CEISMC
Georgia Tech Center for Education Integrating Science, Mathematics, and Computing

in partnership with The Kendeda Building for Innovative Sustainable Design

Lesson: Are You Plugged In? Electricity in the Living Building

Unit Introduction

Grade Level/Band: 5

Summary

The Kendeda Building for Innovative Sustainable Design is the first building in Georgia and 28th in the world to earn Living Building Challenge (LBC) certification, the world's most ambitious and holistic green building achievement. With a goal to be regenerative, the building aims to have a positive impact for the environment and the community. The Living Building Challenge uses the metaphor of a flower and its regenerative properties. The Kendeda Building meets the 7 performance based criteria, called "Petals" including; Place, Water, Energy, Health and Happiness, Materials, Equity, and Beauty.

The Energy Petal in the Living Building needs to make more energy than it uses. This means the building must create extra energy instead of just using it up. But how can it do this when there are students in classrooms all day, using computers, turning on lights, and using heating or air conditioning? The building uses smart ways to save energy, like turning off lights when they're not needed and keeping the temperature just right. But it also makes its own energy using solar panels. These special panels soak up the sun's energy and turn it into power, like a big battery.

In today's lesson, we're going to learn more about circuits. We'll see how we can use a battery or solar panel in a simple circuit. This will help us understand how to make our energy use more sustainable.

Background and Preparation

Background Knowledge

Safety Precautions: Students should understand the importance of basic safety precautions when dealing with electricity. They should never touch exposed wires, they should use insulated tools and not overload electrical outlets.

Students should understand that energy is the ability to do work, and power is the rate at which electrical energy is consumed or produced. Electric current is the flow of electrons in a circuit and voltage is the electrical potential difference that causes electrons to move. The basic components of an electrical circuit are a power source, conductor, and load. They should be able to identify closed and open circuits and understand the flow of electricity.

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At the end of this lesson, students:

- Will make observations to provide evidence that energy can be transferred from place to place by sound, light, heat and electric currents (4th grade)
- Will design a complete, simple electric circuit, and explain all necessary components
- Will apply their knowledge to design a circuit using alternative power sources such as solar panels to investigate sustainable energy sources.

Time Required:

This lesson will take approximately 2 hours depending on how much time you allow for the **Elaborate** portion of the lesson.

Key Vocabulary

Electricity: energy created when electrons move from one atom to another
Static Electricity: produced when two objects are rubbed together, creating friction
Conductor: a material that allows electricity to flow; such as wire
Insulator: a material that electric current does not flow freely through; used to cover wire in order to provide protection from electric shock
Battery: power source
Switch: turns circuit off and on; creates an open or closed circuit
Load: device such as a light bulb that can be powered
Current: the flow of electricity in an electric circuit; measured in amperes(amps)
Voltage: the difference in electric potential between two points
Circuit: a complete path that electricity flows through
Solar power: using energy from the sun to generate electricity
Fuse: a safety device that protects an electric circuit from excessive electric current
Ampere: unit of measurement for current
Direct Current (DC): electric charges move in one direction
Alternating Current (AC): electric charges flow in alternating directions, repeatedly

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Standards and Essential Questions

Next Generation Science Standards	**3-5-ETS!-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem **4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (4th grade)
Georgia Standards of Excellence	**S5P2** Obtain, evaluate, and communicate the information to investigate electricity B. Design a complete, simple electric circuit, and explain all necessary components.
Essential Questions	•What is electricity? How does it flow in a circuit? •What is a circuit? •What are the essential components needed to create a circuit? •How can we solve a problem using what we learned about circuits? •How can a solar panel serve as a power source in a circuit? •How are solar panels a sustainable form of energy?

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5E Model Lesson Overview

Engage

The class will model an electric circuit using an Energy Ball as your power source. The teacher will start with themselves and then begin adding one or two students, continuing until all of the students are a part of the circuit. The teacher will lead a class discussion about what they have observed, allowing students time to formulate ideas and discuss what they think is happening.

Explore

The teacher will provide students with supplies to create a circuit, including copper tape, LED diode lights, and coin battery. Students will work with a partner to light the lightbulb. The teacher will lead a discussion with the class about what worked and did not work to light their bulb in the activity.

After mastering the simple circuit students will create a paper circuit art piece using supplies the teacher has provided. Students will research paper circuits for inspiration and then begin creating! Some suggestions include a card of encouragement, a puppet, a mural, or art related to any topic in class. The options are endless!

