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, it is too low.**

* 1. What do you think might happen? Please don’t actually do this.

**Something would burn to be damaged in the Raspberry Pi.**

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

**A 100 ohm resistor would create an amperage of 0.05 amps, this is enough resistance because the amperage is below the max amps the Raspberry Pi can take.**

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

**Could not get the amperage measurement.**

* + 1. 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
   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 positive end is the long end and the negative end is the short end. Current flows from the long one to the short one.**

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

**The voltage drop across the resistor is about 1.9 volts, not what we expected.**

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

**3.1 V**

1. 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?

**It will get much brighter.**

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

**Increase in resistance will decrease current and thus make the LED less bright and vice versa.**

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

**Yes**

1. Using the configuration with the highest LED brightness
   1. What do you expect to happen to the LED brightness?

**Brightness should decrease**

1. 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 brightness should increase**

1. How would you quantify the LED brightness changes?

**Measure the voltage or current across the LED or use a light meter.**

1. 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.

**The red LED is super dim with a voltage of 1.96 V. The blue is bright at 2.8 V. The green has highest voltage at 2.87 V. The white LED had a voltage of 2.7 V.**

## 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?

**5 V**

1. 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?

**The voltage drop across the resistor is low when the photodiode is covered. The voltage drop across the resistor is still small but about 10 times higher when not covered.**

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

**1.6 micro Amps**

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

**The voltage is small at 1.6 mV but maybe a nice sensor can pick up that resolution. The 3.3 V connection had a slightly higher resistor voltage reading at 1.4 mV.**

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

**It will increase only slightly.**

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

**Dark current is 1.6 micro Amps and the saturation current is 10 micro Amps.**