Soldering Laboratory Manual

Objective

This lab is intended to teach students the basics of soldering. Soldering is used to connect electronic components together or to a printed circuit board. Students will learn how to solder, de-solder, use a solder-wick as well as test circuits for continuity and functionality.

Apparatus and Equipment Overview

The following components will be used in this lab:

- 4 x 5cm of hook-up wire
- 1 x Soldering iron
- Lead-free solder
- 1 x Solder wick
- 1 x De-soldering tool
- 1 x Black heat mat
- 1 x Multimeter
- 1 x Fume extractor
- 1 x Helping hands
- 1 x Wire cutters
- 1 x Tweezers
- 1 x Protoboard
- 1 x Breadboard
- 1 x 2.2 kΩ through-hole resistor
- 1 x 47 kΩ through-hole resistor
- 1 x 0 Ω surface mount jumper
- 1 x 1x4 male header
- 1 x 5mm LED
- 1 x 2N3904 transistor
- 1 x Photoresistor
- 1 x Night light printed circuit board (PCB)
- 1 x Arduino Uno and USB cable
- 2 x Male-female dupont cable

Pre-Lab Preparation

Before arriving in the lab, students should review the lab manual and familiarize themselves with the lab setup and procedures. Also please watch the following videos to review the basics of soldering.

- How to solder. https://www.youtube.com/watch?v=j0At9NZwrqk
- How to de-solder connections: https://www.youtube.com/watch?v=Z38WsZFmq8E

Prelab Questions

Why is it important to have a well-ventilated area when soldering?

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Why is it important to use lead-free Solder (i.e. what happens when you use lead)?

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How can you tell which is the negative terminal when looking at a diode or LED?

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Why is it important to build a circuit on a breadboard before soldering everything onto a proto-board?

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Describe in your own words what an electrical "node" is in an electrical circuit?

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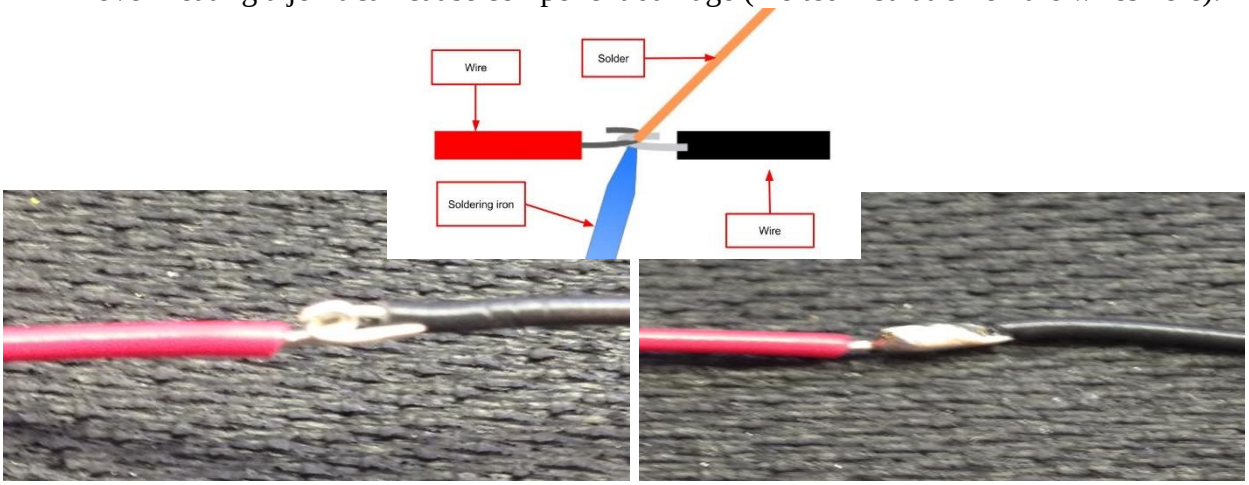
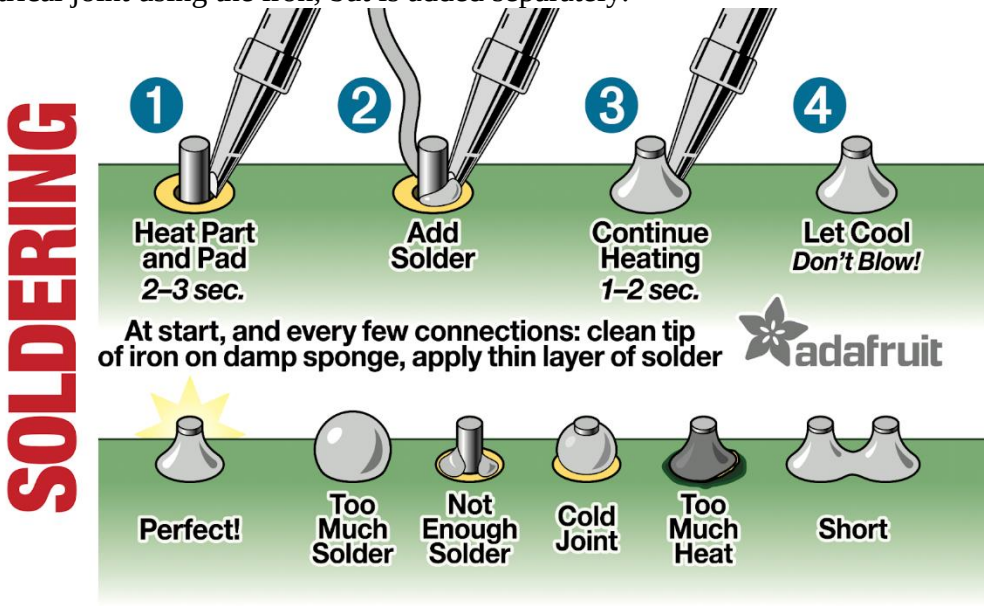
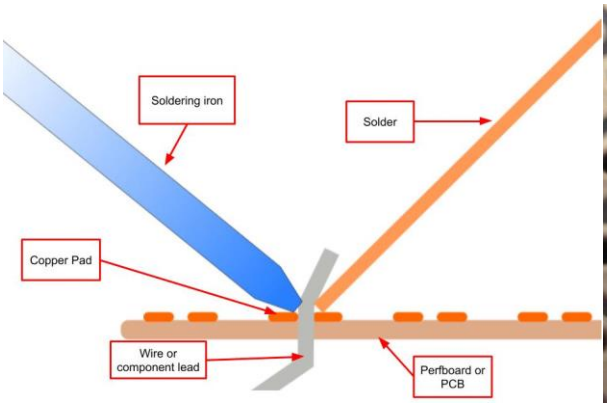
Part A – Soldering basics

