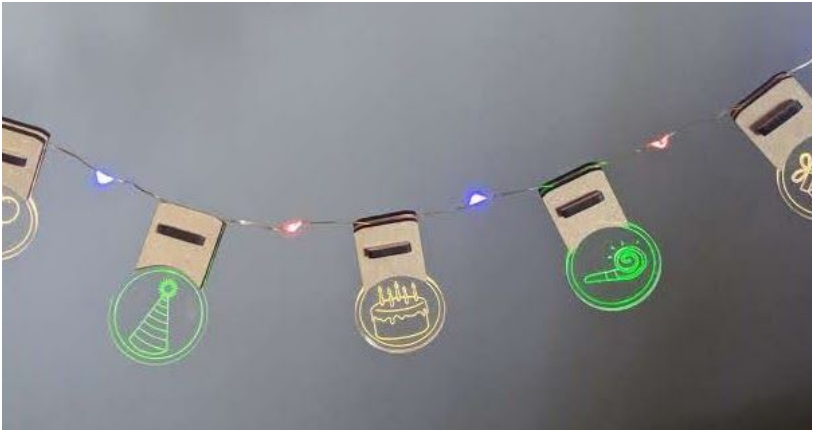


**LESSON**

**Fairy Light Illuminated Banner**



**Overview**

In this lesson, students will:

- In this lesson, students will design and draw a series of pictures and use the Glowforge App **Trace** feature to etch them onto acrylic ornaments. Once printed, the ornaments will be attached to the LEDs on a fairy light string, illuminating students' artwork with a lovely ethereal glow.

**THE OBJECTIVE**

- Plan a series of related images to fit to the ornaments
- Explore the properties of internally reflected light
- Create and assemble illuminated banners

<p><b>GRADE LEVEL:</b> Elementary</p>	<p><b>DIFFICULTY</b> Easy, but adult help will be required for some steps in the assembly.</p>
<p><b>SUBJECTS</b> Arts, Optics</p>	<p><b>DURATION</b> 75 minutes</p>
<p><b>STANDARDS</b> N/A</p>	<p><b>VOCAB</b> Engrave                          Cut</p>

	Score <span style="float: right;">Edge-lighting</span>
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## Supplies

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### SOFTWARE:

- Glowforge App

- Dark colored pen or pencil. A black fine point Sharpie is a good choice to produce a strong dark line

### MATERIALS & TOOLS:

- Proofgrade Medium Clear Acrylic
- Proofgrade Medium Draftboard or other 1/8" thick laserable wood
- Small strand of fairy lights with attached battery pack [e.g. https://www.amazon.com/gp/product/B084WQ3K46](https://www.amazon.com/gp/product/B084WQ3K46). Most strands will contain 20 fairy lights.
- Printed copy of the Ornament Design Sheet (OrnamentDesignSheet.pdf)

### DESIGN FILES:

- [ornaments.svg](#)
- [clips.svg](#)



## Description

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### LESSON OUTLINE:

- Plan a group of illustrations to be included in the banner
- Draw the illustrations on paper
- Use the Glowforge Trace feature to print illustrations onto acrylic ornaments
- Print wooden clips to attach ornaments to fairy lights
- Assemble the banner by securing ornaments to fairy lights with clips

### ASSESSMENT STRATEGIES:

**FORMATIVE ASSESSMENT:** Circulate the classroom and observe students at work, are they collaborating and/or using teamwork, and any other items you wish to assess.

**SUMMATIVE ASSESSMENT:** Use the [Magical Things Journal](#) to document student learning.

STANDARDS



## Lesson Instructions

### Step 1: SETUP

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Each student or group creating a banner will need a string of fairy lights, a printed copy of the Ornament Design Sheet, and a dark colored pen or pencil. Printing the ornaments and clips will require a sheet of Proofgrade Medium Clear Acrylic and Proofgrade Medium Draftboard.



### Step 2: INTRODUCE & IDENTIFY THE LESSON

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Light usually travels in a straight line, but inside certain materials, such as clear acrylic, it will bounce around inside the material, reflecting off the smooth inner surfaces, until it finds a rough, uneven surface through which to escape. This produces an effect known as “edge-lighting”, in which images etched into illuminated acrylic appear to glow from within, even though the light doesn’t shine on them directly.

