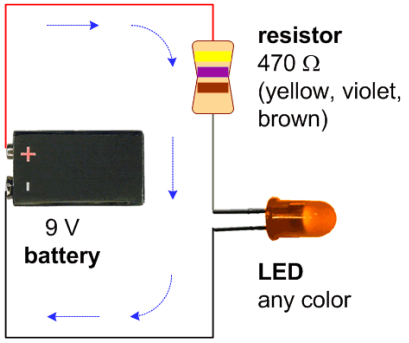
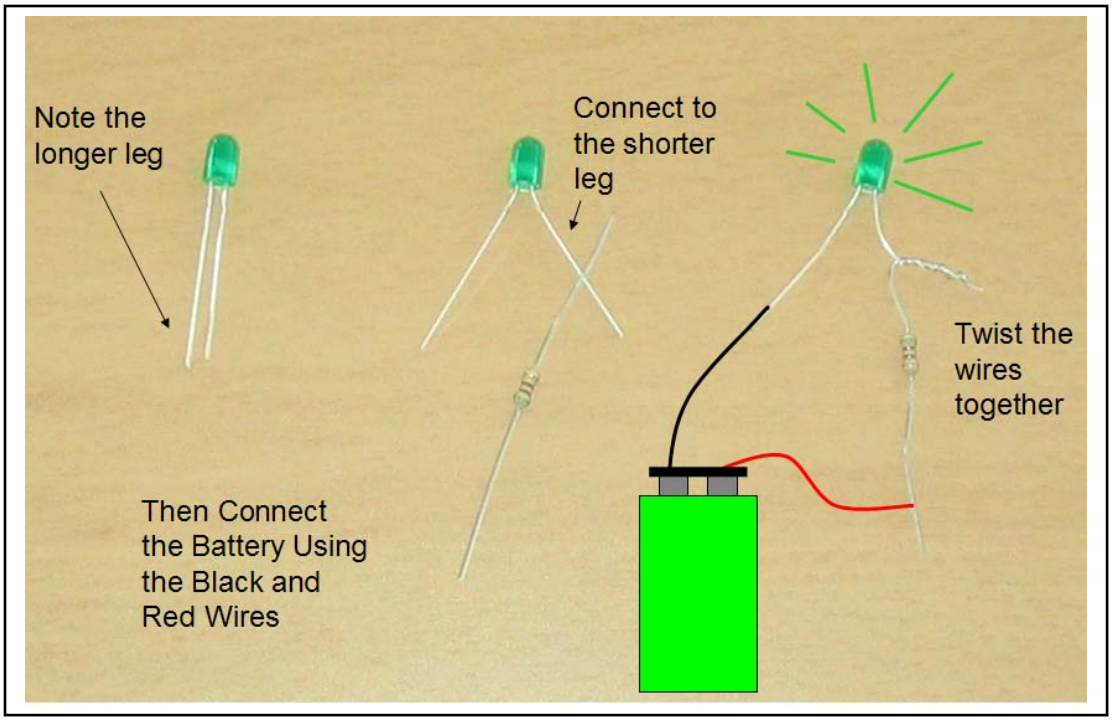
Activities

What follows are short summaries of activities that are meant for people doing outreach or educational programs. Additional details will be necessary for students to understand what is being done in each case.

1. We will begin by learning how to provide electrical power to an LED. We will need an LED, a resistor and a battery. Connect them as shown below. (The diagram comes from http://www.robotroom.com) Note that this is not necessarily the ideal way to connect an LED, but it will work with just about any commercially available device. You can either use a proto-board to make this easy, or just twist the wires together, as shown in the figure below.

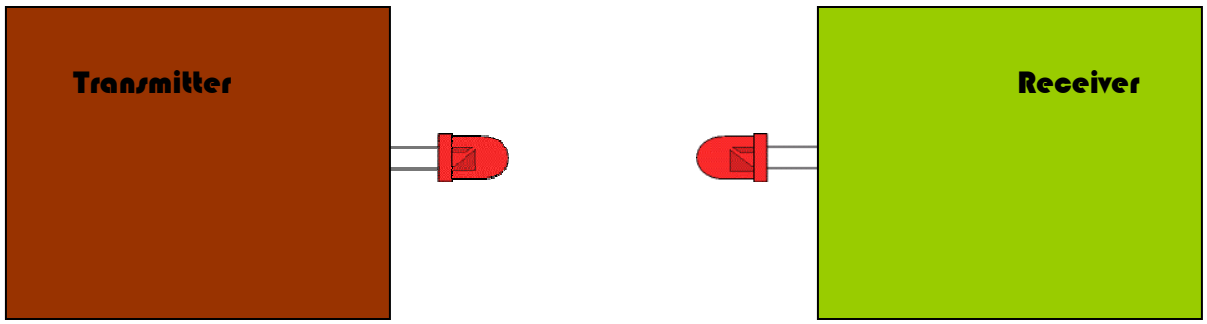




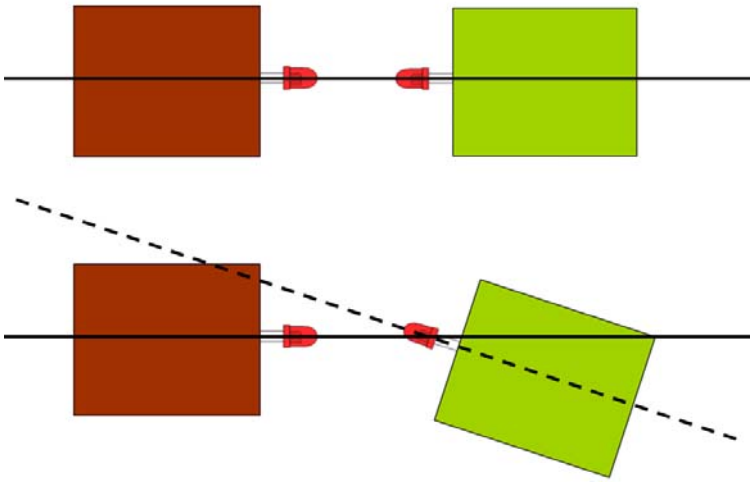
If you have several different kinds of LEDs, go ahead and try each of them in this configuration to verify that essentially all LEDs can be made to light this way. They will not achieve maximum light levels for the given power source. To make

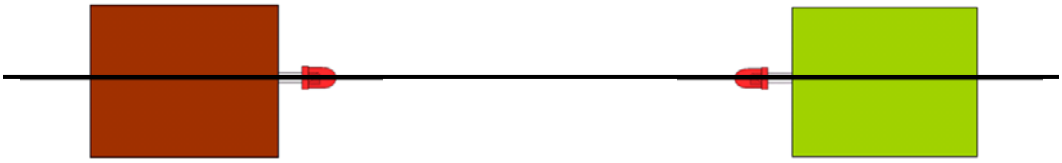
that happen, use one of the LED calculators available online (e.g. http://led.linear1.org/1led.wiz from Rob 'Linear' Arnold) to choose a more appropriate resistor.

The Optical Transmitter-Receiver and Related Activities For the following, you will need access to transmitter and receiver circuits that talk to one another optically. Information on the many ways available to build such circuits can be found elsewhere.

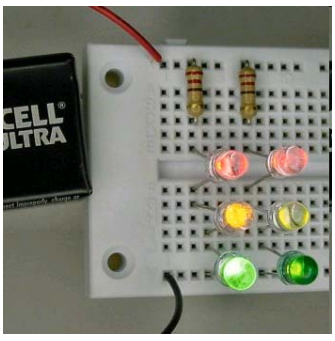


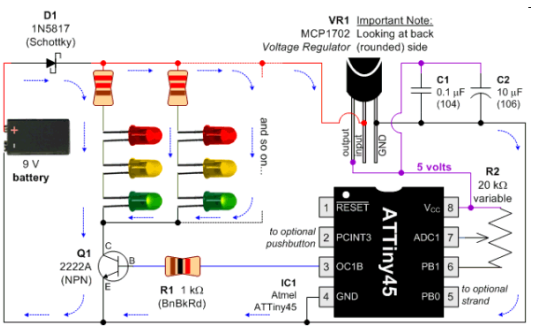
2. Set up the transmitter-receiver pair with the two diodes facing one another, separated by about 2 inches. Connect an MP3 player to the transmitter and turn the volume up as high as possible. Turn on both the transmitter and receiver. Whatever music you are playing from your MP3 player should be audible from the receiver speaker.
3. Place a solid object (such as your hand or a book) between the transmitter and receiver. What happens to the sound from the speaker? Try other materials in between (whatever you may have handy, including glass, metal, wood …) Identify materials the signal passes through and those that block it.
4. The receiver detects the difference between the background light (also called ambient light) and the light that reaches it from the transmitter. Thus, it may produce a quieter sound when the room lights are bright and a louder sound when the room lights are turned off. Verify that this is indeed the case.