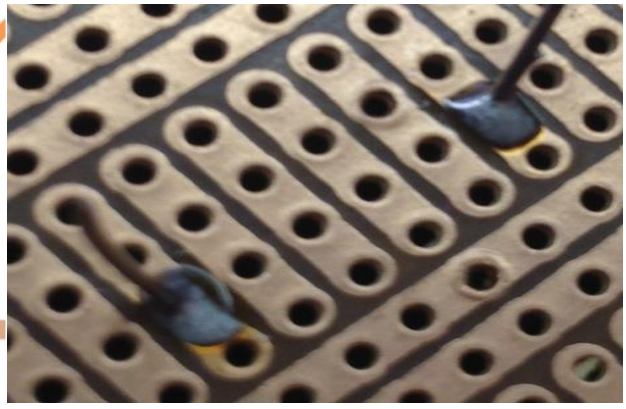
1. Grab 2 wires of about 5 cm, strip 1 cm off each end and bend each end in a U shape.
2. Crimp the two wires together with a pair of pliers and secure the wires so that they can't move around as you solder (you should not need to use your hands to hold the wires steady).
3. Clean the tip of the iron on a damp sponge or paper towel and then use it to heat the two wires for 1-2 seconds and then flow solder on the connection. Once you see the solder flow evenly throughout the connection, remove the solder and soldering iron and do not disturb the joint as the solder cools
4. The solder finish should be shiny and you should be able to see the wire covered but still outlined in the shiny solder covering (not a big ball of solder). A "cold solder joint" occurs when the electrical contacts never get hot enough to allow the solder to melt properly, which results in a poor, or even intermittent, electrical connection. Conversely, over-heating a joint can cause component damage (melted insulation on the wires here).



5. Strip 1 cm off the other end of the wires and bend them to fit in any two holes on the prototyping board. Solder them in place. Snip the excess wire. Use the following picture as a guide for what the solder joint should look like. Note that solder is not brought to the electrical joint using the iron, but is added separately.



