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Title: Solar Living Environment- LED Circuit lesson

Subject: Science and Engineering Design
Unit Duration: Seven 2.5-hour class periods
Focus Grade Level: 4th-8th Grade
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Driving Question: *How can we, as architects, design a solar powered living environment?*

This project-based learning unit challenges students to go "off the grid" and design a home that can be totally powered by solar energy. Students will need to ask themselves: What is solar energy? How do we harness this energy? How much energy do I use in my home? How much energy will solar give me? Will I need to change my lifestyle to live in a solar environment? Along this solar journey, students will experience the engineering design, research, and communication process to discover the application of solar technology in our society and daily lives. The lesson below is one out of the solar home PBL unit focusing on home circuits and LEDs.

Learning Goals

- Students will be able to model the basic structure of series and parallel circuits and explain their differences
- Students will be able to analyze the current flow and differences between parallel and series circuits
- Students will be able to determine the optimal circuit design for the solar home project

Prerequisite Student Knowledge

- Basic use of classroom solar panels
- The positive (red) and negative (black) ends of the solar panel
- Basic understanding of circuits and breaks

Instructor Content Background Information

- Summary article and video of the difference between series and parallel

Materials and Resources

- Classroom set of solar panels (40 panels)
- Small LED lights
- Wire
- Electrical Tape
- Copper Tape
- Building materials such as cardboard
- Student handout

Word Bank

Solar Power	Utilizing the sun's rays to produce energy
Solar Panel	A flat piece of equipment that uses the sun's light or heat to create electricity.
Current	The flow of electricity
Voltage	The force of electricity
Circuit	A path for electrons to flow
Series Circuit	A single pathway through which electricity can flow
Parallel Circuit	A closed circuit in which the current divides into two or more paths before recombining to complete the circuit

LESSON PLAN - Solar LED Circuits

Engage: Ask the students…

- How do you think the lights in your home are connected?
  - Maybe encourage the students to draw a picture to show how they think lights are connected
  - Possible student answers:
    - You lights are connected with wires, light switches..
- Tell students that today we are going to learn different ways to connect the lights in your home.

Explore: Series and Parallel circuits: Which is better for your home?

1. Give a brief introduction to series and parallel circuits. Show pictures on the board and in the student handout
   a. Circuit: The path that electricity flows. The word circuit sounds similar to a circle, this can help you remember that electricity must travel in a path without any breaks or gaps.
   b. Series: A single pathway for electricity to flow.
   c. Parallel: Two or more pathways for electricity to flow.
2. Hand out the fill in sheet for the activity. Have students hypothesize which circuits would be best for their home.
3. Review the steps for the home circuit activity.
   a. Using the materials provided, create a model of a series circuit and a parallel circuit with at least 3 LED lights for each circuit. (6 total lights).
   b. Test the circuits by taking lights on and off. This will model turning the light on and off with a switch.
      i. What happens to the lights in series when you take one light off?
         1. All the other lights turn off
      ii. What happens to the lights in parallel when you take one light off?
         1. The other lights stay on
      iii. Post reflection: Based on your observations, which circuit is best for your home and why?

Explain: Series and Parallel circuits: Which is better for your home?

- Allow students time to review results with their teams. (5 minutes)
- Walk around the room and locate a team with good results. Take those results to show on the board. (Example Below).
- Guide students through a discussion of the results.
  - What do you think is happening here? What happens when you connect in series? What happens when you took a light off in series? How is that different from parallel?
  - Can you summarize the findings in one or two sentences. Fill in the blank statement for extra help:
    - In series, when one light turns _____, the other lights _____.
    - In parallel, when one light turns _____, the other lights _____.
- Keep the discussion going until the following facts are stated below. Show on the board after the students make the discovery.
  - When in series, when one light turns off, the other lights also turn off.
  - When in parallel, when one light turns off, the other lights will remain on.
- Based off the results, answer the question: Series v.s Parallel: Which is better for your home?
  - Some students still may not know the answer or may have some other ideas.
- Propose this to the group: In your house, are there times that you want some lights off and some lights on?

- Maybe when little brother is sleeping in one room but you are still awake.
- Tell the students to keep brainstorming until they have a good list of reasons why they want to be able to turn some lights off and some lights on.

- Ask the question one more time, Series and parallel circuits: which is better for your home?
  - All students should agree that they should wire their home in parallel because it allows them to control what lights go on and off.

Elaborate: Begin to wire home with the proper circuit.

