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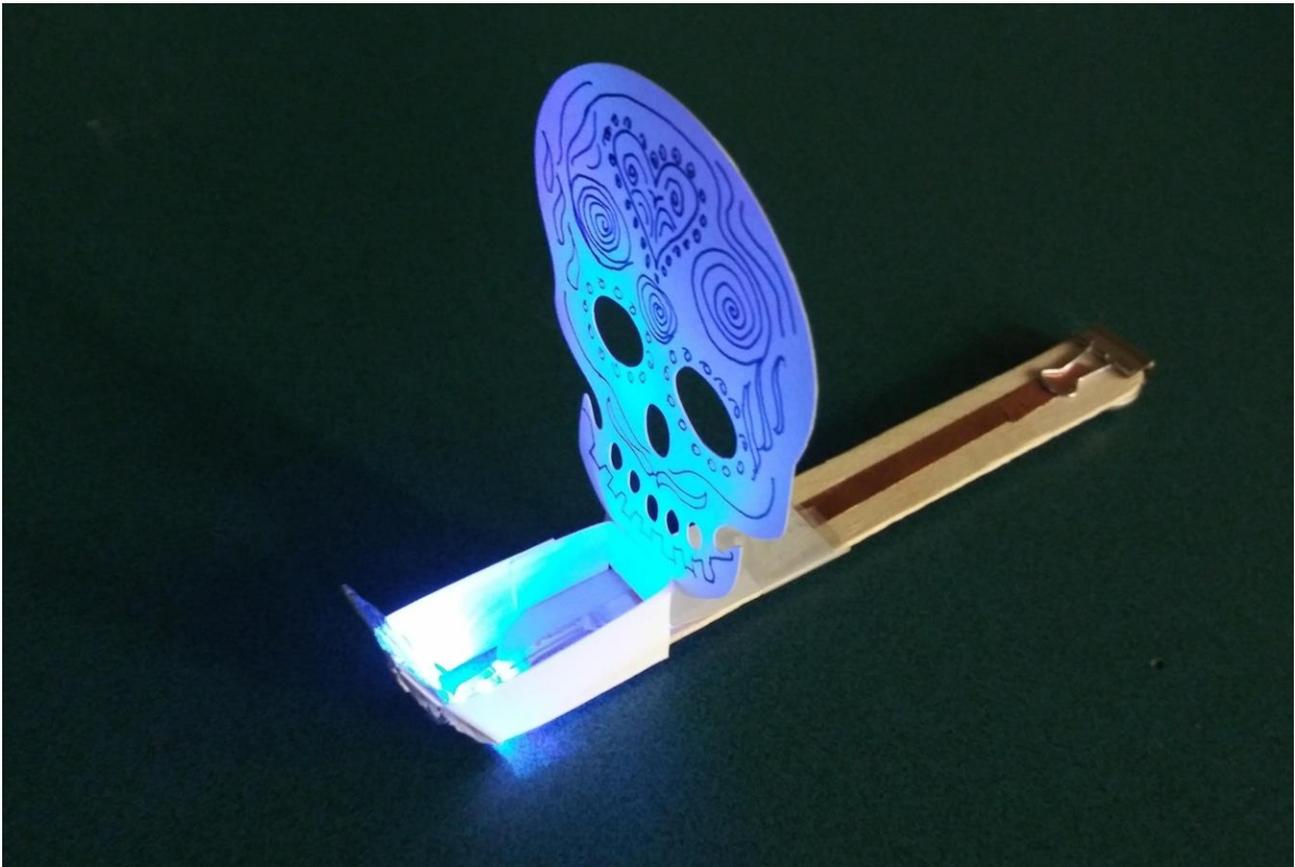**Massachusetts Institute of Technology**

Festive Flashlights

A Do-It-Yourself Guide to Promote STEM Skills and Awareness

Summary
Shine some light on a customizable cut-out figure with this festive electronics project.

