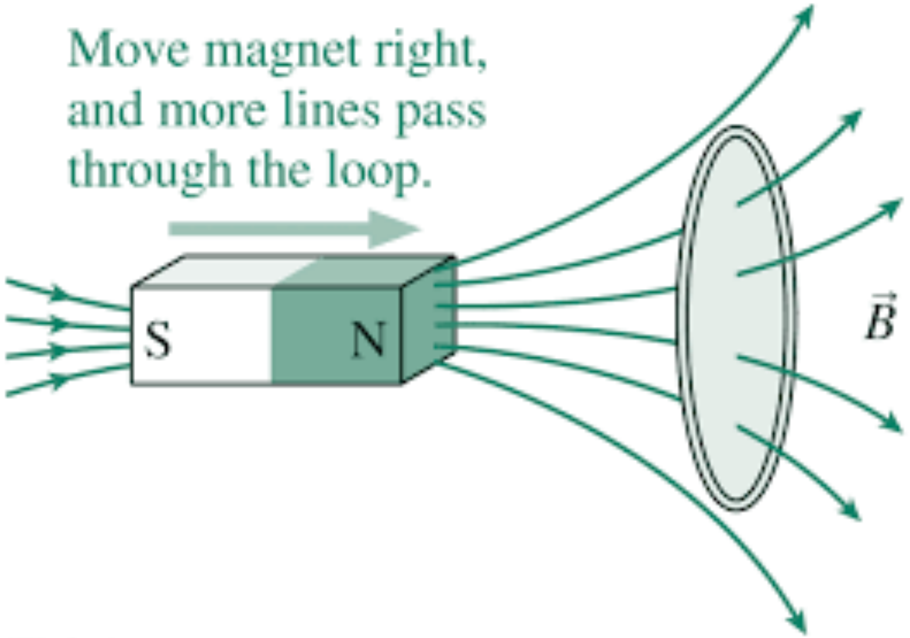




Michael Faraday from England (top) and James Henry from the USA (bottom) simultaneously discovered in 1831 that a changing magnetic field induces a current in a coil of wire