Explain

Students will read an article to gain more background knowledge about electric circuits and the components necessary to create simple and parallel circuits. The teacher will introduce vocabulary to students throughout the lesson using the vocabulary cards provided. Students will demonstrate their understanding by creating a digital representation of simple and parallel circuits. Lastly, students will develop a model of a circuit including labeling the components.

Elaborate

Students will apply their knowledge of circuits solving a problem to create additional sustainable energy sources after reading the book ***Lion Lights***. Students will investigate how the Kendeda Building for Innovative Sustainable Design meets the Energy Petal for the Living Building Challenge requirement. Students will discover the energy conservation measures the engineers implemented as well as the use of the 917 PV panels to harvest sunlight to generate electricity. Students will create solar panel circuits to examine them as a solution to the problem posed in ***Lion Lights***.

Evaluate

The teacher will monitor and assess students during each phase of the lesson to check for understanding of the basics of creating an electric circuit. Students will create a presentation to solve an energy/electricity problem using solar panels and modeling their function in a simple circuit. Students should be able to complete a circuit design and understand that the solar panel and battery perform the same function as a power source.

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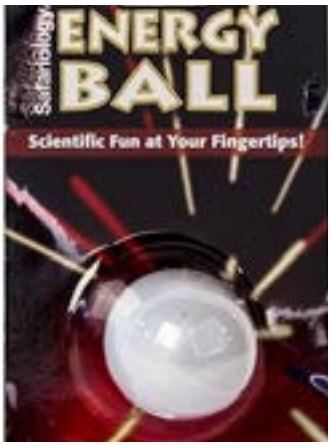
Engage

This Engage activity is an introduction to simple circuits for students. The students will be able to experience a closed circuit using an Energy Ball as the power source.

Materials Needed

- Energy Ball



Time Frame

10 minutes

Teacher Prep

The teacher will make sure students are able to reach one another, possibly making a circle.

Procedure

1. The teacher will demonstrate how the energy ball lights up and makes noise when both sensors are touched and stops when they are released.
2. The teacher will invite one to two students to create a closed circuit demonstrating the energy ball in action, making sure to demonstrate what happens when the circuit is broken (open).
3. Continue to add more students until all students in the class are part of the circuit demonstration.
4. Lead a discussion with the students about their observations making sure to ask what happened when someone broke the connection vs when everyone was touching.

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Explore

Creating an electric circuit

Students will model simple circuits using materials provided by the teacher. After demonstrating their understanding, students will create a paper circuit art project incorporating simple circuits.

Materials Needed

- Copper tape
- LED light diodes
- Coin cell batteries
- Construction paper
- Markers, colored pencils or crayons

Time Frame

30-45 minutes depending on how long you allow students to create their paper circuits art project.

Teacher Prep

Gather materials for the students to create circuit models as well as art supplies to create their paper circuit art projects.

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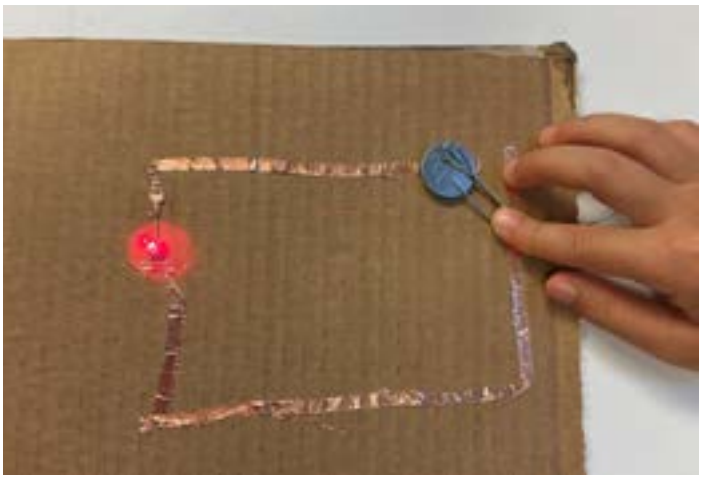
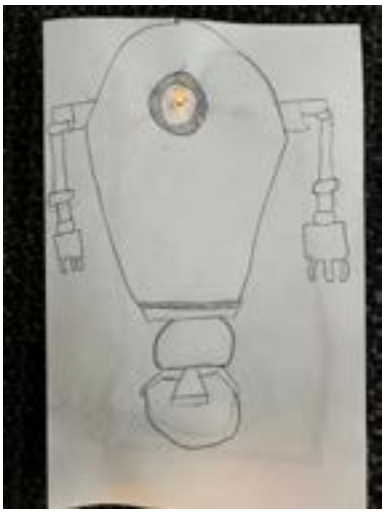
Procedure