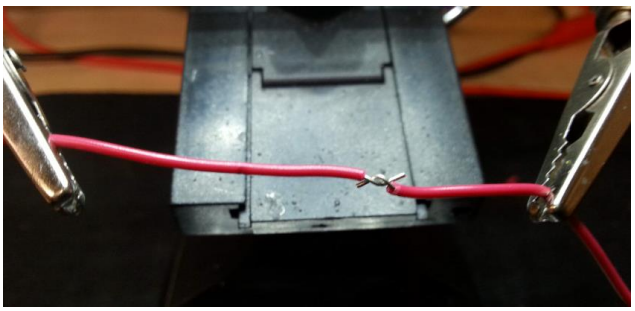
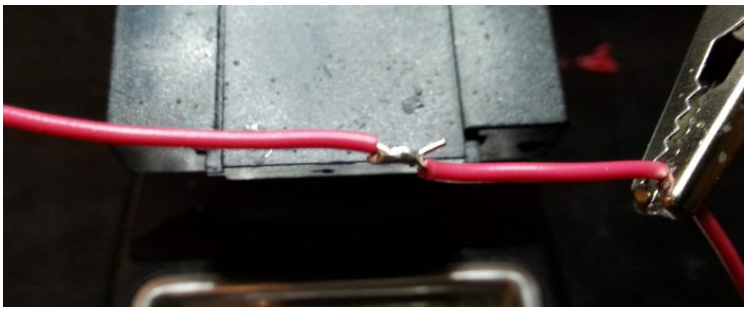




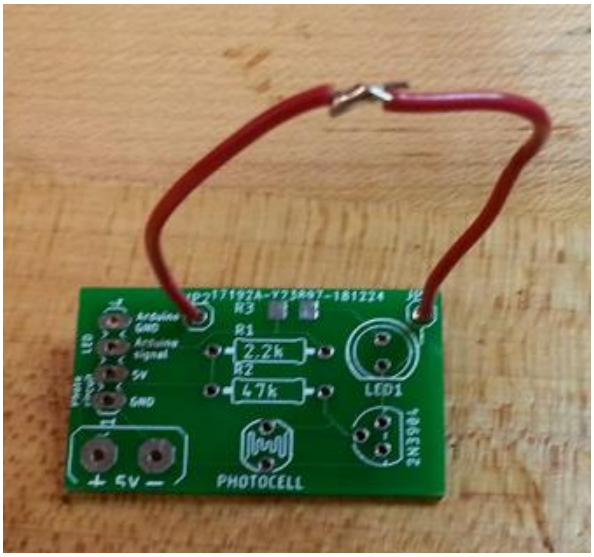
6. De-solder one wire. To activate the de-soldering tool, push the end of the tool in until it clicks. To remove the solder, push the top button on the tool. Place the de-soldering tool close to your joint so you can move it quickly when the joint becomes molten. Heat the solder joint until it becomes molten then place the de-soldering tool directly over the molten joint and press the button.
7. De-solder the second wire using solder wick. Apply a small amount of solder to the iron, place a fresh piece of wick on the joint and press the iron on top of the wick to melt the joint and make sure it gets absorbed by the wick.

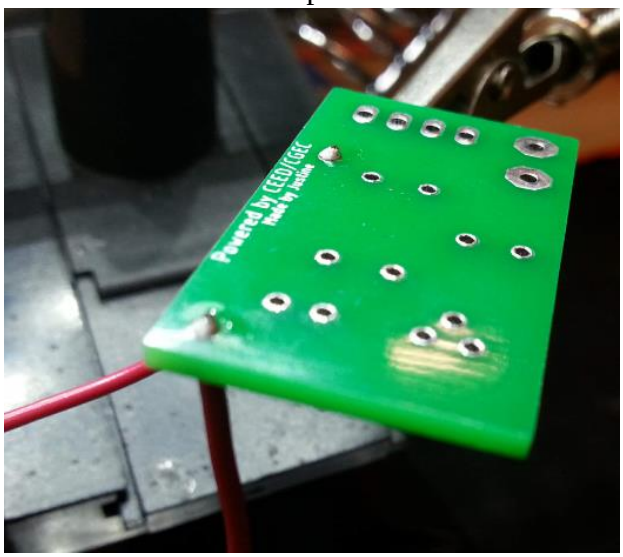
Part B – Night light circuit

1. Twist 2 lengths of wire together (in line with the wire) and hold them with the helping hands. Solder them together with a small amount of solder.