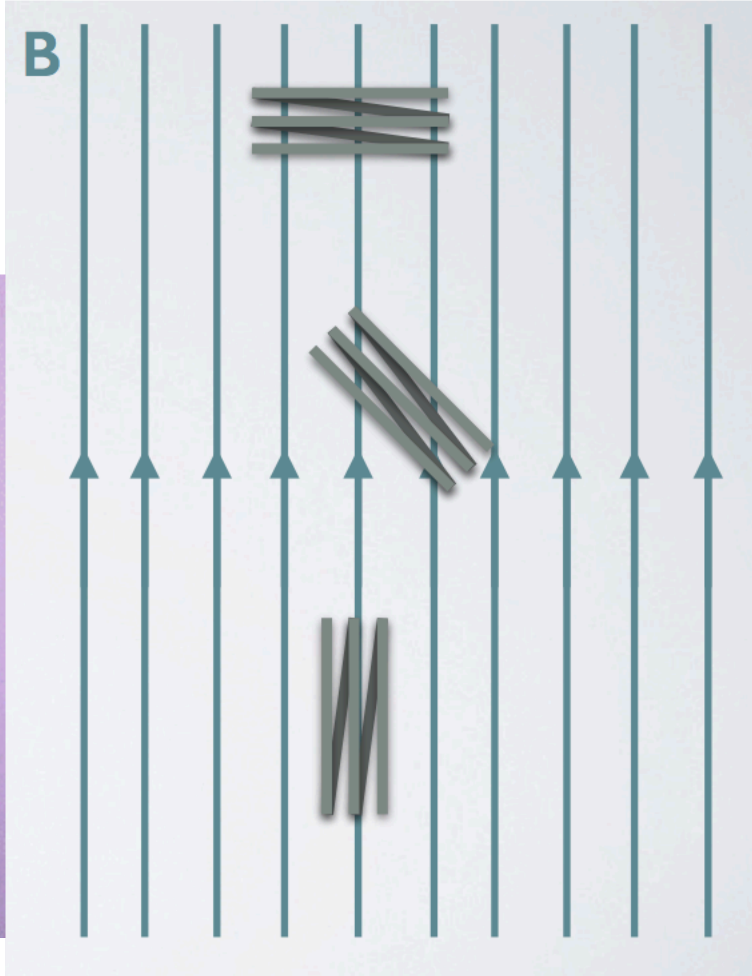




Magnetic field

Magnetic flux $= \Phi = B\,A$

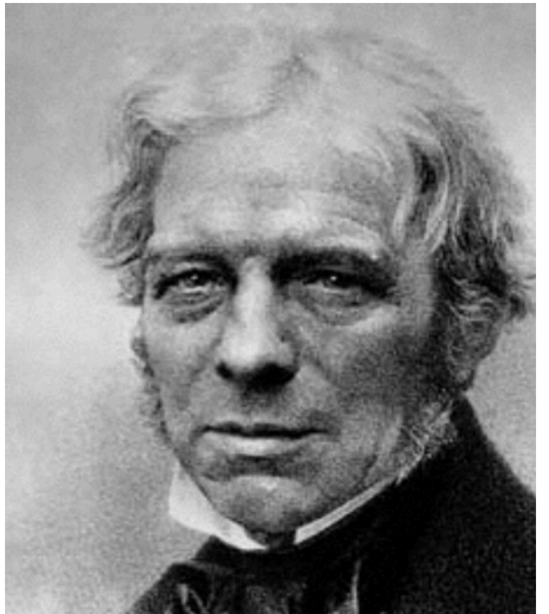
Area perpendicular to magnetic field B

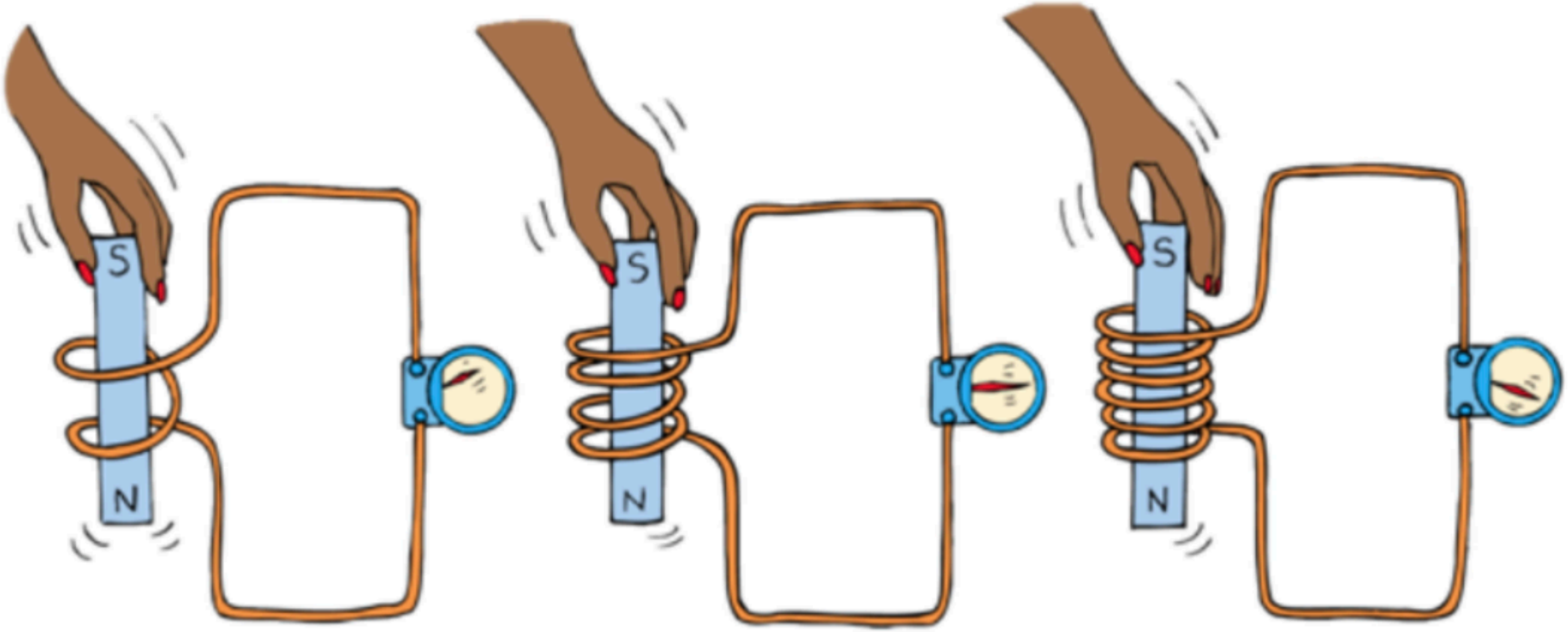


