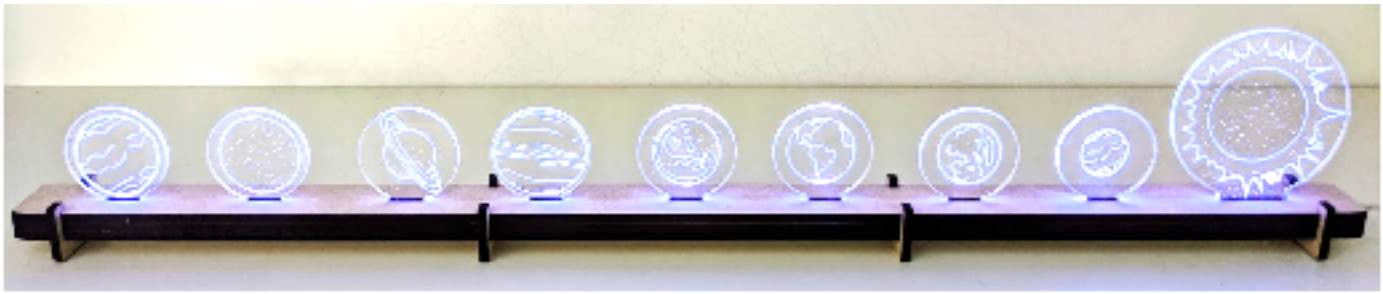
LESSON

ILLUMINATED SOLAR SYSTEM MODEL



Overview

In this lesson, students will:

- Students will explore the solar system by creating their own edge-lit model of the sun and planets

THE OBJECTIVE

- Learn order of planets in the solar system, their distance from the sun, relative sizes and important features
- Draw images of the sun and planets
- Create and assemble a model incorporating the planets in proper order
- Explore the light diffusing properties of edge-lit acrylic

GRADE LEVEL: 2-6	**DIFFICULTY** Easy
SUBJECTS Solar System, Art.	**DURATION** 75 minutes
STANDARDS (list of standards addressed) **N/A**	**VOCAB** Planet, Solar System, Illuminated, Scale Model

Supplies

SOFTWARE:

- Glowforge App

MATERIALS & TOOLS:

- Proofgrade Medium Clear Acrylic
- Proofgrade Medium Draftboard or other ⅛" thick laserable wood
- Strand of fairy lights containing 20 LEDs in 1 meter (e.g. https://www.amazon.com/CYLAPEX-3-3feet-Battery-Christmas-Decorations/dp/B01FOITH9M). Fairy lights which have 20 LEDs in 2 meters will not work well in this project.
- Paper and dark colored pen or pencil. A black fine point Sharpie is a good choice to produce a strong dark line.

DESIGN FILES:

- SolarSystemBase.svg
- SolarSystemPlanets.svg

RESOURCES:

- https://solarsystem.nasa.gov/solar-system/our-solar-system/overview/
- https://nineplanets.org/kids/
- https://www.itsybitsyfun.com/solar-system-facts-for-kids.html

Description

LESSON OUTLINE:

- Research the planets in the solar system
- Draw pictures of the Sun and the eight planets
- Using the Glowforge Trace feature, print planet pictures onto acrylic
- Print the wood base to hold the fairy lights
- Assemble the base and add the planets to create an illuminated model

Following the Design Thinking Process
IDENTIFY - Introduce the lesson plans and prompt for current knowledge
IDEATE - come up with as many ideas as you can
CREATE - Decide on an idea to pursue and prototype.
TEST - Students test their prototypes to see if it works
SHARE - Students reflect on their process to see if it worked.

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

Description

Each student or group creating a solar system model will need a string of fairy lights with 5cm spacing (20 LEDs/meter), a pen and a sheet of paper. To print the parts of the model, they will need a sheet of Proofgrade Medium Clear Acrylic and a sheet of Proofgrade Medium Draftboard.

Step 2: EXPLORE THE SOLAR SYSTEM

Introduction:

We all know that we live on a planet named “Earth” and the closest star to us is the Sun, but do the students know the names of the other planets which orbit our sun along with us? Ask the students to name as many planets as they can from memory.

Find a resource that shows pictures of the solar system and the arrangement of the planets. A good online resource is: https://nineplanets.org/kids/. Ask the students to look at the sizes of the planets. How big is our Earth compared to the others? What is the smallest planet? What is the largest?

