A Shocking Experience

Mairlyn Kiser

OVERVIEW: This lesson focuses on using technology (the Flexcam, the Internet, Calculator Based Laboratory and video) to teach the 4 things needed for an electric current (a source of power, an output device, a conductor, and a complete path). Students will use interactive sites on the Internet to differentiate between current and static electricity, see how resistance affects current flow, and work with open and closed circuits. After exploring electric currents, the students will build circuits using a battery, covered wire, and light bulb. Then students will measure the amount of voltage in batteries using a CBL System and a voltage sensor. The students will then predict the voltage measurement of the batteries when connected. Students will identify the 4 things needed for an electric current and explain how the electric current moves.

GRADE LEVELS: 6^{th} – 8^{th} grades

TIME ALLOTMENT: 3 – 45 minute blocks

SUBJECT MATTER: Science

LEARNING OBJECTIVES:

Students will be able to:

- define/differentiate between current and static electricity.
- describe the role of a power source for the current flow.
- identify/differentiate between conductors and insulators.
- describe the parts of a circuit.
- explain how energy is converted from chemical to electrical energy.
- describe how a circuit is open or closed, using a switch.
- measure the voltage of batteries using a CBL (calculator-based laboratory) and a voltage probe.
- collect data on voltage and predict the voltage of batteries that are connected.

STANDARDS:

State Standards:

The objectives listed may be used in part to address the Virginia Standards of Learning at http://pen.k12.va.us

- The student will investigate and understand basic principles of electricity and magnetism. (VA SOL Science PS.11)
- The student will investigate and understand states of energy and how energy is transferred. (VA. SOL Science PS.6, 6.3)
- The student will investigate and understand basic characteristics of electricity. (VA. SOL Science 6.4)

- The student will use wide-area networks and modem-delivered services to access and retrieve information from electronic databases. (VA. SOL Computer/Technology C/T8.4)

MEDIA COMPONENTS:

Computer
TV
Connector (XGA)
Flexcam

Web Sites:
Electricity and Magnetism
http://ippex.pppl.gov/interactive/electricity/intro.html (shockwave plug-in needed)
Here, students will learn what charged particles are and why you get "shocked" by doorknobs. They will see an electric current moving along a wire and will learn what resistance is. The students will learn what voltage is and will see open and closed circuits.

Streaming Video-***Creating and Controlling Current Electricity***
United Learning: www.unitedstreaming.com At this site, students will view the many components of current electricity and the three components of a complete circuit.
The following clips are to be used: Clip 1 entitled, ***Introduction to Current Electricity***. Clip 2 entitled, ***Electrical Conductors and Insulators***. Clip 3 entitled, ***Electrical Circuit***. Clip 4 entitled, ***The Three Components of a Complete Circuit***.

MATERIALS :

Materials needed for Introductory Activity:
- Flexcam
- TV
- VCR
- 2 #2 lead pencils
- 1 9-volt batter
- 2 alligator clips (Radio Shack)
- 1 9-volt replacement snap (Radio Shack)
- masking tape
- 1 plastic Petri dish, cup, or similar container
- 60 milliliters (mL) of 20% aqueous magnesium sulfate (Epsom salt)
- 5-10 drops of a universal indicator

Materials needed for Learning Activity:
- Computer(s)
- Television
- Connector (XGA)
- "Electricity—an Energy Flow" sheet

- pencil

Materials needed for Culminating Activity for each group of two to three students:
- CBL (Computer-based Laboratory)
- 5 1.5-volt batteries
- 1 20-cm covered copper wire
- 1 small light bulb

Materials needed per student:
- Pencil
- "How Much Energy" Sheet

PREPARATION FOR TEACHERS:

- ✓ Prior to teaching the unit, bookmark the Web sites.
- ✓ Have your United Learning Web site bookmarked on the computer you are using. Have the television and computer connected. Have the Flexcam connected to the television.
- ✓ Prepare the electrolysis apparatus and the aqueous solution.
- ✓ Photocopy all student handouts for distribution as needed during the lesson.
- ✓ Make sure you go through the instructions from the student materials handouts to make certain that you understand and are familiar with the lesson format and what the students need to do or understand for the lesson.
- ✓ When using media, always provide the students with a *Focus for Media Interaction*, which is a specific task to complete and/or information to identify during or after viewing video segments, Web sites, or other media material.
- ✓ Prior to this lesson, students should have been introduced to atoms, the 3 main parts of an atom, and the charges of each part. They should have been introduced to energy and energy conversion.