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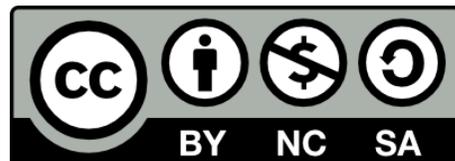
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Festive Flashlights

Shine some light on a customizable cut-out figure with this festive electronics project. In our example, we are using a skull to celebrate *Día de Muertos* or *Day of the Dead*; a Mexican holiday observed at the end of October to remember family and friends who have died. The shape of your Festive Flashlight is up to you – celebrate whatever, however you choose!
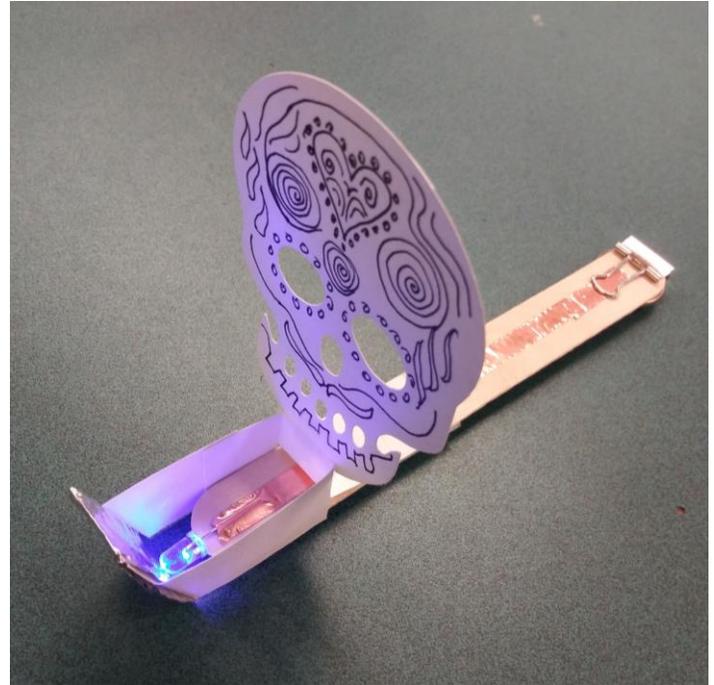
Skills and Concepts:
- Circuit principles - insulators and conductors, series circuits, component functions
- Hand fabrication
- Graphic design
- Troubleshooting

Material and Specifications:
- Jumbo popsicle/craft sticks (6-inch long variety, 18mm x 150mm)
- Aluminum foil
- Clear tape or glue
- Cardstock (white or light-colored for the figure)
- Copper tape with conductive adhesive amazon.com/dp/B01CH4LYZ6/ (¼ inch/6.35mm width tape works well)
- Small binder clips amazon.com/gp/product/B074XTRX7G/
- Coin cell batteries (size 2032 works best) amazon.com/dp/B00VOFE51K/
- Color-changing LEDs amazon.com/dp/B007RO9X82/

Tools:
- Scissors
- Cricut, Silhouette, or equivalent computer-controlled cutter
  -   OR   -
- Xacto knife, cutting mat, straight edge
- Printer (optional, if cutting out by hand)

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Build the flashlight

1 - Apply Copper Tape
On one side of the popsicle stick, apply a strip of copper tape from end to end. This will be the POSITIVE (**+**) side of the circuit and will face down when the festive flashlight assembly is completed. Mark this side with a **+** on both ends.

