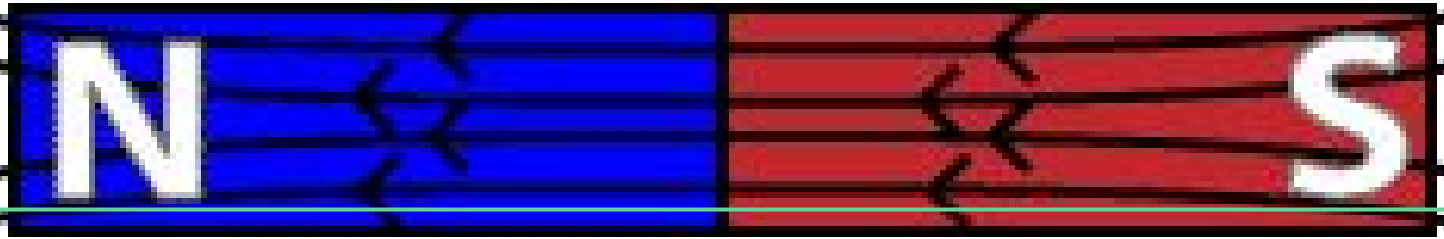
Magnetism



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What is Magnetism?

Magnetism is the attractive and repulsive forces between two objects caused by the motion of electric charge.

Every magnet has two poles: North and South. There is no law stating there has to be two poles, but no monopole magnet has been found.

The electric charge moves from the North to the South poles of the magnets and will always flow from North to South.

Every magnet has a magnetic field and produces magnetic field lines similar to those of an electric field.

Important equations!

$\mu = 4\pi \times 10^{-7}$

Mu naught is a constant and is the permeability of free space and is needed to find the magnetic field.

Magnetic field (β) $\beta = \mu I/2(\pi)r$ Measured in **Tesla's** (T) don't forget about units

Magnetic force = $F = I\beta \boldsymbol{\ell} \sin\Theta$ the other version looks like this: $F = qV\beta\sin\Theta$

The $\boldsymbol{\ell}$ is the length of the wire and the I is the current / the q is charge and V is velocity

A few more equations and important values

Charges

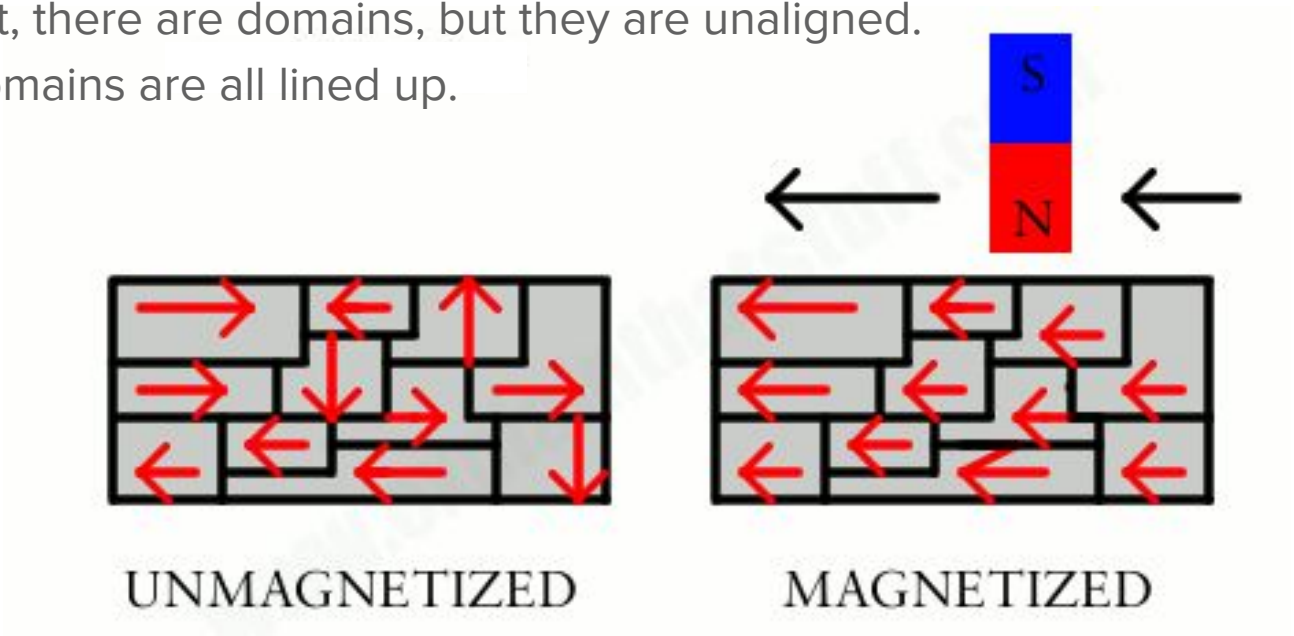
Charges of protons and electrons are the same value EXCEPT electrons have a negative value. q=1.6e-19 and electrons -1.6e-19 (the **e** just means x10 to whatever power you put in the calculator).