Ask students if they’ve ever encountered any edge-lit signs or decorations. This effect is often used in signage for dimly-lit areas. For example, the exit signs in movie theaters are often made of clear acrylic illuminated with green light. The entire sign is illuminated, but the glow appears to only emanate from the letters etched into the acrylic surface.

Show the students the fairy light strand and explain that because the lights aren’t very powerful, each LED will only illuminate a small area. However, since each strand has many (usually 20) lights, students will be able to draw a series of pictures which will hang together in a long banner. Encourage them to think about different images which work well together in their banners.



### Step 3: IDEATE

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Plan the banners with the students. Each fairy light strand typically contains twenty lights. That’s a lot of ornaments to assemble, so it should be decided in advance how many ornaments will be on each banner. A realistic goal is to create ten acrylic ornaments and attach one to every other light in the strand. It is also possible to shorten a fairy light strand by cutting off the end furthest from the batteries, then seal the exposed wires with electrical tape or clear nail polish.

Once the number of ornaments for each banner is set, ask students to think about collections of images they think would work together in their banners.



## Step 4: CREATE

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### **Draw Pictures for the Banners:**

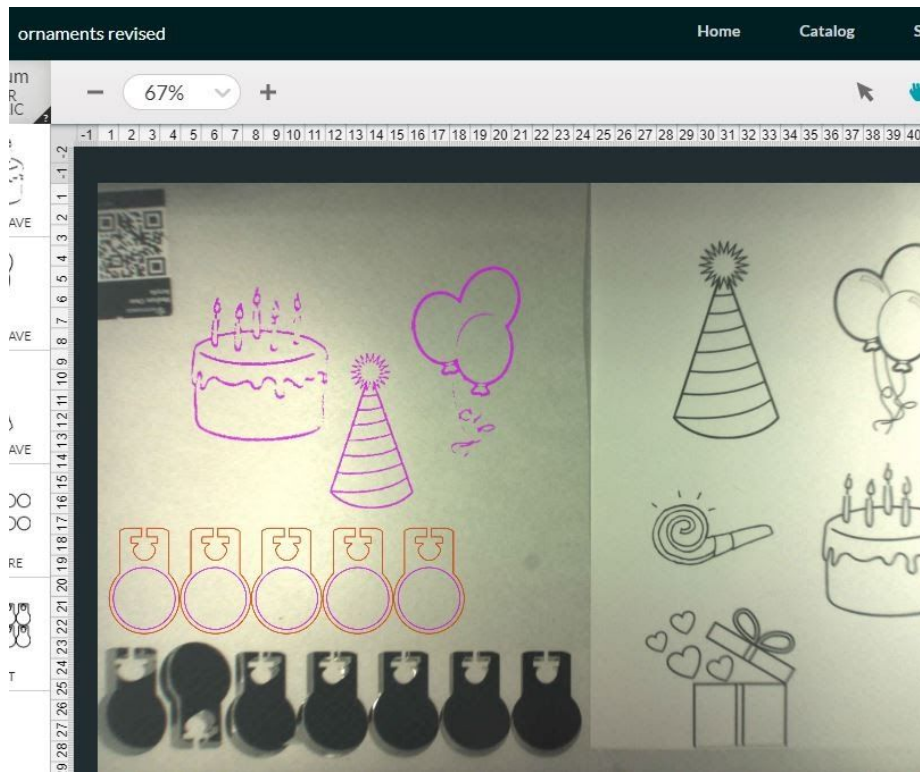
Give each student a dark pen or pencil and a printed copy of the Ornament Design Sheet (OrnamentDesignSheet.pdf) in which to draw the pictures for their ornaments. A black fine point sharpie produces a thick, dark line which will create a nice visible image when scanned. Ask them to draw their pictures inside the faint circles. The circles on the Ornament Design Sheet are twice as large as the print area, so the pictures will be shrunk before being traced onto the acrylic. Any details that are \*too\* small may get lost. Images formed with thick, dark lines will show best in the edge-lit effect.

