When Sparks Fly!

Getting a charge out of electricity

NBSP Physical Science Institute

Monday July 22, 2002
Standard Connections

Students know electrically charged objects attract or repel each other.

How do we electrically charge an object?

How do we create or destroy charge?

Why do we say “opposites attract?”
First Activity: A deeper look at charge

- How do we know that there are two different types of charged particles?
- How can you show that there are two types of charges?
- How can you figure out whether like or unlike charges attract each other?
- Why did we decide that the negatively charged particles were the electrons?
Equipment for first activity

- Silk
- Fur
- Plastic rods
- Pith balls (styrofoam ball covered with metal foil)
- Balloons
- Small pieces of paper
A few things to try:

- Rub different materials on rod
- Bring rod towards pith balls
- Touch rod to pith balls
- Rub different materials on balloon
- Hold balloon near paper pieces
- Stick balloon to ceiling or other things
- Some investigations of your own!
More questions for first activity

What happens when you first bring the plastic rod near the pith ball? Why?

What happens if you touch the rod to the pith ball?

Why does a balloon stick to the ceiling if you rub it with wool?

Why does the balloon attract small pieces of paper?
Electrons and the Greeks

The ancient Greeks noticed that rubbing amber could cause it to attract bits of straw.

The name we use for this type of attraction, *electricity*, comes from the Greek word for amber, *electron*.

Amber is really fossilized tree resin.
Key concepts about charge

- There are two and only two types of electrical charge – why?
- Electrons are defined to have negative charge
- Electrons are free to move in and between certain types of materials
- The flow of electrons is called electricity
Vocabulary for ELL

- Electron: negatively charged fundamental particle
- Proton: positively charged fundamental particle
- Static electricity: build up of charge
- Electricity: flow of electrons
Vocabulary for ELL

- **Attract:** cling together

- **Repel:** push apart

- **Amber:** yellow-orange fossilized tree resin - often containing insects
How many things can you name that use electricity?

Can you alphabetize their names?

Make a table to help remember new words:

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
<th>How I remember</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</table>
Publisher’s Materials

Take some time to look through the state-adopted texts to find activities relating to electric charge and static electricity that could be used in your classroom.
Break – some things to think about

How many things do you see that use electricity while you are on break?

Make a list of the ways you use electricity each day.
Standard Connections

Students know how to design and build simple circuits by using components such as wires, batteries and bulbs

Why are they called “circuits”?  
What is flowing in the circuit?
Second Activity – single-bulb circuit

Given: one battery, one light bulb and one wire

Connect these in as many ways as you can – draw your experiments

Which arrangements cause the bulb to light? (You should have at least four)

What is required in order for the bulb to light?
How does the battery work?

Anode: material connected to the negative terminal of a battery, typically zinc.

Cathode: material connected to the positive terminal of a battery, typically graphite or silver.

Electrolyte paste

“DRY CELL”
Batteries and charge

- Zinc anode corrodes due to exposure to water in electrolyte paste.
- Corroding zinc provides electrons.
- Electrons flow through circuit towards positive cathode.
- Electrons react with electrolyte paste to produce water and neutral materials.
- Cathode structure provides location for paste to interact with electrons.
Electrons and Ben Franklin

Ben Franklin's "single fluid theory" showed that a given body possessing a normal amount of electric fluid was called *neutral*. During the process of charging, the fluid was transferred from one body to the other; the body with the deficiency being charged *minus* and the body with the excess charged *plus*. But no fluid is lost. Ben's "single fluid theory" led to the electron theory in 1900: *electrons move about conductors much as a fluid might move.*
Key concepts

Circuit: complete path of electrical current flow including energy source

If the path is not complete, the bulb will not light

Complete circuit requires flow of electrons from negative to positive terminals **and through the battery itself**

Bulb is used as an indicator of current flow
Vocabulary for ELL

- Cathode: positively charged terminal of the battery
- Anode: negatively charged terminal of the battery
- Circuit: complete loop through positive and negative terminals and through the battery itself
ELD Activities

What other word sounds like circuit and means almost the same thing?

What are other ways to use the word “circuit”? 
Publisher’s Materials

Take some time to look through the state-adopted texts to find activities relating to single bulb circuits and batteries that could be used in your classroom.
Lunch break - Things to think about

• What is the difference between AA, C and D cell batteries?

• How do these types of batteries differ from the 9-volt batteries that are used in smoke detectors (for example.)

• What is the difference between rechargeable batteries like Ni-Cads and alkaline batteries like Duracells?
Standard Connections

Students know electrical energy can be converted to heat and light

What happens to materials when current flows?

