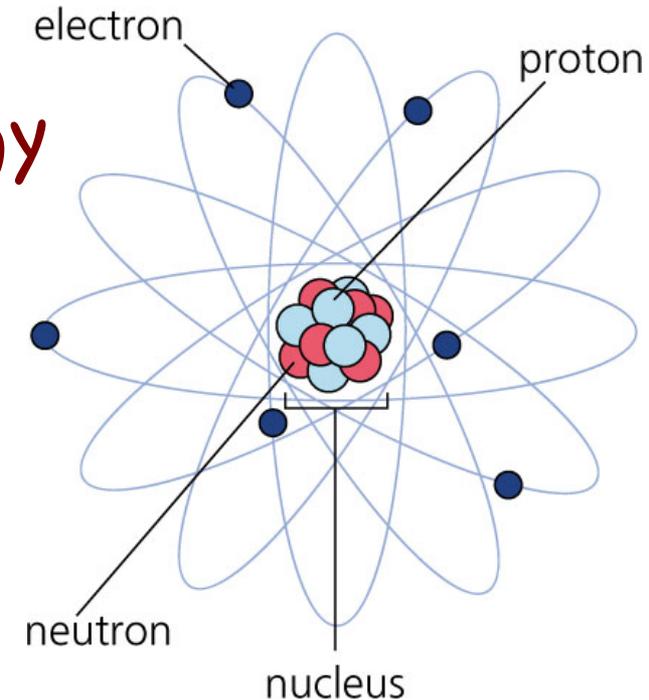


Charge! Electricity and Magnetism

What is Charge?

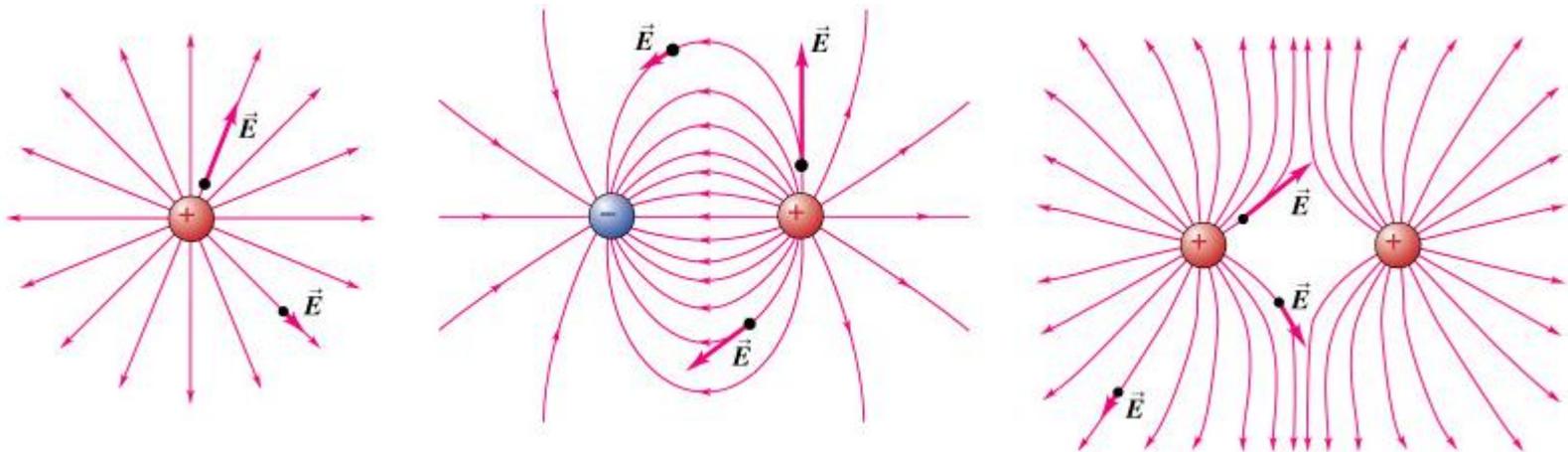
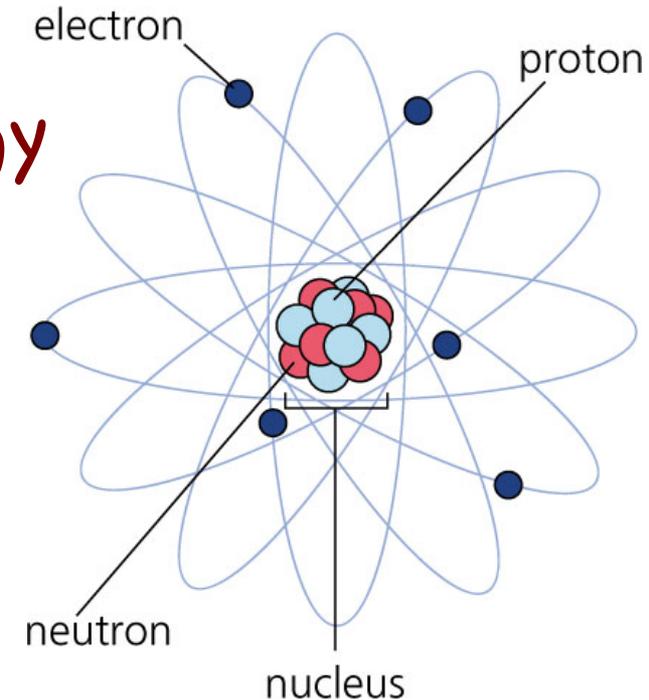
What is Charge?

- When atoms don't have as many electrons as they do protons, they carry a charge!
- How do they ACT?



What is Charge?

- When atoms don't have as many electrons as they do protons, they carry a charge!
- Opposite charges attract
- Like charges repel



Where have YOU seen charge?

- “Stuck” charges are also called “Static Electricity”...
- Everyday examples are:
 - ?
 - ?
 - ?
 - ?

Where have YOU seen charge?

- “Stuck” charges are also called “Static Electricity”...
- Everyday examples are:
 - Socks in the dryer
 - Walking around in your socks on Carpet
 - Getting out of the car in winter
 - Lightning!

Charge in Action!

- We need some volunteers!
- We have some balloons and some string...
 - Can you show us how like charges repel?
 - How can you test for charge? (Electroscope!)
- We also have some wool and plastic...
 - What things get attracted to a static charge?
 - Are you surprised at what does & does not?

Balloon Demo

Electricity is Moving Charge!

- How can we make charges move?

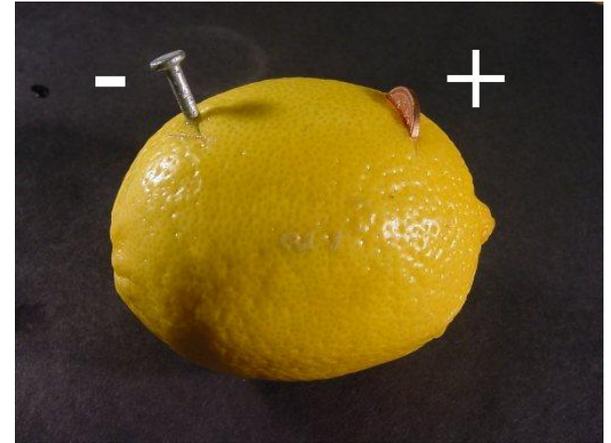
Electricity is Moving Charge!

- How can we make charges move?
- We need a volunteer!
 - We have some lemons, copper, zinc and a clock
 - Can you make the clock work?

Electricity is Moving Charge!

- How can we make charges move?
- We need a volunteer!
 - We have some lemons, copper, zinc and a clock
 - Can you make the clock work?
- This is a chemical generator!
 - What are some other examples of chemicals creating electricity?

Batteries!



More ways to make electricity...

- Not all of our electricity comes from batteries...
- We need another volunteer!
 - We want to light a light bulb...

More ways to make electricity...

- Not all of our electricity comes from batteries...
- We need another volunteer!
 - We want to light a light bulb...
- This is a mechanical generator
 - What other mechanical generators can you think of?

Power Plants!



Circuits

- Electricity needs to flow from high voltage to low voltage
 - Moving electricity is called CURRENT

Circuits

- Electricity needs to flow from high voltage to low voltage
 - Moving electricity is called CURRENT
 - A lot of current can be dangerous!

Circuits

- Electricity needs to flow from high voltage to low voltage
 - Moving electricity is called CURRENT
 - A lot of current can be dangerous!
- If there's a break in a circuit, current won't flow!
 - There are "open," "closed" and "short" circuits
 - Help us make some circuits!

More about circuits...