1. Allow students to go get their solar house.
2. Provide them with time and materials to wire their house with a parallel circuit.
   a. Copper tape
   b. LED lights
   c. Tape
   d. Solar panel

Evaluate

1. Exit ticket
   a. Students also need to clearly answer: Series v.s Parallel: Which is better for your home?
   b. Which circuit did they choose and why?
      i. Real-world Evidence/scenario to support decision
   c. Drawing of a circuit in series
   d. Drawing of a circuit in parallel
   e. Fill in the blank:
      i. Series: A _____ pathway for _____ to flow.
      ii. Parallel: _____ or more pathways for _____ to flow.

Educational Curriculum Standards

Arizona State Science Standards

- Strand 5: Physical Science. Concept 3: Energy and Magnetism. Investigate different forms of energy.
- Strand 3: Science in Personal and Social perspectives.
  - Concept 2: Science and Technology in society: Understand the impact of technology.
    - PO 3: Design and construct a technological solution to a common problem or need using common materials.

Next Generation Science Standards

4-PS3: Energy

- Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- Planning and Carrying out Investigations
  - Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.

4-PS3: Cross Cutting Concept
Energy and Matter

- Energy can be transferred in various ways and between objects.

References

Building A Solar House. (2011, March 9). Retrieved June 25, 2018, from https://www.sciencefriday.com/educational-resources/building-a-solar-house/

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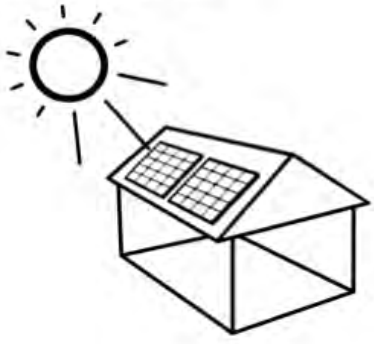
About the Architect

Picture

Solar Living Environment



How do we, as architects, design a solar powered living environment?

Series and Parallel Circuits

Objective:

What is a Circuit?

Series Circuit?

Parallel Circuit?

Circuits Discovery

Using the materials provided, create a model of a series circuit and a parallel circuit with at least 3 LED lights for each circuit. (6 total lights)

Series Circuit:

Draw a picture of your series circuit:

What happens to the lights when you take one light off?

Parallel Circuit:

Draw a picture of your parallel circuit:

What happens to the lights when you take one light off?

Circuit Discovery Results

Observations and discussion notes

Final Results

In series, when one light turns _____, the other lights _____.

In parallel, when one light turns _____, the other lights _____

Series or Parallel Circuits: Which is better for your home and why?

Beads Project

Sketch a "before" picture of your bracelet.

What do you think will happen when you go outside with your beads?

Sketch an "after" picture of your bracelet.

Explain what happened!!

Solar Cell Discovery

Materials:

- Multimeter
- Alligator Clips
- Solar Cell
- DC Motor

Instructions

1. Connect the solar panel to the fan using the alligator clips. When the motor begins to run, complete the questions below.
   a. Draw your design and label each item and color the wires.
   b. Where does the energy that powers the motor come from?
2. Go outside to take measurements and observations. You will place the solar panel in various directions: North, South, East, West, NW, SW… As you place the panel in different directions and angles write down the motion of the fan as well as the current from the multimeter.
3. Predictions:
   a. At what angle will the fan spin the fastest? Slowest?

   a. Which direction will give you the highest and lowest current?

D	0°	45°	90°	
North				
South				
East				
West				

Observations:

1. How long do you predict the motor will remain running, if you left as you have it connected? Explain why.

1. What was the angle in which your panel was facing at which the fan spun the fastest? What was the reading of your current at that angle?

1. At what angle and direction should you put panels on your home? Why?

1. What happens when you switch the alligator clips?

Kill-a-watts

How much energy will your home sustain?
What appliances will you have in your home?

A kilowatt is a metric that equals 1,000 watts of power. Wattage, in turn, indicates how much power a device can provide over a relative amount of time. Thus, a 1,000 watt (1 kW) microwave will warm up a meal much faster than a 600 watt microwave. Because of this relationship between capacity and time, we use the terms *watt-hours (Wh)* or *kilowatt-hours (kWh)* to describe energy use.

Watt-hours and kilowatt-hours define the amount of work performed or energy used in one hour of time. A simple analogy is that speed is a metric that defines distance travelled over a period of time while energy is a metric that defines power used over a period of time. Using that same 1,000-watt (1 kW) microwave for an hour would use up 1 kilowatt-hour (kWh) of energy.

How many watts does one of our panels use?

How many Watts an hour will your panels produce?

How many Kill-a-watts a day will you have to spend?

Product	Wattage	Hours	Kill-a-watts
Microwave	*250 W*	*.08 Hours*	*.02 Kw*
			Total: