

Magnetism, part 2

Ørsted's discovery
Solenoids
Forces between wires

Ørsted's Discovery

- ▶ Known: a current in a straight long wire produces a magnetic field around itself
- ▶ H.C. Ørsted (Danish) quantified this observation:
 - The magnitude of the magnetic field, B , created by the current in a wire varies linearly with the current in the wire and inversely with the perpendicular distance from the wire

Ørsted's Discovery

$$B = \frac{\mu_0 I}{2\pi r}$$

- ▶ Magnetic permeability of vacuum = μ_0

$$\mu_0 = 4\pi \times 10^{-7} \text{ N} \cdot \text{A}^{-2}$$

Solenoids

- ▶ Wire wound tightly around an axis, often with an iron core, that results in a uniform magnetic field
 - Uniform magnetic field = same magnitude and direction in a region of space
- ▶ A solenoid's uniform magnetic field occurs in the interior and is given by:

$$B = \mu_0 \frac{N \cdot I}{L}$$

- ▶ Where N is the number of coils, I is the current, and L is the length of the solenoid

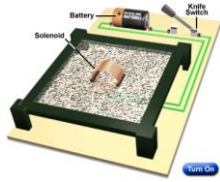
Solenoids

- ▶ Adding an iron core into the center of the solenoid will increase the strength of the magnetic field
- ▶ Essentially, the iron core will "magnify" the solenoid's magnetic field because it will also become magnetic and will have an associated magnetic field
- ▶ So...how do we determine the direction of the magnetic field of a solenoid?

Solenoids...

- ▶ To find the direction of the magnetic field, we will use another right-hand rule:
 - Hold the solenoid with your right hand so that your fingers curl in the direction of the current around the axis
 - Your thumb will point in the direction of the magnetic field
- ▶ Which means...
 - The **North pole** of a solenoid will be the end where the current through the coils runs **clockwise**...and vice-versa for the **South pole**

- ▶ An animation of the solenoid's magnetic field can be seen at the National High Magnetic Field Laboratory's website:



<http://www.magnet.fsu.edu/education/tutorials/java/solenoidfield/index.htm>
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