



## Mini-Lightsabers

*Make a working replica of the classic weapon from Star Wars!*

### Supplies

- LED finger lights
- Black, electrical tape
- Metallic Sharpies
- Clear plastic, acetate, or tinsel
- Clear, colored straws
- Scissors
- Glue
- Wooden skewer or chopstick



Supplies



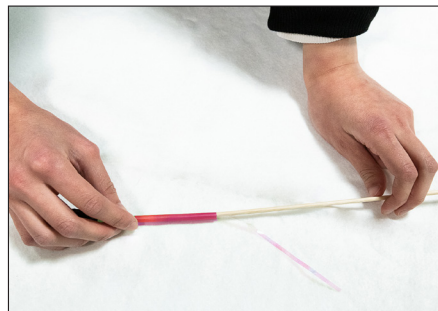
**1.** Twist the tiny cap off an LED light.



**2.** Cut a straw of the same color as the finger light to 3.5-4" long.



**3.** Twist straw onto light. If it does not fit, cut two small slits in straw. Fit between light & plastic case. Glue if needed.



**4.** Use a skewer to insert a small strip of acetate into the open end of the straw.



**5.** Put cap from LED onto end of straw. Glue if needed. Remove rubber band from finger light.



**6.** Wrap the light and the beginning of the straw with electrical tape.



**7.** Cut out a space for the on/off switch.



**8.** Decorate the black hilt of your lightsaber with metallic Sharpies.

*We all know that, in the Star Wars universe, lightsabers are the powerful swords used by both the Jedi and the Sith. But what you may not know is that there is some hidden light physics, also known as optics, working inside the saber. Discover the science behind the forceful blade!*

## The Real Science Behind the Star Wars Lightsabers

The lightsabers in the fictional Star Wars universe are pretty complex devices, but they essentially boil down to a few key elements: a power source, a photon emitter to create light, a crystal to focus the light into a blade, a blade containment field to loop the energy back into the hilt, and a negatively charged opening in the hilt to “catch” the beam of energy as it loops back around.

Our real-world mini light sabers run on electrical power from a battery in the finger light. The light source is an LED (light-emitting diode). When you push the switch on the finger light, you are making the wires touch. This closes the circuit, allowing current to pass through the LED and light it up. Circuits with LEDs have to have a resistor to limit the amount of current coming out of the battery, because the LED burns out if subjected to high current.

To imitate the effect of focusing light onto the blade of a lightsaber, we use clear, colored plastic straws to diffuse (spread out) the light rather than focus (concentrate) it. Diffusers in the hilt help channel light along the length of the drinking straw “blade” to create the effect of even more even light.

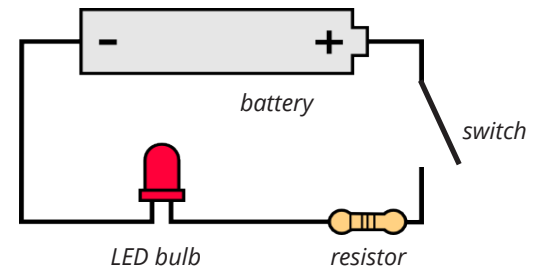


Diagram of a switch circuit

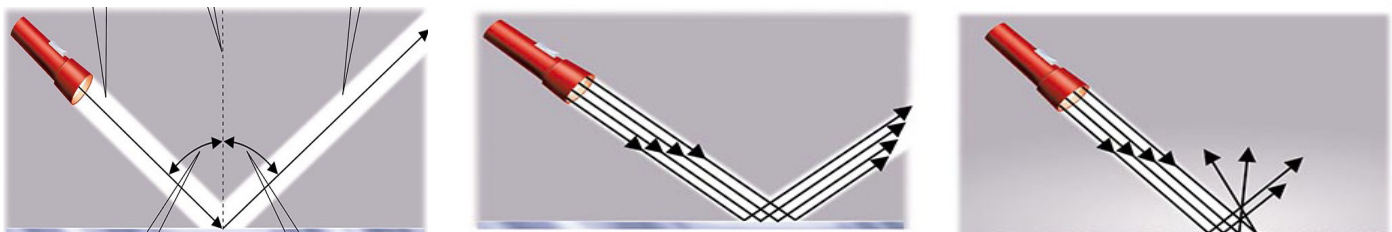
## More About Light

Light is a type of energy called “electromagnetic radiation,” which can be thought of as either a wave or as little packets of energy called “photons.” Light is created when the atoms inside an object gain energy and release it as light. In the sun, the energy comes from nuclear reactions. In our light saber circuit, the energy comes from a battery. The light’s energy level is its color. (Blue light has more energy than red light.)

When light hits a surface, its energy can be absorbed (soaked into the surface), reflected (bounced off the surface), or deflected by refraction (have its speed, and therefore direction, changed when the light hits material with a different density).

Diffusion occurs when light strikes a rough surface and reflects back in many different directions. (The visibility of objects is primarily caused by the diffusion of light from light-emitting sources like the sun and light bulbs.) Since the light is scattered as it hits surfaces, it does not have the intensity of direct light.

Diffusion happens inside a finger lightsaber: the saber’s light source is directed at the end of the cap, which contains little pieces of plastic that reflect the light in all directions. The straw glows when the light is reflected in many directions inside of the straw. You can see the light because the straw is transparent—it allows light to pass through.



*The law of reflection (left) states that light is reflected at the same angle at which it strikes a surface. In regular reflection, (middle) the surface is smooth, so all of the light strikes and reflects together, at the same angle at each point on the surface. In diffusion (right) the surface is rough, so the angle at which light strikes and reflects is different at each point on the surface.*

## Could Lightsabers Ever Really Be Made?

*In the Star Wars universe, a lightsaber creates energy, focuses it, and contains it. That’s science fiction. Could we ever actually build a lightsaber with the science and technology tools we have today? Maybe so! A few years ago, researchers from MIT and Harvard accidentally created a lightsaber (sort of). For the very first time, they found that they could bind photons together, forming what they called “photonic molecules” when the photons interacted. This was the discovery of a possible new state of matter. So, there may be hope for a real lightsaber in your lifetime!*