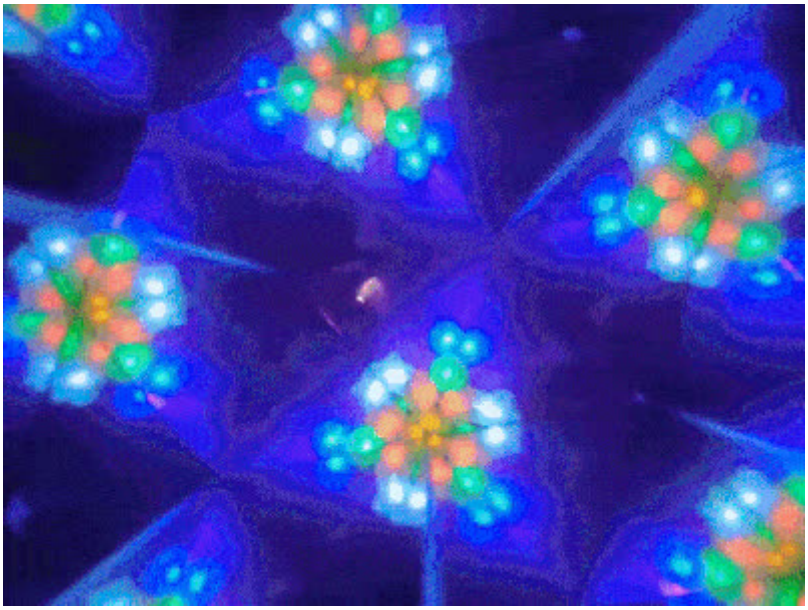
3D Printed Light-Up Kaleidoscope

Created by Debra Ansell



https://learn.adafruit.com/3d-printed-light-up-kaleidoscope

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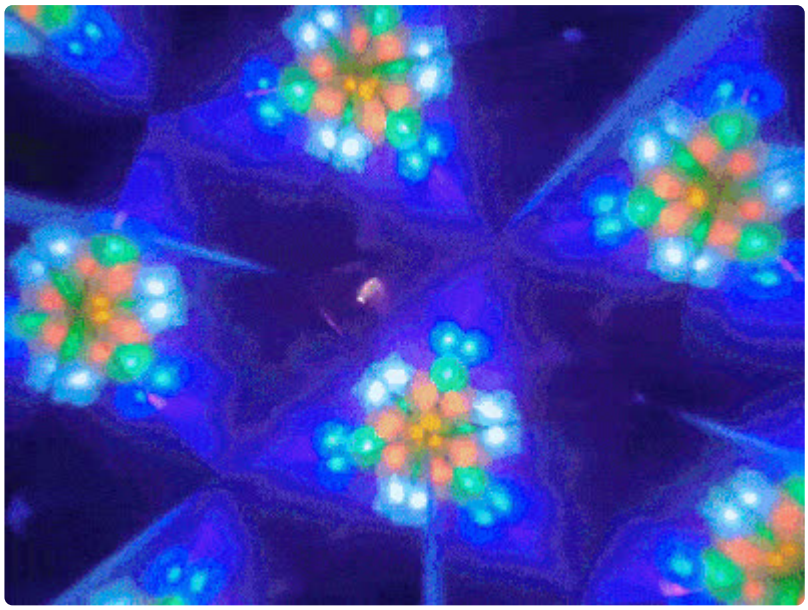


Krafty Kaleidoscopes, Pretty Patterns

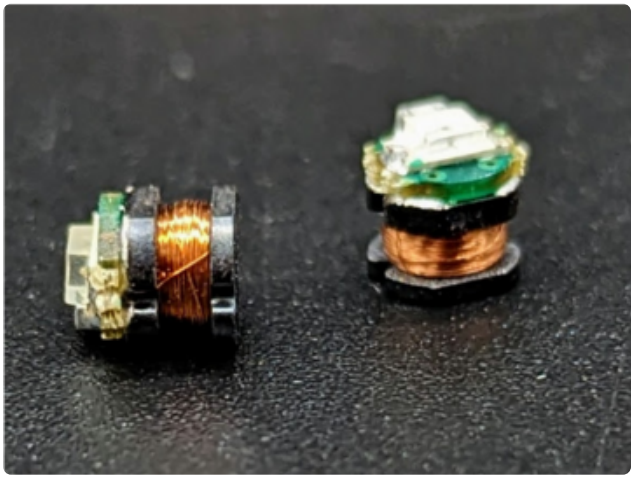
A kaleidoscope uses three mirrors in a triangular arrangement to form repeated reflections of small objects placed inside. These symmetric reflections produce lovely patterns that change with the movement of the objects being viewed.

This 3D printed kaleidoscope project generates patterns that glow with wireless LEDs embedded inside translucent 3D printed shapes. The luminous forms are free to slide around the rotating base to produce colorful changeable configurations that extend as far as you can see.

The illuminated images inside the kaleidoscope are lovely, and the kaleidoscope itself makes an appealing item to display. You can select your favorite filament color for the 3D printed parts, and choose from three different embossed patterns that decorate the exterior.

Wireless Workings

Wireless LEDs glow without connected power, making them ideal elements to slide around freely while still showing a glowing colors inside the kaleidoscope.



