Squishy Circuits

- Classroom Guide -

Squishy Circuits are a great way to introduce electronics education into your curriculum by using two different doughs as circuit building materials. Because of the playful nature of the dough, this activity is suitible for children of all ages. The doughs are made with readily available ingredients such as flour and salt.

This teacher's guide contains the dough recipes, basic instructions, helpful hints and sample worksheets. All of this material is free and open-source, courtesy of the University of St. Thomas.

If any questions, comments, or concerns arise, we urge you to contact us via our website:
www.StThomas.edu/SquishyCircuits
We also have how-to videos and other support materials located there.

We ask that you join our Squishy Circuits community by sharing your experiences and photos of your creations online:
www.Facebook.com/SquishyCircuits

Thank you -

The Squishy Circuits Team

Squishy Circuits

- Conductive Dough -

A conductor allows electricity to easily flow through it. In this recipe, the salt helps electricity flow because it dissociates into Na+ and Cl- ions.

Ingredients:

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
3 Tbsp. Cream of Tartar
1 Tbsp. Vegetable Oil
Food Coloring (optional)

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

Step 2:
Cook over medium heat and stir continuously. The mixture will begin to heat and start to get chunky.

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- Conductive Dough -

Step 3:
Keep stirring the mixture until it forms a ball in the center of the pot.

Step 4:
Once a ball forms, place the ball on a lightly floured surface.

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

Step 5:
Slowly knead the remaining flour into the ball until you've reached a desired consistency.

Step 6:
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.

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- Insulating Dough -

An insulator does not let elctricity flow through it easily. Because of this, they act as a wall to electricity and the electricity must go around them. If a path around the insulator is not avaliable, the circuit cannot be completed.

Ingredients:

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.)

Step 1:
Mix solid ingredients and oil in a pot or large bowl, setting aside ½ cup flour to be used later.

Step 2:
Mix with this mixture a small amount of deionized water (about 1 Tbsp.) and stir. Repeat this step until a majority water is absorbed by the mixture.

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- Insulating Dough -

Step 3:
Once your mixture is at this consistency, knead the mixture into one "lump".

Step 4:
Knead more water into the dough until it has a sticky, dough-like texture.

Step 5:
Now, knead in flour to the dough, until a desired texture is reached.

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.

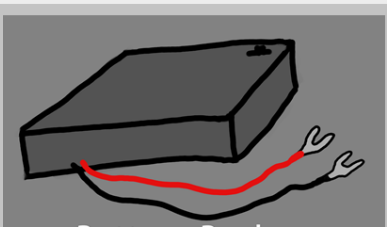
Squishy Circuits

- Basic Components -

Our website has a list of our favorite suppliers, but many components will work for Squishy Circuits! We encourage you to experiment with your own components.

We recommend adding terminals to the end of your components (other that LEDs) to increase the electrical contact surface area. Instructions for doing this are avaliable on our website.

Also, it is important to note that the salt in the conductive dough tends to corrode the terminals. Wiping the components and terminals with a wet cloth may help prolong their life.

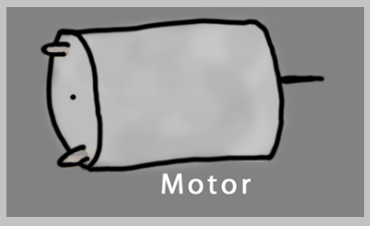


Battery Pack

We use a 4 AA Battery Pack with attached terminals, however Squishy Circuits can be used with other battery packs.

LEDs (Light Emitting Diodes) produce light. They are more energy efficient and durable that light bulbs because they do not have a filament. They come in many sizes and colors, but we prefer the 10mm size because they are the easiest to work with. They also have polarity, meaning one terminal must connect to the battery pack's positive (red) side. This is usually the longer lead.