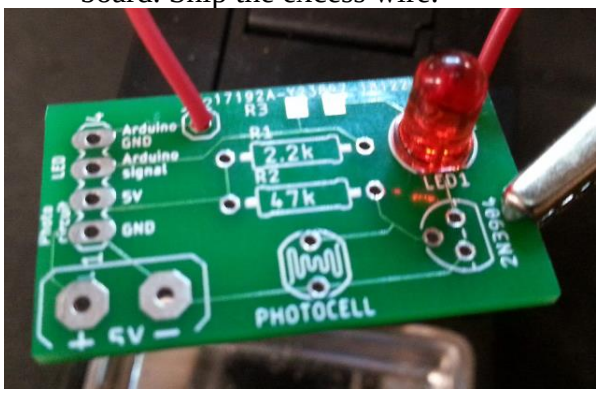



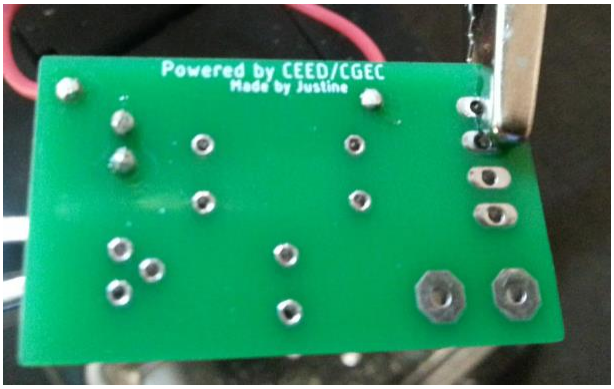
2. Solder the other end of the wires in the PCB in JP1 and JP2. Snip the excess wire.



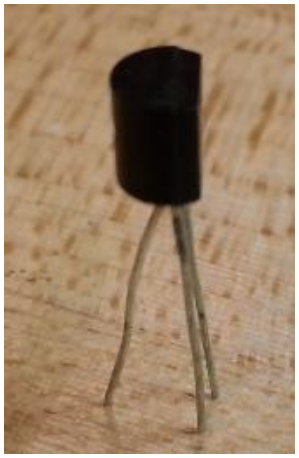
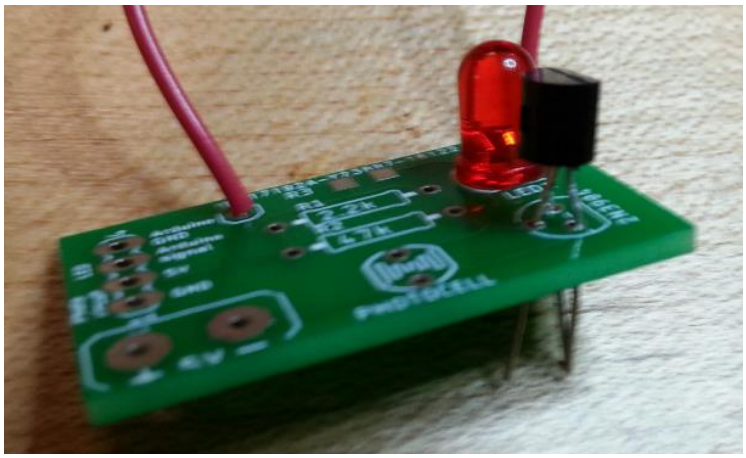


3. Making sure to note the orientation of the LED, line up the flat side of the base of the LED with the flat side on the PCB. Solder both leads so that the LED lays flat on the board. Snip the excess wire.