- There is a special relationship between voltage, resistance and current!

Simple Circuit Demo

More about Circuits...

- There is a special relationship between voltage, resistance and current!

Simple Circuit Demo

- How fast do electrons and electricity really move?

Electrons and Electric Signals

Magnetism

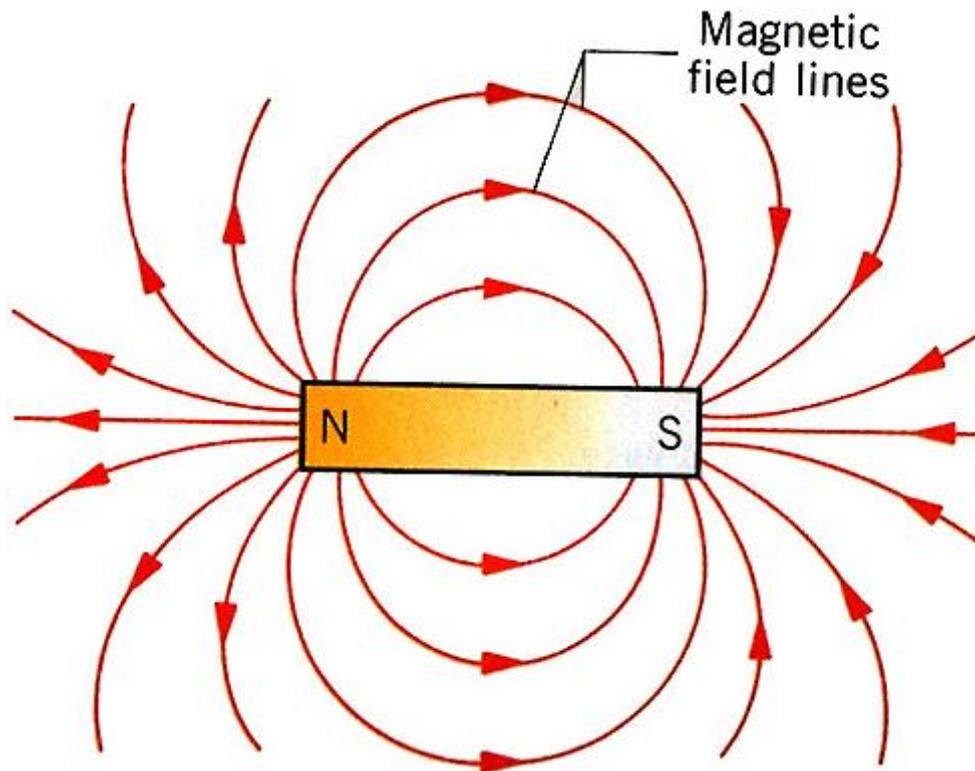
- What is a magnet?
 - How does it act?
 - What kinds have you seen?
 - What happens to non-magnets around magnets?

Magnetism

- What is a magnet?
 - How does it act?
 - What kinds have you seen?
 - What happens to non-magnets around magnets?
- We need another volunteer!
 - What can you pick up with a magnet?
 - Is it the same as we picked up with a static charge?
 - Do magnets carry a charge?
 - What will the magnetic force go through?

