



Squishy Circuits

// Making Conductive Dough:

Materials:

- 1 cup water
- 1 1/2 cups flour (a gluten free version of this dough can be made by replacing the flour with gluten-free flour.)
- 1/4 cup salt
- 2 Tbsp. cream of tartar
- 1 Tbsp. vegetable oil
- Food coloring (optional)



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SparkFun Electronics Squishy Circuits Educational Material



// Making Conductive Dough:

Procedure:

1) Mix water, 1 cup of flour, salt, cream of tartar, vegetable oil and food coloring in a medium sized pot.



2) Cook over medium heat and stir continuously.

3) The mixture will begin to boil and start to get chunky.



// Making Conductive Dough:

4) Keep stirring the mixture until it forms a ball in the center of the pot.



5) Once the ball forms, place it on a lightly floured surface.

WARNING: *The ball will be very hot. We suggest flattening it out and letting it cool for a couple of minutes before handling.*



// Making Conductive Dough:

6) Slowly knead the remaining flour into the ball until you've reached a desired consistency.



7) Store in an airtight container or plastic bag. While in the bag, water from the dough will create condensation. This is normal. Just knead the dough after removing it from the bag, and it will be as good as new. If stored properly, the dough should keep for several weeks.



// Making Insulating Dough:

Materials:

- 1 1/2 cup flour
- 1/2 cup sugar
- 3 Tbsp. vegetable oil
- 1 tsp. granulated alum (optional - the alum helps preserve the dough.)
- 1/2 cup deionized (or distilled) water (regular tap water can be used, but the resistance of the dough will be lower.)



Procedure:

- 1) Mix solid ingredients and oil in a pot or large bowl, setting aside 1/2 cup flour to be used later.



// Making Insulating Dough:

- 2) Mix with this mixture a small amount of deionized or distilled water (about 1 Tbsp.) and stir.
- 3) Repeat this step until the mixture absorbs a majority of the water.



- 4) Once your mixture is at this consistency below, knead the mixture into one “lump”.



// Making Insulating Dough:

5) Knead more water into the dough until it has a sticky, dough-like texture.



6) Now, knead the remaining 1/2 cup of flour into the dough, until a desired texture is reached.



7) Store in an airtight container or plastic bag. While in the bag, water from the dough will create condensation. This is normal. Just knead the dough after removing it from the bag, and it will be as good as new. If stored properly, the dough should keep for several weeks.

WARNING: *If you use deionized water do not let students eat the non-conductive playdough. Deionized water is not good for your kidneys. Eating a little won't have an effect, but it's definitely not good for you. We suggest using distilled water to avoid this issue.*

// Making Squishy Circuits:

Materials for each group or child making circuits:

- 1) A power source of some type with a current value of less than .5A, we use a 9V battery
- 2) A battery connector with spades or probes at the end of the wires, regular wires do not have a large enough surface area to create the necessary connection
- 3) Conductive playdough
- 4) Non-conductive playdough, although not strictly necessary non-conductive playdough is great for separating the pieces of conductive playdough making it easier to create circuits without a short
- 5) 5 LEDs
- 6) Any additional components you want to create circuits with such as motors, photoresistors and buzzers

How to make the circuits:

- 1) If your battery connector doesn't have large contacts at the end of the wires you will need to attach large contacts to the end of the wires. These can be either long metal probes or spades of some type.
- 2) Place your battery or batteries into the battery connector. Make sure you don't touch the battery contacts on the ends of the wire to each other, as this will cause a short.
- 3) Distribute conductive and non-conductive playdough to the students. You will need more conductive playdough than non-conductive. Students tend to like to work with more playdough, but a ball the size of your fist is more than enough of either type.
- 4) Have the students divide the conductive playdough into two pieces and roll these pieces into cylinders no thinner than one inch. Have them also roll the non-conductive playdough into a slightly thicker cylinder.
- 5) Place the non-conductive playdough cylinder between the two conductive playdough cylinders.
- 6) Push one battery contact into one of the conductive cylinders and push the other into the other conductive cylinder. Make sure the two pieces of conductive playdough are not touching each other, as this will cause a short. Your students now have power connected to one of your cylinders of conductive playdough, and a ground connected to the other.
- 7) Handout multimeters if you have them and encourage your students to measure Voltage, Current and Resistance. What kind of an effect does making the pieces of playdough longer or shorter have on these values? What about thicker and thinner?
- 8) When you are done with Squishy Circuit make sure you clean off the metal parts of the components and battery connectors with a damp paper towel because otherwise the salt will cause the contacts to corrode.

// Making Squishy Circuits:

Here is the official Squishy Circuits website:

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

There are many other ways you can use conductive playdough. Here is our blog post about Squishy Circuits, we like using a buzzer and a microcontroller to make a really annoying musical instrument:

<http://www.sparkfun.com/news/626>

If your playdough dries out you can add water to make it malleable again, just make sure you use distilled or deionized water if you are adding water to the non-conductive playdough.