On the other side, apply copper tape to the length of the popsicle stick, but leave about half an inch (or 12 mm) of space on one end with no copper tape. This is where the binder clip will be attached later. This will be the NEGATIVE (**–**) side of the circuit. Mark this side with a **–** on both ends.
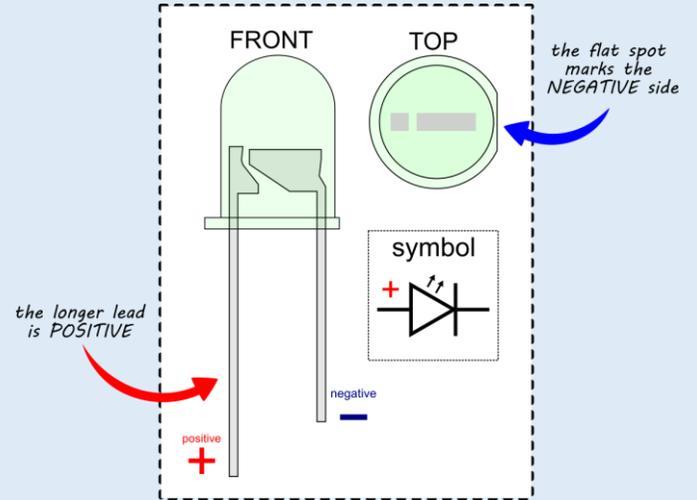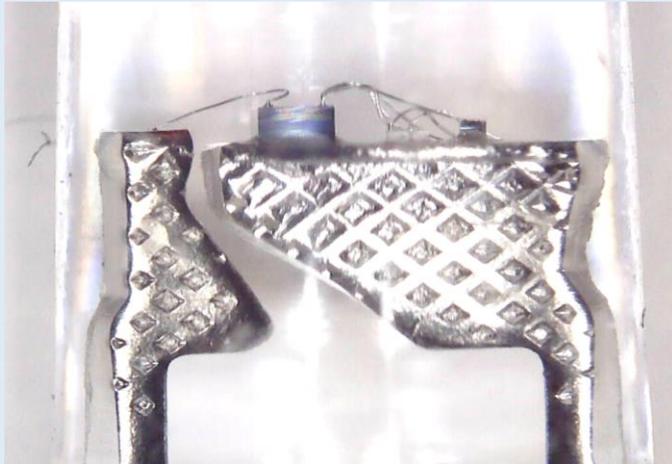
2 – Position the LED
Place the LED on the popsicle stick so that the leads of the LED are touching the copper tape on both sides. Make sure to attach the longer LED lead to the POSITIVE side of the popsicle stick – the side with the longer strip of copper tape. The battery will be attached to this side.

Cover the leads of the LED with copper tape. Rub or "burnish" the copper tape with the edge of your fingernail or the back of a pen/etc. to ensure a solid connection to the LED!
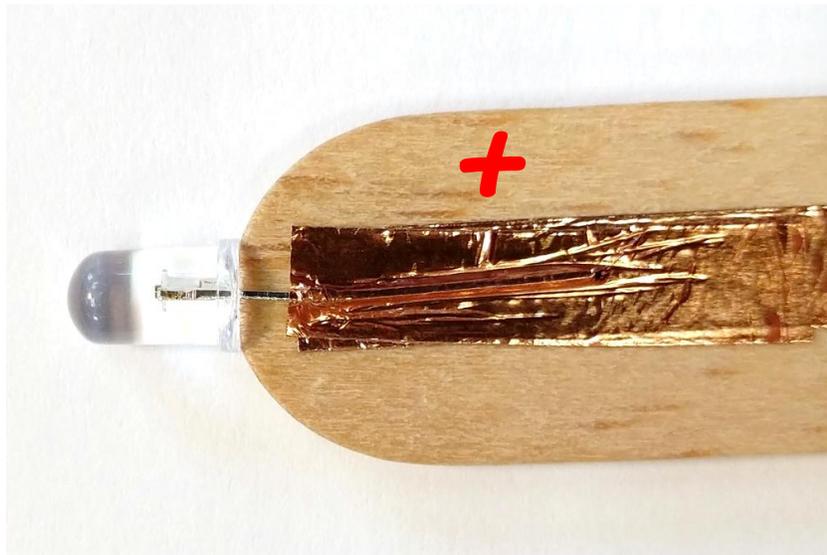
The color-changing LED used in this project is actually three separate LEDs – red, blue, and green – in one component, along with an integrated circuit that controls the cycling and timing of the color changes. All of this circuitry is crammed into a single 5mm LED package! If you look closely, you can see the block inside that contains the integrated circuit, and the tiny wires connecting to each LED.