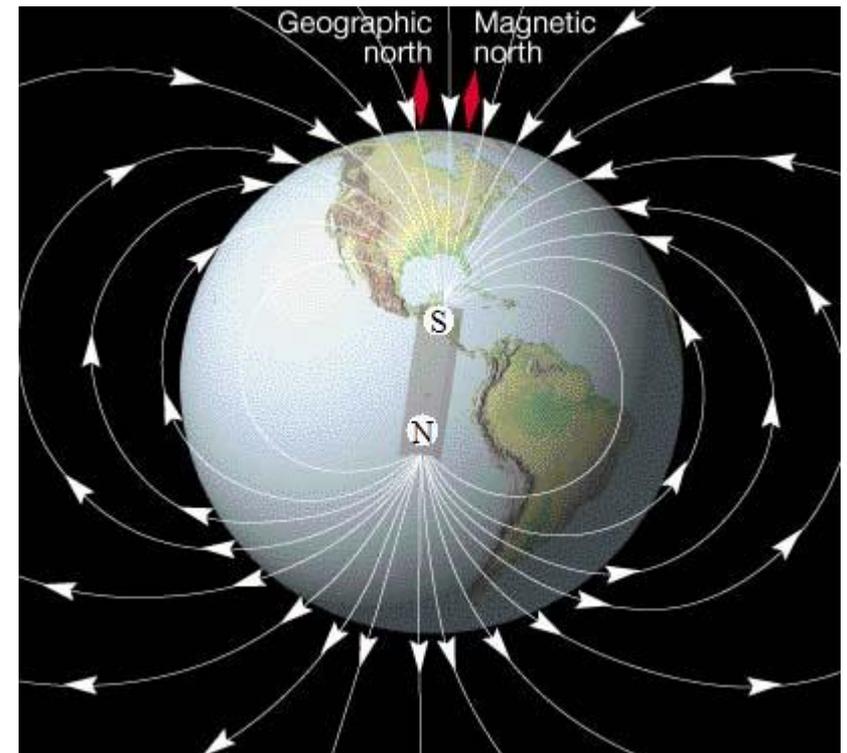
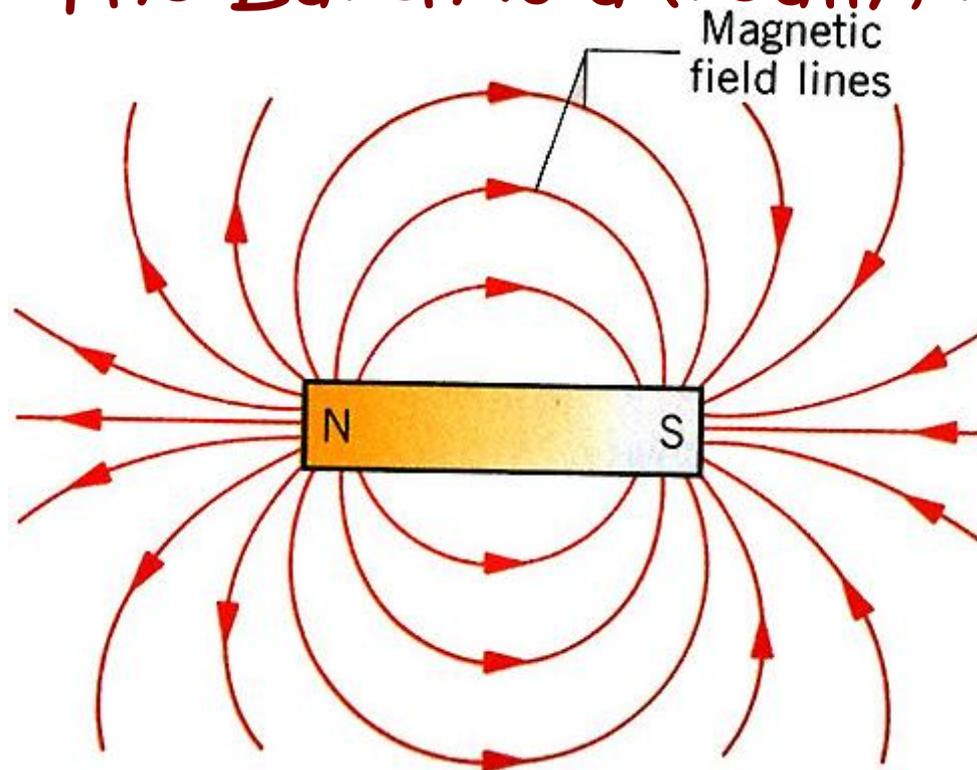
A Compass is a Magnet!

- Compasses align with magnetic field lines
 - What does that imply?



A Compass is a Magnet!

- Compasses align with magnetic field lines
 - What does that imply?
- The Earth is a (really, really big) magnet!



Electricity & Magnetism

- Special things happen when you have a changing magnetic field...

Changing Magnetic Fields

Electricity & Magnetism

- Special things happen when you have a changing magnetic field...

Changing Magnetic Fields

- This is how power plants generate the electricity we use every day!
 - Each type of plant uses something different to turn the magnets:
 - Wind, water, or steam is usually used
 - Coal, natural gas, and fission just make steam!

Magnetism & Electricity ?

- We can also make magnets out of electricity!
 - A loop of current creates a magnetic field
 - More loops = more magnetic field!