INTRODUCTORY ACTIVITY: SETTING THE STAGE

1st Day
Prepare the pencil electrolysis apparatus and the solution prior to being used.

Prepare the pencil apparatus:
1. Cut the eraser and metal part at the top of the 2 pencils off.
2. Sharpen both ends of the pencils.
3. Tape the battery along its narrower sides between the two pencils.
4. Attach an alligator clip to each wire from the battery clip.
5. Snap the battery clip to the top of the 9-volt battery and connect the alligator clips to the exposed graphite in the tips of the pencils.
6. Dip the bottom tips of the pencils into the solution made with epsom salt to make sure there is a good electrical connection.

Prepare the solution:
Prepare a 5-20% aqueous electrolysis solution by mixing 50 grams of magnesium sulfate (epsom salt) into one hundred milliliters (mL) of water. Add 3 to 5 drops of a universal indicator.

The Introductory Activity

1. Have the Flex cam connected to the TV-VCR. (Hook Flexcam up to your TV. Set your VCR "online" instead of a channel. Insert the yellow plug from the Flexcam into the back of the VCR jack that says "video-in". Adjust the focus lens of the Flexcam according to the activity.) Place the Petri dish or container underneath the viewfinder.

2. Pour 30 milliliters (mL) of the solution into the Petri dish.

3. Place the electrolysis apparatus in the solution. Be sure to place the ends without the alligators clips attached. Let the students observe what is occurring.

4. Ask students: "What is happening here?" (Do not expect correct answers at first. Accept all observation answers. Students might say that the water is giving off gas) Ask: "What two components make up water?" (oxygen and hydrogen) "What two substances do you think we are producing now? (hydrogen and oxygen) "What is allowing this to happen?" (The students will probably say that a battery is causing the gas to escape.) Ask: "If water is a compound of hydrogen and oxygen chemically combined, how are we separating the two gases?" (An electric current is passing through the water.) Say, "This is a chemical reaction taking place. It is a decomposition reaction where a compound is broken down into two or more simpler substances. This reaction happened because of electricity."
5. Say, "What you have just seen is electricity at work. Today, students, we are going to be looking at how electricity works and what is needed for electricity to flow."

LEARNING ACTIVITIES

Note to teacher: Have the web site bookmarked and downloaded on the computer and the computer connected to the television. Web site used is: www.unitedstreaming.com The streaming video is Creating and Controlling Current Electricity. The following clips are to be used: Clip 1 entitled, Introduction to Current electricity. Clip 2 entitled, Electrical Conductors and Insulators. Clip 3 entitled, The Three Components of a Complete Circuit.

1. **Focus for Media Interaction**: Say, "We are now going to watch a video on the TV monitor that is hooked up to the computer. I want you to name some movements in nature that are mentioned in this first clip and be able to tell me what current electricity is by definition." **Play** Clip 1 at: 0:51, (This is to start the first clip. Clip 2, 3 and 4 will follow and are used in the order they are listed. The Clip 1 will flow into

Clip 2, which flows into Clip 3 and then 4.) (**Play** when you **see** and **hear** a helicopter flying.) **Pause** at 1:37 (You will **hear**: "…such as the insulators that hold in place the lines we saw" and **see** power line insulators.) Ask: "What movements that occur in nature was mentioned? (clouds moving in the sky, butterflies going from flower to flower, and electron charges moving) What is current electricity? (moving electric charges)"

2. **Focus for Media Interaction**: Say, "What you are going to see now is a simple experiment. I want you to watch and tell me what is the source of the electric current and what kind of wire is used." **Resume** and **Pause** at 2:09. (You will **hear**: "…made of this metal-copper" and **see** a sheet of copper.) Ask: "What is the source of electric current for this experiment? (a battery) What kind of wire is used? (copper wire)"

