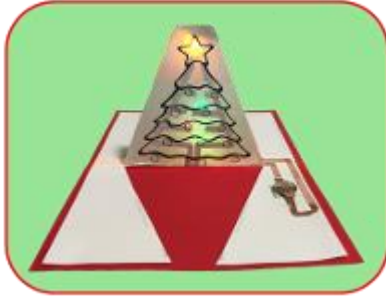


Pop-up Christmas Card Paper Circuit

Our pop-up Christmas card template is a parallel circuit template. The LEDs in this circuit will only need a single source of electricity because each LED has a conductive pathway of its own within the circuit.



During our investigation into building our first pop-up card template, we found that we liked the flashing LEDs best for the Christmas decorations hanging on the tree. We also decided to use a pressure sensor to turn the LEDs on and off, but your older kids may enjoy experimenting in this area. If so, have them check out our paper circuit [switches](#) and [sensors](#) discussion in the [Case of the Missing Easter Eggs](#) post.

Step 1 - Supplies:



Image 1.1



Image 1.2

1.1 Our pop-up Christmas card design uses two sheets of cardstock, one for the background, and one for the Christmas tree paper circuit that will pop up when you open the card. You need to print your circuit template using landscape orientation with double-sided printing, flipped on the short edge. **Image 1.1** above shows the front and back of the template printed separately only to show you what both sides look like.

1.2 You will also need a yellow LED for the star, 3 flashing LEDs for the decorations, a coin cell battery, a 1/2" piece of foam tape, double sticky tape or a glue stick to secure the two pieces of cardstock together, and around 40" of copper foil tape with conductive adhesive (**Image 1.2**).

Step 2 - Testing:

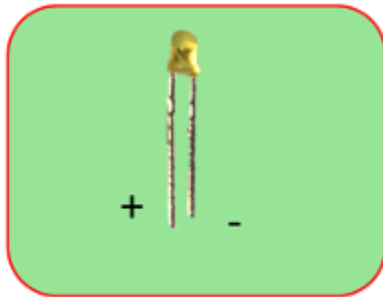


Image 2.1



Image 2.2

2.1 Test your battery and LEDs. The longer leg of the LED is positive, and the shorter leg is negative (**Image 2.1**). You can also use the flat side of your LED to determine which leg is negative as it's the leg closest to that side. We had a hard time finding the flat side during our investigation, so we prefer to look at the leg length when testing.

2.2 Polarity is important with LEDs so be sure to place the positive leg on the positive side of the battery and the negative leg on the negative side. If both the battery and LED are working you should see the LED light up (**Image 2.2**).

If the LED doesn't light up, try switching the direction of the LED legs. If it still doesn't work, you either need a new battery or a new LED. It's a lot easier to replace a bad battery or LED now before you start the project, so these tests are very useful.

Step 3 - Build:

If you haven't already done so, print out the pop-up Christmas card circuit template on the cardstock your kids have chosen for the inside of their card.

Note: If your kids would like to color the front of their tree, they should do that now.

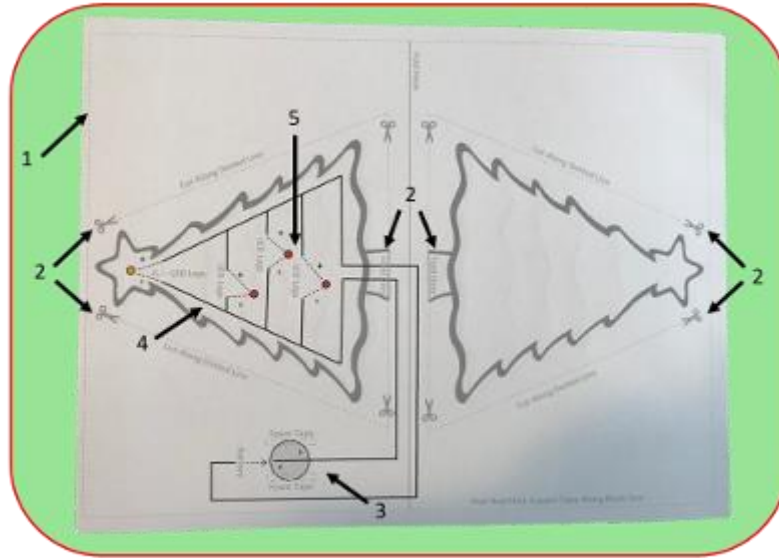


Image 3.1

3.1 Let's take a closer look at the circuit. The gray dotted line along the outside of the circuit template is an optional cutting area. If your kids would like to see a red border around the inside of their card, then they should cut along this dotted line (**Image 3.1, Arrow 1**).

3.2 The gray dotted lines, marked with scissors, that surround the Christmas trees, should be cut until you reach the tree trunk. Do NOT cut the trunks, they need to be folded upward later (**Image 3.1, Arrow 2**).

3.3 The pressure sensor, located at the power source, consists of two thin strips of foam tape that act as spacers to keep the circuit open until your kids press the battery firmly enough to connect with the copper tape below it, closing the circuit.