FRONT   TOP   the flat spot marks the NEGATIVE side

symbol

the longer lead is POSITIVE

negative

positive

3 - Attach the Battery

On the other end of the popsicle stick, attach the battery with the binder clip. The POSITIVE side of the battery – marked with a + symbol – should be touching the copper tape that is attached to the long leg of the LED.

The NEGATIVE side of the battery is connected to the other side of the popsicle stick through the binder clip, which acts like a switch – flip the handle of the binder clip down and the circuit is completed, lighting the LED.

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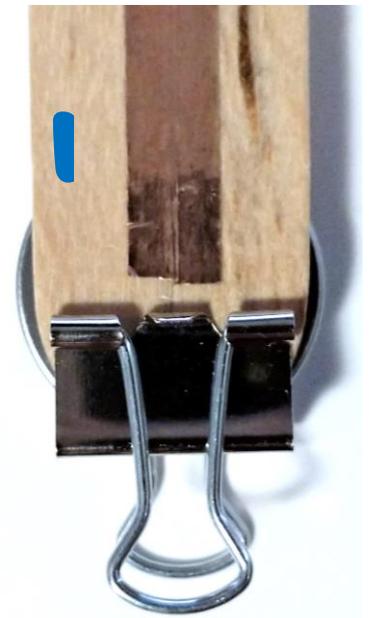
4 – Test the Circuit

You have just created an electronic circuit! Flip the binder clip handle to turn the LED on or off by closing and opening the circuit.

binder clip switch

coin cell

LED
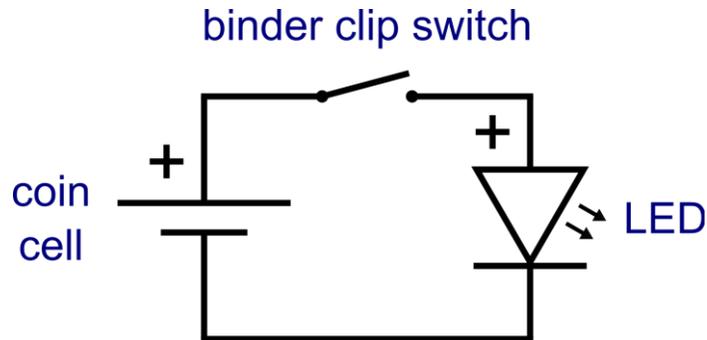
Troubleshooting tips:

A **short circuit** is when part or all of the circuit is bypassed by an incorrect connection – like a stray wire – sometimes leading to very high current flowing through the circuit, potentially generating enough heat to cause damage to components. Short circuits can also cause fires if the current is high enough.

If the LED does not light, check for a short circuit. Start with the binder clip – is it creating a direct connection between the POSITIVE and NEGATIVE sides of the battery?

An **open circuit** is when current cannot flow because there is not a complete path between the POSITIVE and NEGATIVE sides of the power source. We want there to be an open in this circuit when the binder clip handle on the negative side is flipped up – when the switch is in the OFF position.

If the LED does not light, and there is not a short circuit, look for an open. Make sure the battery is contacting the copper tape on the positive side and that the binder clip is positioned to contact the copper tape on the negative side. Check the connections between the copper tape and the leads of the LED – copper tape can be finicky and may require more pressure to ensure a good connection.


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Cut out and assemble the reflector base

1 – Cut Out a Reflector
To hand-cut a reflector, draw this shape onto a piece of cardstock. You can print the last page of this guide on cardstock and cut out the reflectors.