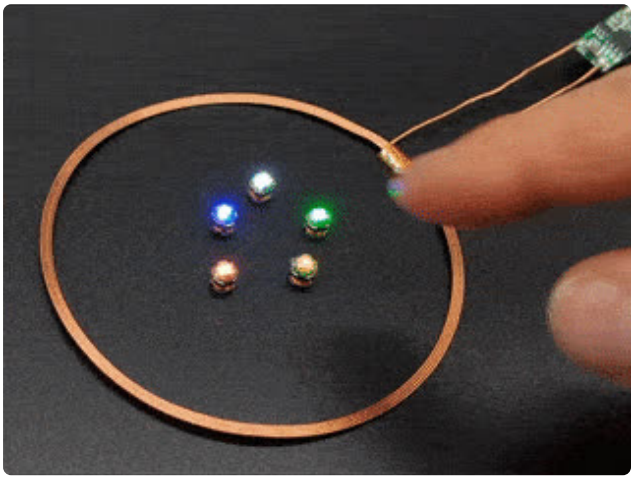
Looking closely at the tiny lights reveals that each is attached to a small assembly of tightly coiled magnet wire. Power is transmitted to these coils using principle known as **Faraday's Law of Induction,** which states that changing magnetic fields generate electric current, and also the converse, that electric current generates a magnetic field.

The energy for our LEDs comes from a larger assembly of coiled wire with circuitry that runs a fluctuating current through its loops. This current generates a changing magnetic field which can induce a small (about 2 mA) electric current in the tiny loops, enough to power the LEDs.

Induction Limitations

There are some constraints on transmitting power via induction. Since electric and magnetic field strength drops off sharply with distance, the power transmitter and

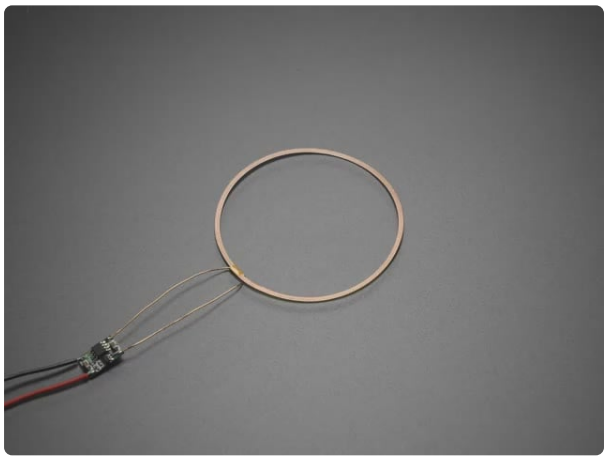
receivers must be close to each other. The greater the distance, the less power that is received.



Additionally the orientation of the receiving coils and transmitting coils must be parallel. You can experiment with your wireless LEDs by placing the LEDs and transmitting coil on a flat surface, and providing 5V power to the induction coil. Notice that turning the LEDs on their side stops them from lighting up.

Parts

Wireless LEDs and Transmitting Coil



Small Inductive Coil and 10 Wireless LED Kit - 5V
Adding LEDs to anything makes it 5x better -- it's a scientific fact! But when you have LEDs, you've got wires and power supplies and all that stuff is kinda annoying. What if...
https://www.adafruit.com/product/5140

Power Connectors

The wireless LED transmitting coil requires 5V power input directly into its red and black wires. There are a number of possible ways to connect it to power, but the easiest (no-solder) method is to use the power adapter and cable below to attach the wires to a 5V USB power source of your choosing.

Female DC Power adapter - 2.1mm jack to screw terminal block
If you need to connect a DC power wall wart to a board that doesn't have a DC jack - this adapter will come in very handy! There is a 2.1mm DC jack on one end, and a screw terminal...
https://www.adafruit.com/product/368

USB to 2.1mm Male Barrel Jack Cable
There's two standard ways to power electronics - USB or 5.5mm/2.1mm DC barrel jack. This or that! With this USB to 2.1mm Male Barrel Jack Cable, you can now power...
https://www.adafruit.com/product/2697

3D Printer Filament

You will need two different colors of PLA filament for the 3D printed parts.

- Opaque PLA for the body of the kaleidoscope
- Transparent (clear) PLA for the LED covers

Acrylic Circles

To cover the eyepiece, you will need **(2) 3-inch diameter circles of clear acrylic** with a thickness of any value from 1mm to 3.2mm (1/8"). You may laser-cut these circles yourself from clear acrylic sheet **or** purchase them pre-cut in a multi-pack, like the one below.

2 x 3" Diameter Clear Acrylic Circles
Pre-cut acrylic circles

https://www.amazon.com/SAVITA-Ornament-Decorating-Milestone-Christmas/dp/B0BG1D459W/ref=sr_1_11

Mirrors

The kaleidoscope requires **three rectangular mirrors, each 160mm x 55mm in size (but no larger), and not more than 1.6mm thick**.

If you have access to a laser or CNC cutter, you will get the sharpest reflections **from 1.6 mm (1/16") mirrored acrylic sheet**, cut to exactly 160mm x 55mm. You can also score this thin mirrored sheet with a craft knife and break it along straight lines, though it is harder to make exact cuts this way.