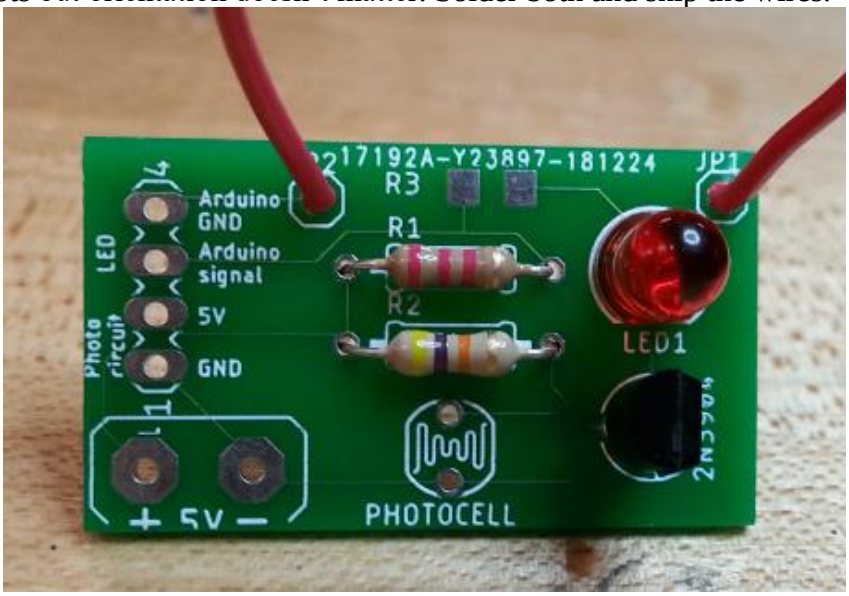




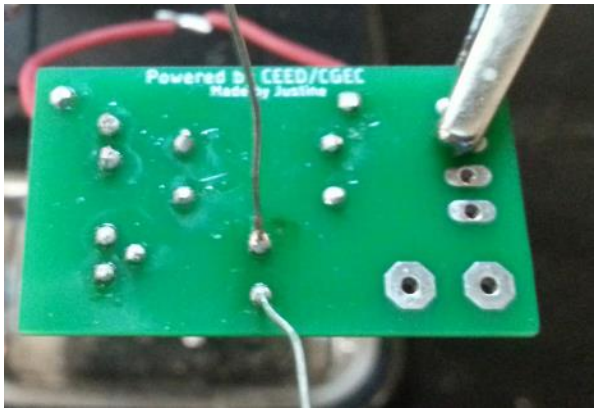
4. Slightly bend the middle leg of the transistor away from the flat side so it will fit in the PCB and push the component down until it is about 5mm from the board. Solder it in place and snip the wire.

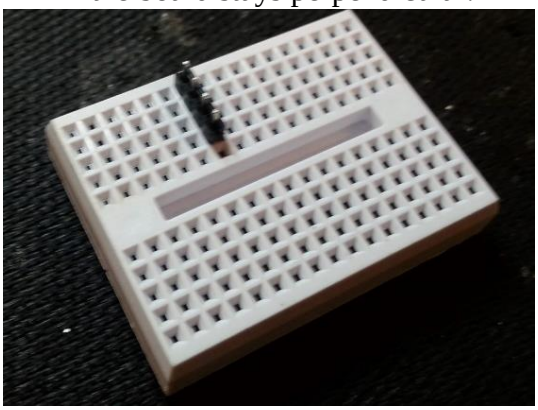
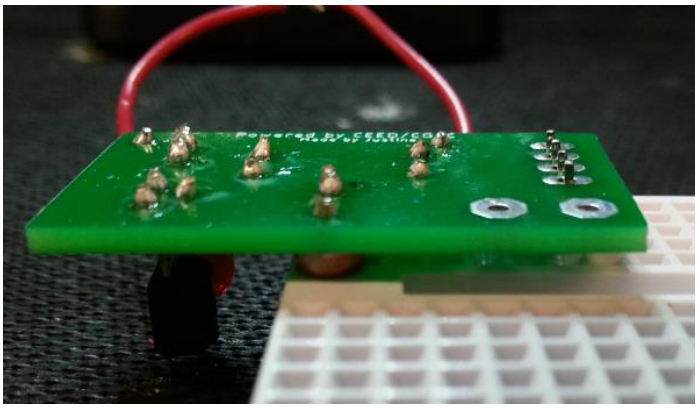
5. Place both through-hole resistors in the board, make sure to use the right values in the right spots but orientation doesn't matter. Solder both and snip the wires.



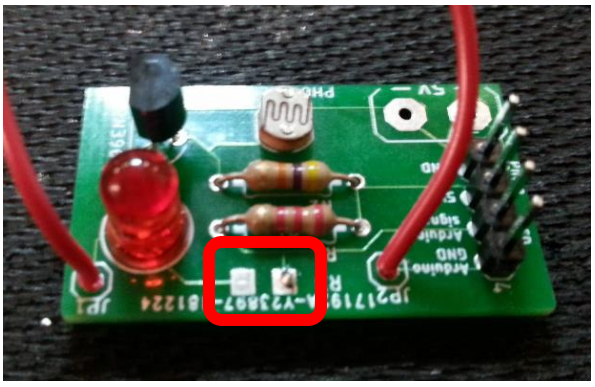
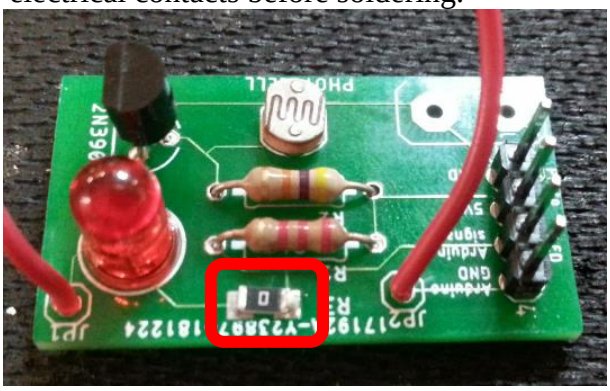
6. Place the photoresistor in the board (orientation doesn't matter). To make sure it doesn't fall out of place when you flip the board, bend the leads outwards. Solder and snip the wire.