Look up the physical properties of the different planets. Do any of them have cloud coverings and weather like earth? What is the temperature at their surfaces? Does the temperature of the planets have any correlation with their distance from the sun?

In 1 lesson, students will create and build their own solar system models. They won’t be able to build a “scale model”, in which the ratios of sizes and distances between the planets are the same as their real distance and size ratios. Discuss this with the students, and ask if they know why it would be very diq2e5^{3}2 see 2¾4 tee tree tree teeter teeteredfficult to create a realistic scale model. Explain that the sun in this solar system model is 2.3 inches in diameter. If we were to build a realistic scale model, with all measurements proportional to our 2.3 inch sun, the Earth would sit almost 21 feet away, and its size would be equivalent to the thickness of a single sheet of paper!

Ideate:
Since the model won't be strictly accurate in size, the focus will be on representing the well-known features of each planet. Have the students make a list of the planets, and for each, write down one or two important visible features. For example, Jupiter has a "great red spot" which is the site of a giant storm larger than the Earth itself!

Create:
Give each student a piece of paper and sharpie or other dark pen and ask them to create a drawing of the sun and each of the planets in the solar system. The drawing should incorporate the most recognizable features of the planets. The size of the drawings isn't important, since they will be scaled inside the Glowforge app before being printed on acrylic.

Build:
Step 1: Create Acrylic Planets from Students' Drawings

First, import the students' images into the Glowforge App as individual drawings. Place the paper containing the drawings of the sun and planets on the Glowforge print bed and open the Glowforge App.

Click the **Import Artwork** button  in the Glowforge app and select **Trace**  to select the Glowforge Trace Tool. When importing each image with the Trace tool, scan the image but *don't* add cut lines. 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.

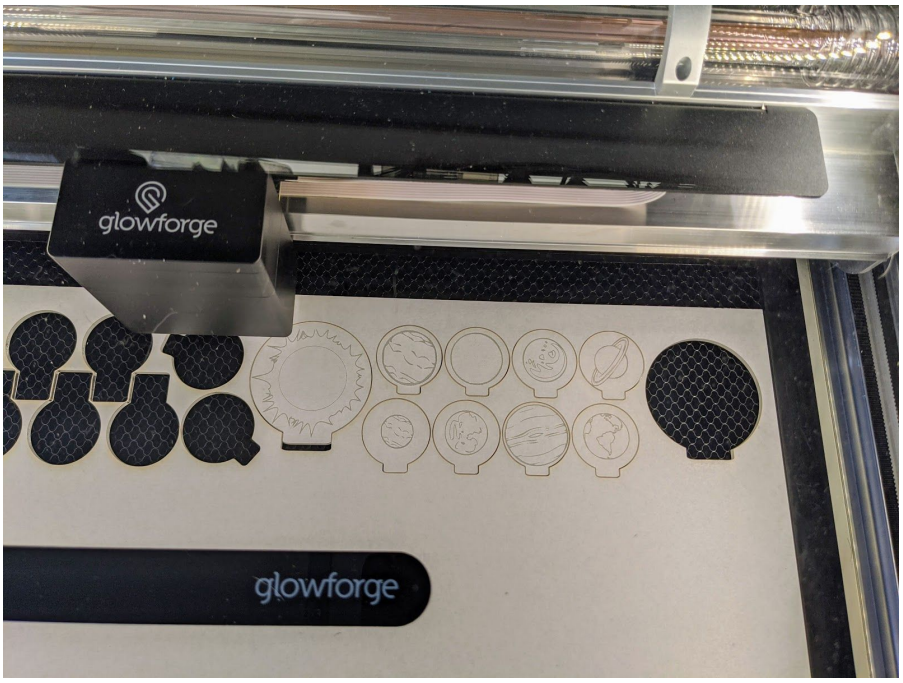
Be sure that the print settings for the drawings are all set to **Engrave.**

Once all the images are imported, remove the paper from the Glowforge, and place a sheet of Proofgrade Medium Clear Acrylic on the bed. Click the **Import Artwork** button and select Upload  to import the "SolarSystemPlanets.svg" file. This file contains outlines for the eight planets and the sun. In the Glowforge app, select the **Cut** setting for the outlines.

Drag the image of the sun into the largest of the cut outlines. Scale it down until it fits entirely inside the outline by clicking on the small circle at the image corner and dragging it towards the center. Move the image so that it is centered within the circular portion of the cut outline.

