CaSTL

Electricity – Electric Circuits (Part 2)

Boys and Girls Club After School Science
NSF Center for Chemical Innovation
Chemistry at the Space Time Limit (CaSTL)
https://www.castl.uci.edu/

Standard(s) Addressed:

3 PS 1b. *Students know* sources of stored energy take many forms, such as food, fuel, and batteries.

3 PS 1d. *Students know* energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

4 PS 1 Electricity and magnetism are related effects that have many useful applications in everyday life. As a basis for understanding this concept:

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

4 PS 1e. *Students know* electrically charged objects attract or repel each other.

4 PS 1g. *Students know* electrical energy can be converted to heat, light, and motion.

Lesson Objective: Students will learn about electricity and electric circuits – this should be the second part of a 2 day/part lesson. The students should have already completed the lesson on Batteries, Bulbs, and Wires from a previous lesson. Students will continue to explore electricity and electric circuits here but with an emphasis on how electricity is created through a chemical process using electrolysis with copper and zinc electrodes paired with fruits or vegetables containing acidic juices.

Materials Used:

- LCD Clock Screen (or some similarly low powered device – small electric motor)
- Low powered incandescent/LED light bulbs (from small flashlights)
- Copper and Zinc Electrodes
- Connector Wires
- Plastic Fruit/Vegetable Stands (or small plastic cups/bowls)
- Objects (fruits/vegetables) to test
    - Lemons
    - Limes
    - Oranges
    - Potatoes
    - Tomatoes
    - Watermelon
- 9 Volt or Lantern Battery
- Zinc and Copper rod electrodes or similarly conductive electrode rods
- Clear Plastic/Glass Beaker (250 to 500ml volumes)
- Clear glass/plastic 10ml to 25ml test tubes
- Distilled water

- Salt/Salt Water
- Plasma Ball
- Low Powered 15w or less fluorescent light bulb

Student Talk Strategies Used:

Talk to your partner
Think/pair/share

Classroom Management:

Conversation: quiet indoor voices
Help: ask the teacher, ask helpers/volunteers
Activity: work with group of three or four children, brainstorm/answer questions
Movement: groups move from station to station
Participation: working well in groups, doing task, working cooperatively

Funding and Credits:

This project was funded by the National Science Foundation Centers for Chemical Innovation award #1414466 and #0802913 to V. Ara Apkarian, Ph.D. at the University of California, Irvine, Department of Chemistry. This lesson was written by Long Hoang, M.S., CaSTL Center and Therese B. Shanahan, Ed.D., University of California, Irvine, School of Education and Cal Teach.

ENGAGE: ***Connect to Prior Knowledge and Experience and Preview New Vocabulary.*** **Estimated time: 15 minutes**		
Teacher's Role	**Teacher Questions**	**Children's Role**
Teacher tells children that they are going to continue to investigate electricity today.	In our last session, we learned about electricity.	Answer questions about what they remember from the previous week.
But first the teacher wants to find out what they remember about electricity and electric circuits.	What is a circuit?	*"A circuit is a closed loop that carries electricity."*
	We are going to investigate density of different objects in water.	*"Surface tension produces the beading of water that we see on windows or smooth surfaces."*
Students are shown an electrolysis set up with zinc and copper rod electrodes	Students, do you know what these rods are made of?	*"Metal."* *"Iron."* *"Copper."*