1. Distribute copper tape, LED lights, and coin batteries to each group/pair of students.
2. Ask students to discuss with their partner how they can use the supplies provided to make the bulb light up.
3. Allow students time to test their ideas while monitoring the class for understanding, and providing support when necessary. **LEDs and coin cell batteries both have a positive and a negative. Make sure the longer leg of the LED diode is making contact with the copper tape on the positive side of the battery.*



4. After modeling the completed circuit, students research paper circuits to get inspiration for their art project. Students might create a work of art related to a topic of study or create a card for a friend or loved one.



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Explain

Students will increase their background knowledge including vocabulary as well as model their understanding of the components of electric circuits.

Materials Needed

- Student computers with internet access or paper copies of the article
- Printed Vocabulary cards
- Printed Vocabulary worksheet
- Printed Developing and Using Models Graphic Organizer

Time Frame

45 minutes

Teacher Prep

Print copies of vocabulary cards for each group and copies of worksheets and graphic organizers.

Procedure

1. Ask students to review the components necessary to create an electric circuit. Allow students to use the vocabulary cards to explain the phenomenon. *If necessary go over any terms not previously discussed at this time. Have students write the terms in their notebook or complete the vocabulary worksheet if necessary.
2. Read aloud and discuss the Electricity & Energy: Circuits article from Readworks.org.
3. Students complete the Electric Circuits slides checking their responses after they complete the slides.
4. Students will complete the Developing and Using Models Graphic Organizer in order to model their understanding of a circuit.

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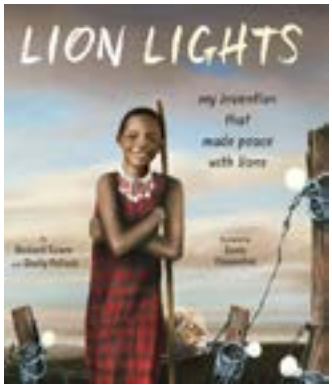
Elaborate and Evaluate

Students will apply the knowledge they gained about electric circuits to generate and compare possible solutions to a problem. Students will then create a presentation that includes the use of solar panels to solve a problem. Students should include what the problem is and how their idea can be a possible solution. As part of their research, students should understand how the Kendeda Building for Innovative Sustainable Design is developing sustainable solutions to energy conservation and renewable energy production. Teachers will give students a choice of presentation methods depending upon the resources available. Some presentation ideas include; Google slides presentation, video, Prezi, Netflix template, Brainpop video, poster, digital poster.

Materials Needed

- A copy of *Lion Lights: My Invention That Made Peace with Lions*
- Small solar panels
- Copper tape
- LED diode lights
- Copies of the Kendeda Building Energy Petal information



Time Frame

45 minutes to one hour

Teacher Prep

- Locate a copy of Lion Lights: My Invention That Made Peace with Lions
- Gather materials for circuits using solar panels
- Make copies of the Kendeda Building Material

Procedure

1. Read aloud Lion Lights: My Invention That Made Peace with Lions
2. Ask the following questions and record students' answers

- What was the problem Richard Turere and his village were facing?
- What were all of the ways that they attempted to solve their problem?
- How did he solve their problem?
- What if he didn't have a battery?
- Can you think of any other power source that he could have used?
- Guide students to solar panels as a source if necessary

Procedure continued

3. Inform students that today they will need to create a model of an electric circuit using a solar panel as the power source.
4. Distribute the supplies for the solar panel circuits for students to work in their groups
5. Have students discuss with their groups how they can transfer their knowledge of circuits to create a simple circuit using solar panels and then allow them to investigate
6. Distribute copies of the Kendeda Building Energy Petal Information and have students read with their groups. Ask students to locate how the Kendeda Building uses solar panels for energy.
7. Ask students to come up with ways they could use solar panels to solve a problem they have encountered or have them research ideas **Some ideas I found were solar powered tents for people experiencing homelessness, lights for use for power outages caused by storms or water heaters*
8. Students' presentations MUST include;

- A problem that needs a solution
- Pictures/video of the problem at its location
- Brainstorming solution ideas and how solar panels would help
- Model of solar panel circuits
- Reasoning why you chose the specific method

9. After presentations, have students give each other feedback any way you choose

Exit Questions

1. How does the Kendeda Building for Innovative Sustainable Design serve as a model for solving energy problems?
2. How can you circuits to explore different types of alternative forms of energy?