### **Print Images on Acrylic Ornaments:**

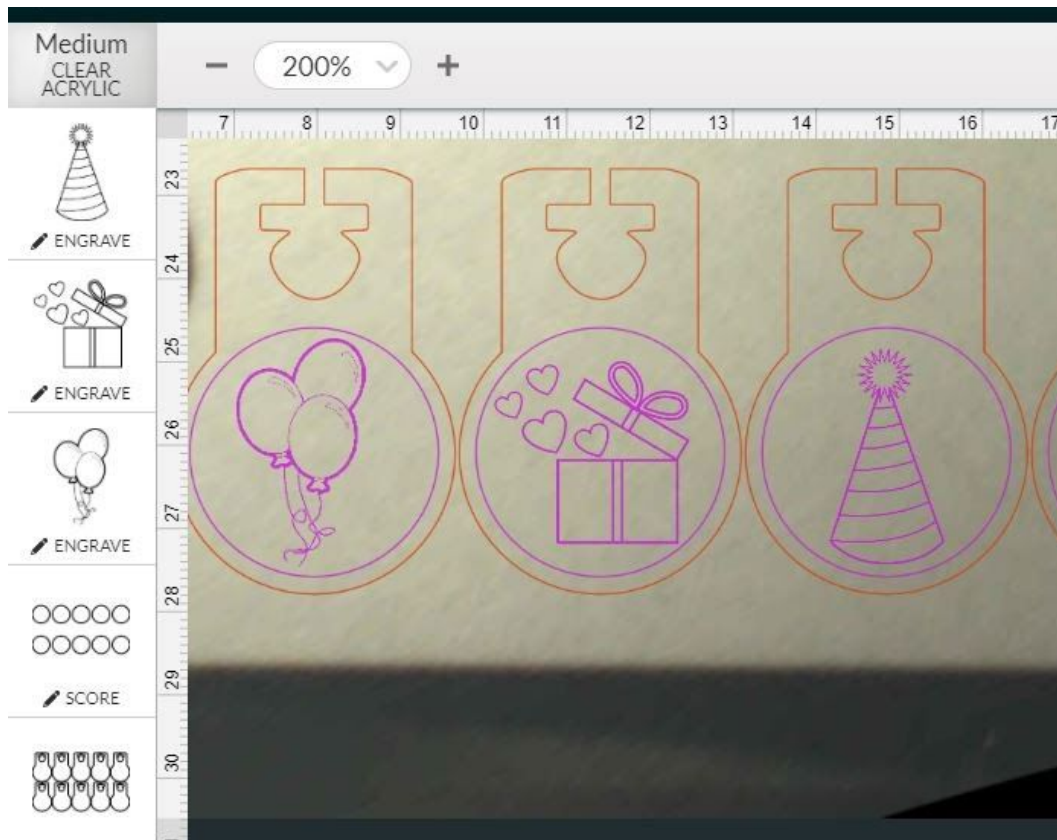
Place the filled Ornament Design Sheet on the Glowforge print bed. Click the **Import Artwork** button in the Glowforge app and select **Trace** to use the Glowforge Trace Tool. When importing each image with the Trace tool, follow the prompts to crop the area around the image you'd like to import. Once the image has been selected, click the **Place Artwork** button to import the image into the Glowforge App. Don't click on the image before selecting **Place Artwork**, because this will add cut lines, and the image should be engraved, not cut.. This posting from the Glowforge Community Forum explains clearly how to use the Trace Tool, without adding cut lines:

<https://community.glowforge.com/t/glowforge-interface-using-the-trace-tool/14074>.


It is important to be able to position each image independently, so you must repeat the scan process once for each image on the sheet. In each scan, be sure to crop the area to be scanned closely, so that it doesn't include portions of other pictures on the sheet. After each image is scanned, place it anywhere convenient in the Glowforge app. It will need to be processed further before it is moved to its final position.