Units of flux = Webers (Wb)

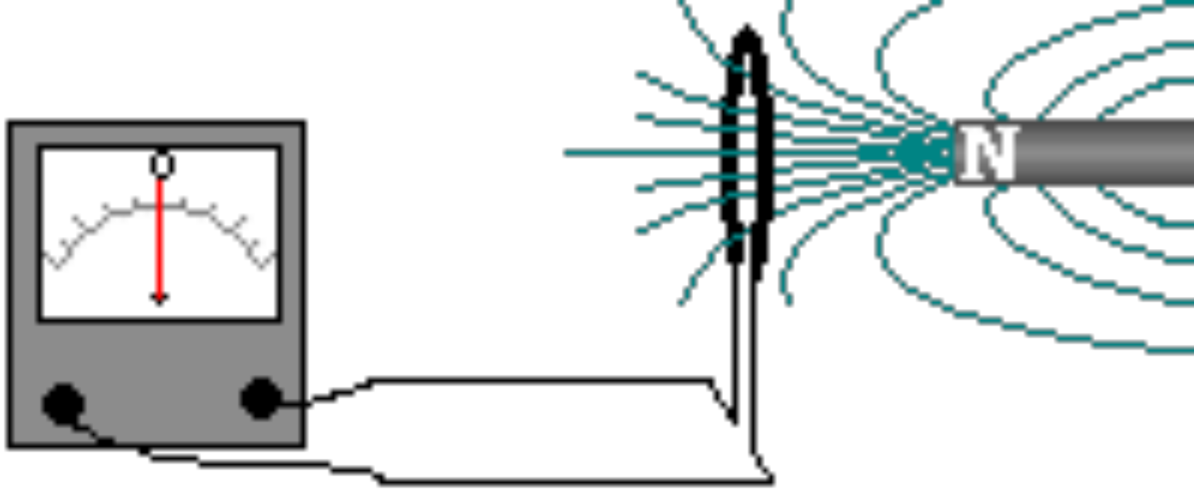
The voltage induced in a coil is proportional to the number of coils times the rate at which the magnetic flux changes inside the coils