The faraday equation: $V=N\Delta\Phi/\Delta t$ and Magnetic Flux $\Phi=A\perp\beta$ and/or $A\beta\sin\Theta$ A is for area don't forget $\pi(r)^2$ *(Pi (r) squared)*

- And don't forget that in transformers that that induced voltage is proportional to the number of coils in a given loop! Vp/Np is equal to Vs/Ns

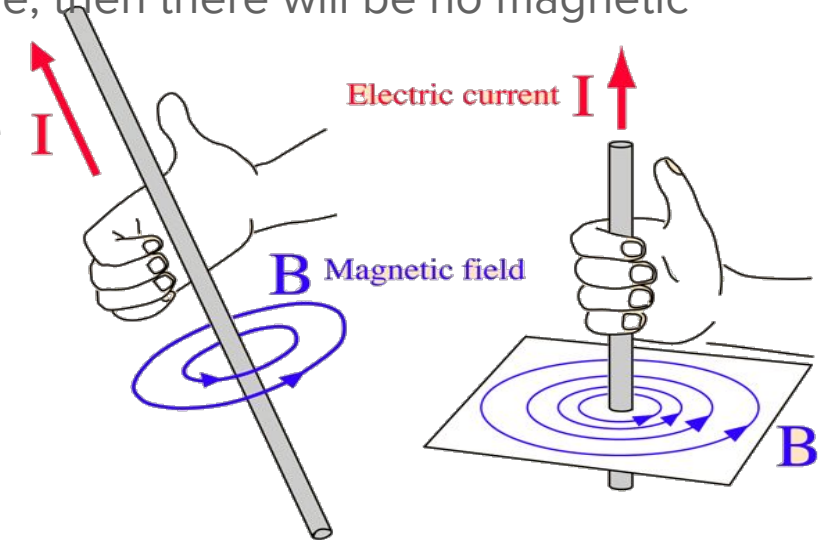
Domains

- Domains dictate whether an object is magnetic or not.
- In a non-magnetic object, there are no domains.
- In a magnetic object, there are domains, but they are unaligned.
- In a magnet, the domains are all lined up.



Magnetism and Current

- All current carrying wires have a magnetic field
- The magnetic field around a current carrying wire is a pattern of concentric circles around the wire.
- If there is no current going through the wire, then there will be no magnetic field.
- We use the **Right Hand Rule** to determine the direction of the magnetic field.



Magnetism and Current Pt. 2

The strength of the magnetic field around a current carrying wire depends on:

- The Current: I
- The distance from the wire:r

The equation for this is: $B = \frac{\mu_0 I}{2\pi r}$

Magnetic field is measured in Teslas (T)

Magnetic Force on Electric Current

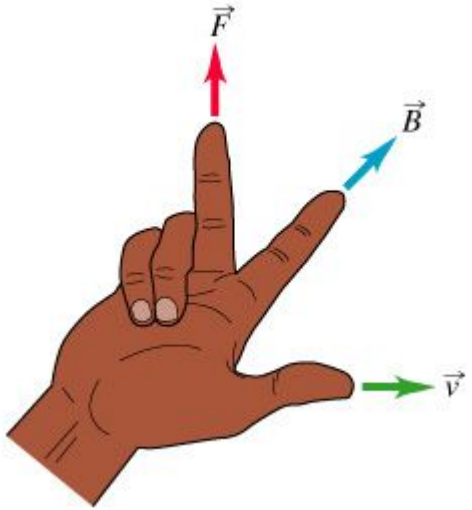
- Electric currents exert a force on magnets
- Magnitude of this force depends on:
  - Strength of Magnetic field, (B)
  - Current, (I)
  - Angle of the wire, (θ)
  - Length of the wire, (l)
- The equation for this is: $F_B = I\ell B \sin\theta$

Right Hand Rule

To determine the relative directions of the magnetic force, magnetic field and current, we use the **Right Hand Rule**.