Once all images have been scanned, remove the Ornament Design Sheet from the Glowforge. Place a sheet of Proofgrade Medium Clear Acrylic on the print bed. Click the “Import Artwork” button and import the ornament design file, called “ornaments.svg” This file contains cut and score lines for ten ornaments. If you don’t want to cut all ten ornaments, you can select and delete the extra ones from within the Glowforge App. In the ornaments, blue lines (ornament outlines) are cut lines and red lines (circles inside the ornament) are score lines.



To position the pictures properly for printing, repeat the following process once for each ornament:

1. Scale down the image until it fits inside the red circle in the center of an ornament. To make the image smaller, select it, then click on the small circle at the corner of the image outline and slide it towards the center of the image.
2. After scaling, move the image into the center of the red circle in an ornament.
3. Edge lit effects look best when the etched image is on the \*back\* side of the acrylic. This reverses the image in the banner. This may not matter for the final image, but if it contains text, it will be inverted when the banner is displayed. To display the image exactly as it is drawn, reverse the image before printing, by selecting the image and then clicking the **flip vertical** button  in the Glowforge App.

Before printing the ornaments, be sure that all ornaments and images are aligned, and that the print settings for each element are correct. Images should fit within the red circles in each ornament. Be sure the images will be printed with the **Engrave** setting. The ornament outlines must be set to **Cut** and the circles in the body of each ornament should be set to **Score**. Double check that there are no cutlines within the images themselves.

It's best to order the printing steps so that the **Cut** step comes last, after all **Engrave** and **Score** steps. This prevents the cut pieces from possibly moving around during engraving. You can specify the order of the printing steps by dragging them around in the list at the left of the Glowforge App.

Once you are certain that the settings and alignment are correct, print the ornaments, remove them from the Glowforge and peel off all protective paper.

**Print the Wooden Ornament Clips:**

Remove the acrylic from the Glowforge and place a sheet of Proofgrade Medium Draftboard on the cutting bed. Import the design file for the wooden clips, named "clips.svg". Each clip consists of three separate pieces arranged in a column inside the file. Printing the entire file creates ten clips. If you don't need all ten, delete any extra from within the Glowforge App before printing. Print the clips and peel the protective paper. It's very important to remove all the paper because the thickness of the clips must be exactly right to hold the ornament to the fairy lights.

**Attach Ornaments to Fairy Lights:**



## FAIRY LIGHT ILLUMINATED BANNER

Arrange the ornaments for each banner in the order in which they are to be displayed. Unroll the fairy light strand and lay it out in a straight line. Three wooden pieces fit together to create one clip. The two same-sized pieces form the outer layers which “sandwich” the acrylic, and the smaller wooden piece has two prongs which slide through the slots and secure the layers together.





Lay the acrylic ornament in front of you with the engraved side facing upwards. This is the back of the ornament. Take the small clip piece with two prongs and the piece with the rectangular hole, and join them together, by sliding the prongs all the way through the hole as shown.



Next, lay the clip pieces you've just assembled on a flat surface with the prongs pointing upwards and slide the acrylic piece over the clip so that the prongs pass through the rectangular hole in the acrylic. Be sure the acrylic is pushed all the way down over the prongs so that it sits flush against the wooden layer beneath it. The top edge of the acrylic will sit a little lower than the top edge of the first wooden layer when they are aligned.