If you don't have a cutting machine, a simpler alternative is to use **flexible mirrored sheet** that can be cut with scissors. The reflections are not quite as crisp, but they are still quite good, and it is a much easier and safer material to shape by hand.

Obtain **ONE** of the two mirror material options listed below:

1 x 1-1.6mm (1/16") Thick Mirror Acrylic Sheet, cut into three 160mm x 55mm rectangles
Cut this mirror acrylic with a laser cutter or CNC
https://www.amazon.com/dp/B01BU99K6E

-OR-

1 x Flexible Adhesive Mirror Sheet, cut with scissors into three 155mm x 60mm rectangles
This adhesive mirror sheet is cuttable with scissors
https://www.amazon.com/Spectra-Mirror-Thicknesses-Much-Mirrors-Smooth-Surface-Shatter/dp/B097RVGQWJ/ref=sr_1_2

3D Printing

Download the Print Files

Download the compressed file containing the 3D printing design (STL) files from the button below, then expand it and save the folder to your computer. The files inside contain designs for the Kaleidoscope's 3D printed parts, as well as the translucent LED covers.

Two versions of the files are available. The first has small tolerances that work well for very precise 3D printers, like a Bambulab, but may result in difficulty assembling the kaleidoscope if your printer is less precise. The second set of files has looser tolerances which should work well for most printers, but may cause jiggly or loose connections for very precise 3D printers.

It's best to start by printing the "LED Container with Bezel.stl" file, which consists of two separate pieces printed together, and verify that the bezel swivels freely around the LED container body without sticking to it (see the **Print the Kaleidoscope Parts** section below). If this piece prints correctly, the rest of the pieces should do so as well.

Kaleidoscope Files

https://adafru.it/18vA

Kaleidoscope Files Looser Tolerances

https://adafru.it/18vB

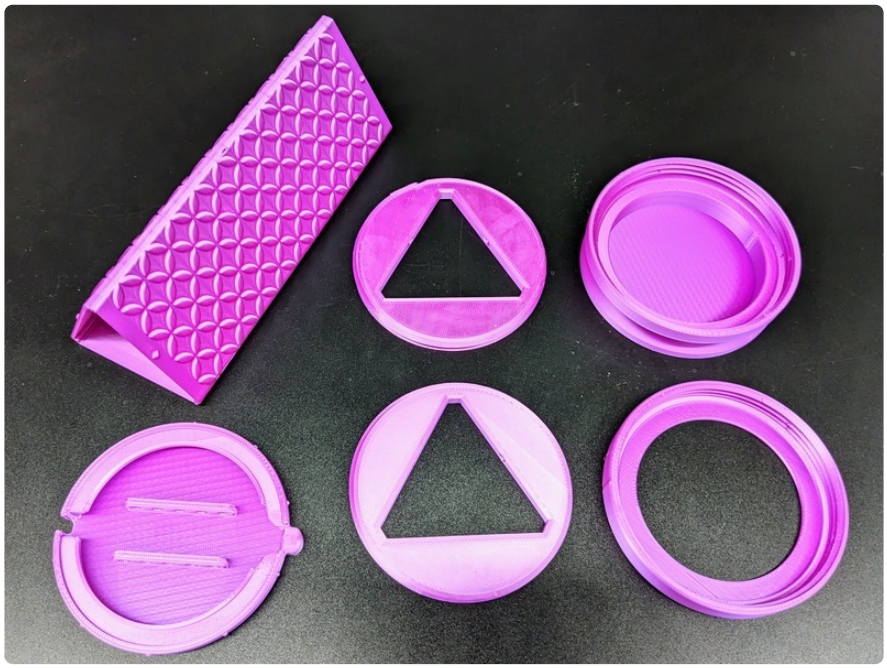
There are two sub-folders in the compressed file. One (Body Designs), contains 3 decorative options for the embossed pattern on the kaleidoscope body exterior. Select **ONE** of these to form the main kaleidoscope body.

The list below shows how many of each part to print.

- **Opaque PLA**
  - **(2)** Eyepiece.stl
  - **(1)** EyepieceCover.stl
  - **(1)** CoilHolder.stl
  - **(1)** LEDContainerWithBezel.stl

    - **(1)** triangular body from the folder Body Designs
- **Transparent PLA**
    - **(10)** items from the 5 shapes in the folder LED Covers

Print the Kaleidoscope Parts



Import the STL files into the slicer program for your 3D printer. The designs include fine detail like screw threads, and should be printed at fairly high resolution to function well. A **layer height of 0.2mm with 40% infill and no support** works well for all kaleidoscope body parts.