When pressed, the negative side of the battery will connect with the copper tape below it. The positive side of the battery will already be connected to the copper tape pathway from the top, so no other steps will be needed to close the circuit and light the LEDs (**Image 3.1, Arrow 3**).

3.4 The solid black lines mark the paths for the copper tape (**Image 3.1, Arrow 4**).

3.5 The three red circles, and the one yellow circle represent the placement of the LEDs, with the attached dotted lines showing the position of the positive and negative LED legs (**Image 3.1, Arrow 5**).

You're now ready to help your kids build their pop-up Christmas card.

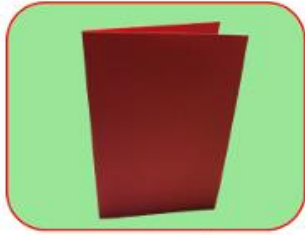


Image 3.2



Image 3.3



Image 3.4

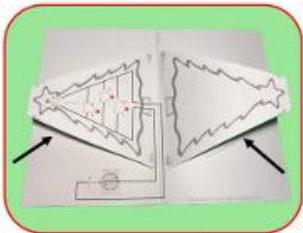


Image 3.5

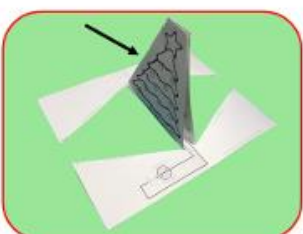


Image 3.6



3.6 Hold the sheet of cardstock you chose for the outside of your card in a landscape position, then fold it in half (**Image 3.2**).

3.7 If you want to see a border around the inside of your card, cut along the outer gray dotted line on the sheet of cardstock for the inside of the card now (**Image 3.3**).

3.8 Fold the sheet of cardstock for the inner card, keeping the decorated trees on the outside (**Image 3.4**).

Note: Be sure to help your kids with this step. Just in case the template doesn't print in the exact center of their paper, make sure the two stars, on top of the trees, line up when they fold the inside of the card.

3.9 Cut along the dotted lines that surround the two trees in a triangular shape (**Image 3.5**).

Note: Make sure you don't cut the tree trunks.

3.10 Fold the trees upward, at the base of the trunk, before the copper tape is added, then unfold them. This will make folding the card easier later (**Image 3.6**).

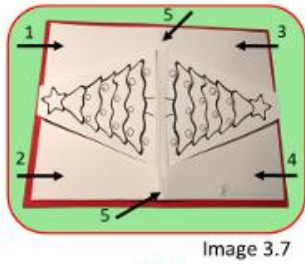


Image 3.7

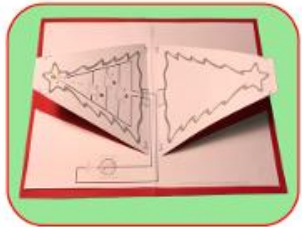


Image 3.8

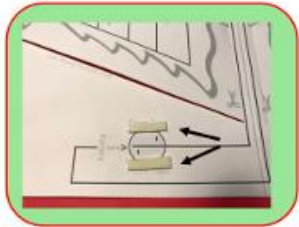


Image 3.9

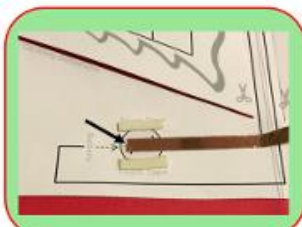


Image 3.10

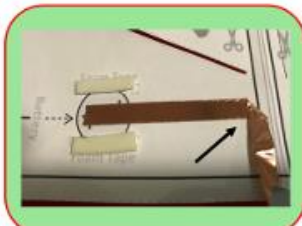


Image 3.11



3.11 The decorated tree side of the cardstock is the back and needs to be taped or glued to the sheet of cardstock you're using for the outside of your card. Make sure to apply the adhesive on the four corners (**Image 3.7, arrows 1-4**) and the long strip in the center, from top to bottom (**Image 3.7, arrow 5**).

3.12 Carefully turn the inside sheet of cardstock over, center it as you go, and firmly press the adhesive to the back (**Image 3.8**).

Note: We preferred the double sticky tape during our investigation, but your kids need to be careful as they attach the two sections together. The tape doesn't allow second chances.

3.13 Attach two small slivers of foam tape to the rectangle boxes located on either side of the gray circle. Be sure to stay within the areas marked. If the spacers are placed inside the circle area, they could interfere with the pressure sensor (**Image 3.9**)

3.14 Attach the copper tape to the solid black line, peeling the backing off as you go. Start in the gray circle marked with the '-' signs and follow the black line toward the right (**Image 3.10**)

Note: During our investigation, we found that if you remove the backing all at once the copper tape will twist and stick to itself.

3.15 Corners can be tricky but we're using copper tape that's conductive on both sides. A little twist in the tape at the corners should be just fine.