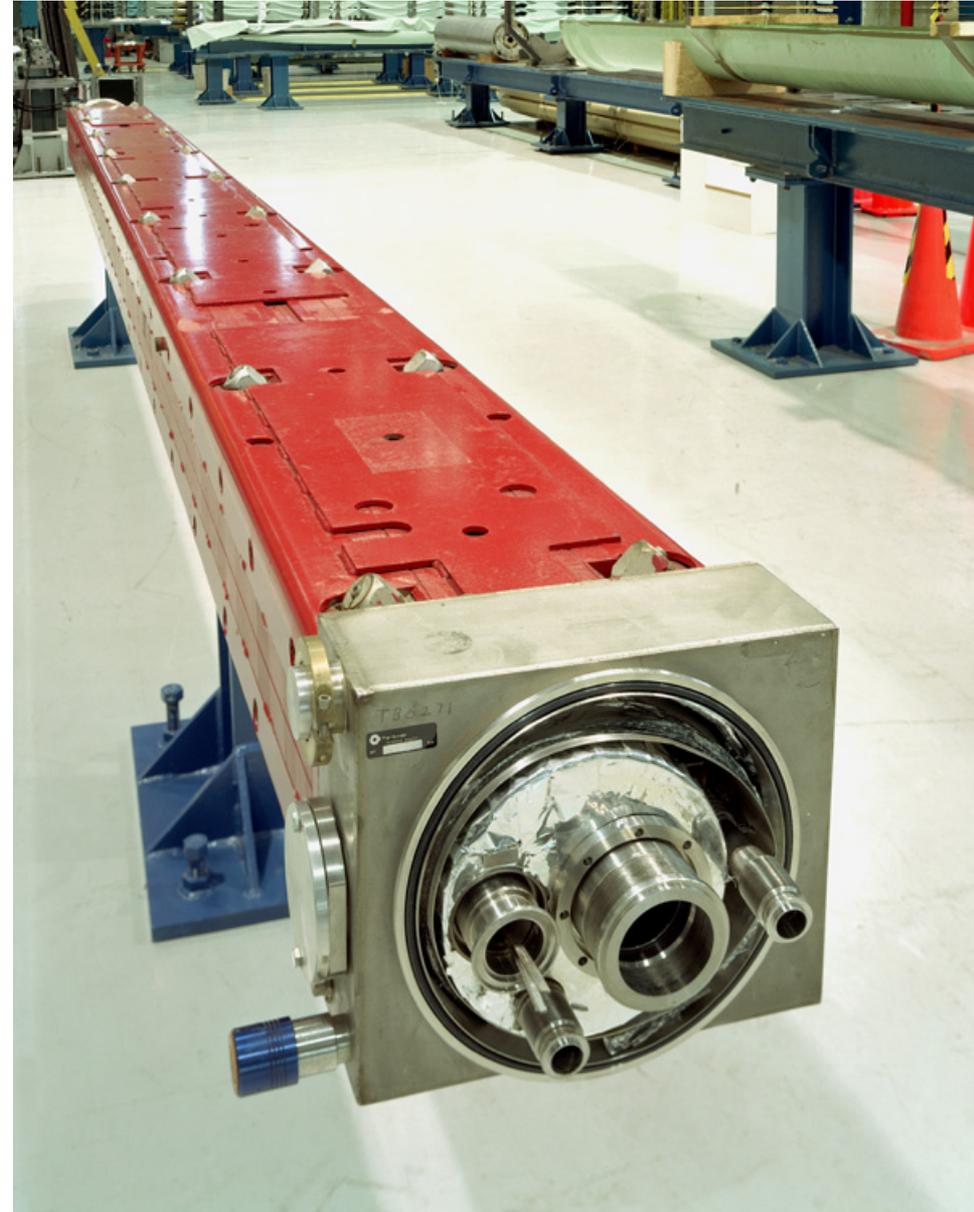
Magnetism & Electricity ?

- We can also make magnets out of electricity!
 - A loop of current creates a magnetic field
 - More loops = more magnetic field!
- We need a volunteer!
 - What can you pick up with an electromagnet?
 - What does the electromagnet do to a compass?

Magnetism & Electricity ?

- We can also make magnets out of electricity!
 - A loop of current creates a magnetic field
 - More loops = more magnetic field!
- We need a volunteer!
 - What can you pick up with an electromagnet?
 - What does the electromagnet do to a compass?
- What other electromagnets have you seen?