If you are using a Cricut, Silhouette, or another computer-controlled cutter to cut out the shape for the reflector base, import this .png image into your craft cutter – available for download at http://k12maker.mit.edu/electronics.html
Be sure to check your dimensions after importing – the overall dimensions of the .png should be 2.42in x 4.25in (61.47mm x 107.95mm).
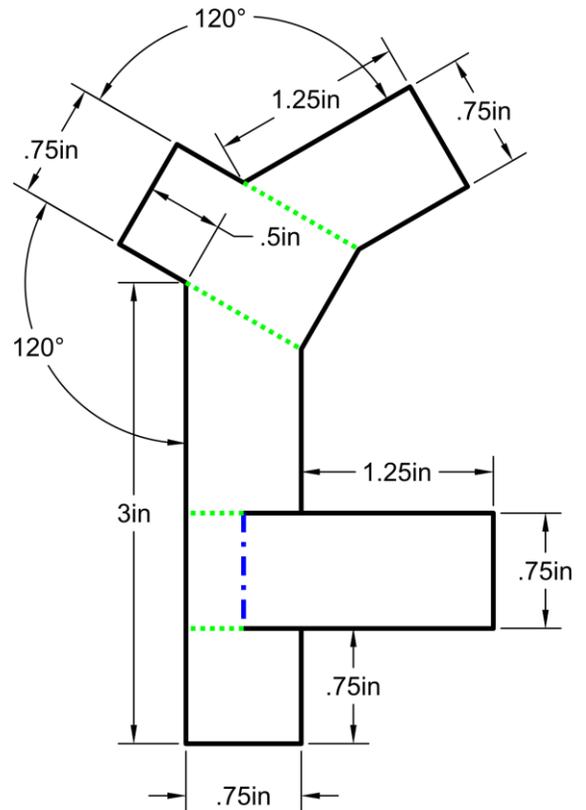
2 – Attach Foil
Use clear tape or glue to attach a piece of aluminum foil to the reflector. Be sure to put the shiny side out.

Tip: use the side of a pen or a marker to smooth out the foil before attaching it to the reflector. Or leave it crinkly – experiment to see how the texture of the foil changes the way the light from the LED is reflected.

3 – Fold
Fold the reflector as shown, and use tape or glue to complete the assembly.

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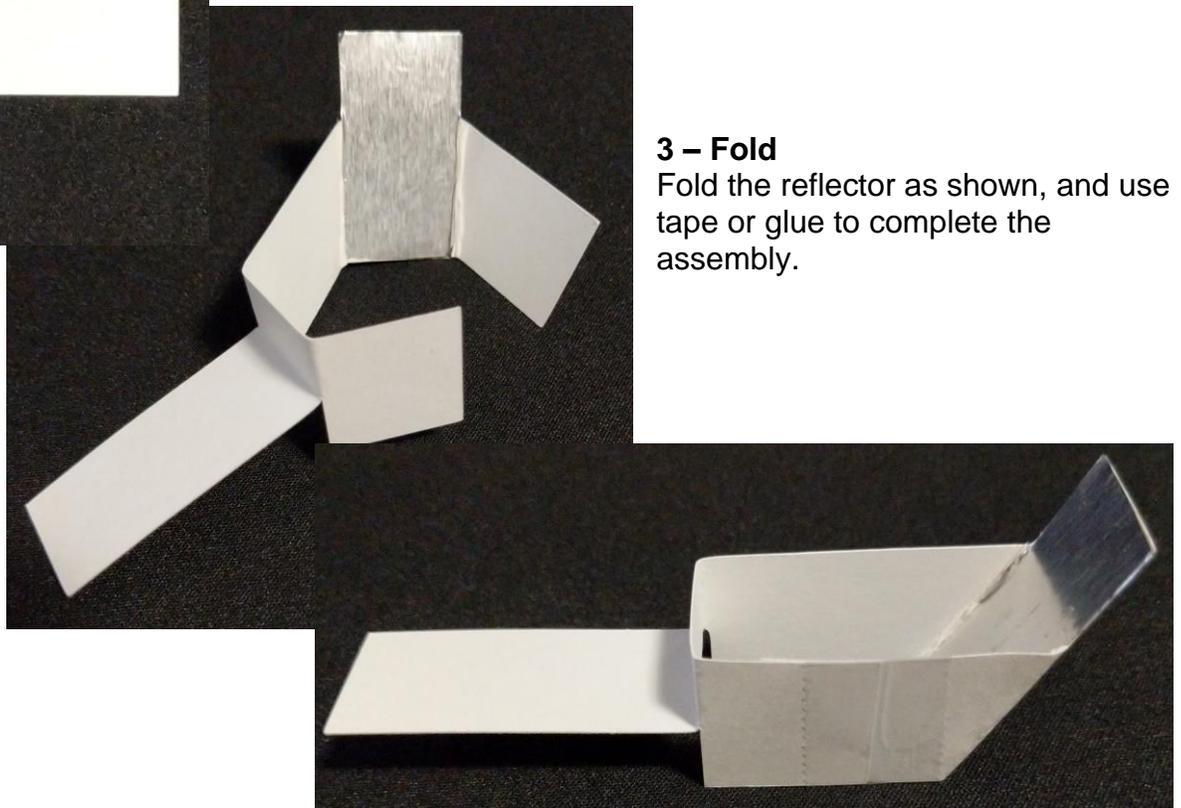
Cut out, decorate and attach the figure