Faraday's Law of Induction

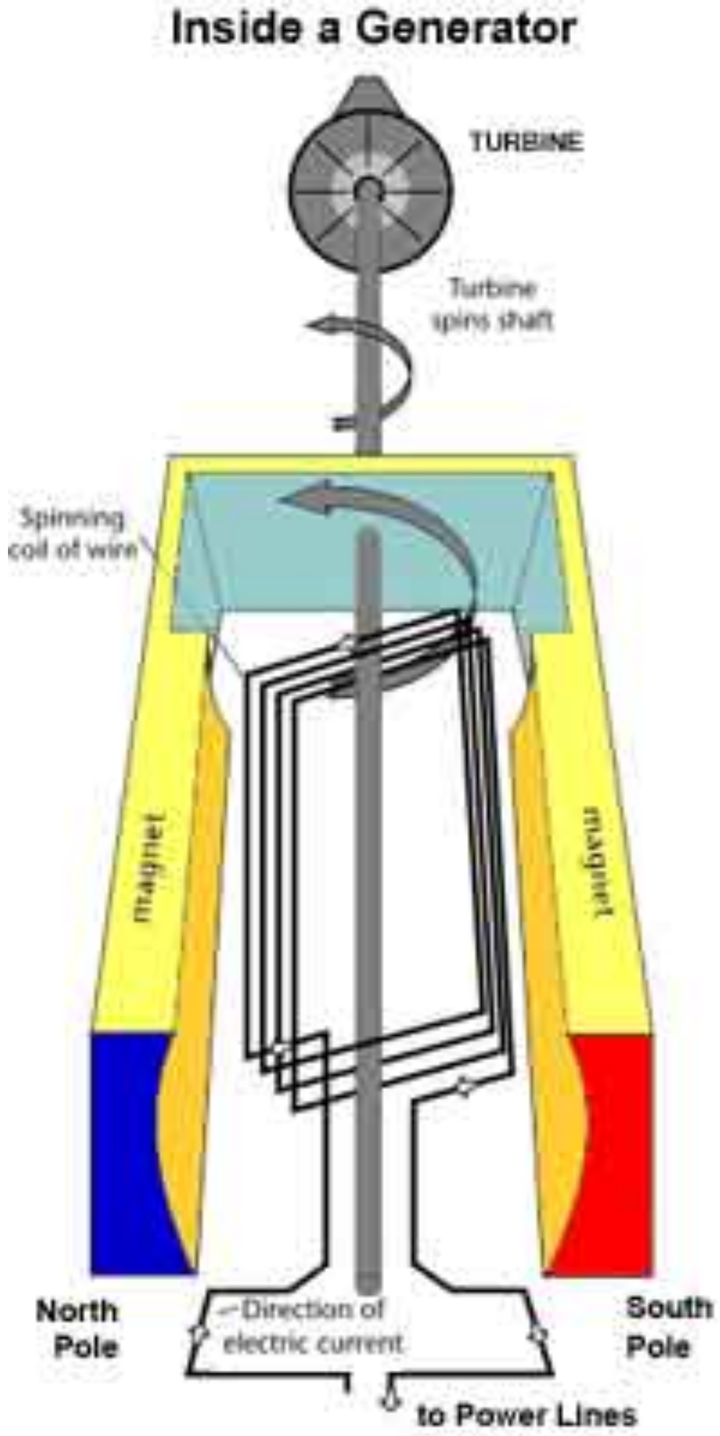


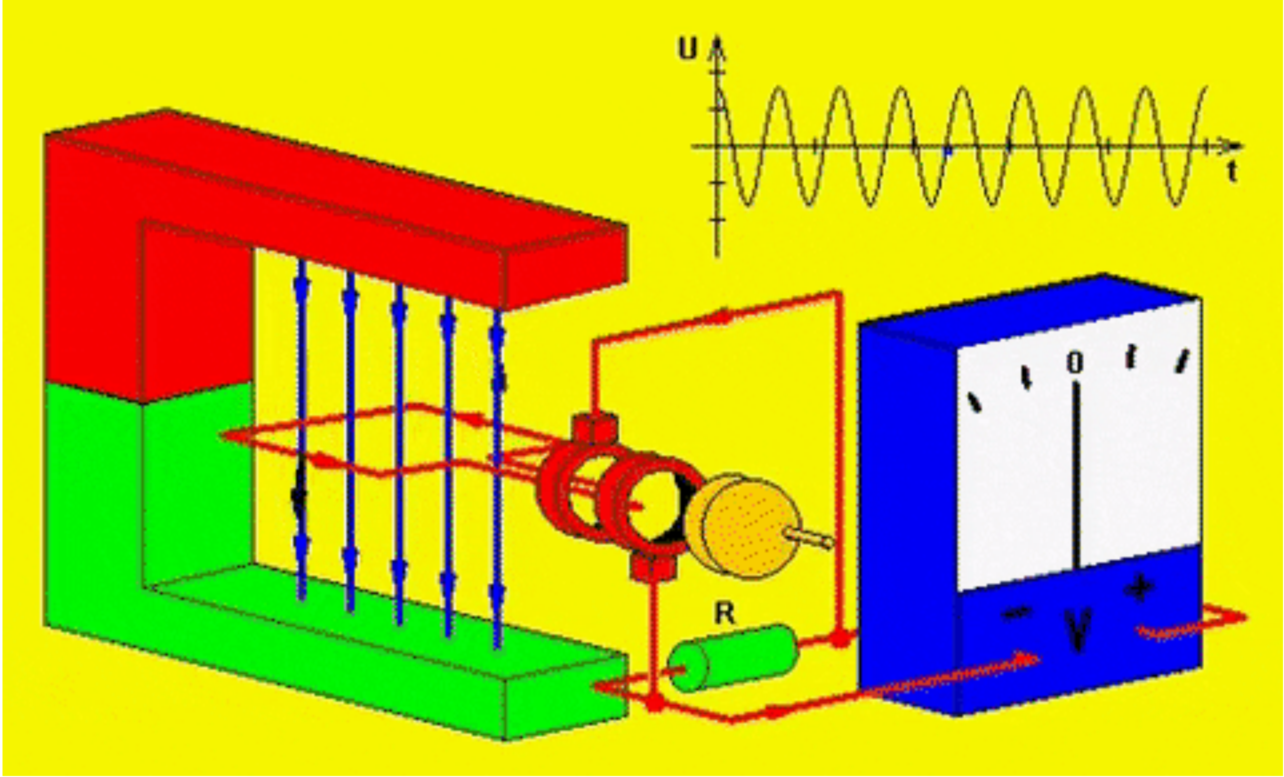


More coils and faster change in flux (faster movement of the magnet or wire) = more voltage generated = more current generated



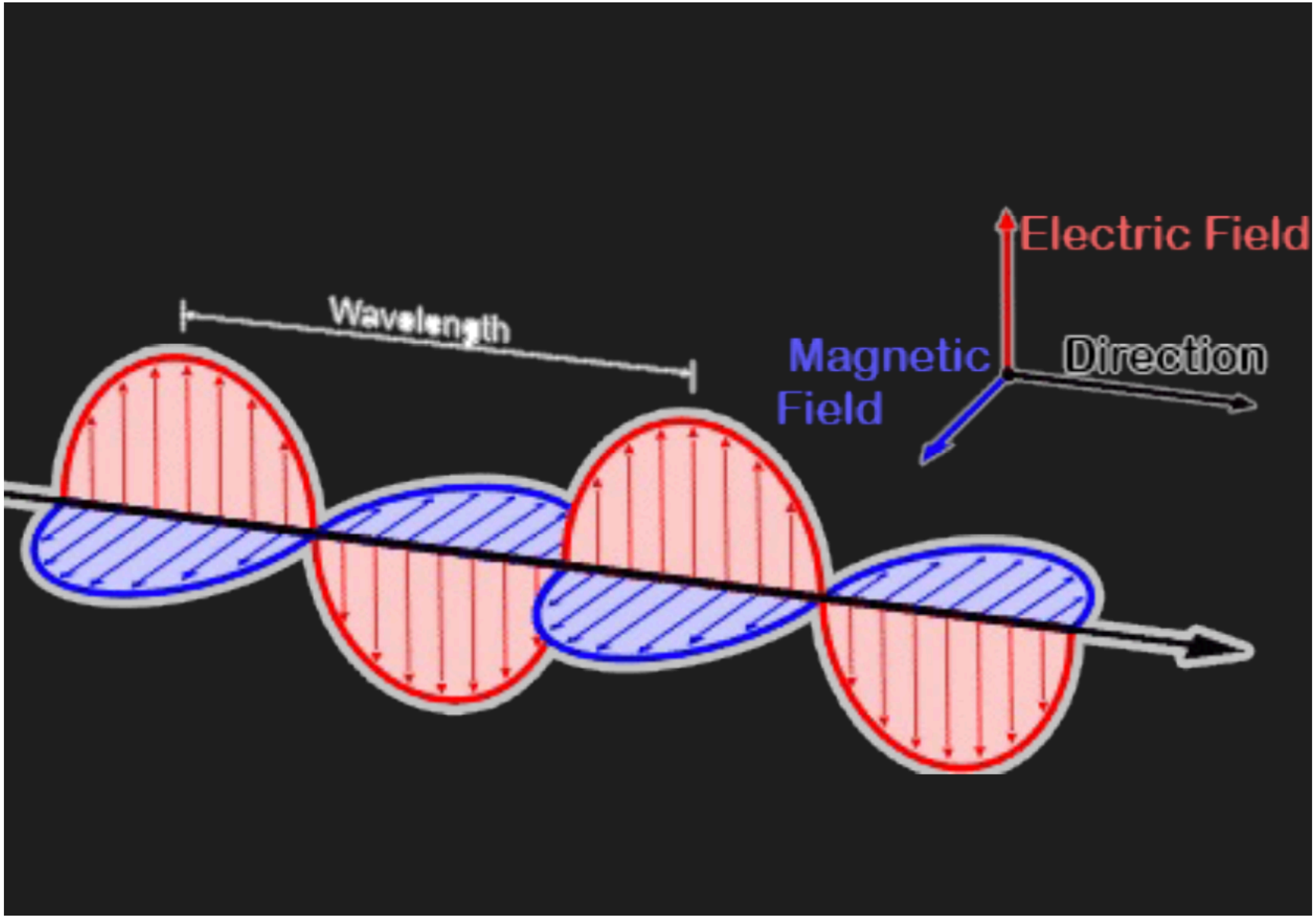
- An ammeter is connected in a circuit of a conducting loop
- When a bar magnet is moved closer to, or farther from, the loop, an electromotive force (emf) or voltage is induced the loop
- The ammeter indicates currents in different directions depending on the relative motion of magnet and loop
- When the magnet stops moving, the current returns to zero as indicated by the ammeter