3. **Focus for Media Interaction**: Say, "What I want you to look for in this next section is: what are the materials called that provide good paths for electricity to flow? From what are these materials made?" **Resume** and **Pause** at 2:31. (You will **hear**: "…electricians use wire to wire houses" and **see** an electrician wiring a house) Ask: "What are the materials that provide good paths for electricity to flow called? (conductors) From what are the conductors made?" (copper and many other metals)

4. **Focus for Media Interaction**: Say, "Now, I want you to watch and listen for the 3 parts of every atom, where they are located in the atom, and what charge each has. Be able to determine what allows loose electrons to move from atom to atom and what scientists call the movement of electrons." **Resume** and **Pause** at 3:32. (You will **hear:** "Scientists call such a movement of electrons an electric current" and **see** a boy pointing out the path of the electric current.) Ask: "What are the three main parts of an atom? (neutron, proton, and electron) Where are they located in the atom? (The neutrons and protons are in the nucleus and the electrons move around the outside of the nucleus) What charge does each have? (neutron – no charge, proton- positive charge, and electron- negative charge) What allows loose electrons to move from atom to atom? (a power source) What do scientists call the movement of electrons? (electricity)"

5. **Focus for Media Interaction**: Say, "I want you, in this next clip, to see what happens to the current when the end of a wire is attached to a comb that is touching a bulb socket. See if you can tell me why whatever happens, happens." **Resume** and **Pause** at 4:49. (You will **hear**: "…no flow of electricity from the battery to the bulb" and **see** a comb touching the light connection.) Ask: "What happened when the comb was used to make the connection from the wire to the bulb?" (nothing) "Why?" (The comb is made of plastic.) "How are the comb's atoms different from the copper's atoms?" (The comb's atoms hold on tightly to their electrons and the copper's atoms are free flowing.)"

6. **Focus for Media Interaction**: Say, "I want you to listen for what the materials like plastic are called and give me 3 examples. Also, what do they do?" **Resume** and **Pause** at 5:21. (You will **hear**: "…through which current does not pass" and **see** a metal spoon and wooden toothpicks) Ask: "What are materials like plastic called?

(insulators) What are 3 examples of insulators? (rubber, glass, and ceramics) What do insulators do? (They do not allow electric current to pass through.)"

7. **Focus for Media Interaction**: Say, "I want you to be able to tell me what a complete circuit is and how many basic parts one has in this next clip." **Resume** and **Pause** at 6:18. (You will **hear**: "…has to have 3 basic parts" and **see** a wire being attached to the light connection) Ask: "What is a complete circuit? (a complete path for electrons to flow) How many basic parts must a circuit have?" (3)

8. **Focus for Media Interaction:** Say, " Okay, now that you know what a circuit is and that it has three parts, I want you to listen to this next clip and identify what the first part of the circuit is and the reason for it. Be able to give me some examples." **Resume** and **Pause** at 7:11. (You will **hear**: "..turn into electric energy" and **see** a calculator being used.) Ask: "What is the first part of a circuit that is named in the clip?" (a source of electricity) "What was the source of electricity used in the experiment?" (a battery) "Why is a battery used as a source of electricity?" (It converts some non-electric energy to electric energy.) "What are some examples of electricity sources given?" (battery, electric generator plant, and solar cells)"

9. **Focus for Media Interaction**: Say, "Do you remember what kind of energy changes that takes place with the 3 examples of electric sources? I'm going to go back and replay that section and I want you to be able to tell me the energy conversion that takes place with the three examples of electric sources given." Sl**ide the time bar back to 6:14 and replay. Pause** at 7:11. (You will **hear:** "…turn into electrical energy" and **see** a calculator being used) Ask: " What 3 examples of electric sources were given?" (a battery, an electric generator, and solar cells) "What kind of energy conversion took place with the battery?" (Chemical energy to electrical energy) "..the electric generator?" (mechanical energy to electrical energy) "…the solar cells?" (light energy to electrical energy)