Your figure should be roughly 3 ½ inches (89 mm) tall and 2 ½ inches (64 mm) wide. Add a tab to the bottom of your figure, about an inch wide (25 mm) and ½ inch (13 mm) tall, to attach the shape to the reflector.

The skull used in this example, as well as others we have designed, are available to download at http://k12maker.mit.edu/electronics.html as .png images and .svg files which can be imported into a computer-controlled cutter program, or printed onto paper and cut out by hand.

The figure can be cut out of cardstock, but thinner material may be used for a backlit effect.
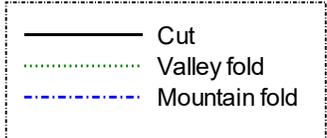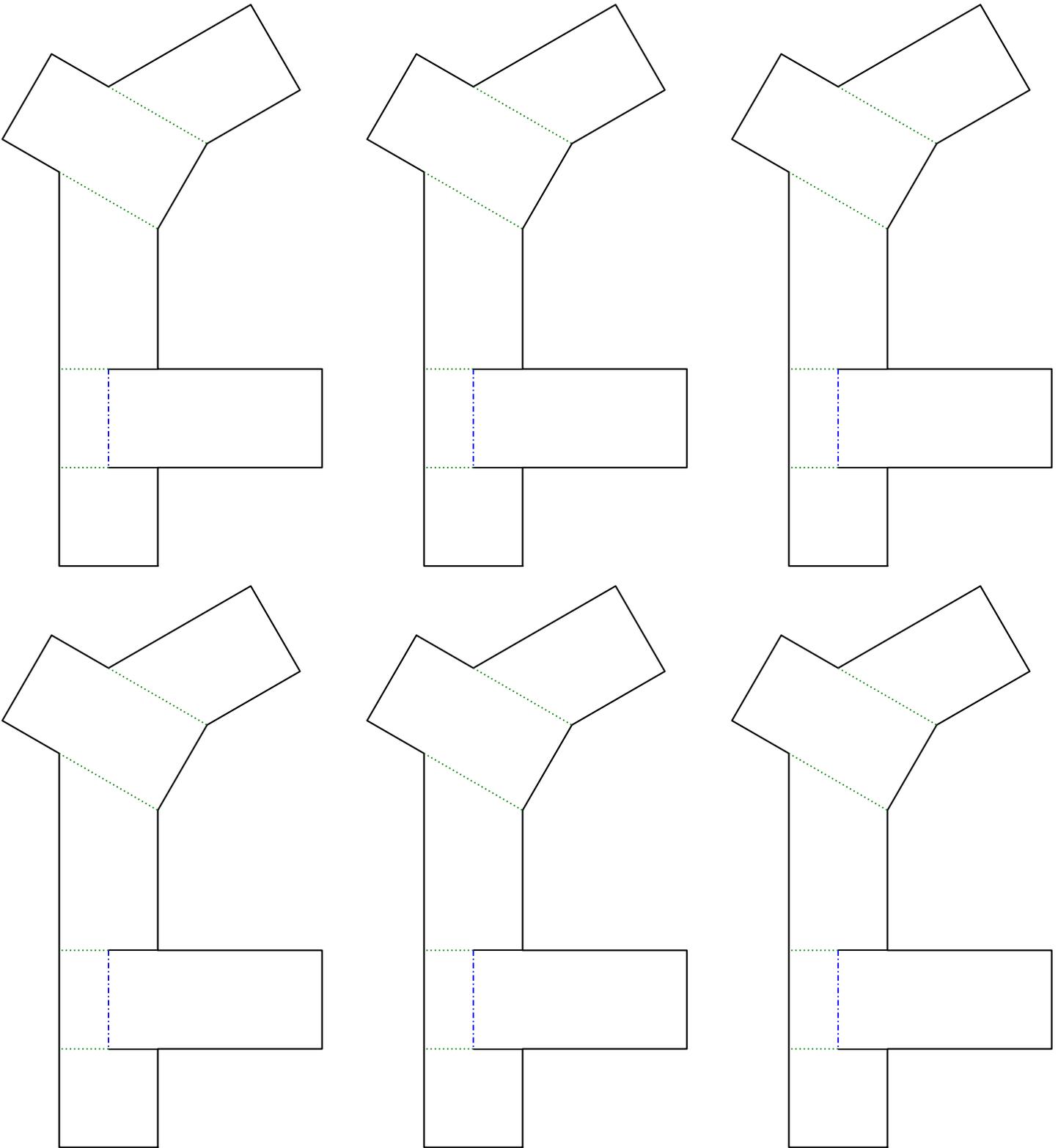
Attach your figure to the reflector with clear tape or glue, as shown.