How do light bulbs make light?
Third Activity: electrons in materials

- What is inside of a light bulb?
- What path does electricity take through a light bulb?
- What types of materials are good conductors?
- What types of materials block electricity?
Equipment for third activity

- Insulated wires
- Battery and holder
- Christmas tree and flashlight bulbs
- Brass fasteners and masking tape
- Cardboard with holes in it
- Film can with holes in it
- Paper clips
- Test materials: rubber, wood, glass, plastic, aluminum, paper clips, etc.
Two types of circuits to build:

- **Make and take:** use cardboard with holes in it, brass fasteners, paper clip for switch, film can with holes in it, c-cell battery, xmas tree bulb

- **More expensive:** use battery holder, knife switch, masking tape, d-cell battery, flashlight bulb and holder
A few things to try:

- Examine the two types of bulbs
- Build both types of circuits
- Make sure your circuit lights the bulb
- Stick test materials in different places
- See if the bulb still lights
- Record which materials allow the bulb to light and which do not
- Some investigations of your own!
More questions for third activity

- Were you surprised by some of the items that were conductors?
- Were you surprised by some of the items that were insulators?
- What did the conductors have in common?
- What did the insulators have in common?
More questions for third activity

Did it make any difference where you put the test materials in the circuit?

Did it make any difference which way you put the battery in the holder?

Did it make any difference which way you connected the (xmas tree) light bulb in the circuit?
Key concepts

Conductors are usually (but not always) metals – they have electrons that move easily.

Insulators are materials that block the flow of electrons.

It does not matter which way the battery is oriented – but sometimes the battery holder won’t connect if the battery is not oriented properly.

It does not matter which way the (xmas tree) light bulb is oriented.
Vocabulary for ELL

Conductor: material that allows the flow of electricity

Insulator: material that blocks the flow of electricity
ELD Activities

The person who leads an orchestra or a band is called a conductor. How is an orchestra conductor similar to an electrical conductor?

Buildings stay warm because of insulation material. How is insulation material similar to electrical insulators?
Publisher’s Materials

Take some time to look through the state-adopted texts to find activities relating to conductors and insulators that could be used in your classroom.
Break - things to think about

What is a semi-conductor?

Can you think of everyday items that depend on semi-conductors?

Can you think of any materials that are used to make semi-conductors?

Hint: they named a Valley after one elemental semi-conductor material
Standard Connections

Students know how to design and build simple **series and parallel circuits** by using components such as wires, batteries and bulbs

What is the difference between series and parallel circuits?
Series Circuits

A series circuit has all the elements arranged one after the other, so all the electrons follow one single path through the circuit.

Example: A flashlight
Parallel Circuits

A parallel circuit has more than one path for the electrons to take through the circuit – and only some of the electrons go through each path.

Example: electrical system in a car
Two-bulb circuit

• Set up the circuit as shown

• Compare the brightness of each of the bulbs with that of an identical bulb in the single-bulb circuit

• What can you conclude about the amount of current through each bulb?

• Is the current “used up” in the first bulb?
Questions about 2-bulb circuit

Do you think the order of the bulbs makes a difference to their brightness?

How can you find out?

Do you think there is more or less current flowing through each of these bulbs than through the bulb in the single-bulb circuit?

Is this circuit series or parallel?
Another two-bulb circuit

• Set up the circuit as shown

• Compare the brightness of each of the bulbs with that of an identical bulb in the single-bulb circuit

• What can you conclude about the amount of current through each bulb?

• Is the current “used up” in the first bulb?
Questions about 2-bulb circuit

Do you think the order of the bulbs makes a difference to their brightness?

How can you find out?

Do you think there is more or less current flowing through each of these bulbs than through the bulb in the single-bulb circuit?

Is this circuit series or parallel?
More questions about 2-bulb circuit

What do you think would happen if the bulbs were located on different sides of the battery?

Describe the current flow through the circuit. What happens to the current at point A? At point B?

Does the amount of current that comes out of a battery appear to remain constant or does it depend on the number of bulbs in a circuit and how they are connected?
Key concepts

Series circuits – all of the electric current flows through all of the circuit elements

Parallel circuits – the electric current splits - part flows down each parallel branch of the circuit
Vocabulary for ELL

Series: elements are arranged in a sequence

A → B → C

F ← E ← D
Vocabulary for ELL

Parallel: elements are arranged in branches

A  B  C
   /   \
  /     \       
F  E  D
ELD Activities

- Draw pictures of other things that you have seen that are part of a series
- Draw pictures of other things that you have seen that are parallel to each other
Publisher’s Materials

Take some time to look through the state-adopted texts to find activities relating to series and parallel circuits that could be used in your classroom.
Lesson Study Activities

- Identify a key concept from today’s lecture for further development
- Review the publisher’s materials about this key concept
- Discuss the best way to present this key concept in your classroom
Resources

http://www.bbc.co.uk/education/gcsebitesize/science_physics/electricity_and_magnetism/electric_charge_and_current_rev.shtml#charge
http://blueox.oure gon.edu/~courses/dlivelyb/ph161/L6.html#charge
http://www.thetech.org/exhibits_events/noyce_center/topics/13g.html
http://www.uvi.edu/Physics/SCI3xxWeb/Electrical/Circuits.html

Physics by Inquiry – L. McDermott and the PEG at U Washington
Resources (continued)

http://www.proteacher.com/110016.shtml
http://www.franklinbusybody.com/