3.16 When you reach a corner the trick is to bend the copper tape in the opposite direction from where you want to go first, creating a diagonal fold (**Image 3.11**).

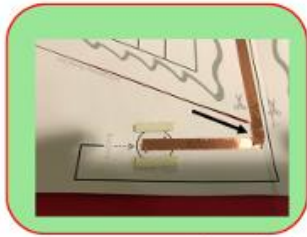


Image 3.12

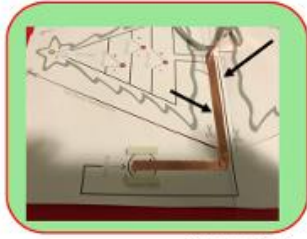


Image 3.13



Image 3.14



Image 3.15



Image 3.16



3.17 Hold this folded section in place with your finger as you bend the copper tape back over the fold to continue going in the right direction. You should see a nice corner formed but don't worry if it's messy. It gets easier with practice (**Image 3.12**).

Note: We found it easier to create cleaner corners by removing the excess white backing material before we folded the corners.

3.18 Continue placing the copper tape along the path formed by the black line. Make sure the section of copper tape heading towards the tree trunk is over as close to the tree as possible, without attaching to the triangular section that was cut earlier (**Image 3.13**).

Note: You need room for the copper tape as it comes back to the battery to complete the circuit.

3.19 When you reach the gap for the yellow LED, at the top of the star, use your fingers to cut the tape and then continue placing the tape along the black line on the other side of the gap (**Image 3.14**).

3.20 As you continue attaching the tape, make sure the section of tape below the tree, as you return to the battery, does NOT touch the tape from earlier (**Image 3.15**).

3.21 Stop attaching the copper tape when you reach the end of the outer black line where you see the Battery label (**Image 3.16**).



Image 3.17



Image 3.18



Image 3.19

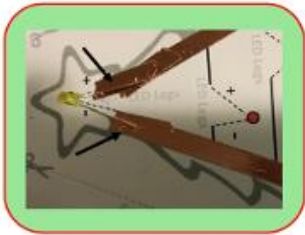


Image 3.20

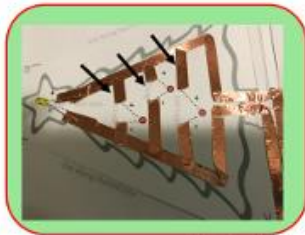


Image 3.21



3.22 Place the battery, positive side up, on the two foam spacers. Make sure the battery is centered over the gray circle (**Image 3.17**).

3.23 Continue running the copper tape along the dotted black line, and across the battery to its far edge. Be sure to stop at the edge so it doesn't touch the copper tape from the beginning of the circuit (**Image 3.18**).

Note: If this end of the copper tape touches the section of copper tape under the battery it will short circuit.

3.24 You just completed the pressure sensor and power source. It's time to connect the first LED to the gap along the outer pathway. It's easier to troubleshoot a problem in the circuit now before additional pathways are added.

3.25 Bend the LED legs wide enough to connect to the copper tape on both sides of the gap, line the legs up with the dotted lines and the LED to the yellow circle (**Image 3.19**).

3.26 Tear off two small pieces of copper tape and use them to cover the LED legs and stick them to the existing copper tape (**Image 3.20**).

Note: Remember that polarity matters. The positive leg needs to connect to the side marked positive and the negative leg needs to connect to the side marked negative.

3.27 Press the battery firmly against the bottom of the card. Once you see the yellow LED light up you will be ready to build the other three pathways in the circuit.

Note: If your LED doesn't light up, you should check out our troubleshooting tips at the beginning of this post, next to the investigation tab.

3.28 Attach the copper tape to the remaining three pathways that cut through the circuit. Be sure to overlap the piece of copper tape already in place so a connection is formed.

Run the copper tape down along each black line. When you reach the gap in each pathway use your fingers to cut the tape and then continue placing the tape along the black line on the other side of the gap. Each pathway is complete when the copper tape overlaps the copper tape along the outside of the circuit (**Image 3.21**).



Image 3.22



Image 3.23



Image 3.24

3.29 It's time to connect the other three LEDs. Bend the LED legs wide enough to connect to the copper tape on both sides of the gaps, line the legs up with the dotted lines and the LEDs to the red circles, one LED per pathway.

Note: Remember that polarity matters. The positive leg needs to connect to the side marked positive and the negative leg needs to connect to the side marked negative.

Tear off two small pieces of copper tape and use them to cover the LED legs and stick them to the existing copper tape (**Image 3.22**).

3.30 Fold the trees up and attach with tape or glue along the top edge (**Image 3.23**).

3.31 Press the battery firmly so that it makes contact with the copper tape below it and watch your LEDs light up and flash (**Image 3.24**)

Now that you have a working circuit you may want to use some scotch tape to secure the LED bulbs to the template. You can also poke a small hole through the template near each LED if your kids would like the LEDs to shine a little brighter from the outside of the tree.

Congrats, you just finished creating your pop-up Christmas card. Close the card, decorate the front, and enjoy!