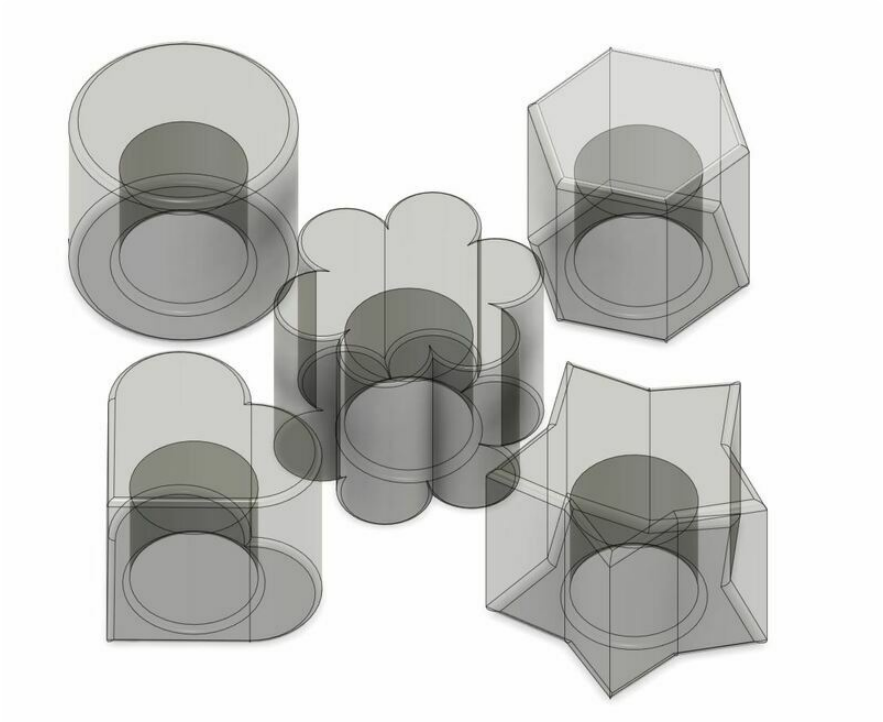
Depending on the size of your print bed, you may be able to print all of the parts in a single session, or you may need to break them up into multiple print runs. The kaleidoscope body is the biggest part and takes considerably longer than the other elements.

Note that the LED holder is technically two separate pieces that print together so that the bezel is free to rotate around the exterior of the LED compartment, but can't slide off the top or bottom. This MUST be printed as a single piece with the same positioning as in the LEDContainerWithBezel.stl file.

Print the LED Covers

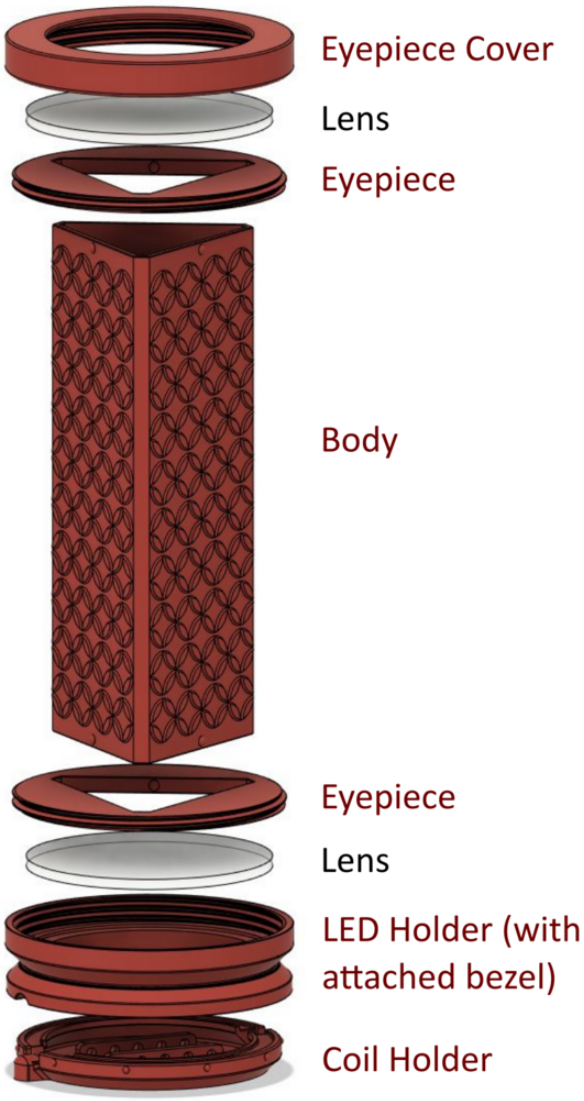
Download the design files for the LED covers. There are 5 shapes to choose from. Since the Wireless LED kit comes with 10 LEDs, you can print two covers of each shape, or vary them however you'd like.

Print the LED Covers from **translucent PLA at 0.2mm layer height and infill of 40% or higher** with the open end facing upwards.