As the loop rotates, the magnitude and direction of the voltage (and current) change

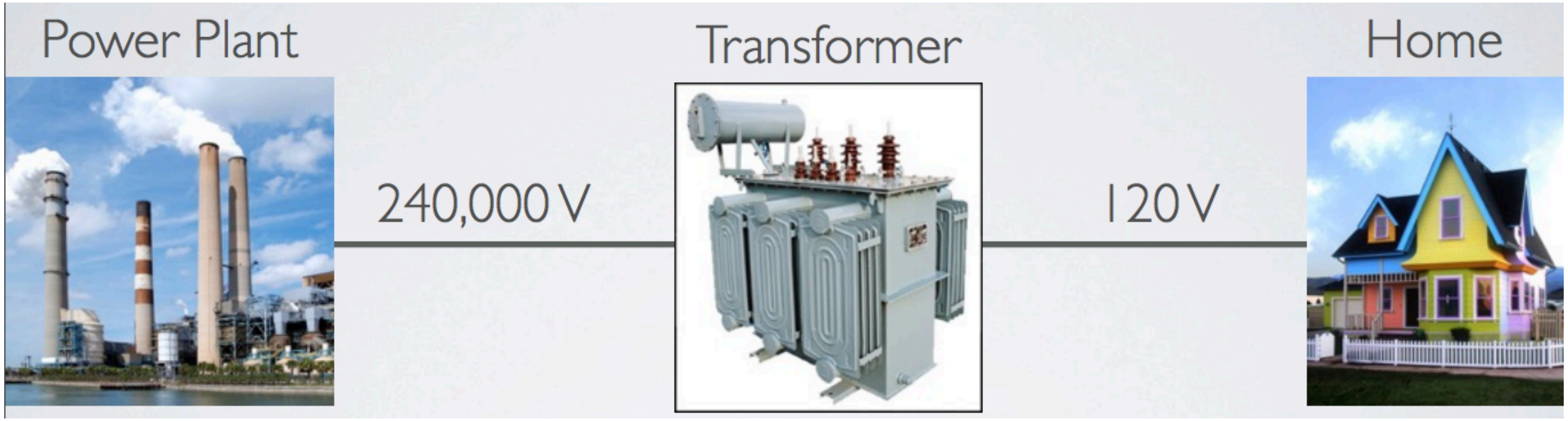
• One complete voltage cycle is produced for every full rotation of the loop. The voltage induced by the generator alternates and produces an alternating current (AC)



