Sew Bright!

Now that we've learned how to sew a simple circuit with conductive thread, let's try lighting up a project with multiple LEDs! We'll use a type of hook-up called a **parallel circuit** to make a mask with three LEDs sewn across the top.

MATERIALS LIST

- Conductive Thread
- Needle
- LilyPad Switched Coin Cell Battery Holder
- CR2032 Coin Cell Battery
- 3 LilyPad LEDs
- Felt
- Scissors
- Glue Gun
- Markers
- Ribbon or String
- Misc. Craft Supplies (for decorating)

STEP 1: Cut Out Template

Use the template to cut out the mask template out of felt. Hold the felt mask up to your face and make any adjustments to the eye or nose shapes so it fits the way you like. There are two layers - one to sew your electronics to, and a larger mask shape we will glue on after the project is complete to give it some extra support.

STEP 2: Series vs Parallel Circuits

Just like we did with our single LED circuit, we will be connecting the boards to the battery holder, but first we need to decide how to lay out the LED boards. In our circuit we'll be using a *parallel circuit*. This isn't just a choice based on the look of the boards, it is actually an electrical plan as well! In a parallel circuit, all the components are aligned so that they get the same amount of voltage running through them, and meaning each LED gets the same amount of power and shines just as bright as the others. Another type of circuit that we aren't using is called a *series circuit*, in which components are hooked up one after another in a line. In that configuration the voltage would have to pass through one LED to get to the next, and some of the power would be absorbed by each, leaving the next one in line dimmer than it's neighbor.

STEP 3: Place Components

Use a dot of hot glue on the back of the battery holder and glue to the top right corner of your mask. Arrange the 3 **LilyPad LEDs** in a line, or **parallel circuit**, across the top of the mask with all the positive and negative sides facing the same direction. Space them out over the eyebrow region of your mask to make an even pattern. Use a tiny dot of hot glue in the middle of the boards to help hold them onto your felt for sewing, make sure not to cover the holes at the end of the boards.

STEP 4: Ready, Set, Sew!

Using a long long piece of **conductive thread** (~2 ft) begin sewing the positive ends of the LED to your battery holder in a line. You can use one piece of thread and sew along to the first LED, sew 3-4 stitches through the hole to secure and instead of knotting and cutting, continue on to the next LED and repeat until you've reached the end of the row. Then tie off and cut. Repeat for the negative sides with a separate piece of thread. Make sure each LED 3-4 stitches around the hole to secure tightly before moving on. *Try a 'wiggle test' – if you can easily wiggle the LED back and forth after stitching it, the stitches are too loose and your connection isn't secure.*

STEP 5: Test Your circuit

Insert your **coin cell battery** into the battery holder. Turn on the switch and see if your LED row shines bright! If any of the LEDs aren't illuminating, check your stitching to make sure they are tight. If not, you can go in and sew with a bit of conductive thread over the connection point, holding the piece down tighter and making sure that your thread is touching both the board and the original sewn line.

STEP 6: Troubleshooting

With any electronics project, there are times you will have to problem solve if your circuit isn't working. If your circuit isn't lighting up, try a new battery or checking that your project is switched on. Check your sewing for any loose threads or ends that may be touching other parts of your circuit and causing a *short circuit*. See the picture for examples of conductive thread short circuits – practice tidy stitching to keep your thread from going where it shouldn't.
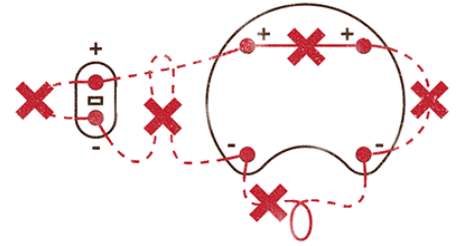
STEP 6: Customize Your Character

After you've checked your circuit, get creative with adding some details to your mask. If you have craft supplies such as glitter, paint, or other decorative accents you can add them to enhance or hide your LEDs and stitching. If you want to cover the battery holder on the front of the mask, using feathers or big buttons could be a nice flourish that adds pizzaz and hides the board. Make sure you leave a bit of room so you can remove the battery and put in a new one when needed. Once your mask is decorated and circuit is tested, hot glue the second layer of felt you cut out earlier on the back to add some extra stability. To complete the project, cut small holes on either side of the mask with scissors or a hole punch and tie a string or piece of elastic to hold the mask on. Try it out and now you are ready for a masquerade party or Halloween!

TAKING IT FURTHER

- Brainstorm ways you could add LEDs in a parallel circuit without being in a straight line, can you extend your traces so that you have LEDs around the eyes while still keeping the parallel circuit design?
- Try this project with more than three LEDs, how bright can you get while still having room to sew the traces?
- LilyPad Design Kit Experiment 2: Multiple LED Circuits
- Series and Parallel Circuits

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