Squishy Circuits

What you’ll need:
- a Squishy Circuits kit (or more than one)
- Conductive dough (Find the recipe here or on the lid of the Squishy Circuits box)
- Insulating dough (Find the recipe here or on the lid of the Squishy Circuits box)
- 4AA batteries for each kit

Length of lesson: 45-60 minutes

Ideal group size: 3-5 students per Squishy Circuits kit

This lesson covers the following Indiana Academic Standards for Science:
3.1.6: Describe evidence to support the idea that light and sound are forms of energy.
3.4.2: Define the uses and types of simple machines and utilize simple machines in the solution to a “real world” problem.
4.1.3: Construct a complete circuit through which an electrical current can pass as evidenced by the lighting of a bulb or ringing a bell.
4.1.4: Experiment with materials to identify conductors and insulators of heat and electricity.
4.1.5: Demonstrate that electrical energy can be transformed into heat, light, and sound.

Recommended Reading
Squishy Circuits by Kristin Fontichiaro (This is a library ebook. You will need a digital device (i.e. a tablet or smartphone) to read this book.)
DK Eyewitness Books: Electricity by Roger Bridgman. (Refer to pages 22-23 to see how to build circuits.)

BEFORE THE LESSON
You will need to prepare the dough you will use in this lesson plan. Instructions for the dough are on the Squishy Circuit kit box or you also go online, using the links provided above. Dough preparation will take up to an hour and a half.

Before building speak with students about the dough. Ask what “conductive” or “conductor” means to them. Help them along if you need to. Make sure before you start, they understand that anything that is conductive will allow electricity to run through it.

Step One: The Short Circuit
Goal: Students learn how to create a short circuit.

This step uses the basic circuit the students will make next.

1. Without altering the basic circuit, turn on the battery pack so that the LED is lit.
2. Ask one student (or two students) to push the two balls of conductive dough together. The LED light will turn off.

3. Have students pull the dough apart again to turn the light back on. Let students repeat this process several times.

Discussion:
Why did the light go off when the dough was touching?

The electricity coming from the battery will make take the path of least resistance. When the light turns off, that does not mean there is no longer any electricity. Although some of your students will think this is the case. Instead, the electricity moves straight through the first ball of dough to the second ball of dough. It bypasses the LED, which is no longer acting as a bridge for the electricity.

**Step Two: The Basic Circuit**
Goal: Students learn how to create a circuit using conductive dough, a LED light, and the battery pack.

1. Ask two students to each roll out a ball of conductive dough, place the balls on a flat surface with a space between them. It is important that the balls do not touch.

2. Insert one part of the battery pack into a ball of dough. Repeat this step with the other probe and ball of dough.

3. Take the LED. Identify which end is shorter. Insert that part of the LED into the ball of dough with the black probe. Then, insert the other end into the other ball of dough.

4. Turn on the battery pack. The light will work if the probes and LED are inserted properly.

Discussion:
Why does this work?

Electricity flows from the battery pack, down the red wire, through the dough, through the LED (which lights it up), through the dough again, and then down the black wire. Talk with the students about the LED and how it acts like a “bridge” for the electricity.

**Step Three: Using an Insulator**
Goal: Students learn how to use insulating dough to separate conductive dough and still light a LED.

This time you will use both types of dough that you prepared for this lesson. Before building, discuss with the terms “insulate” and “insulator.” The goal is for them to understand that an insulators do not allow electricity to flow. Discuss different types of insulators. See if your students can name any materials used to insulate. (Some examples include glass, porcelain, rubber, plaster, and ceramics.)
1. Repeat the process used to create a basic circuit. Do not add the LED light.
2. Take a small amount of insulating dough. Have a student roll it into a ball, then flatten the ball to create a disc.
3. Slide the disc between the two balls of conductive dough. Press everything together, making sure that the conductive dough on either side is separated by the insulator dough.
4. Add the LED light. Remember that the short side of the LED must go into the ball that has the black probe attached. Just like before, the LED is attached to both balls of conductive dough.
5. Turn the battery pack on.