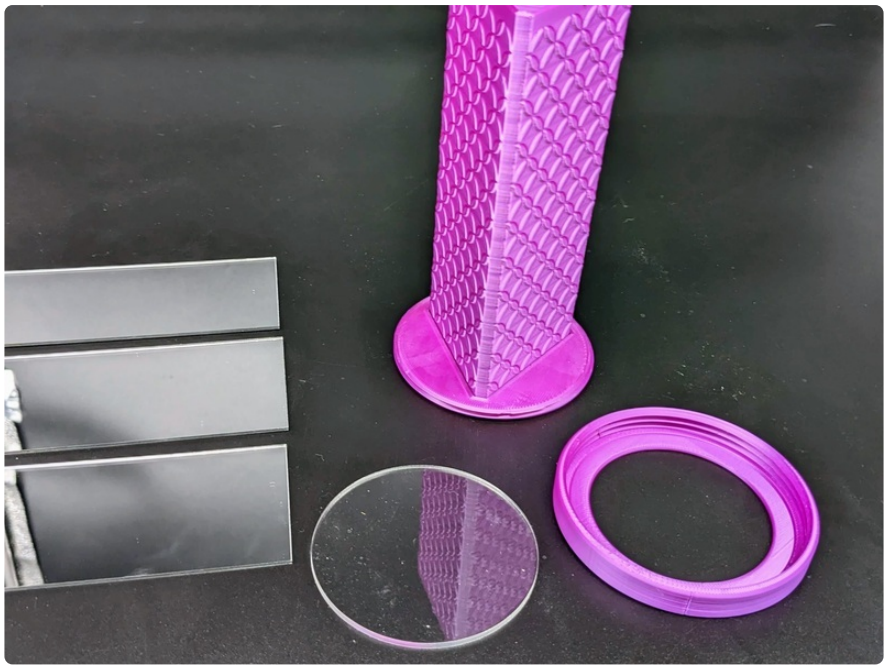
Assembly

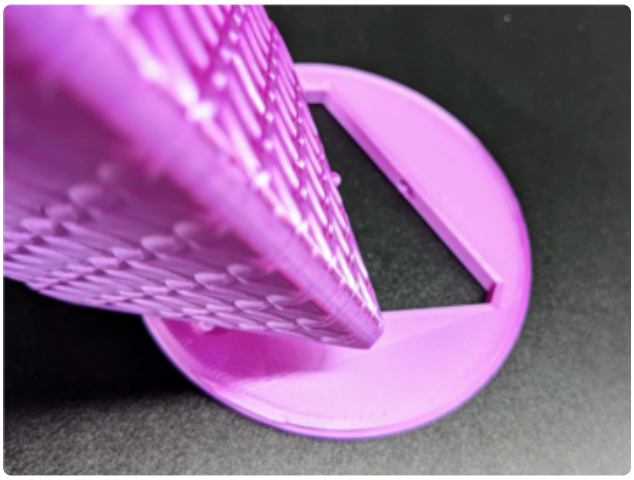
The next image shows the placement of the 3D printed kaleidoscope body parts and the clear acrylic lenses. Follow the steps outlined below the image to put them all together.



Attach Eyepiece and Eyepiece Cover

Gather the kaleidoscope body, one eyepiece, the eyepiece cover, and one 3" clear acrylic lens for this step.





Insert one end of the triangular body into the triangular hole in the eyepiece. The three small bumps on the end of the triangular body fit inside corresponding notches in the eyepiece, and a bit of gentle pressure will help slide it into place.

Once the body and eyepiece click together, set the eyepiece cover on a flat surface with its screw threads pointed upwards. Remove any protective paper from one of the 3" clear acrylic lenses, and place it inside the eyepiece cover.

Gently insert the eyepiece into the cover, and, using the kaleidoscope body for leverage, rotate the eyepiece until the threads mesh and the eyepiece slides downwards into the cover. Stop when the eyepiece just touches the lens. Do NOT overtighten the eyepiece.

Insert Mirrors into Body

The method you use to attach the mirrors will depend on whether you have the stiffer acrylic mirrors cut from 1/16" acrylic or the flexible mirror sheet with adhesive backing. Follow the steps below which correspond to your particular mirrored material.

Acrylic Mirrors

If you are using acrylic mirrors, remove any protective covering from the cut mirror pieces. One at a time, take each mirror slide it carefully down into the open side of the triangular kaleidoscope body until the mirror is fully inserted and comes to rest against the lens. Each mirror should fit snugly and rest flush against one of the triangular body's interior sides.

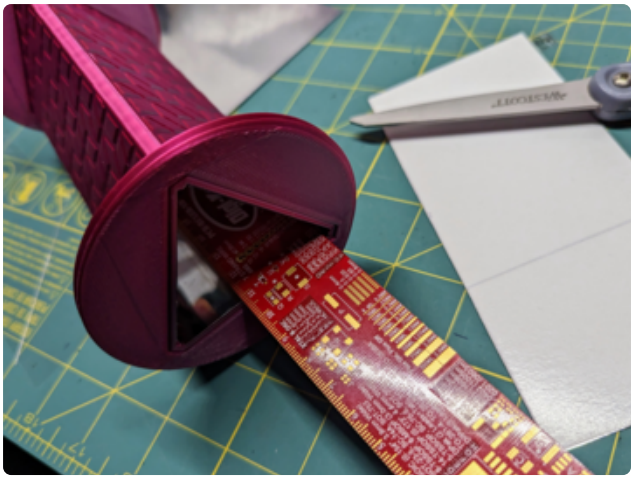
Once all three mirrors are in place, they should push against each other just enough to keep them in place. If the mirrors are too tight to slide in, you will have to trim them down until they fit. If they are slightly too small, and slide around, you can place a drop or two of glue between the back of the mirrors and the 3D printed interior to keep them in place.

