MONTE SAYS

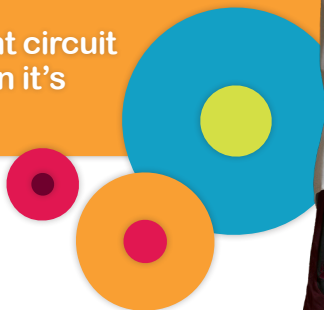"Stare at spectrUM's logo for 30 seconds and then look away to a blank wall. What do you see? The colors are reversed because of something called afterimage. **Pretty cool, huh?"**

Sensing for Science:
Night Light
GRADES 9-12
Make a night light circuit that senses when it's dark or light!

UNIVERSITY OF MONTANA
spectrUM

SENSING FOR SCIENCE
Light Sensor

What You Need:

- Ambient Light Sensor
- Red LED
- Resistor
- Transistor
- Battery
- Copper Tape
- Binder Clip
- Circuit Diagram Card
- Scissors (not included)

Try it

1. **Tape** down a length of copper tape about the same length as each of the 5 dotted boxes on the circuit card. It helps to cut the tape but you can also tear it - USE CAUTION, as the edges of the tape can be sharp!
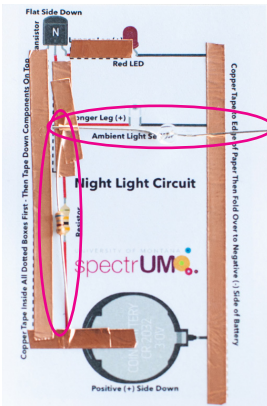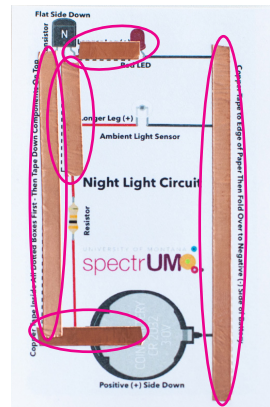

2. **Add** the resistor and ambient light sensor where they are shown on the card. The light sensor needs to be taped down with its **longer leg on the positive (+) side,** which is the left-hand side of the card. The sensor leg and resistor legs should be touching for a good connection. Tape them in place as shown.

3. Add the transistor with the **flat side down** onto the card as shown - bend the legs of the transistor so that they contact the three traces you taped down in the first step. Make sure none of these connections touch each other or you'll have a short circuit!
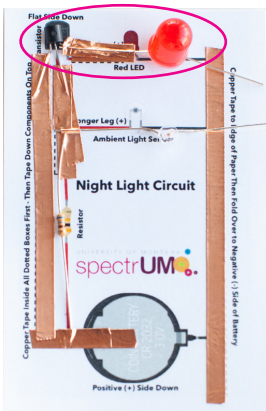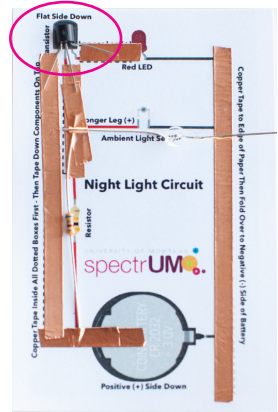
4. Tape down the LED where shown with the **longer (+) leg** touching the leg of the transistor that is pointing towards the LED, and the shorter (-) leg touching the long strip of copper tape along the right side of the card. Then tape down the other two legs of the transistor.

5. Bend the shorter (-) legs of the LED and light sensor to follow along the long copper strip on the right hand side of the card and tape them down.
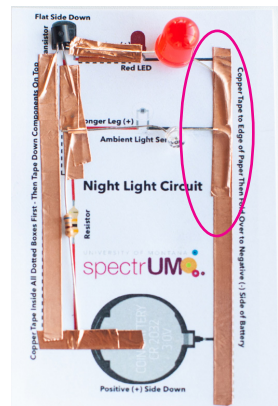
6. Place the battery with the **positive (+) side facing down.** The negative (-) side should be facing up — it has a dotted or grid pattern on it.

7. Fold over the corner so the negative strip of copper tape touches the back part of the battery, which is negative. Clip this folded part in place with the binder clip.

8. Test your night light by shining light on it, then covering the ambient light sensor with your finger. What happens?

If your sensor isn't working, try **debugging** it by considering the following:

- Are the positive (+) and negative (-) sides of the LED and light sensor in the right spot? What about the battery?

- Push the tape down around each component is to ensure good contact.

- Are any of the pieces of tape by the transistor touching each other? Make sure each connection to and from the transistor is separate.

- Did you add the resistor where shown?

- Is the transistor in place with the flat side down?

- Is the tape by the battery shorting it out by touching along the side of the battery?

- See the link and QR code on the last page for more ideas on troubleshooting.

What's going on here?

This sensor circuit works very much like a night light that you may already have in your house. When light falls on the ambient light sensor component, it interrupts electrical current to the transistor. When it is dark, the sensor triggers the transistor to allow current to flow to the LED.

All electrical circuits can be expressed in a circuit schematic that electrical engineers can use to replicate the circuit. Here's the diagram for our circuit:
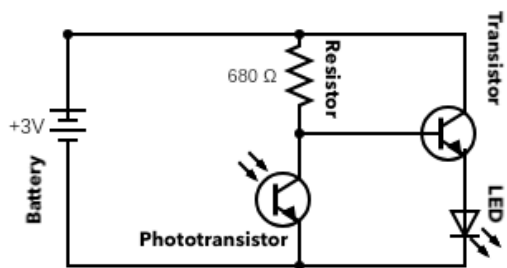
Light Sensors in our Lives

This type of light sensing circuit is used in quite a variety of applications! Night lights are certainly useful, but it is also used in street lights to sense when it is dark in the evening so that they can turn on (and turn off when it gets light in the morning). Have you ever noticed that your smartphone dims its screen when close to your face while talking, but brightens when you move it away? It's using the same kind of sensor as we created here to tell when your ear is covering the speaker.

Scientists measure the amount of light falling on an area in nature to determine things like the effects of light pollution on nocturnal animals, how much light plants are receiving throughout the day, and so much more! They use a more sophisticated way to measure the light than our sensor could detect, but the concept is very similar.

Here are some ideas to ponder:

- Can you think of other applications of a circuit like this one in everyday life?

- What about a sensor that works the opposite of ours - it turns a light on when exposed to light, and off in the dark?

- What happens when you shine a bright light on the circuit when it's in a dimly lit room?

- If you're curious about why LEDs are sensitive to polarity, look up **diodes** or **photodiodes** on the internet – they are quite fascinating and a revolutionary technology in lighting. Many different circuit components are polarity-dependent.

- Transistors, such as the one we used in this activity, are one of the most common electronic components. There are many different ways they are used to control how a circuit turns on and off.

For more troubleshooting tips, ideas to explore and a GIF of how to assemble this circuit see our Instructable at **tinyurl.com/nightlightkit** or scan this QR code:

Directions

spectrUM Discovery Area is located on the Children's Floor of the new Missoula Public Library at 455 East Main Street, in downtown Missoula.

Science. Try it.