attached with connecting wires to a 9 Volt minimum or higher (lantern) battery.		*"Zinc."*
Students are asked if they know what the rods are and if they have seen something similar to this before.	Does this setup remind you of anything that you have done/seen before?	*"It looks like the circuit set up we had done before but it's much bigger than the lesson we did before."* *"Also there is no light bulb like the previous lesson we did."*
The teacher places the zinc and copper electrodes into an empty clear plastic/glass beaker ensuring the electrodes DO NOT touch each other (especially when they are hooked up to the battery. This can be ensured by placing the metal electrode rods each into separate glass/plastic test tubes so they do not accidentally contact each other.) The teacher asks the students if anything will happen once the electrodes are hooked up to the battery.	Will anything happen when we connect the metal electrodes to the battery? (No observable effects should occur.)	*"Yes."* *"No."* *"It will spark."*
The teacher then asks the students if distilled water is poured into the beaker submersing the electrodes in water will anything happen.	If we pour water into the beaker will anything happen? (If the water is truly distilled water without any electrolytes present very little if anything should happen to the setup when the electrodes are connected to the battery.)	*"Yes."* *"No."* *"It will spark."* *"It will explode."*
The teacher then asks the students if we pour some salt/salt water into the distilled water will anything happen.	If we pour salt into the water or salt water into the beaker with distilled water will anything happen? (The salt electrolytes will allow the circuit to be complete which is observable through the electrolysis of water into separate hydrogen and oxygen by the creation of	*"Yes."* *"No."* *"It will spark."* *"It will explode."*

	bubbles of each gas at each electrode. The gasses can be collected in the test tube if the tubes with the electrodes are inverted and can be used in further experiments or lessons as an extension.) What do you see forming at each metal electrode?	*"Bubbles."* *"Gas."*
Emphasis is placed on informing the students that a complete circuit does not always need physical wires to complete the circuit. (Here, the salt/electrolytes help to carry the electrons from one electrode to another through the water.) Following the engage part, the students are told they will use a similar process (electrolysis) to make their own circuits today but using fruits and vegetables.	How is this similar or different to the circuits you created in a previous lesson?	*"We used wires."* *"We didn't use a light bulb."* *"We used water and salt here also which we didn't do in the previous lesson."* *"There were no bubbles/gasses in the previous lesson but we see them here in this lesson."*

EXPLORE: ***Hands-On Learning, Cooperative Learning, Check for Understanding***
Estimated time: 20-25 minutes

Description of Explore: In small groups, students perform the investigations to determine if their predictions were correct and to further investigate how objects sink or float in water. Staff members at each station ask questions to further children's understanding and guide them to the correct setup to complete their electric circuit using the fruits/vegetables and the supplied circuit material.

Teacher's Role	Teacher Questions	Children's Role
Teachers guide the students to the proper setup to make a successfully working circuit that powers the LCD clock. Give the students guiding questions or suggestions but do not make the circuit for them. The lesson is much	What do you notice about the metal electrodes? How many different wires (colored wires) do you see?	*"One is silver but the other is orange."* *"No."* *"It will spark."* *"It will explode."* *"3"*

more useful and engages students to think when they can experiment on their own to determine what works and what doesn't to complete their circuit. (For the fruits/vegetables rolling or squeezing them in the rind/skin first will release more juices to power the devices.)	What would happen if…(we try connecting the zinc/copper electrode here, connect the wire here, etc.)?	
Teachers demonstrate each station, help students perform the investigations, and ask relevant and probing questions as the students try to make a successful working circuit. Once the students have successfully completed the circuit to make their LCD clock work, have them switch out the fruit/vegetable with another fruit/vegetable to see if different fruits and vegetables can work also to power the LCD clock. Ask students if they notice the common properties of fruits/vegetables that work and which do not.	What do the fruits/vegetables that work have in common?	*"They are sour fruits."* *"They are citrus fruits."* *"They smell good."*
	What do the fruits/vegetables that did not work have in common?	*"They have little juices."* *"They are harder and not softer inside like the fruits/vegetables that work."*
If time permits have the students switch out a correctly working circuit with another low powered device such as a small flashlight bulb or a small electric motor. If the	How can we connect more fruits together to get more power/electricity to get this device to work?	*"We will need more wires and more fruits/vegetables to make a series/parallel circuit that will give us more electricity/power."*

fruits used are not sufficient to power the device ask the students how they could connect more to get more power/electricity to power the devices. Teacher moves students along so that each group experiences each station.		

EXPLAIN: ***Listening, Speaking, Reading, and Writing to Communicate Conceptual Understanding*** **Estimated time: Throughout**

Description of Explain: Students regroup with the whole class to report their findings and explain what happened.

