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 Amps
   1. The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient? No, this current is not sufficient, because there is not enough resistance
   2. What do you think might happen? Please don’t actually do this. It will short circuit and cause an electrical fire.
7. Connect a resistor of more than at least 50Ω (Why might this be enough resistance?)
   1. If you have a multi-meter able to measure current evaluate the current across the resistor, is it what you expected? The multi meter, measured 4.66 Amperes of current, however these measurements were difficult to take so the error may be larger than desired.

## LED in a circuit:

1. Add an LED to your circuit
   1. Put it in series with the resistor and move the +/- connectors to the RPi 5V supply as needed
      1. 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 Ground has to be with the led while the positive is with the resistor only then the two will be in series with each other.
   2. What is the voltage drop across the resistor? Was this what you expected? The voltage drop is about 2.7 close to what we expected.
   3. What is the voltage drop across the LED?
   4. Voltage drop was about 2.5 which is very close what we expected.
2. Try removing the resistor from the circuit, keeping the circuit closed - the LED is just in series with the 5V supply.
   1. What do you think will happen to the LED brightness? – the led will be much brighter because there is more current available.
3. Try including resistors of different values - how does LED brightness change vs resistor strength?
   1. Do the voltage drops across the resistors and LED change?
   2. Yes, the voltage drops change, across each to, .7 volts for the resistors and 3.7 for the LED.
4. Using the configuration with the highest LED brightness now move the 5V connection on the RPi to one of the 3.3V pins.
   1. What do you expect to happen to the LED brightness? We think the LED will decrease in brightness.
5. Add a step-up circuit components to increase your RPi voltage from 5V to 10V but do not close your circuit yet
   1. Using the dimmest configuration for the LED explored previously (meaning select the appropriate resistor from those you tried previously) now
   2. How will the LED brightness change? The LED brightness will increase.
6. How would you quantify the LED brightness changes? We would measure the current across the light bulb and use the specs of the LED to find its relative brightness.

## Photo-diode:

1. Replace the LED with a photo-diode (remove the step-up component as well if you had one included previously)
   1. 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? 7.3 mV
3. What happens if you cover the photo-diode? The voltage drops to very minimal values. What happens if you change the +connector to go to the 3.3V pin on the Rpi? The voltage drops drastically across the photo-diode.
   1. What is the dark current for this photo-diode? 0.01 mA
   2. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V? Yes, 5V is enough to see a signal from this diode, 3.3V gives a very small voltage.
   3. What happens if you attach the step-up circuit component to increase the supply up to 10V? The Voltage values become much higher.
4. What are the dark current and saturation current for the photo-diode?
5. 10V light: 63 mV, 0.093mA, dark: 1.7mV, 0.0025mA, 5V light: 7.3 mV, 0.01mA, dark: 1.8 , 0.003 mA