Flexible Adhesive Mirrors

If you are cutting your mirrors from flexible mirrored sheet, follow the steps below.

Leave the protective cover on the mirror material until just before you insert the mirrors into the kaleidoscope body. With a ruler, mark the 160mm x 55mm rectangles to be cut on the matte adhesive size, and cut them out using scissors.

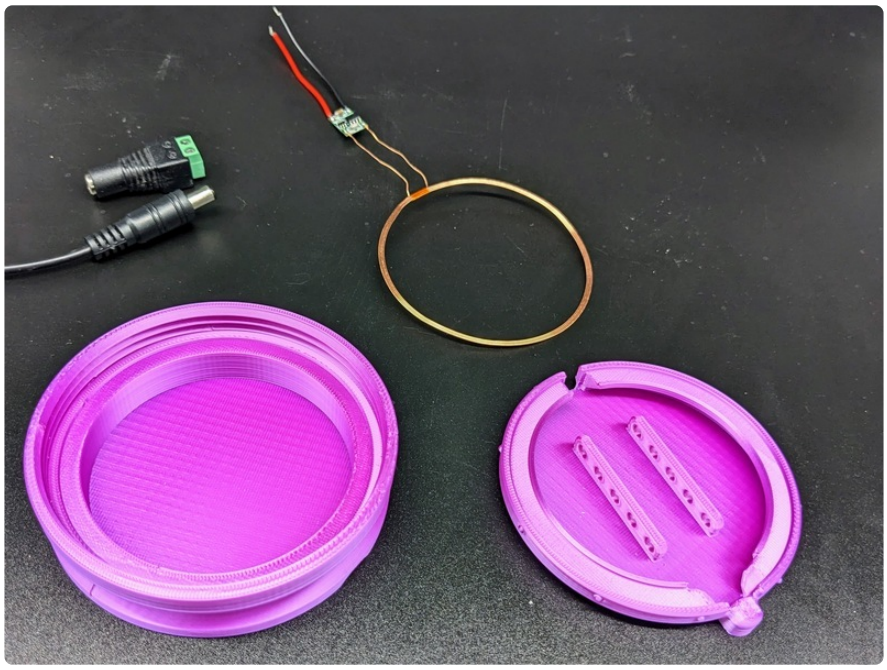
Peel the protective covering from the shiny side of the mirror. After this point, try avoid touching the mirror surface, instead, hold the mirror pieces by their edges. Next, peel the paper covering the adhesive back surface of the mirror, and gently slide it inside the kaleidoscope body until it fits fully inside.

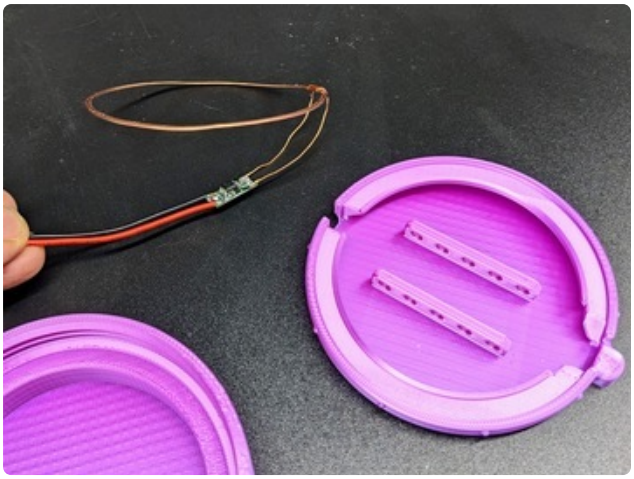


Using a spatula or ruler, press gently down on the surface of the mirror to help it lie flat against the inner surface of the kaleidoscope. Repeat the previous steps until all three mirrors are in place.

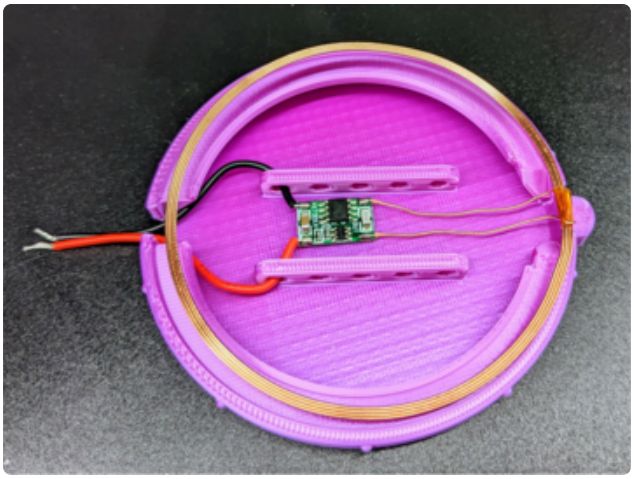
Install Electronics in Coil Holder

Gather the 3D printed LED Compartment and Coil Holder, along with the wireless transmitter coil and power connectors and cables.