10. **Focus for Media Interaction**: Say, "Now, I want you to listen for the other two parts needed for a simple circuit and for an example of each." **Resume** and **Stop** at 8:10. (You will **hear:** "…complex circuit can have many loops" and **see** a computer) Ask: "What is the second part needed in a simple circuit?" (an output device) "What examples were given?" (a lamp or an electric motor) "What is the third part needed in the complete circuit?" (a conductor or path) "What is the example that is being used in the clip?" (copper wire) "As a review, what are the three main parts of a complete circuit that was named in the video?" (The three main parts are the energy source, the output device, and the conductor and/or path.) "What was the energy source used?" (A battery was used.) " What is an example of an output device that was used in the clip?" (A light bulb was used.) "What was the conductor that was used?" (A metal wire made of copper was used.) "If electricity is to flow, the path must be what?" (The path must be complete.)

2nd Day

Before beginning the second day, refer what students have learned the previous day, emphasizing the vocabulary: electrons, neutrons, protons, insulators, conductors, and simple circuits.

1. Bookmark the web site: http://ippex.pppl.gov/interactive/electricity/intro.html Electricity and Magnetism

Focus for Media Interaction: Tell the students: "You are now going to go to the computers where you will work on a site dealing with electricity. You will work in groups of two. There will be an "Electricity- an Energy Flow" sheet that is to be completed as you investigate the electricity site. (**Pass out the "Electricity – an Energy Flow" sheet**. Each student will have a sheet to complete.) This must be turned in completed in order to be evaluated." Tell students: "When you open up the site you will notice an arrow at the bottom of the picture on the monitor. Click on that arrow and you will go to another page. Be sure to follow the directions and answer all the questions." *Remind students that they are not to wonder away from this website!*

(At this website, students will see that electricity is the movement of charged particles and the charge that is not moving is static electricity. Examples used to show static electricity are a balloon being rubbed on a sweater and stuck to a wall and lightning. The students will see electrons flowing through a wire within a certain amount of time. They will work with resistance to the flow of electrons, showing an insulator. Here, they will discover how batteries use their energy to cause electrons to flow. They will be able to open and closed circuits to understand that electricity will flow through a closed circuit only.)

After students have completed the "Electricity – an Energy Flow" Sheet, "ask:

- " What is electricity?" (Electricity is the flow of electrons along a path.)
- "Can electricity flow through any path?" (No. The path must be closed and complete.)
- "Will electricity flow through any material?" (No. It will flow through conductors but not insulators.)
- "What are some examples of good conductors?" (Metals are good conductors.)
- "Why are can't electricity flow through insulators?" (There are too much resistance against the electrons in insulators.) "
- "If the electrical charge does not flow but remains on an object, what is that situation called?" (That is static electricity.)
- "What are some examples given that show static electricity?" (A balloon rubbed against wool and then stuck to a wall and lightning are examples given.)
- "Since the electrons need to move away from their nucleus, what must be used to move the electrons?" (Energy must be used.)
- "What is the energy source used at this site?" (A battery was used.)
- "Batteries store energy in what form?" (Chemical energy is stored in a battery.)
- "The measure of the energy in batteries is called what?" (Volts)
- "The 4 things that a common circuit is made of are what?" (A circuit must have an energy source, a complete path, a conductor, and a device that does work.)

(3rd Day)
CULMINATING ACTIVITY

This activity emphasizes the need for a power source, a material over which to move a current, and a useful output device for an electric current to flow.

