CLEAN ENERGY BRIGHT FUTURES
A Program of BEF

LESSON PLAN

Solar SPRK+

Lesson 4: Electricity Fundamentals and Photovoltaics

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DESCRIPTION
Students work through a number of solar circuit explorations that culminate in a challenge to charge the Sphero SPRK+ devices with solar panels. In this exploration, students will investigate the requirements of various loads, working toward the voltage and amperage requirements presented specifically by the SPRK+ charging station.

GRADE LEVEL(S)
6, 7, 8

SUBJECT AREA(S)
Electricity fundamentals; photovoltaics; solar battery charging; solar powering electronic devices

ACTIVITY LENGTH
2 class periods (100 minutes)

LEARNING GOAL(S)

1. Students will determine how to create various types of circuits in order to power loads with different electric needs.
2. Students will identify the electric needs of a Sphero charger and build a circuit needed to charge this device.

STANDARDS REMINDERS

- This is a fantastic opportunity to discuss with students how there can be multiple methods for devising solutions to the same engineering problem, despite how specific it may seem. Additionally, this can be an area where students face the task of devising the "optimal" solution for a particular need, i.e. the smallest circuit to minimize chariot load.
- As always, use language such as "criteria for success" and "constraints" when discussing the requirements of various electric loads.

CONTENT BACKGROUND

STUDENT BACKGROUND

Students participating in this lesson should be familiar basic circuitry concepts, or can be introduced to them here.

EDUCATOR BACKGROUND

Educators leading this lesson should be familiar with basic electricity concepts and how to charge something using solar panels.

REQUIRED MATERIALS

HANDOUTS/PAPER MATERIALS

- N/A

CLASSROOM MATERIALS

- Light source (e.g. 250 Watt halogen work light)
- Solar 4R Schools Fundamentals of Electricity PowerPoint
- Classroom set of SPRK+'s and chargers

ACTIVITY MATERIALS (GROUPS OF 3-4)

- Snap Circuits kit
- 6 2-volt modules or a combination of different sizes that add up to this voltage (in order to provide more than they need)
- Micro USB cable with alligator lead attachment

LESSON PROGRESSION

PLANNING AND PREP

Get materials for students prepared ahead of time to hand out to groups.

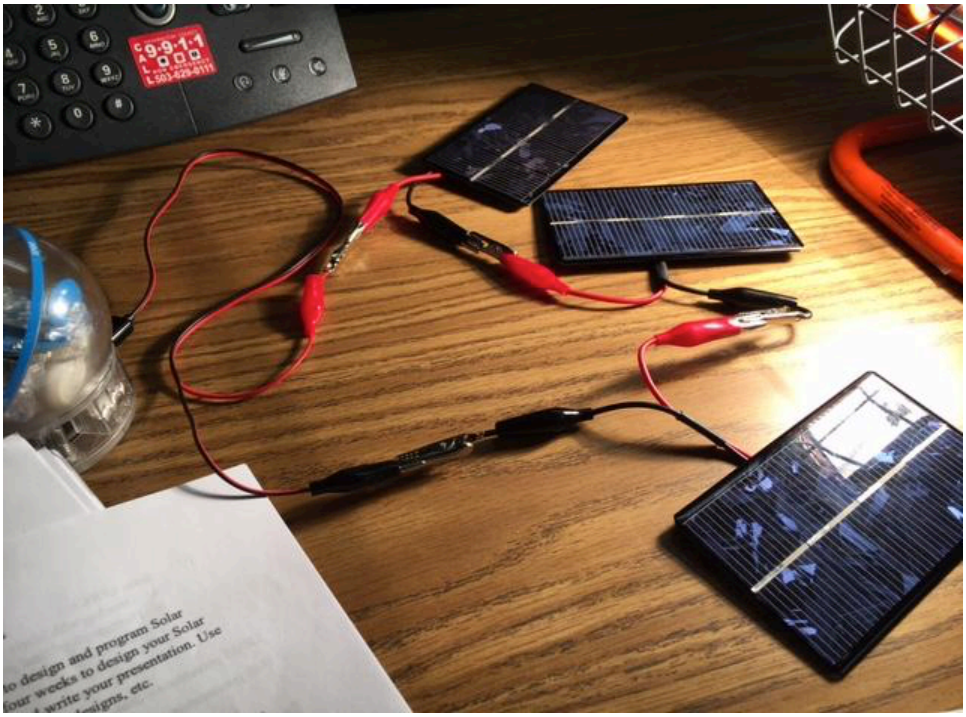
LESSON SEQUENCE

INTRO

- Before students can "solarize" their Sphero charger, they will need to have a background in circuitry. This can be accomplished through a number of routes.
- One option is to follow lesson plans from the CE website (cebrightfutures.org). Go to the Educator Library and search by author, then scroll until you find the specific lesson needed. The following lessons are great introductions to simple circuits:
    - Solar vs. Wind, Lesson 2 by Craig Marais: this lesson requires having students create simple circuits using "snap" wires, batteries, and small light bulbs in conjunction with a PhET online simulation.
    - Mini Solar Houses, Lesson 2 by Beverly Satterwhite: Open the full unit and scroll down until you have reached Lesson 2, which comes in three parts.
- Another option is to use Snap Circuits, having your students complete a number of "Projects" that come in the Snaptricity Kit manual:
    - Project 1: Electric Light and Switch
    - Project 2: DC Motor and Switch
    - Project 5: Lamp and Fan in Series
    - Project 6: Lamp and Fan in Parallel
    - Project 80: Lamp, Speaker, and Fan in Parallel
- For each iteration of their snap circuit, have students note the flow of electrons, voltage sources, location where energy is being transformed, and observations and questions for what is taking place.
- Note: Make sure that students are provided with definitions that work for the appropriate level they are at, as electricity definitions can often be quite convoluted. Additionally, if exploring the photovoltaic effect, students at a middle school level can keep it relatively straightforward, noting primarily that electrons are excited enough to move along a closed circuit in a loop. There is no need to dive into chemistry and the doping of elements for this age range.
- Track vocabulary, drawings, and explanations in student notes/engineering notebooks. These will be used in their final presentations.

SOLAR CHARGING

- In order to figure out the correct circuit for powering their Sphero charger, make sure to start by having a discussion of why solar energy on Mars is vital to begin with. Additionally, discuss the importance of finding the minimal required setup. Through determining the least amount of solar modules required, they are eliminating as much weight as possible for their chariot to carry. This can promote discussion of different materials and design advancements made in aerospace engineering for the same purpose.
- Provide students with up to 6 2V modules, a Sphero charger, and the adaptor cables required.
- Ask students to find as many clues as they possibly can to determine the needs of the charger, i.e. looking for Voltage and Amperage requirements. Depending on the year and make, this may vary. However, many SPRK+'s will have a 6V .5-.7A requirement.
- Based on a background knowledge of how series and parallel circuits affect current and voltage, ask students to make a prediction about the required circuit and have them draw this before they construct it.
- With drawings complete, have students connect to the Sphero with a light source available (either the sun or work lights indoors). This may take some troubleshooting and if they are incorrect the first time, have them continue drawing and noting what they think may be incorrect until they find the right combination. This should essentially be 3 2V modules hooked in series. If they find this right away, prompt discussion that lays out the benefits and drawbacks of adding any more modules to the circuit, and what potential options of combination circuits (adding a parallel branch to increase amperage) would be. The photo below is of the most minimal potential option.



ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENT

Teacher should be making observations and notes to help students troubleshoot their circuits throughout these activities.