Teacher's Role	Teacher Questions	Children's Role
Teacher regroups students and has them report what they did and what they observed at each station. Teacher has students explain why they think it happened. Teacher records each group's response on 1 chart paper per station.	Does the order and position of the wires and electrode matter to make your device (LCD clock, bulb, motor…) work?	*"Yes."* *"No."*
	Does it matter which fruit/vegetable you use to make the circuit?	*"Yes."* *"No."*
	Can we have a volunteer come up to the board and draw how your team made a successful circuit?	Student volunteers come up to the board to draw how they completed their circuit with the fruit/vegetable that makes their device work.
	Do you think this would work with other objects like a soft foam ball/block? A ball of play doh? Milk? Orange juice? Apple? Apple juice? Lemonade? Melon (water melon) Why or why not?	*"Yes."* *"They are sour and have liquid inside of them.* *"No."* *"There is no liquid inside of them."*
The teacher explains why there is a need to use fruits or vegetables with emphasis to	Why do you think some fruits/vegetables worked but others did not? (Those	*"The fruits/vegetables had salt in them."*

have students recall the engage section on why the circuit worked with salt water and why it did not work with distilled/pure water.	containing acids worked best but those containing little or no salt/electrolytes were the worse.)	
Explain to students why metal electrodes are required in this lesson.	Why do we need metal electrodes in this lesson? (The metal is needed to react with the acid in the fruits/vegetables to create electrons that can travel through the object which serves as a conductor.)	
Explain to students that they have just created a battery. (The process is very similar to the engage part where the copper and zinc electrodes in the fruit/vegetable are the electrodes with the acidic juices acting as the electrolyte (salt). The electrolysis process here creates electrons. The deposition of metal on the zinc electrode can be seen through the "rust" (discoloration) of the electrode from silver to blackish smears.	Did you know you just created a battery? How do you know that this is a battery? Take a look at your silver zinc electrode. What do you notice on the electrode?	*"No."* *"Electricity was created using the fruits/vegetables to power the clock/device. So there must have been some electricity/battery somewhere."* *"It's turned black/smeared on the silver zinc metal."*

EVALUATE: ***Summarize Lesson and Review Vocabulary, Variety of Assessment Tools***
Estimated time: Throughout

Description of Evaluate: Evaluation will occur throughout the lesson and particularly during the explain component. Teachers should listen carefully to the conversations and presentations during the explain part of lesson. Teachers should check for understanding throughout the investigations and explain.

Teacher's Role	Teacher Questions	Children's Role
Teacher will review what students had previously learned about circuits. Teachers check for understanding.	After having done this lesson do you think that an electric circuit always needs a solid wire to complete the circuit?	*"No."*
Emphasize to students that a complete circuit does not	What is the process that we used that creates electricity by	*"Electrolysis."*

always need a solid wire to complete the circuit. Students can be asked if they should ever use an electrical device like a blow dryer in the bath tub? (Possible better to show the plasma ball as an extend or explain/review session following this lesson) Teacher shows student a plasma ball and asks students if they have ever seen one or know what it is before turning on the power to the plasma ball. The lights are dimmed/turned off and then the plasma ball is turned on. Students are asked about their observations and how they think the plasma ball created the light show that they saw. Then a fluorescent light bulb is placed in close proximity to the plasma ball but not touching the plasma ball. The light bulb should light up. Here students can see that a circuit can be completed even through the air/empty space through electrical induction which can lead to a whole extended lesson on magnetic induction.	using acids and electrolytes? Should you ever use an electrical device connected to the wall socket like a blow dryer or heater while in the bath tub? Why or why not? Not that you should ever do this but is it safer to use a blow dryer in a bath tub with pure distilled water or in a tub with bubble bath?	 *"No. Because the blow dryer or heater can fall in the tub and shock you."* (The soap and any salts/electrolytes in the water can conduct electricity to shock you.) *"Pure/distilled water because it doesn't conduct electricity as well as soapy bubble bath water."*