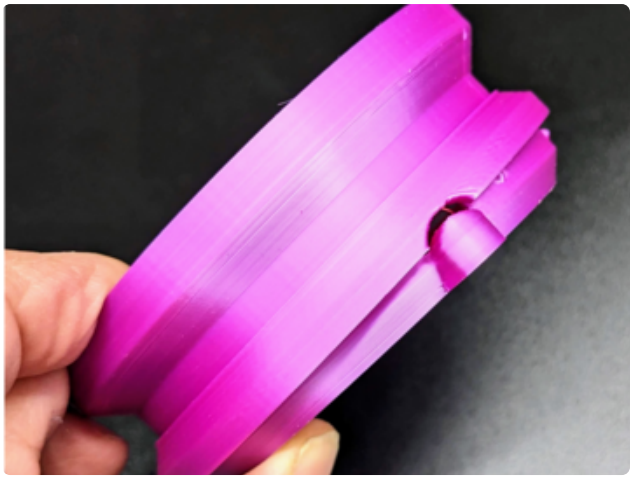


To make the power transmitter fit inside the holder, you must gently bend the power wires back underneath the coil as shown. Don't crease the wires sharply and keep about 1 cm separation between the two wires leading from the coil.

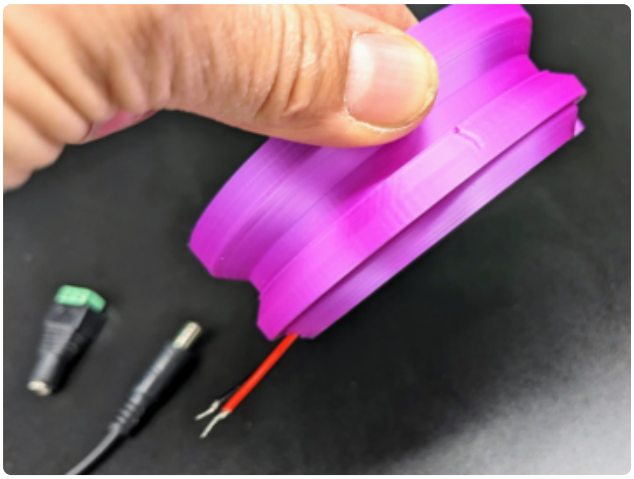


Place the coil inside the coil holder compartment as shown as left. The coil should rest inside the elevated ring, and both the black and red power wires should run through a hole in one of the interior rails to protect the electronics from strain on the wires. The ends of the wires should extend outside the compartment through the hole in the side opposite to the small exterior knob.

Place the LED compartment over the coil holder. Push down the bezel so that it extends past the bottom of the LED compartment, and orient the bezel so that the notch aligns with the knob on the coil holder. Be sure the power wires extend out of the hole in the side of the coil holder.



Press the bezel down over the coil holder so that the bumps in the holder slip into the small notches on the bezel interior. The knob in the coil holder will fit into the large notch in the bottom of the bezel. You may need to push the two pieces together incrementally, working your way around the circle as you go.



Once they have fully snapped together, you should be able to slide the bezel and coil holder together so that they rotate around the LED compartment freely.

Power It Up

Insert the red and black power wires into the + and - terminals of the screw terminal connector respectively, and tighten the screws with a small Phillips-head screwdriver until they are firmly secured.

Insert the barrel jack end of the DC jack to USB cable into the screw terminal connector. Finally connect the USB end of the cable to a 5V power source, such as a wall adapter or portable phone charger.

After connecting the electronics to power, place the wireless LEDs inside the LED compartment, with LEDs oriented upwards and watch them glow!

Seek Cover

Place a 3D printed cover over each of the wireless LEDs, making sure that the LED itself remains pointing upwards.

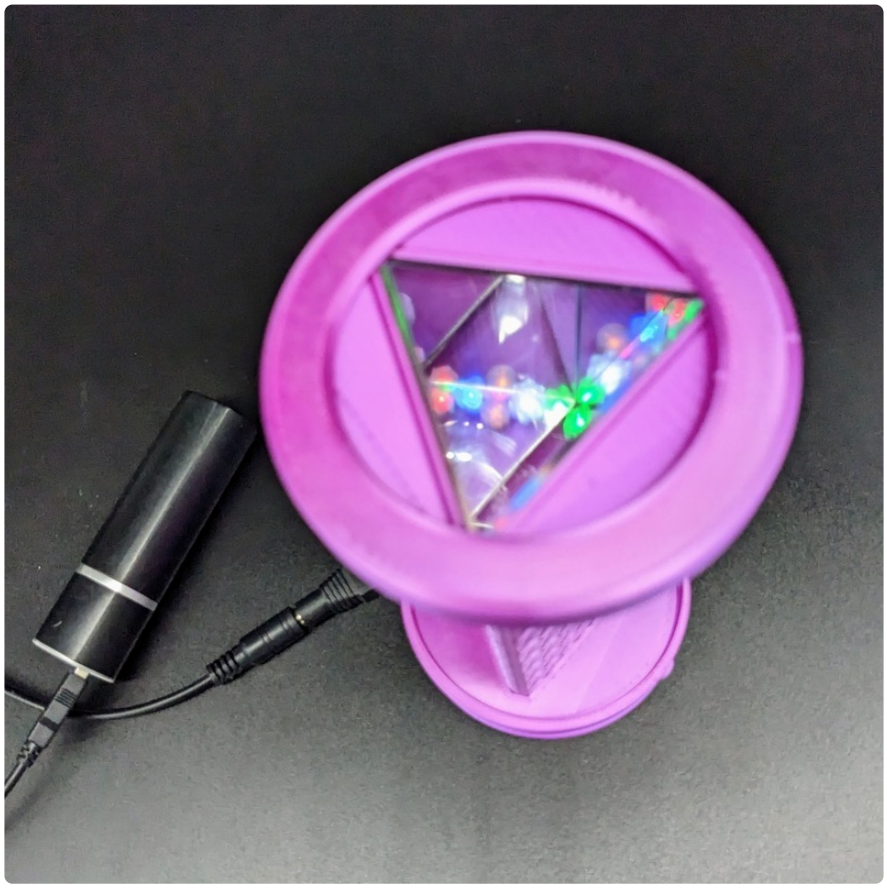
Once you've covered all of the LEDs, place the second acrylic lens over the top of the LED compartment. The small clearance between the lens and the LED covers will let them slide around while still maintaining the orientation of the LED coils parallel to the transmitting coil.

