## Building circuits

Record all measurements made as part of the lab under the relevant section. Graphs of current or resistance versus voltage when relevant are encouraged.

**Basic circuit:**

1. *Turn on the Raspberry pi (Rpi)*
2. *Connect one of the 5V pins on the Rpi to the + column on the breadboard*
3. *Connect one of the ground pins on the Rpi to the - column on the breadboard*
4. *Run a connector from the + column to one row on the main part of the breadboard*
5. *Run a connector from the - column to a different (but close) row on the main part of the breadboard*
6. **If we connected a 1Ω resistor between these two rows - so that it is in a closed loop with the 5V supply from the Rpi, how much current would this circuit attempt to draw across the resistor?**

   5.03 Amps

   a. **The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient?**
      No, because we need 5 Amps, so 2 Amps is not sufficient.
   b. **What do you think might happen? Please don't actually do this.**
      It would melt if we attempted to do this.

7. **Connect a resistor of more than at least 100Ω (Why might this be enough resistance?)**

   You would get 0.05 Amps. Yes, since it is an amount most can handle.

   a. **If you have a multi-meter able to measure current, evaluate the current across the resistor. Is it what you expected?**

      19.3 milliAmps about 0.02 amps predicted which is equivalent to 20 miliamps.

      I. NOTE: To measure current, you have to put the meter in series with the rest of the circuit – it cannot measure current like it would voltage (connecting leads to +/- side of a component) – the current has to run through the meter

## LED in a circuit:

**1. Add an LED to your circuit**

a. *Put it in series with the resistor and move the +/- connectors to the RPi 5V supply as needed*

**I. How does the diode need to be oriented? Which wire on the LED goes to the +5V side, and which goes to the GND connector?**

Long side: positive 5V

Short side: goes to negative GND connector

b. **What is the voltage drop across the resistor? Was this what you expected?**

-3 V: Lose 3 across resistor. Yes

c. **What is the voltage drop across the LED?**

-2 V: Lose 2 across LED.

**2. Try removing the resistor from the circuit, keeping the circuit closed - the LED is just in series with the 5V supply.**

a. **What do you think will happen to the LED brightness?**

LED brightness will increase.

**3. Try including resistors of different values - how does LED brightness change vs resistor strength?**

As we increase the resistor strength, the LED brightness will increase. As we decrease the resistor strength, the LED brightness will decrease.

a. **Do the voltage drops across the resistors and LED change?**

Yes, the voltage drops across the resistors and LED change. This time, the LED has the larger voltage drop.

**4. Using the configuration with the highest LED brightness now move the 5V connection on the RPi to one of the 3.3V pins.**

a. **What do you expect to happen to the LED brightness?**

The LED brightness will dim.

**5. Add a step-up circuit component to increase your RPi voltage from 5V to 10V, but do not close your circuit yet**

a. **Using the dimmest configuration for the LED explored previously (meaning select the appropriate resistor from those you tried previously) now**

b. **How will the LED brightness change?**

The LED brightness will dim.

**6. How would you quantify the LED brightness changes?**

It was brighter than the previous (5V connection on the RPi to one of the 3.3V), but not as bright as the non-resistor. (2a)

**7. Do any of these results change with different color LEDs? Specifically, do any voltage drop values change, is the relative brightness similar for different color LEDs, etc.**

Color LEDS are dimmer. Blue was the brightest of the colors. -5 V -4V loss.

**Photo-diode:**

1. *Replace the LED with a photo-diode (remove the step-up component as well if you had one included previously)*
    a. *NOTE: photo-diodes operate in reverse bias mode, so you will need to orient the diode accordingly*
2. **What is the voltage across the resistor when you simply connect the 5V supply to close this circuit?**
   The voltage across the resistor is 0.6 V
3. **What happens if you cover the photo-diode? What happens if you change the +connector to go to the 3.3V pin on the Rpi?**
   If we cover the photo-diode, the current goes down to 0.1 V.
    a. **What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)**
       0.06V.
    b. **Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?**
       Yes, they are both enough.
    c. **What happens if you attach the step-up circuit component to increase the supply up to 10V?**
       The voltage drops by 10 V.
4. **What are the dark current and saturation current for the photo-diode?**
   Dark current: 0.0 V
   Saturation current: 0.2 MilliAmps