**LIGHTS, COSTUME, ACTION—**

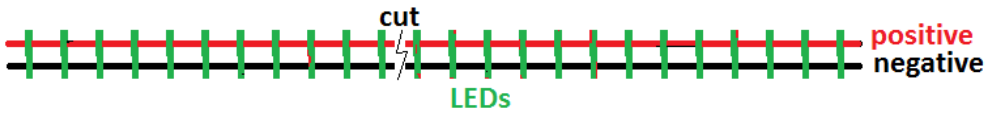
by P. J. O'Connor, based on a panel done at Windycon 37, November, 2010

So, you want to make a costume that has lights, maybe even lighting effects. Where do you start?

LEDs:

If you want to decorate your costume like a Christmas tree, one place to start is with a string of Christmas lights. Don't think in terms of the Christmas lights that plug into the wall; you don't want anything on your skin that can accidentally include you in a circuit with 115 volts; that can lead to injury or death. You don't want a costume that requires an extension cord, either, but the main factor in choice of types of lights should be safety. Strings of Christmas lights that can be bought at a discount in January will do just as well as custom-made lighting systems, for a lot of applications, but start by looking for solid-state LED (light-emitting diode) lights that can be operated off a battery pack. For red or yellow LED lights, two 1½ volt AA or button cells will provide enough voltage to run the lights. More voltage is needed or colors like green and blue, or 'white' LEDs (which are really blue LEDs with a phosphor like that in a fluorescent lamp). Those require three 1½ volt cells to light them, so your choice of colors can affect the weight of the battery pack. You can find Christmas-light packages that run off a battery pack at a number of places on the internet.

Suppose your costume does not need as many lights as the shortest string of Christmas lights you can buy. Is there a way to safely shorten the string of lights? Battery-pack lights are generally wired like a railroad track (a parallel circuit), with the two rails being a positive and a negative wire attached to the battery holder, and the 'ties' connecting one track to the other being the LED's.

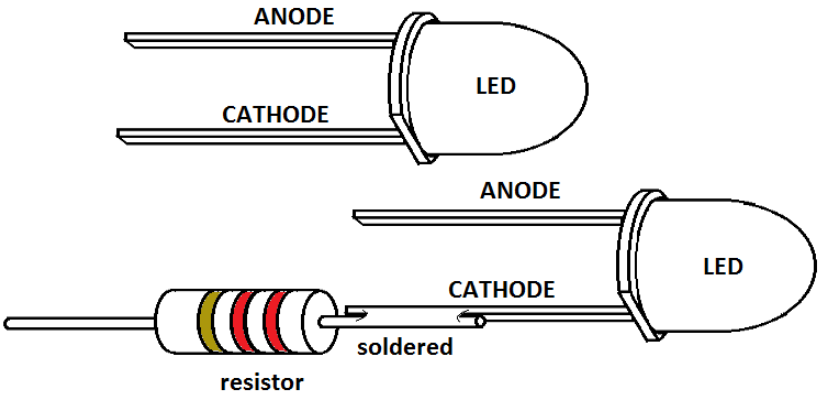



SAFETY: You can sever the positive and negative leads (wires), cutting off the unwanted LEDs so you can discard the ones no longer attached to the battery pack. One important consideration is to not leave exposed copper wire where it can touch other wires or your skin. A drop of epoxy glue on each cut end can insulate it against this possibility. (and—don't cut the wire while the battery pack is turned on!)

This is all fine if you can find lights that have the colors you want, and are spaced apart as far as the lights of a Christmas-light string. But what if you want something else? Suppose you just want one or two lights, maybe different colors, and spaced far apart on the costume? Then, you need to do your own custom wiring, and that means you need to know more about these lights than just where to buy a string out of Christmas surplus.

Every light is part of a circuit. Electrical charge circulates around a loop going from the battery to the light, and back to the battery. With LED lights, in addition to the battery, the wires and the light, there must be a component called a resistor somewhere in the path to limit the current to a safe value. The easiest way to do this is to connect the resistor to one terminal of the LED, and consider the combination as your 'lamp.'