Follow the same process to place the images of the eight planets inside the smaller cut outlines. Decide with the students whether they'd like the planet images to fill the full space of the outlines to make them more easily visible, or whether they'd like to scale down the size of some planets to give an idea of their relative sizes. Both methods work fine for our model solar system. It is simply a matter of preference. Once they've settled on the way they'd like their planets to look, scale the images appropriately and drag each into its own cut outline.

Edge lit effects look best when the etched image is on the *back* side of the acrylic. This reverses the image when it is viewed from the front. If the students would like their drawings to display exactly as they have been drawn (which will be important if they've included text), then reverse the image before printing by selecting it and clicking the **flip vertical** button  .

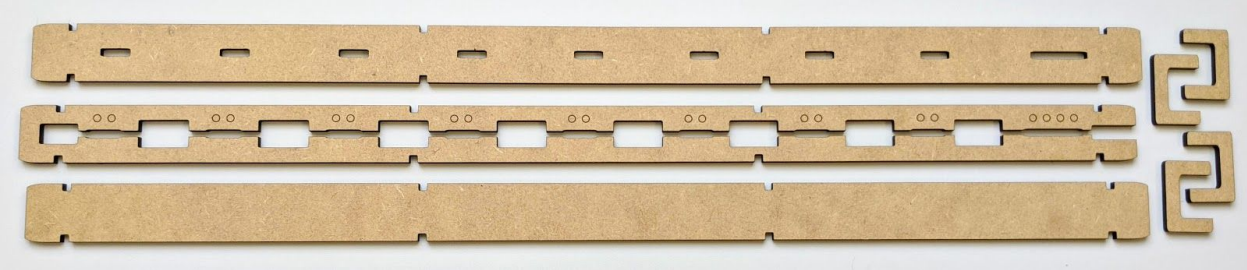


Before printing, double check that all images will print with the Engrave setting and outlines will print with the Cut setting. Once everything looks good, print the models of the planets and sun on the acrylic. Then remove the models from the Glowforge and peel of all protective paper.

Step 3: CREATE AND BUILD THE WOODEN BASE

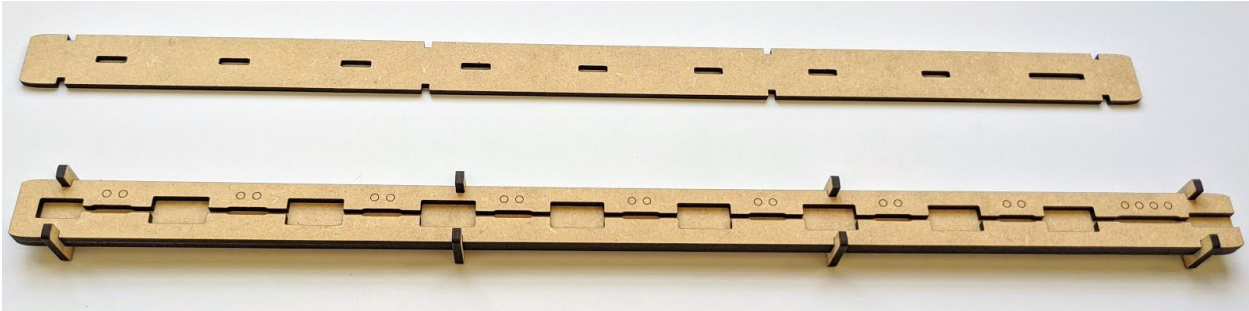
Remove the acrylic from the print bed, and insert a sheet of Proofgrade Medium Draftboard or other ⅛" thick wooden sheet. Erase any leftover images or print files from the Glowforge App. Click the **Import Artwork** button and select Upload 

to import the "SolarSystemBase.svg" file. The red circles in the file should be set to **Score**, and black lines set to **Cut.** Print the wooden parts for the base, remove them from the Glowforge and peel any protective paper from all wood pieces.



The base consists of three layers, shown above, which are held together by the four wooden, U-shaped clips.