Attach the reflector to the flashlight. Experiment with the distance between the aluminum foil and the LED to get the ideal projection on your figure. Once set, secure the reflector to the flashlight with clear tape or glue.
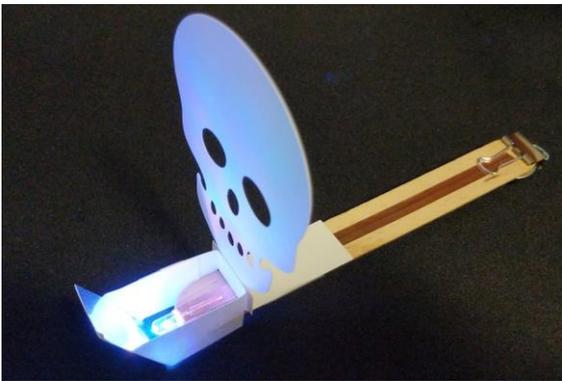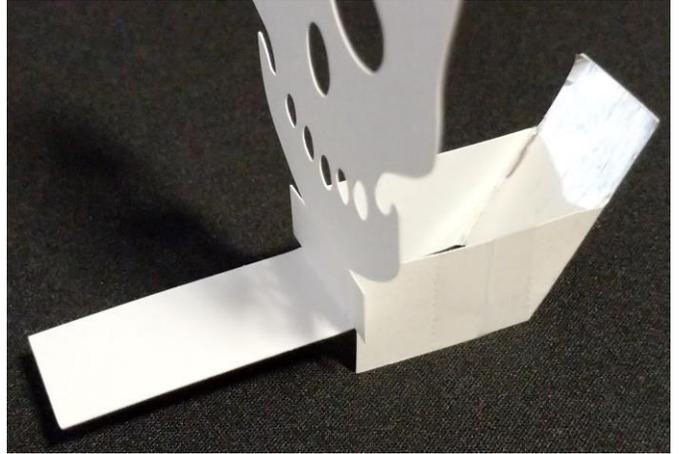
For best results, enjoy your Festive Flashlight in a darkened room!

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print this page on cardstock at 100% scale.

——————	Cut
··············	Valley fold
—·—·—·—·	Mountain fold

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