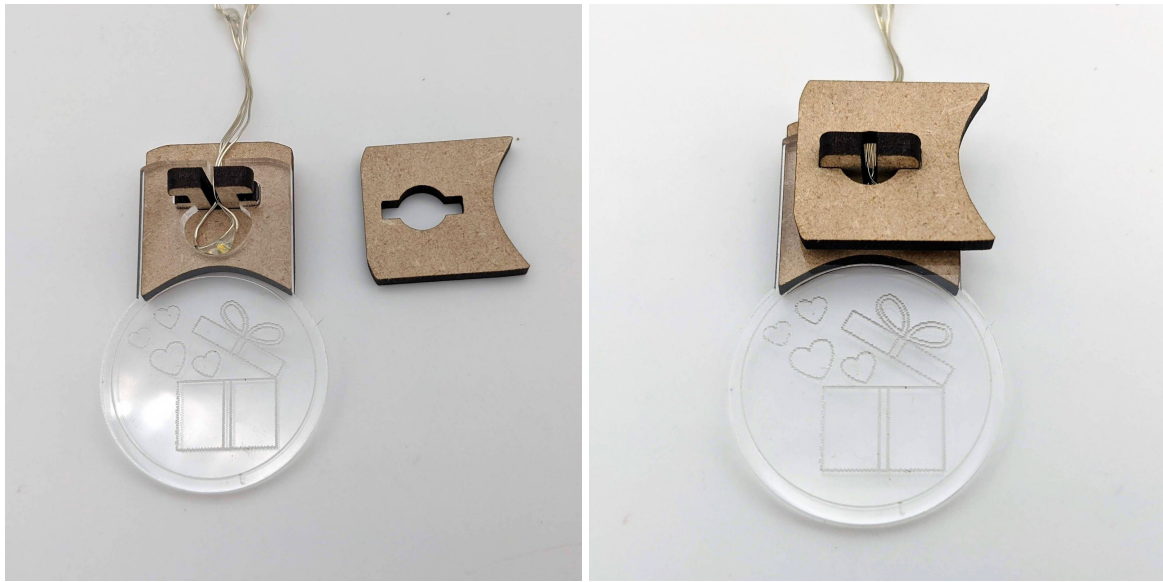
Take a portion of the fairy light strand containing a single LED and bend it into a narrow loop with the LED at the bottom as shown above.



Take the two sides of the loop, hold them together and slip them down between the two prongs in the clip, so that the fairy light sits over the acrylic ornament.



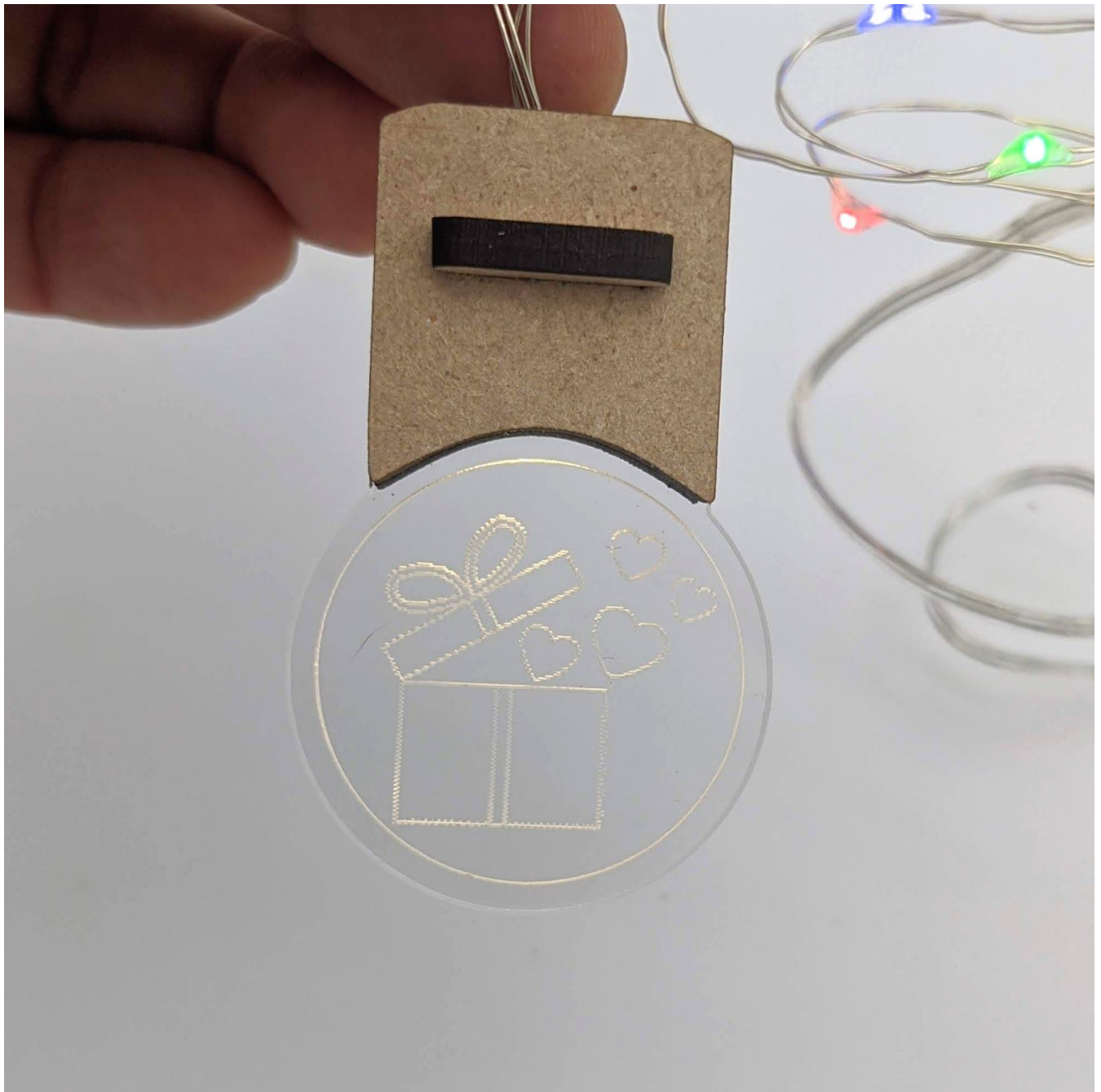
Now gently pull upwards on the fairy light loop so that the wires stay between the prongs and the LED moves upwards into the round hole in the acrylic layer. Stop when the LED fits entirely within the hole. If necessary, press down on the wires and the LED with your fingertips or a tweezers, until it is seated entirely within the hole. All portions of the fairy wire and the LED which will be inside the ornament should fit completely within the cutouts in the acrylic layer.