LEDs



Motor

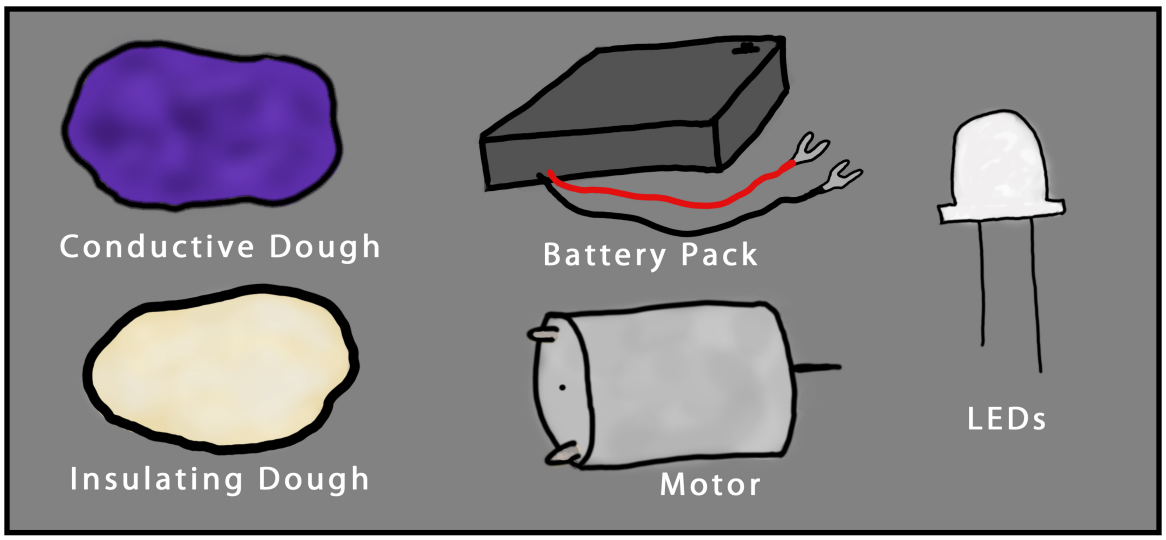
A motor converts electrical energy into mechanical energy or motion. They do not have polarity, but switching red and black will reverse the motors direction. We have found that motors used for Squishy Circuits should have terminals attached and a low current rating (~30mA or .030 Amps).

Buzzers are also great Squishy Circuits components, but can get noisy! Most buzzers (both mechanical and piezoelectric) need less than 30mA to operate, so common buzzers can be used.

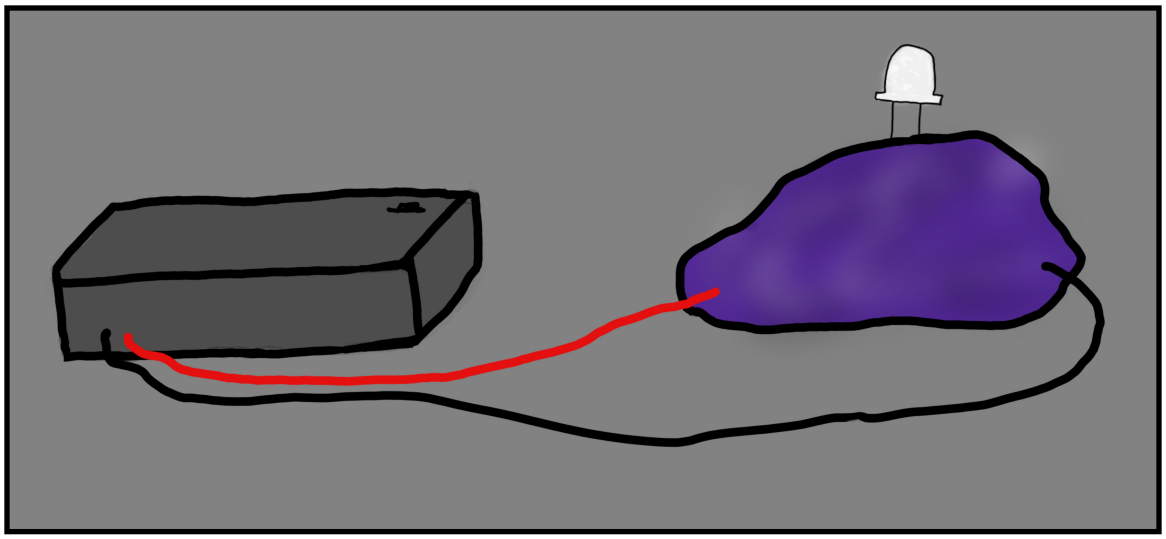
Squishy Circuits Basics

University of St. Thomas - Squishy Circuits Program
www.StThomas.edu/SquishyCircuits

What you will need for this activity:

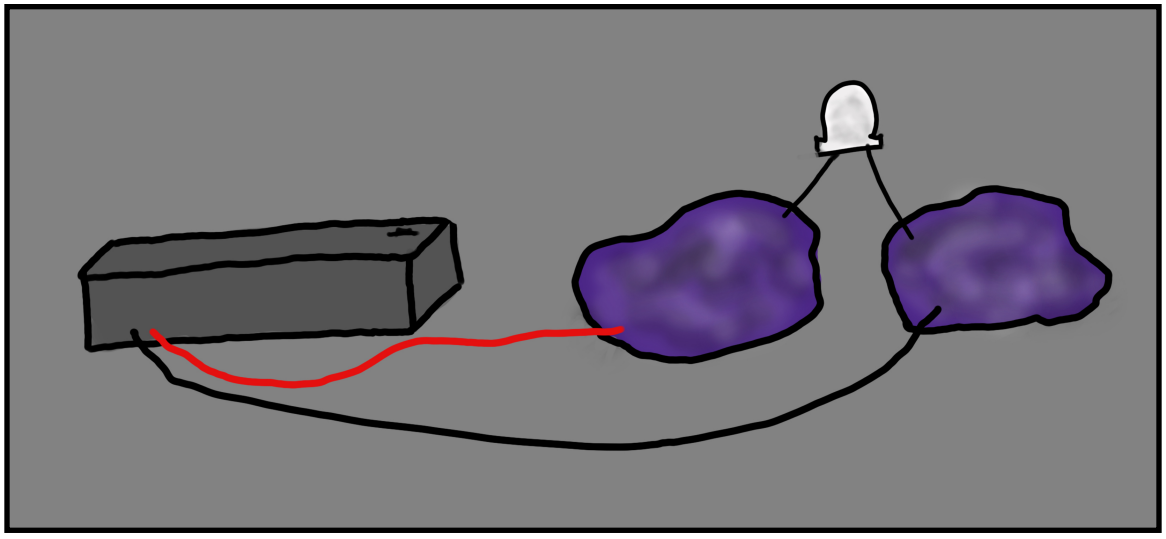


Begin with one lump of the conductive dough. Insert the battery pack's wires into the dough on opposite sides. Next, insert a LED into the dough.



Does the LED light up? Yes No

Separate the conductive dough into two pieces. Plug one wire from the battery pack into each piece and bridge the gap with a LED.



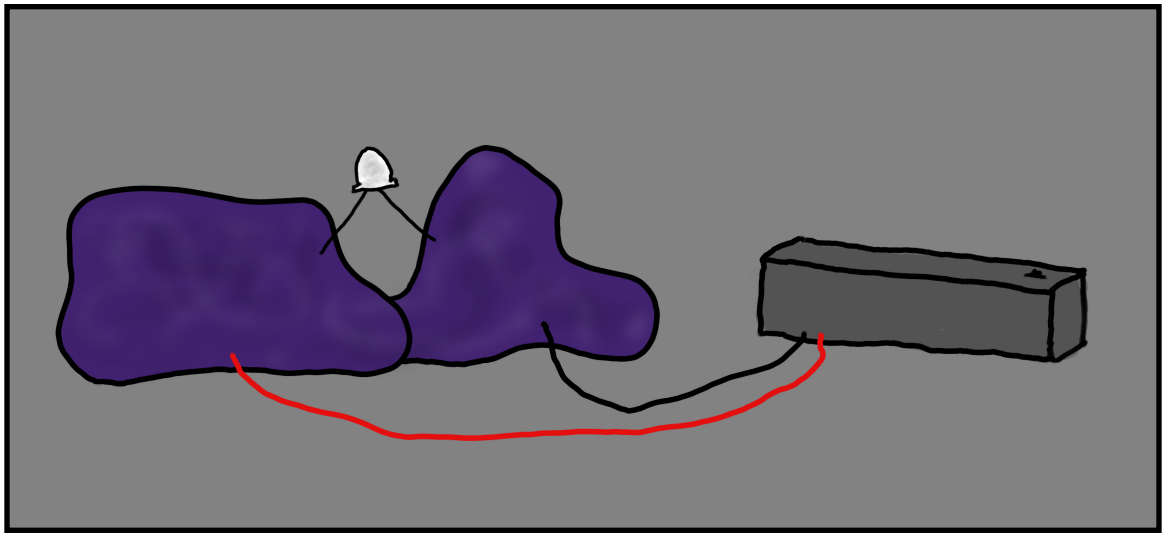
Does the LED light up? Yes No

Now take the LED out and flip it around so that each "leg" or terminal is in the opposite piece of conductive dough.

Does the LED light up? Yes No

The LED only works in one direction. This is called polarity. Take the LED out. Notice how one "leg" is slightly longer than the other one. The longer terminal should be attached to the positive or red wire from the battery pack.

Next, with your LED on, take the two pieces of conductive dough and push them together or add some dough to connect them.