Magnetic force is always perpendicular to the direction of the current, and the direction of the magnetic field.

- Your index finger represents the magnetic field
- Your middle finger represents the magnetic force
- Your thumb represents the direction of the current



Induction

- The key concept of Induction is that a changing magnetic field will produce a voltage.
- The voltage that is produced is a factor of the movement of the conductor within a magnetic field. The conductor could move past the magnetic field and produce voltage or the magnetic field could move past the conductor and still produce the same voltage.
- The amount of voltage produced relies on how fast the conductor or magnetic field move past each other and also the number of coils in the wire.
- The more loops a coil has will mean it takes more work to push the magnet through the magnetic field. The magnet will be forced into the opposite direction of its movement.

Faraday and Lenz’s Laws

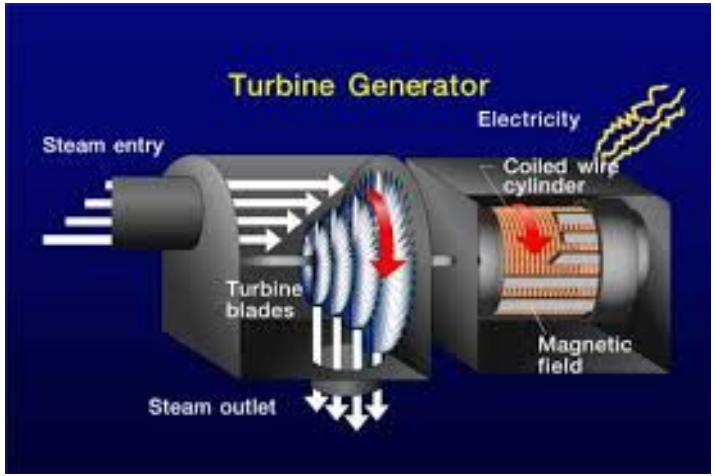
- The product of the magnetic field and the area of the magnetic field equals magnetic flux.
  - Equation: $\Phi = B \perp A = BA(\sin\Theta)$
  - Don't forget Units: Webers (Wb)
- Faraday's Law of Induction:
  - $V = \Delta\Phi/\Delta t$
  - The voltage will equal the change in magnetic flux over the change in time.
- Lenz’s Law says that an induced voltage will always create a current whose magnetic field will oppose the original magnetic field that produced it.
  - Pushing the magnet in= the magnetic field produced will push it back out.
  - Pulling the magnet out= the magnetic field produced to pull it back in.

Electric Generators and Motors

- Motors convert Electrical energy to Mechanical energy
- Generators convert Mechanical energy to Electrical energy
- To create a generator, you just have to move a magnet in and out of coil
  - When it moves into the coil, the field strength in the coil increases, and the current is induced in one direction
  - When it moves out of the coil, the field strength diminishes and current is moved in the other direction
- The higher the frequency is, the higher the voltage
- This can also be done by rotating a coil in a stationary magnetic field
- This creates Alternating current

Electric Generators and Motors Pt. 2

- To spin this generator, you can use something like a turbine
- A motor is the same as a generator, but it is run in reverse\



Transformers

- Not the ones from the movies
- Transformers are devices that either increase or decrease AC current.
  - Every Transformer has 2 sets of coils of wire known as the primary and secondary coils
  - The 2 sets of coils are either interwoven with insulated wire or they can be connected by a soft iron core.
- Transformers are built so that most magnetic flux produced by current travels through the primary and secondary coils.
  - Faraday's law can be used here: Vp/Np=Vs/Ns
- Step up Transformers: more loops in the secondary coil making it produce a higher voltage.
- Step Down Transformers: Less Loops in the secondary coil making it produce a lower voltage

The Common Mistakes

Common mistakes made while measuring magnetism is as follows:

-The magnetic field and voltage can change hence give a psuedo result

-Ordinary multimeter is unsuitable for measuring high frequency signals

-An open circuit consisting of two wires joined by a single weld. This can create a significant difference in potential

-Don’t use your left hand when the right hand rule is needed