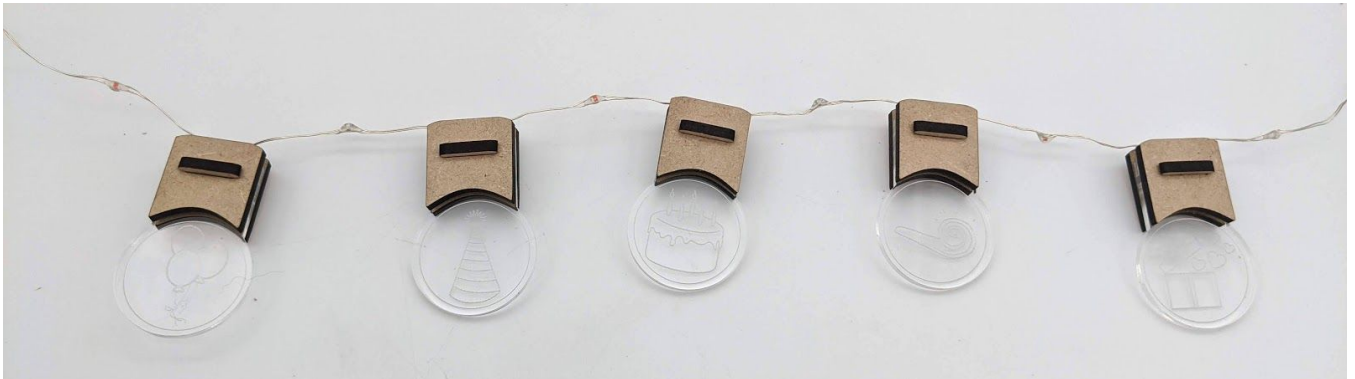
Once the LED is seated in the ornament, take the last wooden clip piece which contains a circular hole centered inside a rectangular slot, and rotate it so that the slot aligns with the clip prongs. Slide the last piece down over the prongs until it sits directly on top of the acrylic layer. Check that no portion of the fairy light strand has wedged itself between the acrylic and the last wooden layer.



If all layers of the clip lay flush together, you should be able to gently rotate the last clip layer 90 degrees around the notches in the clip prongs until it aligns with the rest of the ornament, as shown above. If the wooden piece doesn't rotate easily, make sure it is oriented with the prongs exactly in the center of the circular hole before attempting to turn it. You should only have to apply moderate force to rotate it into position. Once rotated, it will not be able to slip off of the prongs, and the ornament and LED will be firmly secured within the clip.

