Magnetism

What is it and how does it work?

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Magnetic Poles

- All magnets have two poles
  - monopoles do not exist.
- North pole points toward to the north, south towards the south.
- Like poles repel, unlike attract.
- Earth's magnetic North is actually geographic South.

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Magnetic Materials

- Ferromagnetic
  - Strongly attracted to magnetic materials (ex: iron, steel, cobalt)
- Paramagnetic
  - Very slightly attracted to magnetic materials (ex: wood, aluminum, platinum)
- Diamagnetic
  - Weakly repelled by magnetic materials (ex: gold, zinc, sodium chloride)

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Cause of Magnetism

- Magnetism is caused by a charge in motion
- Electrons in motion
  - Revolving around the nucleus
  - Spinning around it own axis
  - Usually occur in pairs, neutralizing each other
- Magnetic materials have an imbalance of electrons in orbits and spins.

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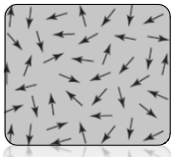
Magnetic Domains

- Electron motion occurs in microscopic magnetic regions called domains.
- Domains are oriented in random directions neutralizing any overall magnetic field.



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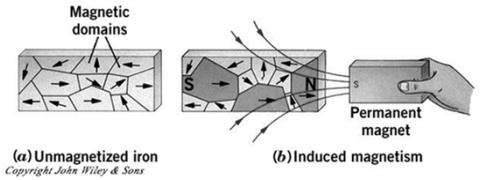
Creating Magnets

- When a ferromagnetic material is placed in an magnetic field, the domains align, magnetizing the material.



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Types of Magnets

- Permanent magnets
  - If the domains remain aligned after the magnetic field in removed, the material is said to be permanently magnetized.
- Temporary magnets
  - If the domains randomize after the magnetic field in removed, the material is said to be a temporary magnet.

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“Neutralizing” Magnets

- Heating a ferromagnetic material to a specific temperature breaks down the domain regions resulting in a paramagnetic material.
  - This temperature is known as the Curie point.

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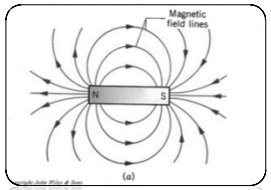
Magnetic Fields

- The lines of magnetic flux are drawn away from North and towards the South
- The strength of a magnetic field is shown by the number of magnetic field lines in a certain area.
- More Magnetic Field Lines = Stronger Magnetic Field



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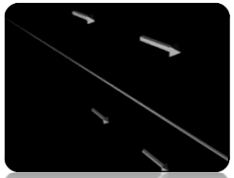
Electromagnetism

- Current passing through a wire creates a magnetic field.
- Discovered by Oersted, when a compass was placed by a current carrying wire.



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Magnetic Field Strength

- To determine the magnetic field strength (B) along a wire, we use:

$$B = 2k\frac{I}{r}$$

Where

k = 1 x 10^{-7} N/A^2
I = current in the wire (A)
r = distance from wire (m)
B = magnetic field strength (T)

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Example Problem

- Calculate the current passing through a wire if a magnetic field strength of 8.89 x 10^{-5} T occurs at a distance of 0.135 m from the wire?

$B = 2k\frac{I}{r}$

$8.89 \times 10^{-5} = 2(1 \times 10^{-7})\frac{(I)}{.135}$

$I = 60A$

Answer: I = 60 A

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First Right Hand Rule

- Used to determine the direction of the magnetic field in a current carrying wire.
- Grasp the conductor with your right hand with your thumb pointing in the direction of the current. Your fingers will circle in the direction of the magnetic field.

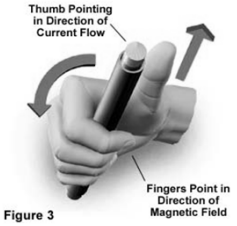

Figure 3

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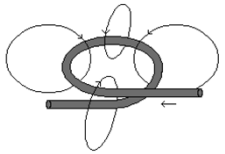
Loops of Wire

- If we bend a current carrying wire into a loop, we find that the magnetic field along the inside of the loop faces in one direction, producing a magnetic field pointed in that direction.



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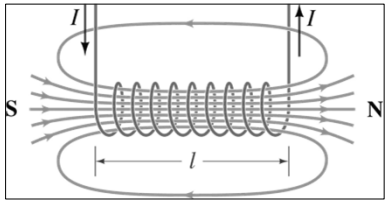
Multiple Loops

- By increasing the number of loops, the magnetic field can be increased.



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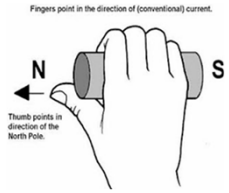
Second Right Hand Rule

- Grasp the coil with your right hand with your fingers circling the coil in the direction of the current. The extended thumb will point in the direction of the north pole of the core.



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