Everyday Electromagnets



Magnets Making Magnets

- We've seen that a changing magnetic field makes electricity
 - This is what made power plants run!
- But electricity also makes magnets...

Magnets Making Magnets

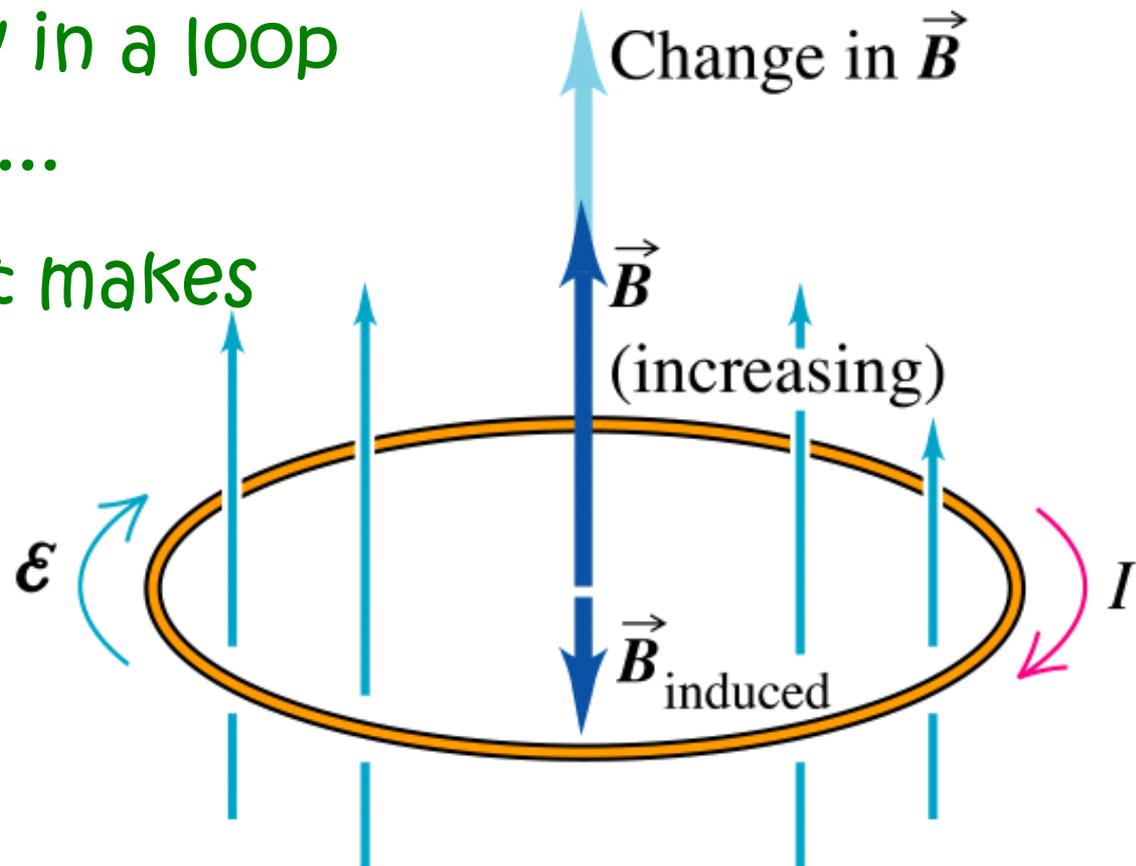
- We've seen that a changing magnetic field makes electricity
 - This is what made power plants run!
- But electricity also makes magnets...
- We need another volunteer!

Magnets Making Magnets

- We've seen that a changing magnetic field makes electricity
 - This is what made power plants run!
- But electricity also makes magnets...
- We need another volunteer!
 - The “induced electromagnet” creates a field that **opposes** the changing magnetic field!
 - You don't get something for nothing!!

One Thing Leads to Another...

- Imagine that instead of starting with a magnet, we started with some wire!
 - Running electricity in a loop will make a magnet...
 - A changing magnet makes electricity move...
 - Which will make another magnet!