7. Next, solder the header in place. The best way to do this is to use a breadboard as a guide to show that the header is perpendicular to the board. Solder each of the pins making sure the board stays perpendicular.

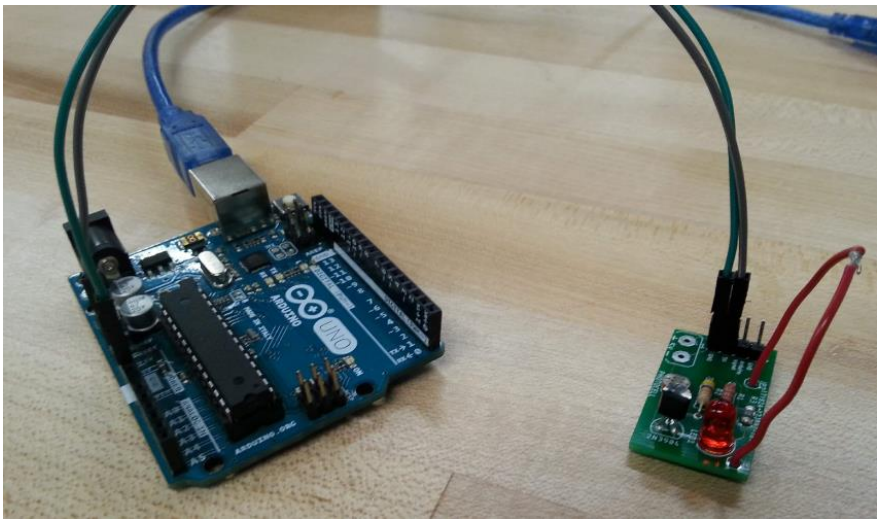



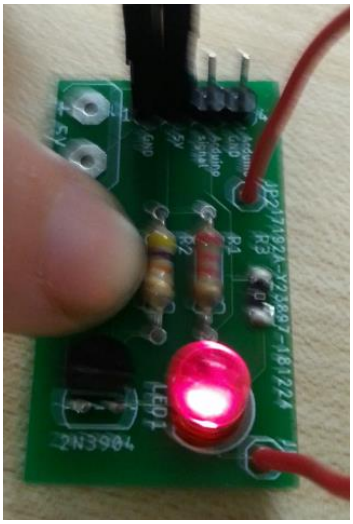
8. Finally solder the surface mount jumper (0 Ω chip resistor). Start by tinning one of the pads (adding a small amount of solder). Hold the jumper in place with pliers or tweezers and heat the solder that is already on the padto stick to the component. Solder the other side of the jumper and add some more solder to the first side if necessary.
    a. If you don't succeed with surface mount you can solder a small wire in place instead (like a wire or resistor leg that was clipped off earlier). In real production factories, chip resistors like this are sometimes glued on with a tiny dot underneath that doesn't touch the electrical contacts before soldering.

9. Test your soldering work with a multimeter by testing for continuity between joints. The multimeter will beep if you have a complete circuit. If the multimeter does not have a continuity measurement mode (the picture with the sound) on it, then measure the actual resistance, which will be around 0.01 Ω or less for a good electrical connection. Note that changing resistance value or glitching resistance value might indicate an intermittent electrical connection or could be a probing problem (there is not a good electrical contact with the multimeter probe).

10. To test the night light circuit, take 2 male-female cables and connect PCB 5V to Arduino 5V and PCB GND to Arduino GND. Varying levels of light will now make the LED turn on or off.





11. You can also use the other 2 pins on the PCB to turn on/off the LED for testing purposes with the Arduino. Or you can solder a 5V power source to the PCB to be independent of the Arduino.

Additional Resources

- Here are a few tips and tricks about soldering to remember, http://www.instructables.com/id/Soldering-tips-and-tricks/ and here is a more in depth tutorial on soldering https://learn.sparkfun.com/tutorials/how-to-solder-through-hole-soldering.
- For some project suggestions visit http://www.makeuseof.com/tag/learn-solder-simple-tips-projects/.