

1 - Magnetism

Dipoles

- Poles** – dipole; North and South
 - Suspend a magnet and the north seeking pole aligns with North due to Earth's own magnetic field
 - Documented as a navigational tool since 11th century China
 - Opposites attract and likes repel even without contact
 - Field Force – like gravity and electric field
- NOT** like electric charges in that a + or - charge can be isolated.
 - You cannot isolate a magnetic pole
- NO** monopole has ever been isolated.
 - When you break a magnet, you get pieces with new N and S poles

Magnetic Elements

- Iron (Fe), Cobalt (Co), Nickel (Ni), and Gadolinium (Gd)** show **strong** magnetic effects and are called **ferromagnetic**
- Dysprosium (Dy) and Neodymium (Nd)** are also magnetic (rare earth magnets)

Magnetic Field Lines

- Magnetic Field Lines** – the force one magnet exerts on another can be described as the interaction between the magnet and the magnetic field of another magnet
 - direction of magnetic field is tangent to a line at any point
 - the number of lines per unit area \propto the magnitude of the magnetic field
 - direction is the direction the N pole of a compass needle would point
 - draw the lines from N to S

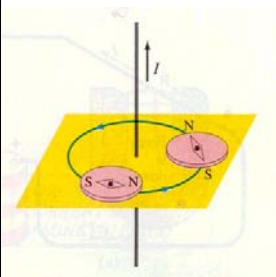
Magnetic Field

- Symbol – B
- Unit – **Tesla**
- related to torque exerted on compass needle
- greater torque = greater field strength
- Magnetic North is really the Earth's South pole
 - 1300 km from Santa's home.
 - Geographic N occurs at the "top" of the earth's rotational axis

Magnetic Field

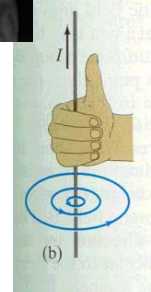
- Magnetic declination** – angular difference between magnetic and geographic N poles.
 - Value varies between 0° and 25°
- uniform field**
 - hard to produce over a large area
 - fringes at the edges; much like the electric field lines do

Electric Current Produces Magnetism



- 1820 Hans Christian Oersted found that a compass needle was deflected when placed near an electric wire; therefore, an electric current produces a magnetic field!
- A compass needle aligns itself so it is tangent to a circle drawn around the wire

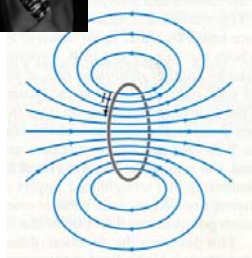
Curly Hand Rule



- One of the Right Hand Rules**
- This one is for a straight wire
- Grasp the wire with the right hand
- Point thumb in the direction of the POSITIVE current
 - [it's all about the Benjamin!]
- Your fingers point in the direction of the magnetic field

Curly Hand Rule

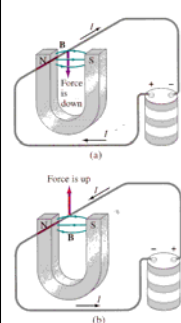
- Loop of wire – curly hand rule still applies
- You can still use a compass to determine field as well



Force on Electric Current in a Magnetic Field

- Oersted was a good Newtonian physics student and reasoned that if an electric current exerts a F on a magnet [the compass needle], then shouldn't a magnet exert a force on a current carrying wire according to Newton's 3rd Law?

Force on Electric Current in a Magnetic Field



- A straight section of wire is placed between the two poles of a horseshoe magnet.
- When current flows, a force is exerted normal to the magnetic field.
- Reverse the current, force reverses direction [same magnet with same amps coursing through it]. F is normal to current flow and normal to magnetic field.

Right Hand Rule

- lets you know the direction of the **force** exerted
- Middle Finger is the Force – F
- Index Finger is the Magnetic Field – B
- Thumb is the Current – I
- FBI