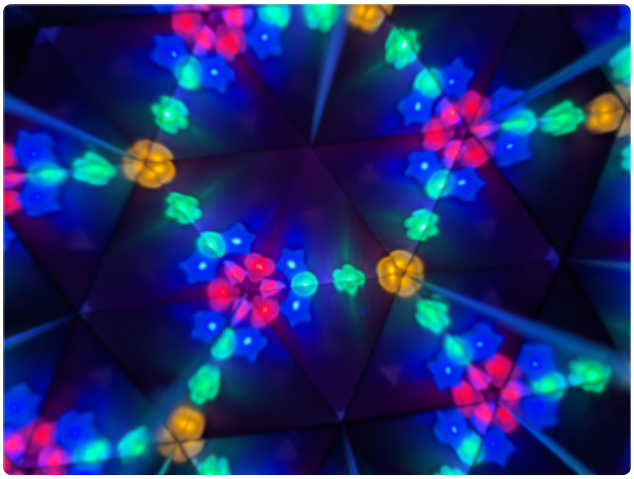
All Together Now

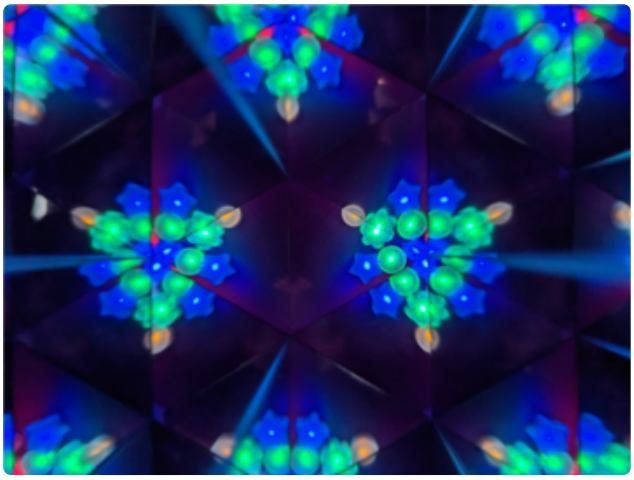
Carefully place the kaleidoscope body next to the covered LED compartment and slowly tilt it over the lens until the kaleidoscope body is vertical and the eyepiece rests on top of the acrylic lens. The mirrors may slide out a bit, but will be pushed back into place by the lens.

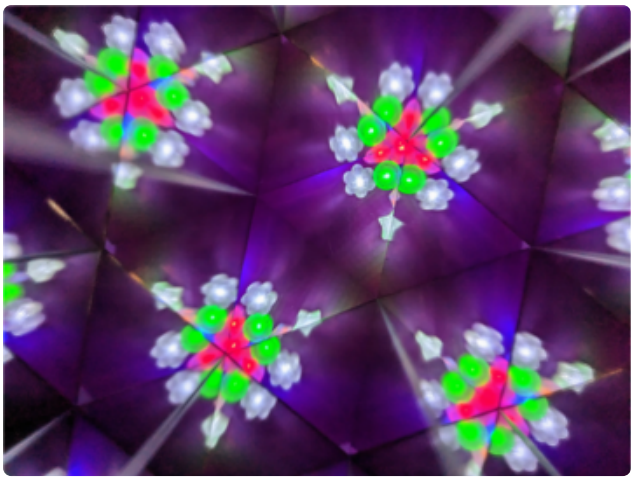
Gently rotate the body of the kaleidoscope until the eyepiece and LED container threads mesh, and the eyepiece moves down into the container. Stop turning just when the eyepiece touches the lens. Do not overtighten.

Once you screw the second eyepiece in place, you be able to look through the top of the kaleidoscope and see the illuminated shapes along with their reflections. Tilt the kaleidoscope a bit away from vertical, then, holding it by the coil compartment so the power wires remain stationary, rotate the body of the kaleidoscope so the shapes slide around inside. You will see the shapes regroup to form dynamic colorful arrangements as they move around.









Small changes in the LED positions will produce dramatically different patterns that are as unique as snowflakes. Now that you've finished your kaleidoscope, you won't have to look far to find a pretty view!