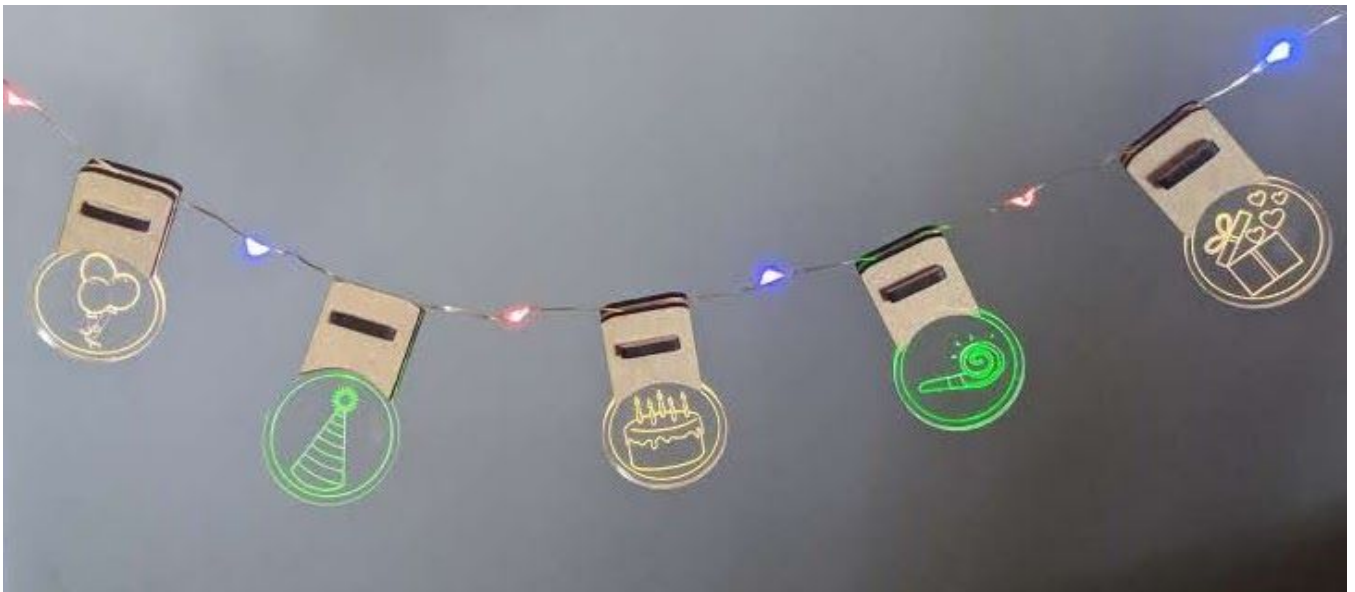


This is the back side of the banner. If you turn the ornament over to view it from the front, it should resemble the picture above. The fairy light wires extend upwards through the top of the ornament



Repeat this assembly process for each ornament until the banner is completed.

## Step 5: LIGHT IT UP AND TAKE A LOOK



Once all ornaments have been attached to the fairy lights, orient the banner so that the etched sides of the ornaments face away from you. Turn the fairy lights on and observe the edge-lit effects. Even though the light shines from the top of the ornament, the brightest parts of the ornament are the etched portions of the surface.



If they used different color fairy lights, ask the students whether they notice any differences in brightness or diffusion between the different colors of light. Notice which pictures are illuminated most effectively. Are small details visible? Do filled areas illuminate well, or do etched lines look better? How does the ornament appear different when viewed from the front side vs. from the back side.

Now that they've seen their creation fully assembled, ask the students to think of other ways they might use this banner design (e.g. etch arrows on the ornaments to indicate direction, or draw letters and words to form a message).

The edge-lit effect will be brightest in a dark room and may disappear almost entirely in the daylight. When complete, the banner may be hung on a wall or attached to the edge of a table for a festive decoration that gives hand-drawn artwork a little subtle extra glow.