1. Pass out to each group of students one battery, a 20 cm covered copper wire, and a small light bulb.
2. Tell students that you are giving them about 5 minutes to see if they can get a complete closed circuit using the 3 objects that they received. Allow students time to investigate and try to make a circuit.
3. As they are doing this, ask: What is a complete circuit? (A complete or closed path that the electrons travel along.) What is the power source? (the battery) What is the useful output device? (the light bulb) What do electrons need in order to move? (a conductor) Which is your conductor? (the copper wire) Why is the copper wire covered? (to act as an insulator)
4. If students have not discovered how to make a complete circuit, give students clues on how to make the circuit. (Example: Remember that you need the three things that you have there at your table to make a circuit and the circuit has to be in a complete circular path.)
5. When the completed circuits have been made by each group, have the students try to find another way to make the circuit.
6. After this, give each group 4 more batteries, the TI Voltage Probe and a CBL.
7. Have the students plug the TI Voltage Probe into Channel 1 of the CBL and turn on the CBL.
8. Tell the students they are going to measure the voltage of the batteries, using the CBL. Ask: What is voltage? (the electric force that pushes the electrons)
9. Prepare the CBL for data collection. Have the students turn on the CBL. Press the Mode key on the CBL. The CBL should now be displaying "Sampling" and "Done" on the screen of the CBL.
10. Tell the students that they are to measure the voltage of each battery and record the voltage reading in the "How Much Energy?" sheet. The red lead wire of the CBL will touch the positive end of the battery. Ask the students to find the positive end of the battery. When they have found the positive end, ask them to then find the negative end. Now touch the black lead wire of the CBL to the negative end. Record your voltage reading.
11. Students are to repeat Step 9 with the remaining 4 batteries, recording each reading.
12. Tell the student to write the correct symbol in the < > = column of the data sheet.
13. Tell the students they are now going to use their math skills to predict how much energy is in the batteries when they are put together. Have the students complete the Prediction column of the data sheet. Now the students can use the CBL Voltage Probe to get the correct Voltage reading.
14. Press the On/halt key to stop the sampling of the CBL. Complete the "How Much Energy?" sheet.

ASSESSMENT

1) The "How Much Energy" Sheet and the "Electricity –an Energy Flow" sheet will be evaluated.
2) A quiz on the vocabulary for electricity will be given.
3) Using insulated copper wire, batteries and small light bulb, have students build an open and closed circuit, identify the 3 main parts of the circuit, and explain how the electric current moves.

CROSS-CURRICULAR EXTENSIONS

Science:
Students can use the knowledge gained from this lesson to explore direct and alternating currents and investigate and build series and parallel circuits. Students can also find the current, voltage, and/or resistance, using the formula I = V/R. (I = current, V = voltage, R = resistance)

Social Studies:
Students can research the history of electricity. Students can research and report on Ben Franklin's contribution to discovering electricity. Students can research and report on the invention of the light bulb and/or battery.
Web sites that may be used are:

- http://sln.fi.edu/franklin/rotten.html

Ben Franklin: Glimpses of the Man
(Quicktime Movie: shockwave plug-in needed)
At this site students can investigate Ben Franklin as a scientist, an inventor, a statesman, a printer, a philosopher, a musician and an economist.

- http://edtech.kennesaw.edu/web/electric.html

Ben Franklin – Think Quest
At this interactive site, students will find out more about Ben Franklin and his life. There are puzzles, word searches, and quizzes on Ben and his life. Here they will find some of his proverbs and discover his part in the writing of the Constitution.

Math:
Students can show the relationship among current, voltage and resistance by using Ohm's Law (Current = Voltage/Resistance) and calculate the unknown when given the values for two of the variables.

Language Arts:
Students can write a report on how static electricity is formed during a thunderstorm.

COMMUNITY CONNECTIONS

- Invite the contact person of the local electricity company. He/she can explain how electricity is made and carried to the students' homes.
- Invite a representative of a home security company to speak to the class about the need of circuits for the security system installed in homes and businesses.

Name:_____

How Much Energy?

Using the CBL and the Voltage Probe, measure how much energy is in each battery. Write down your voltage measurements under "Energy". In the < > = Column, write the correct symbol to show of the battery's energy is greater than, less than, or equal to 1.5V.

Battery	Energy	< > =	
A			1.5 V
B			1.5 V
C			1.5 V
D			1.5 V
E			1.5 V

Using you collected data and your math skills, predict how much energy is in the batteries when they are put together. After you have completed your predictions, use the CBL and Voltage Probe and measure the batteries together as they are listed below. Don't forget you unit of measurement (V).

