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COMMUNITY RESOURCES FOR SCIENCE

BASIS Lesson Plan

Lesson Name: Squishy Circuits

Grade Level Connections:

Next Generation Science Standards: Grade 4, Physical Science (4-PS3)
FOSS Next Generation Edition: Grade 4, Physical Science, Energy

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

What happens to electricity once it reaches your phone, computer, or television? How do engineers use electricity to make tools from microwaves to microprocessors? Can Play-Doh be used in engineering as well as arts and crafts? In this hands-on lesson, students will perform experiments to learn about electrical circuits using Play-Doh as a conductor. Students will first be introduced to basic circuitry concepts, using analogies to help them think about electrons flowing in conducting material. Students will work through three activities – first they will build a simple circuit, then they will create a short circuit, and finally build a parallel and series circuit to compare the similarities and differences.

Lesson Objectives

- Students will learn about electricity, circuits, conductors, and insulators.
- Students will build their own circuit using a battery, alligator clips, Play-Doh, and an LED, realizing that the LED must be positioned in one direction because circuits have polarity.
- Students will make hypotheses about what will happen to an LED light in a circuit after different conditions are changed when they create a short circuit, parallel circuit, and series circuit.

Vocabulary Words

- **Electricity:** a form of energy that results from charged particles; it can either be a build up and sudden release of electrons (static electricity) or a flow of electrons through a circuit.

- **Electron:** a negatively charged particle that moves through a circuit to make power. When we say that electricity is moving through a circuit, the electrons are doing the moving!
- **Circuit:** closed loops through which electricity is intended to flow
- **Current:** a flow of electrons between atoms in a material, which produces electricity
- **Insulator:** material that electrons will not through to create electricity
- **Conductor:** material that electrons will flow through to create electricity
- **Polarity:** direction; electrons flow through a circuit from negative to positive
- **Short Circuit:** when two or more parts of a circuit touch where they weren't intended to, causing some elements of the circuit to not be powered
- **Parallel Circuit:** each device is placed in its own separate branch so that there are multiple pathways along which electrons can travel through the circuit
- **Series Circuit:** each device is connected in a way where this is only one path along which electrons can travel through the circuit

Materials

Scientist Volunteers will bring:

Play-Doh (1 container in each bag, 16 total)
Popsicle sticks (2 in each bag, 32 total)
Alligator clips (2 in each bag, 32 total)
9V battery (1 in each bag, 16 total)
LEDs (100, in different colors)
Worksheet on circuits (32)
Extra batteries, alligator clips, LEDs

Materials teachers should provide:

Students should have pencils ready

Classroom Set-Up

We will start the lesson with a topic introduction at the white board while students are seated. Then students should be placed into pairs so that they can work together to build a simple circuit and our other activities. We will provide a worksheet to guide students through the hands-on activities so they will need a pencil or other writing utensil. It would be helpful if students wear name tags during the lesson.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
Being a role model for students is an important part of being a BASIS volunteer. Begin your lesson by introducing yourselves! Every team member should take a moment to explain who they are and what they study/do as a scientist. A bonus will be to tell your "story," as if giving an elevator pitch to 9-year-olds: Why did you become a scientist? What made you interested in your topic? Why should students relate to you, or be interested in you? Feel free to draft a script of what you will say, here. And remember, you can also weave your story throughout your lesson through examples from your own life, and/or return to it with Q&A at the end.

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: *circuits and electricity*. It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **The power of electricity comes from electrons moving through a circuit. We can figure out what is happening to electrons by changing the conditions of a simple circuit.**

Your topic introduction should follow the outline below. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitate student-guided conversation.

- Today we are going to talk about **electricity**! Who can provide me with some examples of things we use in our daily lives that require electricity? [Gather ideas from students and write on board]
- These are all great examples and we can see that we use electricity a lot each and every day. But what *is it* exactly? **Electricity** [define, write on board] is a force that uses charged particles, specifically parts of an atom called electrons. **Electrons** [define, write on board] are negatively charged particles that produce electric energy. Electrons flow through closed loops called **circuits** [define, write on board]. You can think of a circuit as a race track and the electrons are like the Go-Karts on the track. They go around and around and around.
- What determines how quickly those Go-Karts are moving along the track? They need an initial push to get going. In a circuit, the initial push comes from a battery.
- Do you think the speed of the Go-Karts depends on what the track is made of? What if the Go-Karts had to move along a track that was covered in honey? [Probably move really slowly, if at all] What if they were moving along a track that was covered in oil? [Probably move really quickly]

- Materials for our circuits matters too! Materials where electrons can't flow (like the honey track) are called **insulators** [define, write on board]. Electrons can't move through these materials. But other materials, the electrons can move through really well. These materials are called **conductors** [define, write on board].
- What if we had a long, skinny track compared to a short, wide track. Would it make a difference how many Go-Karts could go around and how quickly? Do you think the same would be true for electrons moving around a circuit?
- Let's do some more science activities and find out for ourselves!

