

Bay Area Scientists in Schools Presentation Plan

Lesson Name Squishy Circuits
Presenter(s) EE Outreach @ Berkeley

Grade Level 2-4 (can be altered for middle school with addition of snap circuit kits)
Standards Connection(s) Electricity: Simple circuits, components, materials

Teaser:

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 module, students perform hands-on experiments to learn about electrical circuits by building them with Play-Doh. After an introductory presentation providing intuitive analogies to think about how electrons flow in conducting material, students work through self-guided activities to test these concepts firsthand.

Objective: *As a result of your lesson, what will students learn? What will they be able to do?*

After this lesson, students will be introduced to basic concepts of electricity—what electrons are and how material shape impacts conductivity. In a series of hands-on activities where students use Play-Doh to build a basic circuit with a light emitting diode (LED) array, students can compare series and parallel resistance, see how resistivity varies with a material's length and width, and even build an adjustable light switch. For middle school visits, we will also bring snap circuit kits that introduce the idea of an integrated circuit (IC).

Vocabulary/Definitions: *3 – 6 important (new) words*

Electrons, circuit, resistance, conductor, insulator

Materials:

What will you bring with you?

- Play-Doh
- LED bar graphs
- 9V batteries and connectors
- Worksheet (see attached)
- (optional) Toothpicks to help cut Play-Doh in precise shapes

What should students have ready?

- Pencil or pen for worksheet

Classroom Set-up:

Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed

- A projector is required for the introductory presentation.



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- Students will work individually to construct Play-Doh circuits. The Play-Doh is not too messy on tables or desks if it is cleaned afterwards. Allow five minutes for cleanup at the end of the lesson.

Classroom Visit

1. **Personal Introduction:** 5 Minutes

Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?

We'll introduce ourselves as engineering students from Berkeley, talk about what we do and also talk about where we come from to help establish a more personal connection.

Topic Introduction: 10 Minutes

What questions will you ask to learn from students? Big Idea(s), vocabulary, assessing prior knowledge...

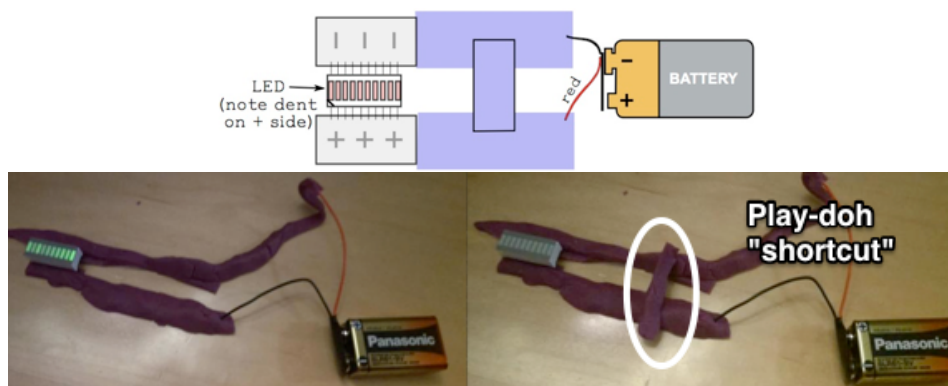
This module begins with a discussion about where students have seen electricity in their current lives. From there, we talk about how to think of electricity, presenting a go-kart analogy to electron flow. Using this analogy, we ask students to think about how material properties (such as material shape and width) can influence the flow of electrons within a circuit. We also talk about the differences between conductors and insulators, building to the idea that they can build circuits by hand using Play-Doh as a lead-in to the activity.

2. **Learning Experience(s):** 30 Minutes

What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring... Describe in order, including instructions to kids.

The students will each get some Play-Doh, an LED array, and a 9V battery with connector to test out different activities, detailed in the attached handout. Note that because the LED only lets current flow in one direction, the positive terminal of the battery must be connected to the side of the LED with a notch. Here is a summary of the activities:

- Short circuits:
 - o Activity: Students compare the brightness through the LED before and after a piece of play-doh is connected between both battery terminals:

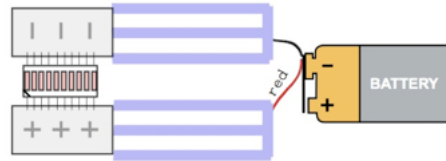


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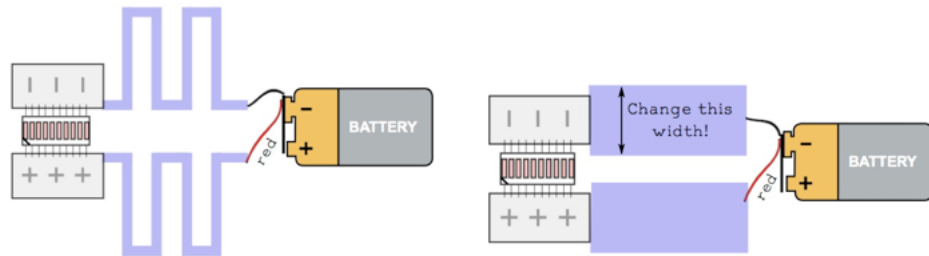
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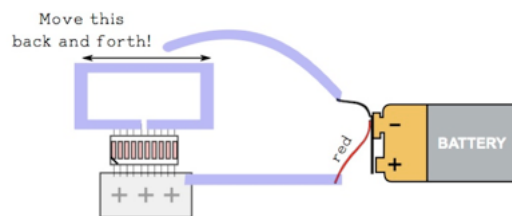
- Result: Building a 'shortcut' through the play-doh will prevent the electrons from going through the light, effectively turning it off. This 'shortcut' is known as a 'short circuit.'
- Series vs. parallel connections:
 - Activity: Students compare the brightness through the LED when multiple play-doh strips are connected between the light and the battery:



- Result: Adding more strips (adding parallel connections between the light and the battery) will make the light brighter, because you give more paths for the electrons to move from the battery to the light, just like adding more lanes in a street will help reduce traffic.
- Width, length, and resistivity:
 - Activity: Students compare the brightness of the LED when the Play-Doh is made longer or thinner.



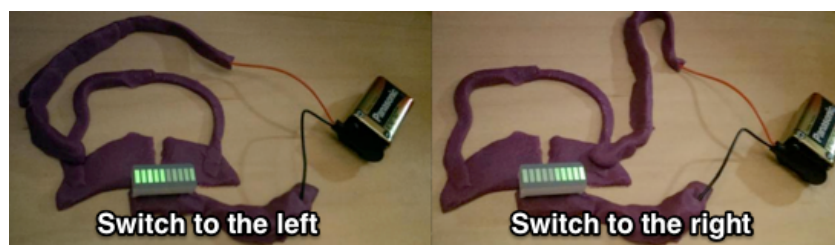
- Result: Making the Play-Doh longer (with the same thickness) will make the LED dimmer, because the electrons have to travel further in order to get through the LED and back to the battery. The thicker Play-Doh (with the same length) will make the LED brighter, because there is a wider path for the electrons to travel through.
- Adjustable light switch:
 - Activity: Students make two halves of the LED array have different distances between the Play-Doh and the battery, by adding a loop of Play-Doh to one end of the LED array.



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- Result: The half of the LED array that has the least Play-Doh will be brightest, while the other will be longer. Moving the 'switch' back and forth lets you change the balance in brightness between the two halves of the array.

3. **Wrap-up: Sharing Experiences** 5 Minutes

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

At the end, we will relate the activities back to things the students are familiar with. The last circuit is an example of a voltage divider, which is something found in everyday objects like adjustable light switches and sliding controls for fan speeds. Parallel circuits are the sort of connection used to tie Christmas lights together, so that a single light breaking won't turn off the entire string of lights.

4. **Connections & Close:** 5 Minutes

What else might kids relate this to from their real-life experience? How can they learn more? Thanks and good-bye! Clean-up.

To conclude, we will talk about how all of this relate to the circuits that go into phones, tablets, and computers today. Modern circuit design focuses on tiny circuits (more than a billion tiny switches in less than a square inch!) that are cut out into specific shapes according to defined patterns, much like the way students cut out Play-Doh shapes in the activity.

Total 55 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining “How we learned about _____?”

List or attach examples of activities, websites, connections for additional learning.

Attach worksheets, hand-outs, visuals used in classroom presentation.

Play-Doh circuits are a great “try it yourself” activity for students. Circuits can be made out of store-bought or homemade Play-Doh.

Students can take a look at the TED talk about squishy circuits by AnnMarie Thomas:

http://www.ted.com/talks/annmarie_thomas_squishy_circuits



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There are also instructions about how to make conductive and non-conductive Play-Doh from household materials on the following site:

<http://courseweb.stthomas.edu/apthomas/SquishyCircuits/howTo.htm>