# 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?

   FYI: We're using a 10Ω resistor. Thus it should be 0.5 A

   a. The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient?

      Our current is fine as it's below 2 A.

   b. What do you think might happen? Please don't actually do this.

   If it's above 2 A, then it'll damage the circuit through burning.

7. Connect a resistor of more than at least 100Ω (Why might this be enough resistance?)
   a. If you have a multi-meter able to measure current and evaluate the current across the resistor, is it what you expected?

FYI: we're using a 121.2Ω resistor. Theoretically, the current–via Ohm's Law–should be 0.0412 A. Experimentally, the current–via multimeter–is

   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?

The longer wire goes to the +5V side and the shorter wire goes to the GND connector.

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

Experimentally, the voltage drop across the resistor is 2V. This isn't the value we expected, but it's still relatively close to the theoretical value of 4.8–via Ohm's Law/

    c. What is the voltage drop across the LED?

3V.

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?

It will get brighter because there's no resistor to limit current.

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

As resistor strength increases, LED brightness decreases; they're inversely related.

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

1000Ω resistor : 2.5 V
LED: 2.5 V
No, as seen from data, it doesn't.

4. Using the configuration with the highest LED brightness now moves the 5V connection on the RPi to one of the 3.3V pins.
    a. What do you expect to happen to the LED brightness?

Brightness will probably decrease in intensity.

5. Add a step-up circuit components 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 brightness will be brighter.

6. How would you quantify the LED brightness changes?

It can be quantified through current because the LED functions as a resistor. So the more voltage applied, the less the resistance, thus the brighter the LED will be.

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.

Yes, it does change. Different color LEDs might have varying resistance and require different power inputs. The brightness was not the same: Blue > Green > Clear.

## 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?

16 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?

Covering the photo-diode, the voltage goes down to 1.4 V.
Changing to the 3.3V pin, the voltage is now 20.4 V.

a. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)

Dark current: 1.4 mA. (1.4V/1000Ω)

b. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?

Yes to both because the voltage changes across the circuit with 3.3V and 5V.

c. What happens if you attach the step-up circuit component to increase the supply up to 10V?

The voltage across the diode becomes nearly 9.9 V.

4. What are the dark current and saturation current for the photo-diode?

Saturation current: 10 mA. Dark current: the same as the saturation current; this is due to the larger voltage and the diode can't absorb enough energy to change the current to a significant amount, thus not changing the voltage.