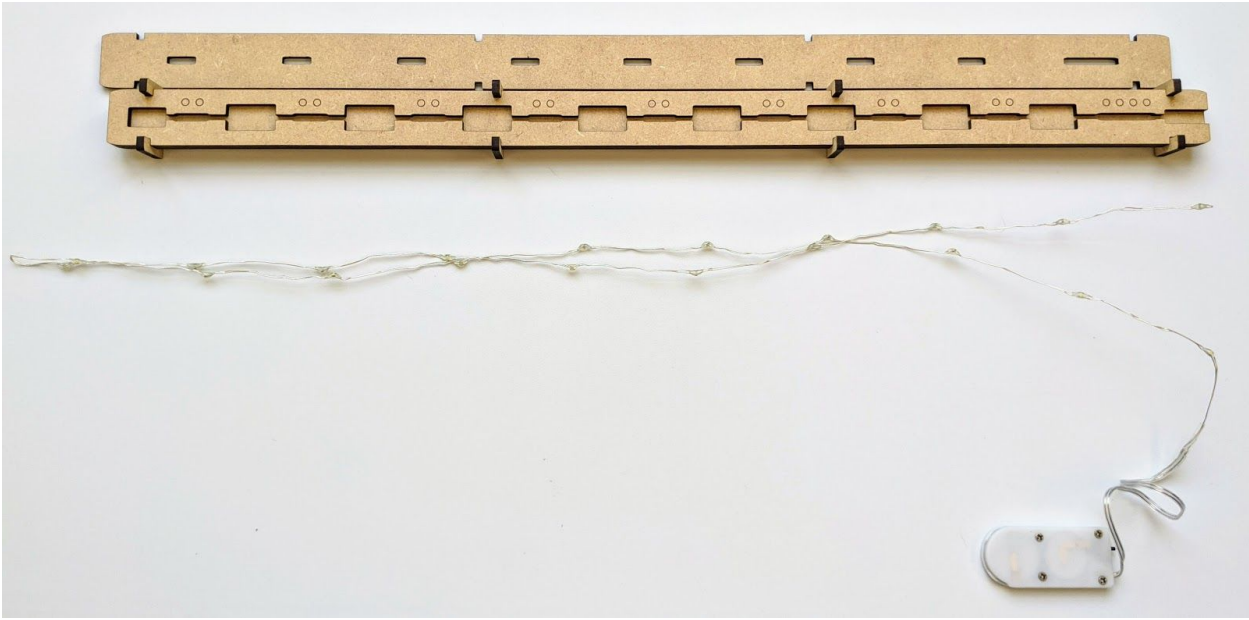
The bottom base layer has no holes in it. Pick up the bottom layer, and slot one of the U-shaped clips into each of the four parallel sets of notches. It will be a snug fit, but you should be able to gently wiggle the base layer down into each clip until it settles into the very bottom of the "U" as shown above.