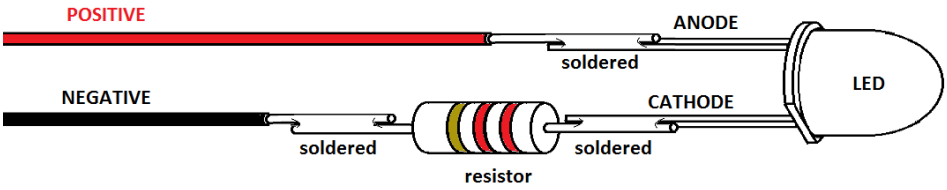
Here is a picture of an LED by itself and with a resistor added:




Typical resistor values are a few hundred ohms. For a two hundred twenty ohm resistor (which is a good value for most LEDs) the three color stripes (seen in the diagram) are red, red and brown.

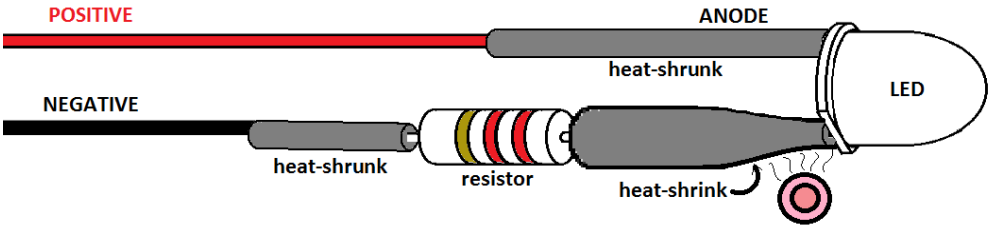
To complete the wiring, you need to connect a wire from the Positive end of the battery pack to the ANODE end of the 'lamp' and a wire from the Negative end of the battery pack to the resistor on the CATHODE end of the lamp, as shown below: Note: LED's are polarity-sensitive. That means there is only one direction current will go through the lamp to light it up. If you do it wrong, reverse the connections from the battery and see if the lamp lights up. The CATHODE end is always identified by a flattened section on the flange around the base od the LED, as shown in the diagram.

The best way of connecting the resistor to the LED is to solder them together. A soldering iron is like the hot-glue-gun of electronics. It will make properly-conducting connections that join conductors to one another with a metal having a lower melting point than the wires. Rather than going into detail, let's suppose you have learned to use a soldering iron and electrical solder to join electrical conductors, and you have completed the connection of your light to the battery wires. It should look like this:




SAFETY: In case you wondered how you are going to electrocute yourself with the voltage from those three AA or button cells, you can't. If you tried to electrocute yourself with this voltage (less than five volts) you wouldn't even feel it. That's not the hazard. You can get along with five volts, but you can also get a short (a short circuit). If, for instance, the exposed metal sticking out of the positive (red) wire were to touch the exposed metal sticking out of the negative (black) wire, the battery would put thousands of times more current through those wires than they would normally carry to and from the LED. The wires would then get super-hot, and might burn through your fabric, your accessories, and YOU—

So, there's all this exposed metal, from where the red and black wires were stripped to solder to the light, (for costuming, 36-gauge stranded wire will allow a desired amount of flexibility in the wiring) and where the resistor and LED contacts were soldered together. All of these exposed pieces of metal are an accident waiting to happen. To protect these connections against banging into something that isn't supposed to be connected to electricity, slide pieces of heat-shrink insulating tubing over the exposed




connections. Once it is heated with a hot air gun (or by holding it over the hot end of the soldering iron and letting the rising heat force it to shrink) all the metal will be sealed off from outside and safe to attach to something that will be worn.

SOURCES: Battery-operated Christmas LED light strings:
Amazon.com
Sears.com
Christmaslightsetc.com

SOURCES: 'Loose' LEDs, heat-shrink tubing and components:
Superbrightleds.com
Sciplus.com
Radioshack.com
Mouser.com
Digikey.com

FIBER OPTICS:

If the idea of running wires alongside your skin still bothers you (and we realize mistakes happen, now and then!) there is another way to get light where you want it without wires that might turn **hot** in the event of a short, running through your fabric or under the lining. Plastic and fiberglass strands called ***optical fibers*** can be used to carry light around corners. At the point where the fiber is cut off, the light becomes visible as a bright point of light at the end of the fiber. To make a more extended or spread-out point of light, 'rough up' the end of the fiber with sandpaper or an emery board. An LED source of light (or even a flashlight in a pocket) can be fastened to one end of a fiber with a clear cement, so light goes into one end of the fibers, then wound through the fabric of the costume and brought out where the point of lights are supposed to show up. This way, light can be brought several feet away from the LED or other lamp that is the source, and the light appears at the far end of the fiber.

NEXT ISSUE: More about Fiber Optics, plus switching and sequencing of LED lights.