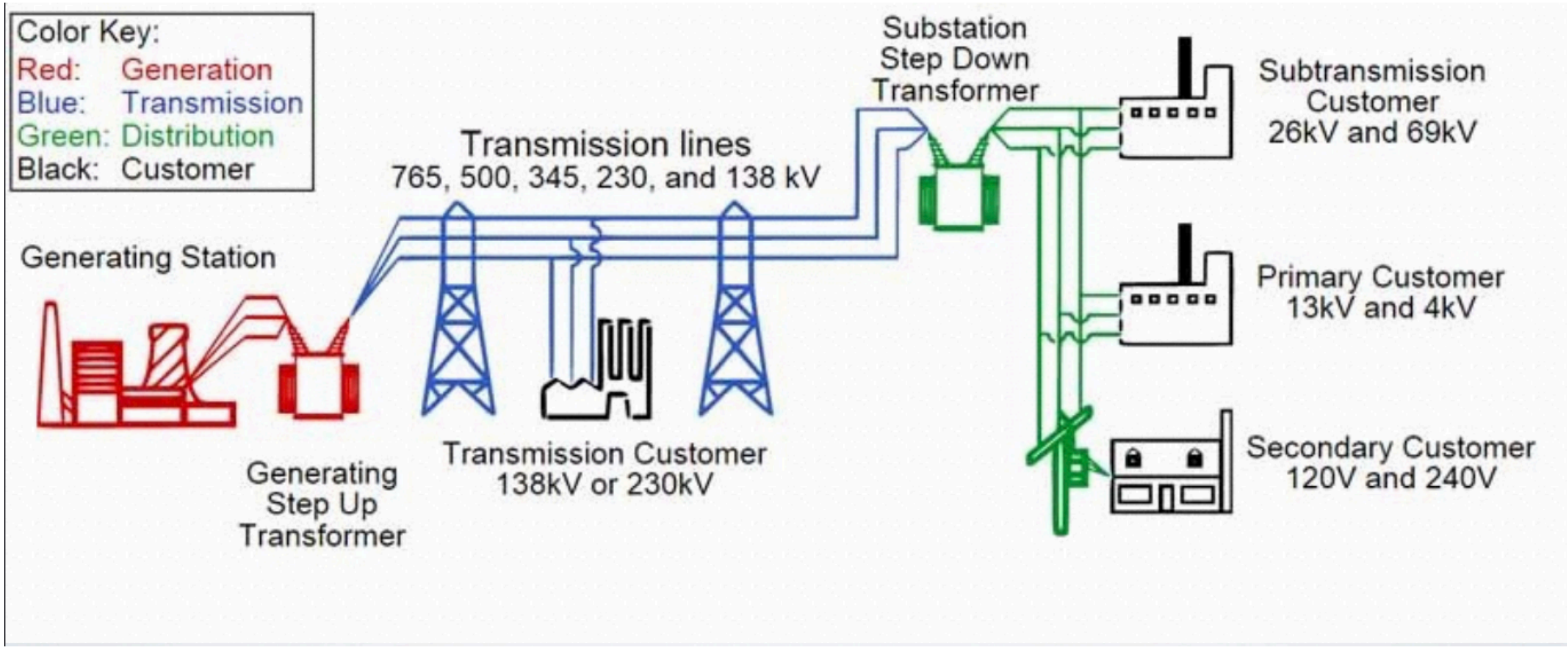
Electromagnetic Waves

Changing magnetic field induces electric field, which induces an magnetic field!