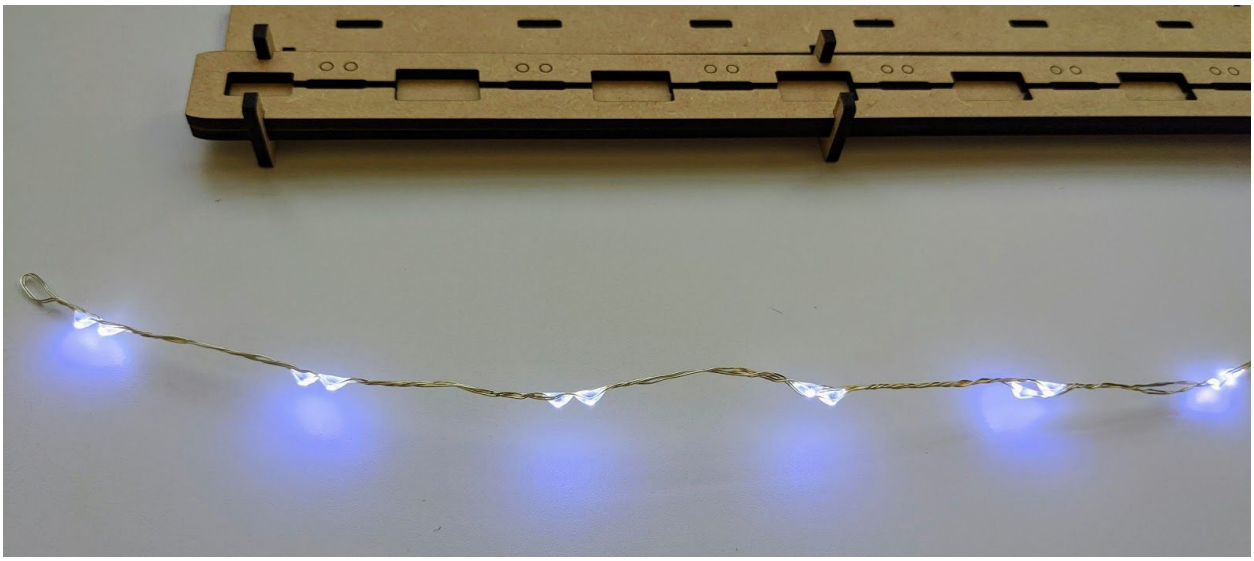


The middle layer contains the printed circles. Slide the middle layer, with the circles facing upwards, between the clips until it sits directly on top of the bottom layer. Since there is a channel running along the length of the middle layer, its outer edges may end up sliding towards the center. If this happens, put your fingertips inside the channel and push the sides of the middle layer gently outwards until its outer edges align perfectly with the bottom layer beneath it.

STEP 4: ADD FAIRY LIGHTS TO THE BASE

Put the pieces of the base down and pick up the fairy light strand. If it is coiled into a circle, gently unwind and straighten the wire, and lay it out in a straight line.