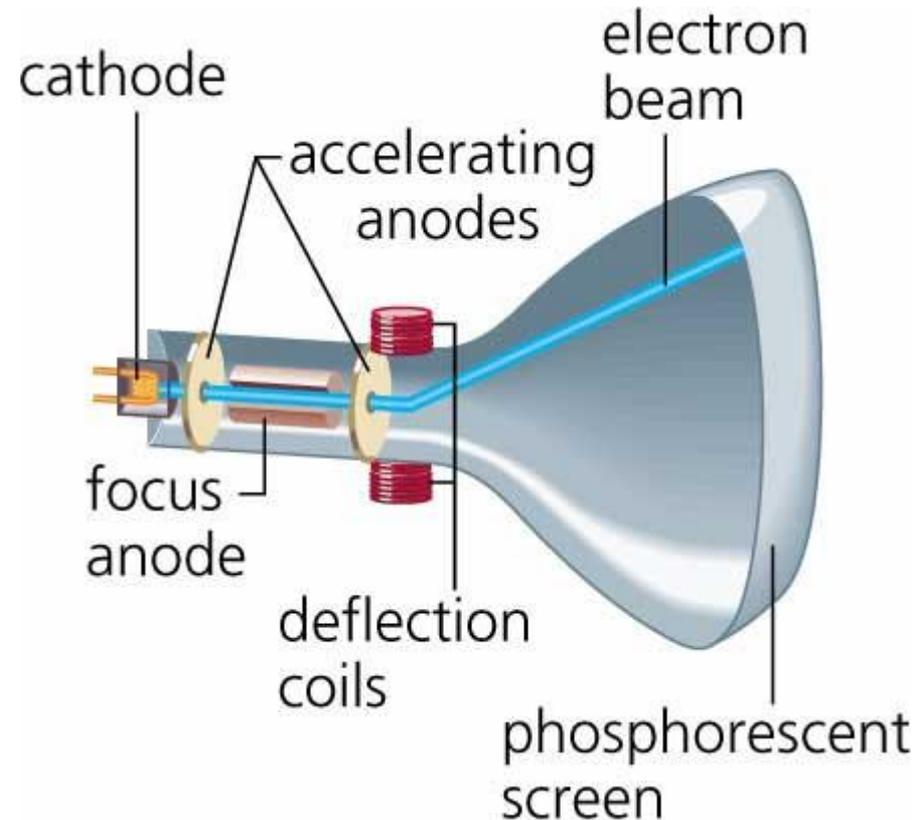


Particle Accelerators at Home!

- Did you know that you probably have a particle accelerator at home right now?

Particle Accelerators at Home!

- Cathode Ray Tubes, the original kind of TVs, are particle accelerators!

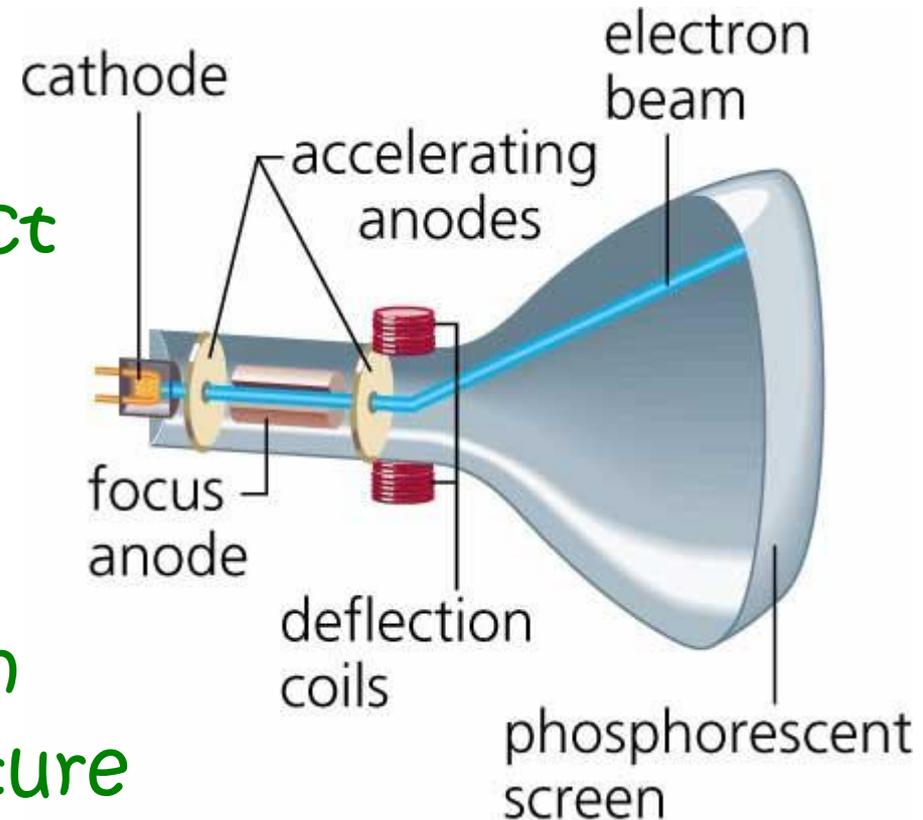


Particle Accelerators at Home!

