Discovering STEM Program

Light Energy: Snap Circuits

Description: Using snap circuit materials; students will use the picture image or the circuit diagram to construct a closed circuit. The closed circuit will light a bulb. Students will then be encouraged to modify the circuit to include more light bulbs in series (similar to Christmas lights). Students will explore the consequence of removing one bulb which breaks the circuit. Students will think about energy being transferred to the bulbs. Students will be challenged to redesign their circuits based on certain challenges.

Grade: K-5

Estimated Time: Approximately 20 minutes

Recommended Group Size: 1 - 2 students per group (kit supports 15 groups)

Key Questions: What does it mean to have a closed circuit? How does adding more bulbs in series effect the circuit? What if you take out one bulb? What kinds of energy do you see in the circuit? Do you see any energy transformations?

Content Expectations Addressed (Michigan Science Standards):

CCC (cross cutting concepts):

2. Cause and Effect, 5. Energy and Matter in Systems, 6. Structure and Function, 7. Stability and Change of Systems

Meets the Science and Engineering Practices

Specific Standards met:

3-5-ETS1-1 Define a simple design problem reflecting a need or want that includes specific criteria for success and constraints on materials, time, or cost.

Student will need to light several bulbs with limited materials.

3-5-ETS1-2 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.

Students can be challenged to light as many bulbs as possible using the fewest number of snap connectors.

Students can be challenged to make the most compact circuit taking up the smallest amount of space on the board.

Students can be challenged to build a circuit that maximizes the distance between bulbs using as much of the board as possible.

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, **electric currents**.

Chemical energy stored in the batteries is transformed into electrical energy. The electrical energy transfers the chemical energy from the battery to the light bulbs.

4-PS3-4 Apply scientific ideas to design, test and refine a device that converts energy from one form to another.

Chemical energy stored in the batteries is transformed into electrical energy, which when flows through a light bulb, transforms into thermal energy and light.

Teacher Background:

Closed Circuit verses an Open Circuit

A closed circuit allows a continuous path for current to flow. In this particular circuit, the path must connect the positive (+) terminal and the negative (-) terminal of the battery to without breaks or openings to be a closed circuit. An open (or broken) circuit does not allow the current to flow because of a break (or opening) in the path. While the switch is in the “off” (or open) position, there is a break (or opening) in the path and current will not be able to continuously flow from the positive + terminal of the battery to the negative (-) terminal. When the switch is “On” (or closed), a connection is made across the switch.

Other ways to “open” the circuit shown in the single bulb picture/symbolic diagram is to:

1. Disconnect any of the snap circuit connectors.
2. Unscrew the light bulb

A closed circuit allows energy to be transferred to another place in the form of electrical energy.

Series (and issues with Parallel)

Students will then observe that chemical energy can be transferred to electrical energy and be transported to more than one place as they light more than one light bulb. While they can connect the bulbs in series or parallel, please be careful of a dimming misconception when they are linked in parallel. Specifically; these materials, due to the internal resistance of the batteries and connectors, show the bulbs will parallel dim slightly; **which is a misconception**. Houses are wired in parallel; however lights do not dim in one room when they are turned on in another.)

Students should see how light bulbs dim when connected in series. Light bulbs are resistive, so the total current flowing through the circuit decreases as the total resistance increases with each bulb.

In series, students should also explore how unscrewing just one of the bulbs makes them all go out. This is true of Christmas lights; often if one bulb is bad the whole strand, or a portion of the strand will no longer be lit and energy is not being transferred.

Materials: Single Bulb circuit pictures, Single bulb symbolic circuit diagrams (with key), 3 ring binder (with ideas for the leaders of how to hook up more than one bulb), white paper for students to draw their own diagrams, 10 – 12 set-ups where; each set-up contains: 1 snap circuit boards, 1 snap battery holder, 2 AA batteries, 4 L1 snap bulb holders with bulbs, variety of snap connectors (1 - 6 snap, 1 - 5 snap, 2 - 4 snap, 3 - 3 snap, 6 - 2 snap, 4 - 1 snap).

Set-Up:

A. Determine whether it is more appropriate to use the Single bulb circuit picture and/or the Single bulb symbolic circuit diagram (with key). Place appropriate image(s) at the station.

B. Each station will START with:

- Snap circuit board
- Snap battery holder with 2 AA batteries
- S1 Snap Switch
- 1 (L1) Snap light bulb holder (with light bulb).
    - TEST ALL L1 light bulb holders in the kit. Make sure light bulb is screwed securely into the base. Test each L1 piece individually to make sure light bulb lights. While students start with 1 bulb holder, leaders will provide students with more bulb holders during the activity so it is important that they are all in working order.
- Small bin of connectors which should include:
    - 1 - 6 snap connector, 1 - 5 snap connector, 2 - 4 snap connecter, 3 - 3 snap connectors, 6 - 2 snap connectors, 4 - 1 snap connectors.

C. **Cautions**:

a. Small pieces are a choking hazard.

b. Circuits must contain at least 1 light bulb. (Using a snap connector to link the + and – terminals of the battery holder together without a light bulb can result in overheating.)

Procedure:

1. Tell students get their circuits checked by leader before turning on the switch.
2. Talk with students about closed circuits and the transformation of energy using the teacher background.
3. Students use the Single bulb picture and/or symbolic circuit diagram to construct a closed circuit that lights one bulb.
4. Students practice the idea of closed circuits by trying various ways to break the circuit including the switch, unscrewing the bulb, or simply disconnecting any of the snap connectors.
5. Once complete, leader will provide student with more bulbs and encourage them to connect them in series using the idea of a closed circuit. Students will explore what happens to all the bulbs when one is unscrewed.
6. Challenge the students to light four bulbs using the fewest snap connectors.
    - Materials cost money. What are some ways you can reduce the number of snap connectors?
7. Challenge the students to make the most compact circuit taking up the smallest amount of space on the board.
    - What are some advantages to taking up the smallest amount of space? (Sometimes size matters. Cell phones and circuits become smaller and smaller so they can be hand-held portable devices.)
8. Challenge the students to build a circuit that maximizes the distance between bulbs using as much of the board as possible.
    - What benefit might you get by spreading out the light bulbs? (Lighting a larger area).

Extension:

Have students use appropriate symbols to draw their circuit(s) with multiple bulbs.

Which meets NGSS K-2-ETS1-2 Develop a simple sketch, drawing, or physics model to illustrate how the shape of an object helps it function as needed to solve a given problem. In this case the problem is lighting the bulb.

Resources: Snap Circuits