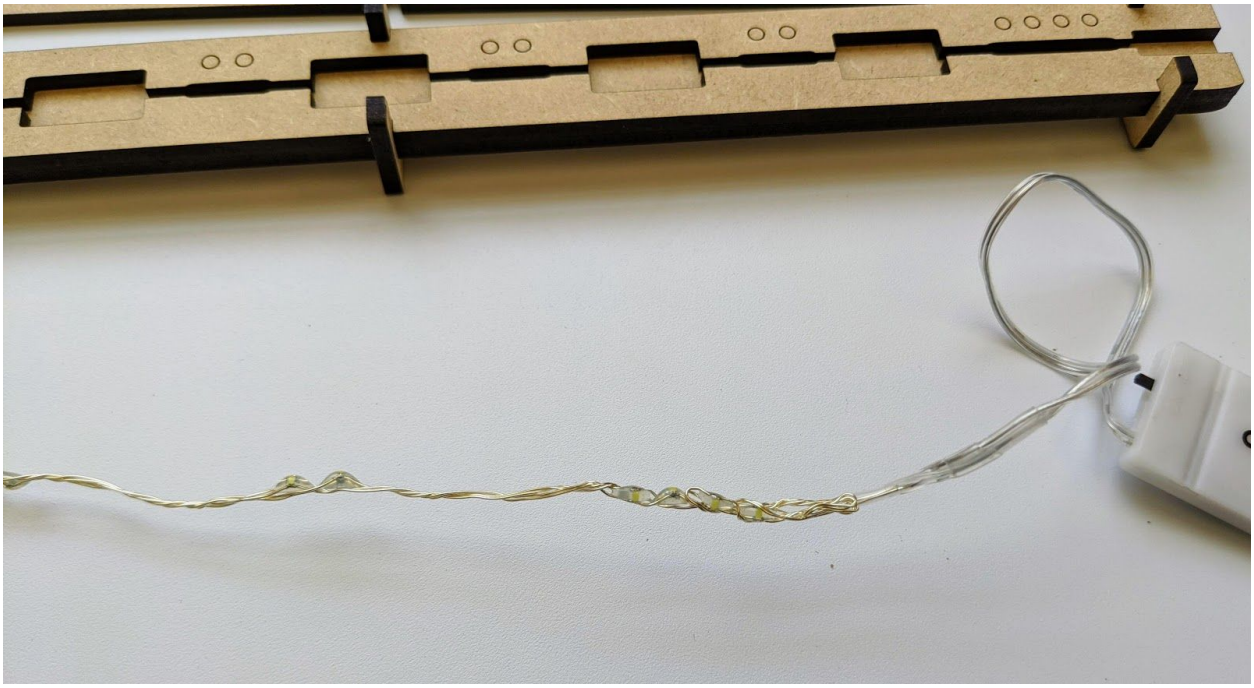


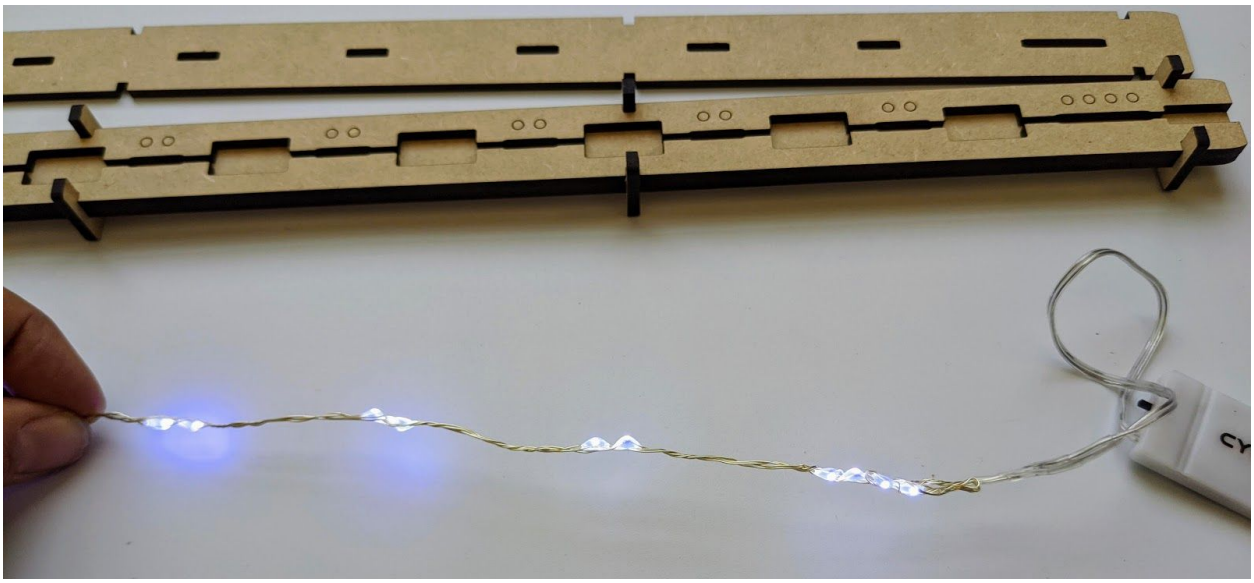


Next, we will bend the fairy light strand to group the LEDs into pairs. Each LED pair will illuminate a planet. Divide the LED strand into two sections of ten LEDs, and fold it over at the middle so that the LEDs in the two sections lie one after the other along the length of the strand, as shown in the pictures above. It's important that the LEDs not sit at the exact same position on the strand or they won't fit into the base. They should sit just next to each other along the strand. If possible, try to orient the LEDs so that they are pointing in the same direction.

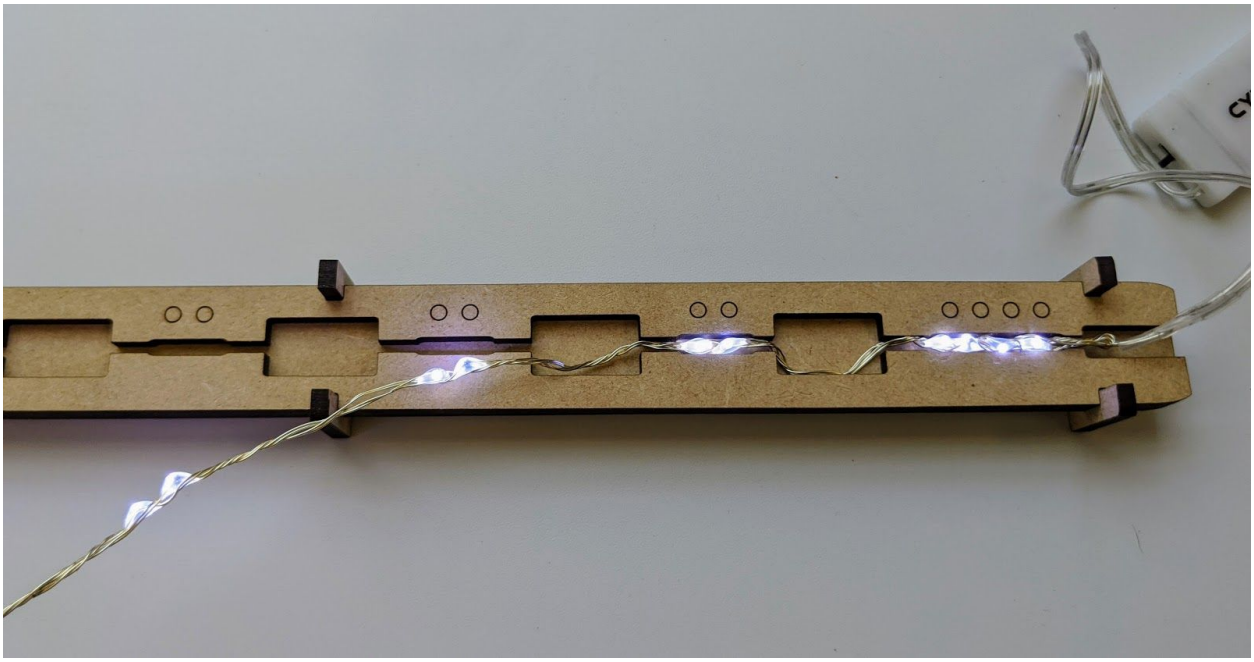
To keep the LEDs in place next to each other, gently start to twist the two parts of the strand together, starting with the end furthest from the battery pack. It doesn't need to be twisted tightly, just firmly enough to hold the LEDs in place next to each other.