- Cathode Ray Tubes, the original kind of TVs, are particle accelerators!

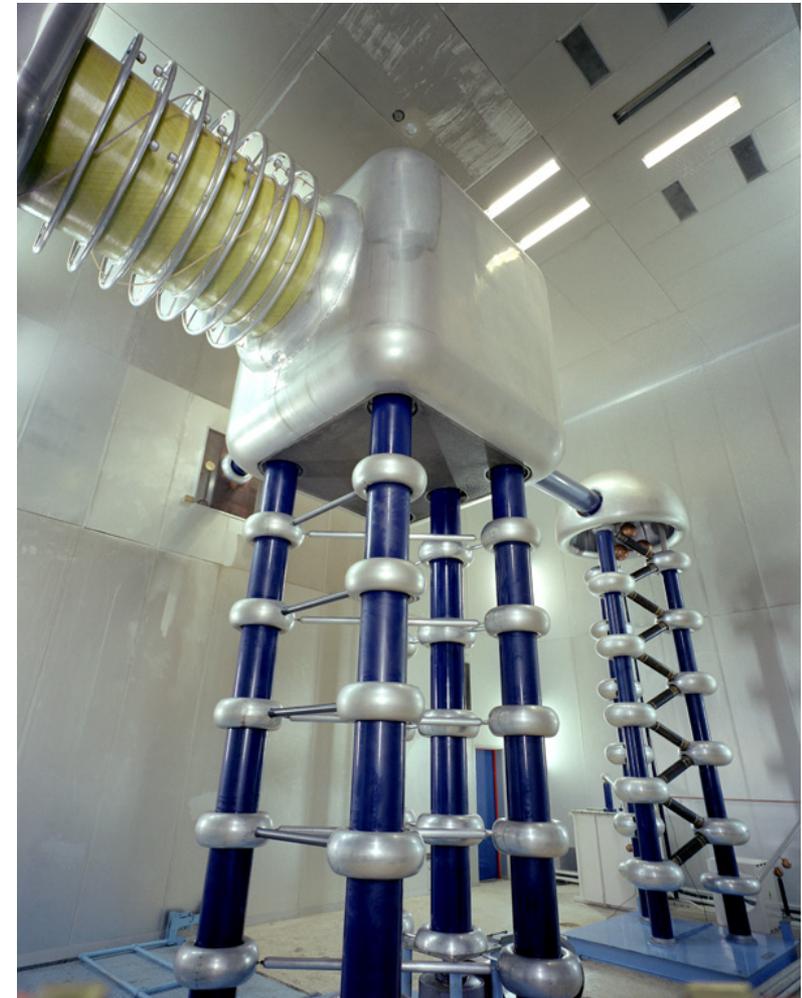
- We need a volunteer!

- Magnets don't just effect other magnets, they also bend moving charge
- Electromagnets in your TV make a single electron beam draw a moving picture



Back to Charge...

- A Van de Graaff generator creates a large voltage difference
- We've learned a lot about static and moving charges today...
- Help us guess what will happen when we experiment with the Van de Graaff!



Questions & Answers

- It has been a fun day! Thank you for being such good hosts!!
- Any questions about charge, electricity or magnetism?

Questions & Answers

- It has been a fun day! Thank you for being such good hosts!!
- Any questions about charge, electricity or magnetism?
- Any questions about physics, science, scientists or Fermilab?

Thank You!!!

- Please visit Fermilab anytime!
 - The Lederman Center has lots of activities to help you learn about what we do at Fermilab
 - We have buffalo and prairie trails, too!
- Useful links:
 - Fermilab Education Office: <http://www-ed.fnal.gov>
 - American Science & Surplus: <http://www.sciplus.com/>
 - Java Demos: <http://www.colorado.edu/physics/phet>