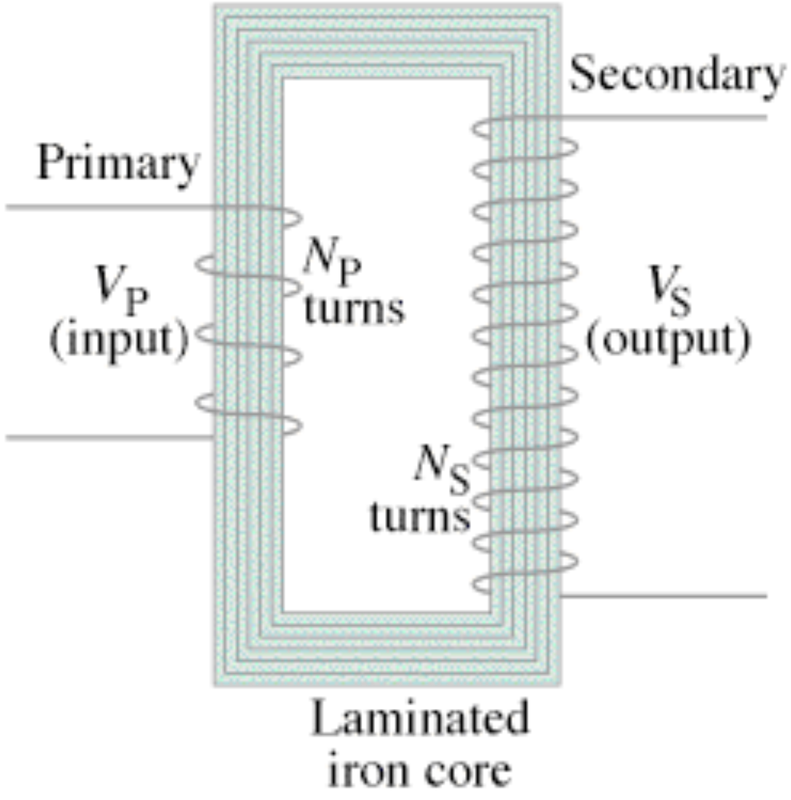
Transformers



Transformers: device for increasing or decreasing an AC voltage



A transformer consists of two coils of wire known as the primary and secondary coils



If the secondary coil has more loops than the primary, the secondary voltage will be greater than the primary

- Called a step-up transformer

If the secondary coil has less loops than the primary, the secondary voltage will be less than the primary

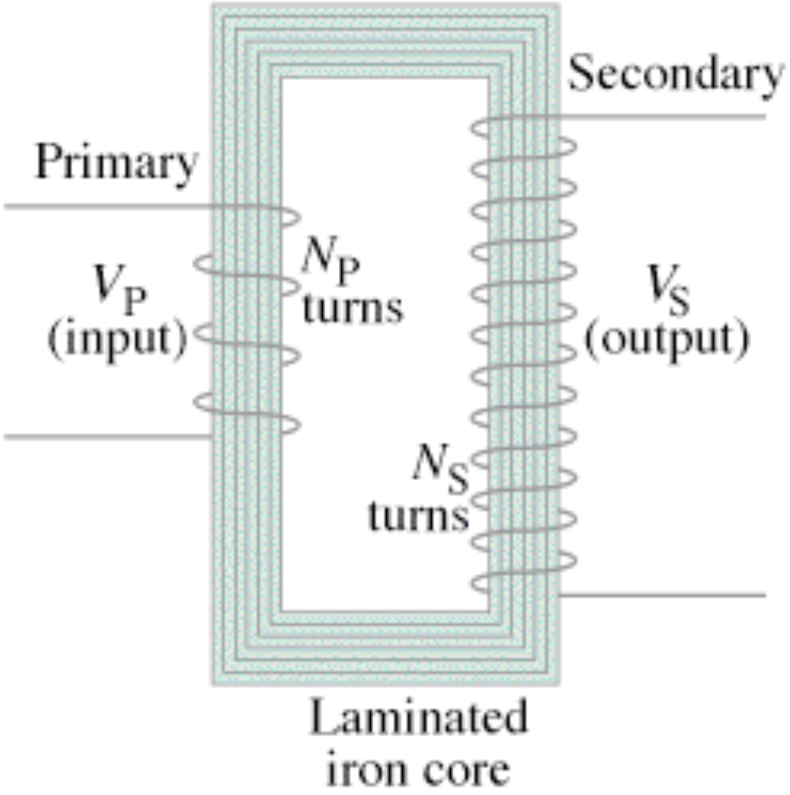
- Called a step-down transformer

$$\frac{\textbf{Primary Voltage}}{\textbf{\# of 1}^{\textbf{o}}\textbf{ turns}} = \frac{\textbf{Secondary Voltage}}{\textbf{\# of 2}^{\textbf{o}}\textbf{ turns}}$$

Energy <u>must</u> be conserved!

Because power is the rate of change of energy, the power in must be the same as power out.

We learned from electricity that P = IV



$$\textbf{(Power IN)} = \textbf{(Power OUT)}$$

$$\textbf{(Voltage x Current)}_{\textbf{primary}} = \textbf{(Voltage x Current)}_{\textbf{secondary}}$$