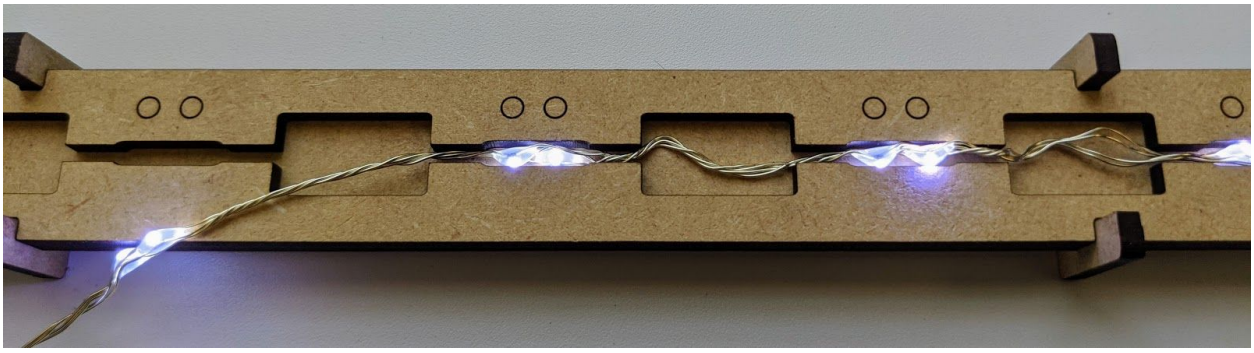
Once the fairy light strand is twisted, with the LEDs held together in pairs, we are going to group the two LED pairs closest to the battery into a single group of four LEDs which will illuminate the sun. Place the fairy lights down, as shown above, and bend the twisted wire back on itself, so that the last four LEDs closest to the battery are positioned next to each other. The pair of LEDs closest to the battery pack should still remain closest to the battery pack once positioned next to the neighboring pair.



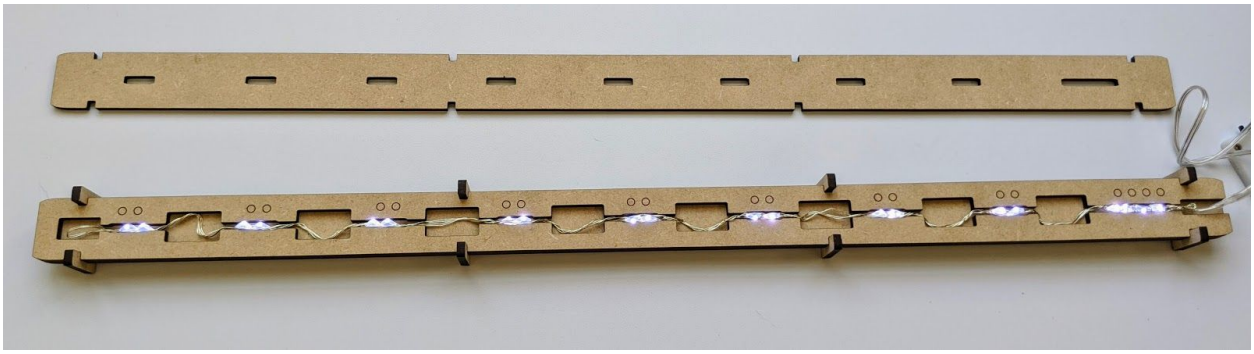


Now, very gently, take just the section of lights that has been doubled over again, and twist it until the four lights closest to the battery pack are twisted together, as seen in the pictures above.