5. Vary the relative position of the transmitter and receiver with no objects obstructing the view the receiver has of the transmitter. (See above.)
    a. Increase the distance separating them. What is the greatest separation distance at which you can still hear sound from the speaker?
    b. Change the angle so that they no longer face one another. At a separation distance of about 2 inches, what is the maximum angle between the transmitter and receiver at which you can still hear sound from the speaker?
    c. Given sufficient time, it is possible to investigate the entire range of operation in distance and angle.
6. Turn off the MP3 player and remove the transmitter. We wish to investigate the response of the receiver to other light sources.
    a. Flashing LED – It is possible to purchase LEDs that are packaged with pulsing circuits that are so small you cannot tell they are any different from conventional LEDs. Hook up such an LED in the same manner as the conventional LEDs you used in the first activity. You will notice that the light flashes on and off relatively quickly. Estimate the on and off times for the LED you were given. Now place the flashing LED near the receiver circuit so that it shines directly on the receiver diode. Each time the light flashes, you should hear a click from the receiver. Thus, the receiver detects changes in light level and produces a sound. This is not a very exciting sound, just the same click every time the light flashes. Note that now we do not have to see the light to know that it is flashing because we can hear the clicks. Such a device could be used to tell a blind person that a light is flashing nearby. Since we use flashing lights to indicate danger, this could possibly be useful. However, there are other reasons why a circuit might click like this, so this would not be very reliable. Note that there are many online resources such as http://www.robotroom.com that contain many, many other types of LED circuits that are fun to build.





Next we will use a light source we cannot see.

b. Remote Controls – Using any handy remote control (from a TV or other electronic device), aim the remote at the receiver diode. What do you hear? If you hear anything, the remote works by sending infrared (IR) pulses from its diode to the receiver. These pulses contain commands for its intended device. For example, it may turn on or turn of a TV. We cannot see the pulses from such remotes because the light is not in the visible range, but is rather in the infrared. In the next activity, we will investigate a simple technique for making the pulses from the remote visible to humans. However, before addressing that issue, try any other remotes you may have available. Ideally, you should have remotes from at least two different manufacturers. When you listen to the pulses detected by the receiver, you will notice that each manufacturer uses a different language (sequence of pulses) to talk to its components. Remotes made by one manufacturer cannot talk the language of another unless they are what are called universal remotes. In such remotes, all of the different languages are stored and one can tell the remote which one to use for each component. Thus, one can have a Panasonic TV and a Toshiba DVD player as long as the remote is multi-lingual (universal). Note that just like in the previous activity, the receiver lets us know that lights are flashing, even when the light is not visible, but is in the infrared.

c. Infrared LED light sources – Most LEDs produce visible light, since that is their job. However, the light sources in remote controls are not visible. Can you think of reasons why we do not use visible light sources in

remotes? We have heard pulses from the remote control when visible light flashes and when IR pulses are detected. We conclude that the IR pulses behave the same way as visible light pulses since they are detected as being the same. However, we would be more convinced that the IR light is just like visible light (except that we cannot see it) if there was some way to make it visible. What we need is something that works like our eyes but that is sensitive to IR. Fortunately, we don't have to look hard to find such a device. The light detectors in digital cameras are quite sensitive in the IR range. Thus, using the camera on someone's phone or an actual high quality digital camera, aim the camera at a remote control, push one of the buttons on the remote and observe the viewer in the camera. You should clearly see flashing lights coming from the end of the remote. Just to be sure, double check that you cannot see the pulses with your eyes and then look at the camera again. See if you can identify where the IR light pulses originate in the remote control. The following figure is an example of a photo taken of a flashing remote control.

From http://sci-toys.com