Discussion:
Why does the light work even though everything is touching?

With the insulator dough now in place between the other types of dough, the electricity cannot flow from one ball of dough to the other. The only way for the electricity to complete the circuit is to go through the LED, which lights up.

**Step Four: Series Circuits**
Goal: Students learn how to add onto the basic circuit to create a more complex circuit call a series circuit.

A series circuit will show students how electricity flows through more than one LED as it completes the circuit.

1. Build a basic circuit with insulator dough in between. Do not add LED.
2. Have a student add another disc of insulator dough to one end of the circuit. It does not matter which end.
3. Have another student add another ball of conductive dough the insulator dough. You should now have the pattern:
   Conductive-insulator-conductive.
4. Add the wires from the battery pack.
5. This circuit will require two LEDs. Add one between the first layer of conductive dough and the middle layer. Likewise, add the second LED between the middle layer and the last layer. Make sure you connect the short wire from the LED with the black or negative side of the battery. Make sure the long wire is connected red or positive side of the battery.
6. Turn on the battery pack.

Discussion: Did the LEDs light up? If so, why are the lights dimmer than when there was just one? If not, what could be preventing them from lighting up?
If the circuit is built properly, the LEDs will light up. Their lights will be dimmer, though, because there is less electricity available to power them. If the lights do not light up, have students experiment with the amount of dough they used to create the circuit. Discuss if taking any dough away will change the result. Also, double check the polarity of the LEDs to make sure they are aligned the correct way in the dough.

**Step Five: Buzzer Circuit**
Goal: Students build a circuit with conductive dough and a buzzer.

The design of a buzzer circuit is identical to a basic circuit except instead of using a LED, students will use a buzzer.

1. Ask two students to roll out a ball of dough each.
2. Connect the red lead from the battery pack into one ball. Repeat with the black lead in the other ball of dough.
3. Take the black lead from the buzzer and connect it to the ball of dough with the black lead.
4. Repeat with the red lead into the other ball of dough.
5. Turn on the battery pack.

Discussion: What happened?

If the circuit is built correctly, a sharp sound, similar to a fire alarm, will emit from the buzzer. Discuss with students the polarity of the battery and the buzzer. Did they expect the same colored leads to go into the same balls of conductive dough? What happens if the leads are switched?

Remind students that even though the leads from the LED are not colored, they still have polarity (long lead=positive; short lead=negative). The basic circuit with the LED would have looked just like the buzzer.

**Step Five: Motor Circuit**
Goal: Students learn how to build a circuit that will power a motor.

1. Begin with rolling out two balls of dough.
2. Connect the leads from the battery pack just as you did for building the buzzer circuit.
3. Take the motor piece and insert the leads, one each, into the balls of dough. Polarity does not matter for this circuit. The motor will work regardless.
4. Take a small piece of dough and slide it onto the top of the motor. This will allow students to see the motor working. Feel free to use other small materials than the dough.
5. Turn the battery pack on.
Discussion: What happened?

If the circuit is assembled correctly, the motor will spin the piece of dough. Ask students to predict what will happen if they switch which balls of dough the leads from the motor are in. If they are switched, the motor should spin the ball of dough in the opposite direction.

*This lesson plan is adapted from the University of St. Thomas. Below are links to the original page as well as instructional videos that range from mixing the dough to building complex circuits. Youtube is another great resource to consult with even more building ideas!

http://courseweb.stthomas.edu/apthomas/SquishyCircuits/
http://courseweb.stthomas.edu/apthomas/SquishyCircuits/buildingCircuits.htm
http://courseweb.stthomas.edu/apthomas/SquishyCircuits/videos2.htm

If you have extra time:

Side Lesson: Chemistry
Compare and contrast the list of ingredients for both types of dough. Discuss which ingredients might help with conducting and which might help with insulating.