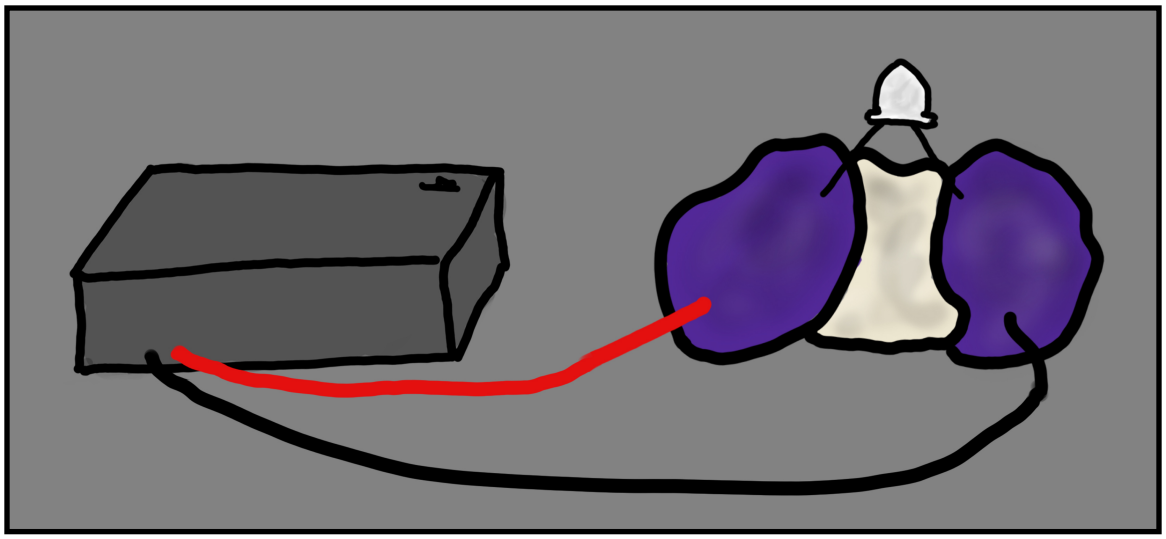


Does the LED light up? Yes No

In the last step, the LED went out. This is because a short circuit was created. Electricity flows in a loop called a circuit which begins and ends at the battery pack.
Electricity takes the path of least resistance, meaning it goes through whatever loop is easiest to flow through. In this case, the conductive dough is less resistive than than the LED, so the electricity chooses to go around the LED and through the dough.

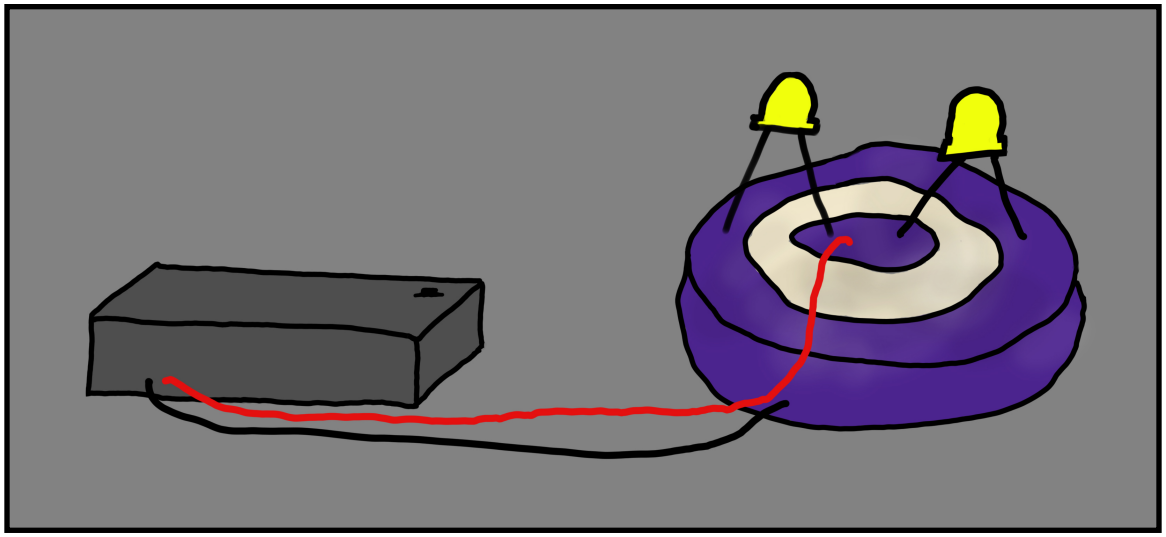
Separate the two pieces, the LED should once again light up because the electricity must go through the LED to complete the circuit.

Create a "sandwich" with the insulating dough between two pieces of conducting dough.



Does the LED light up? Yes No

The insulating dough does not let electricity flow through it easily. It acts like a wall to electricity. Therefore, the electricity has to go around the insulating dough and through the LED which lights the LED. Now we can create Squishy Circuits that do not have to be separated.



Create your own Squishy Circuits by combining multiple LEDs, a motor to create motion, or perhaps a buzzer for sound! Share your creations with our online community at:
www.Facebook.com/SquishyCircuits