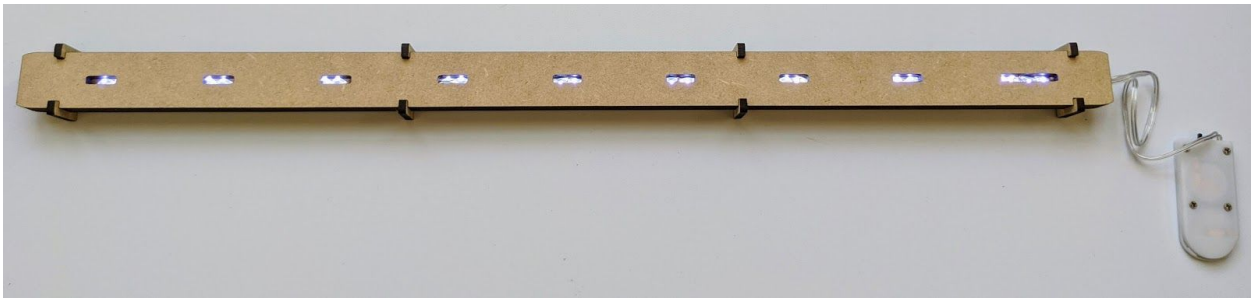




Once the wire is twisted so that the LEDs are grouped into eight pairs and one set of four LEDs, the strand is placed in the channel in the middle base layer. Starting from the end closest to the battery pack, gently push the twisted strand down into the channel so that each LED lines up near a circle, as shown. The fit will be snug, but press down with your fingers until the LEDs sit firmly within the channel. There will be a little bit of slack in the fairy light wire between the LEDs. This extra wire can be bent and pushed into the square boxes between the LEDs so that it fits completely within the middle base layer. It is important that the fairy light strand not extend upward above the middle base layer. Try to orient the fairy lights so that the brightest side of the LEDs is pointing upwards when they are seated inside their channels.



Repeat this process along the length of the wire, pushing each pair of lights into the channel near the etched circles. Continue arranging any slack wire between the LEDs so that it fits within one of the rectangular gaps. When finished, it should look like the picture above.



Place the top layer over the rest of the base so that its longest slot sits over the group containing four LEDs. If the fairy light strand has been securely pushed into the channel, the top layer will fit directly against the layer beneath it. Once the base is assembled, all LEDs will be visible through the slots in the top layer.

Step 5: ASSEMBLE THE SOLAR SYSTEM MODEL

The acrylic planets have stubs which fit snugly into the slots in the base. The larger model of the sun slides into the longest slot. Students should place their planets in order, and align them with etched sides all facing the same direction. Once inserted into the slots, they will see their planets glow where their drawings were traced onto the acrylic. The edge lighting will show to best effect when the etched side faces away from the viewer.

Step 6: EVALUATE

How did your testing go?

Have the students examine their creations. Did their projects turn out the way they expected? If they saw a picture of each planet on its own, would they recognize it, or do they need to be presented in order to identify the different planets? What did they learn about our solar system by creating their own?

Step 7: KEEP GOING

If students would like to make their display permanent, the planets can be glued into the slots. However, the base can also be re-used for other kinds of illuminated displays. Additional images can be printed onto the acrylic shapes.

One possible project is to have students design and draw their own, imaginary solar system that rotates around a faraway star. Their star can be like ours, or completely different. It could be a white dwarf, or a neutron star. In their imaginary solar system, students can create their own planets, orbiting their star at whatever distance they'd like. They can determine the characteristics of the planets based on size and distance from the star. They can explore whether smaller or larger planets are more likely to have an atmosphere with clouds, and whether some of their planets might have rings or moons.

They can also take the model they build of our solar system, rearrange the planets, and speculate how the properties of each planet might change as a result. For example, how would Mercury be different if it swapped positions with Neptune? What would life on Earth be like if it were much closer to the sun? Much further away?

Ask the students if they can think of any other kinds of pictures they'd like to print on acrylic shapes and display in the base they just built. The illuminated display can be re-used for a variety of projects. The only limit is their imagination!