Batteries	Prediction	CBL Reading
A + B		
B + C		
C + D		
D + E		
A + C		
A + D		
A + E		
B + D		
B + E		
C + E		
A + B + C		
C + D + E		

Did your meter reading match your prediction? Why or Why not?

_____

_____

_____

ELECTRICITY – AN ENERGY FLOW

1. Click on the arrow at the bottom of the picture on the monitor. This will take you to the next page. Click again on the arrow at the bottom. (This is just an introduction to electricity.) _____ is the movement of charged particles. The charge that is not moving is called _____ _____ or _____ _____.

2. Click on arrow. Click on arrow, again. What did the site use to demonstrate static electricity?_____ When the balloon is rubbed against the wool sweater, the balloon gains an excess of what? _____ What are their charges? _____

3. Click on arrow. Why does the balloon stick to the wall? _____ _____ Will two negative charged balloons stick or stay together? _____ Why? _____

4. Click on arrow. Move the knob under the balloons to increase the like charges. As the similar charges increase, what happens to the balloons? _____

5. Click on arrow. _____ is another example of charge exchange or static electricity. Explain how lightning occurs. _____ _____

6. Click on arrow. Look at the close up of the wire, what is orbiting around the nuclei? _____

7. Click on arrow. If we apply a type of force (called _____ _____) to the metal, the electrons will "_____" through the wire.

8. Click on arrow. The electrons that flow through the wire within a certain amount of time is called an _____ _____.

9. Click on arrow. Resistance is _____. Resistance is measured in _____. When the resistance is so high that electrons cannot move through the material, the material is called an _____.

10. Click on arrow. Since the electrons need to move away from their nucleus, _____ must be used to separate the opposite charges. Click on the white arrow in the green circle under the objects to add energy to the atom and the man. As energy is added, the atom and the man begin to _____.

11. Click on arrow. To add energy to the wire and to get electrons flowing, a _____ can be used. Batteries store energy in the form of _____ _____. The electrical force which causes The electrons to flow is measured in _____. So far, you've learned that the electromotive force is measured in _____ and that electrons don't always like to leave the nuclei in some materials – so each material has a _____. Also, the flow of charge per unit of time is called a _____.

12. Click on arrow. Read this page.

13. Click on arrow. A common _____ consist of a battery, some _____ connecting the two ends of the battery, a _____ that lets you open and close the connection, and a _____ which used electricity to perform a function.

14. Click on arrow. Read this page.

15. Click on arrow. With the switch open, is the circuit opened or closed? _____ Is the light bulb on?_____ Why? _____ Now , close the circuit by clicking on the switch with your mouse. Is the light bulb on? _____ Why? _____ Click on the close up of the battery with your mouse. When the switch is closed, what happens with the battery in the circuit? _____ _____ Now, click on the close up of the bulb. What do the electrons do? _____ Now, click on the close up of the wire. What is happening here? _____

16. Stop here. Turn in this paper for evaluation.

Answer Key for Electricity- an Energy Flow

1. Electricity
   static charge
   static electricity
2. A balloon is rubbed against a wool sweater and is stuck to a wall.
   Electrons
   negative
3. The balloon becomes negatively charge when rubbed against the wool sweater.
   The positive charges of the wall will attract the negative charges of the balloon.
   No
   Similar charges repel.
4. The balloons move farther away from each other.
5. Lightning;
   During a thunderstorm, the cloud will become negatively charged. Whereas, the ground or other clouds have positive charges. Since opposite charges attract, a lightning bolt will occur as charges are exchanged between clouds or cloud and ground.
6. electrons
7. electromotive force
   flow
8. electric current
9. slowing or stopping the flow of electrons
   ohms
   insulators
10. energy
    move
11. battery
    chemical energy
    volts
    volts
    resistance
    current
12.
13. circuit
    wire
    switch
    device
14.
15. Open
    No; There is no complete path for the electrons to flow through.
    Yes; There is a complete path for the electron to flow through.
    Chemical reactions occur in the battery, which keeps the top of the battery positively charged and the base of the battery negatively charged.
    The electrons are flowing through the filament.
    The electrons are flowing through the wire.