2. Learning Experience (35 minutes)

Students will work in pairs. Remember that these activities are designed to address the take-away in a particular way: **The power of electricity comes from electrons moving through a circuit. We can figure out what is happening to electrons by changing the conditions of a simple circuit.**

Activity 1: Create a Circuit Using Play-Doh

1. Pass out worksheets to students. Have each student put their name at the top and complete instructions as you go through the activities. Draw a simple circuit on the board so that all students can see and visualize what they should be doing at each step in the lesson (this will also be on their worksheet).
2. For each pair of students, pass out a bag that contains one pack of Play-Doh, two alligator clips, two popsicle sticks, and one 9V battery.
3. Have students examine the battery. Is there a positive and negative end? Which is which?
4. Attach one alligator clip to the positive end of the battery. Attach the other alligator clip to the negative end of the battery.
5. Instruct (and model) students to take two pieces of Play-Doh and roll them into cylinders. Insert the opposite ends of both alligator clips into one cylinder of Play-Doh.
6. Okay, we have the initial push (the battery) to start our electrons flowing and we have a track. What else do we need to complete the circuit? Light!
7. Pass out one LED to each group. Have students examine the LED. Is one side longer than the other? This corresponds to the positive end and the negative end of the LED. Instruct students to place one end of the LED in one cylinder of Play-Doh and the other end of the LED in the other cylinder of Play-Doh.
8. If the light doesn't turn on for some student groups, check in and see if they can figure out what the problem is. Does the LED need to be turned around in the other direction? Remember polarity! Are the alligator clips properly connected? It's possible the LEDs or the battery is not working for that particular group and needs to be replaced.
9. Have students draw the path of the electrons on their worksheet for this Play-Doh circuit.
10. Once all students have a working circuit, call their attention back and discuss the directionality of their circuit. Bring this back to the Go-Kart analogy. Do the Go-Karts always travel in one direction? Or do they go back and forth? Circuits behave the same way – they have only one direction in which the electrons flow. We call this **polarity** [define, write on board]

Activity 2: Short Circuit

1. Ask students what they think will happen if you were to add another track for the Go-Karts. Some (or all) of them might take the path of this new track. Making the connection here, ask students what they think would happen if we add another piece of Play-Doh in between the two cylinders of Play-Doh that they have in front of them. Have them circle their prediction on their worksheet. Let's test it!
2. Instruct students to take another piece of Play-Doh that will reach between the original two cylinders, connecting them. What happens?
3. Have students draw the path of the electrons on their worksheet for this Play-Doh short circuit.
4. Once all students have completed this step, call their attention back and discuss. What do students notice? [The light should have become very dim or gone out completely.] Why does this happen? This is called a **short circuit** [define, write on board]

Activity 3: Parallel Circuit

1. Tell students that in a moment you're going to pass out more LEDs for them to add to their circuit. Add to your drawing on the board. Ask students what they think will happen in their circuit when we add these additional lights. Have them circle their prediction on their worksheet. Let's test it!
2. Pass out two more LEDs to each pair of students. If the lights don't turn on immediately, remind students about the **polarity** of the circuit. What can they do to fix the lights? [Turn them around]
3. Have students draw the path of the electrons on their worksheet for this Play-Doh parallel circuit.
4. Once students have completed this step, call their attention back and discuss. What did they notice when more lights were added? [They should become less bright/dim] Why does this happen? This is called a **parallel circuit** [define, write on board]

Activity 4: Series Circuit (Optional, if time allows)

1. If time allows, draw a series circuit on the board. Ask students what they think will happen in their circuit when we put the Play-Doh. Have them circle their prediction on their worksheet. Let's test it!
2. If the lights don't turn on immediately, remind students about the **polarity** of the circuit. What can they do to fix the lights? [Turn them around]
3. Have students draw the path of the electrons on their worksheet for this Play-Doh series circuit.
4. Once students have completed this step, call their attention back and discuss. What did they notice when they changed the arrangement of the lights? [They should all be equally bright] Why does this happen? This is called a **series circuit** [define, write on board]

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

It's important to leave time to **review** and **discuss** the learning experience at the end of the lesson. This might take the form of discussing conclusions from an experiment; or review of the take-away of the lesson

- Discuss the difference between conductors and insulators
- Discuss what students noticed with the short circuit, parallel circuit, and series circuit in relation to the LEDs. What does this tell us about the electrons and how they are moving through the circuit?

4. Connections & Close (5 minutes)

Connections to the real world around students:
Does anyone have any questions, about circuits, electricity, or being a scientist?
Thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  - Physical Science: 4. Energy
- Connections by disciplinary core ideas
  - Physical Science: 4-PS3. Energy
- Connections by scientific & engineering practices
  - 3. Planning and carrying out investigations
  - 6. Constructing explanations & designing solutions
- Connections by crosscutting concepts
  - 2. Cause and Effect: Mechanism and explanation
  - 5. Energy and matter: Flows, cycles, and conservation
- Connections by performance expectation
  - 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
  - 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.