Electricity & Magnetism
What’s an electron?

Model of the atom

Cartoon is deceptive.

This is a better image of electrons.
Static Electricity

- What’s electric charge?
  - Scotch tape activity
- Induced Charge vs. Charge Transfer
- Demos
  - Balloons
  - Fur, wool, plastic, & glass
Electric Fields

- Where’s the field?
  - The field indicates a force that can push on a charged particle.
- Van de Graaff generator
Current Electricity

- Circuit game - What’s it like to be an electron?
Series Circuits
Parallel Circuits
Current vs. Voltage vs. Power

- **Current** = # of electrons per second
- **Voltage** = energy per electron
  - Sometimes called potential difference
- **Power** = energy (of all electrons) per second

High voltage won’t kill, but high current will!
What’s going on here?

- Jacob’s Ladder
- Tesla Coil & Fluorescent Light bulb
Generating Electricity

- Identify the energy transformations:
  - Hand-held generator
  - Windmill
  - Hydroelectric Power
  - Nuclear Power
  - Coal Power (steam generator)
BREAK TIME
Magnetic Fields

- What do the fields look like?
  - Map using iron filings
- The presence of a field means there’s a force!
Types of Magnets

- The refrigerator vs. the fridge magnet
- Magnetic Domains
Examples

- **Ring Magnets**
  - What forces are acting here? Why do they balance?

- **Floating Globe**
  - The earth has a magnetic field, is this how it stays in orbit?

- **Levitating Train**

- **Magnetic Linear Accelerator**
  - Why does the ball speed up?
Electromagnetism

- What’s the relationship?
- Use the compass and current-carrying wire to find out.

A current carrying wire produces a magnetic field. This is Ampere’s Law.
Electromagnetism (in reverse)

Can a magnet create a current?

Yes, a moving magnetic field creates a current in a wire. This is Faraday’s Law.
Examples

- Battery free flashlight
- Eddy currents
- Ring launcher
- Can crusher/launcher

  - What about the energy transformations here?
Motors

- The current in the wire creates a magnetic field.
- It is repelled by the permanent magnetic field and makes the wire loop spin.
Can you make a motor from this?
Generator

- A motor in reverse.
- Turning the loop creates a current in the wire.
Maxwell’s Equations

\[ \oint E \cdot dA = \frac{q_{enc}}{\varepsilon_0} \]
\[ \oint B \cdot dA = 0 \]
\[ \oint E \cdot ds = -\frac{d\Phi_B}{dt} \]
\[ \oint B \cdot ds = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc} \]
Plasmas

What’s a plasma?
- A very hot, electrically charged gas
- Can be controlled using a magnet…therefore the moving charges must be effected by the magnetic field