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?
   V=IR so 5=I*1 -> I=5 A
   1. The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient?
      Yes
   2. What do you think might happen? Please don't actually do this.
      Maybe there would be too much current it would get very hot or otherwise damage some equipment
7. Connect a resistor of more than at least 100Ω (Why might this be enough resistance?)
   470 Ohm
   1. If you have a multi-meter able to measure current evaluate the current across the resistor, is it what you expected?

I = 5 V / 470 ohm = 10.6 mA ~~ 11mA

   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 longer side has to be connected to the 5 volt side.

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

2.08. We expected it to be 5V assuming the resistance of the LED was 0.

3. What is the voltage drop across the LED?

2.98

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?
       It will get brighter
3. Try including resistors of different values - how does LED brightness change vs resistor strength?
   LED brightness decreases with higher resistor strength
    1. Do the voltage drops across the resistors and LED change?

For 1k ohms: 2.34V across resistor, 2.77 across LED
Voltage across LED decreases with higher resistance value of the resistor and the voltage across the resistor increases

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?

It decreases

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?

More voltage -> Brighter

6. How would you quantify the LED brightness changes?
   In terms of the power formula, so P = V^2/R
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.

Blue: 2.75V change
Red: 1.86 V change, somewhat dimmer but roughly the same

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?

0.28V across 1k ohm resistor, 4.86 V across photodiode

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 it, the voltage across the resistor drops to .005 and the voltage reading across the photo diode increases to 5.13V
   When we switch to 3.3, the voltage across resistor changed to .24 and the voltage across the photodiode dropped to 3.08
    1. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)
       If it is .005V across the 1k ohm resistor, then V=IR, so dark current is 0.005 mA
    2. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
       Both are yes as long as there is light in the room to activate it. We measured a significantly higher current in both situations as long as there is light.
    3. What happens if you attach the step-up circuit component to increase the supply up to 10V?
       The voltage drop across each component would increase, therefore increasing the current.
4. What are the dark current and saturation current for the photo-diode?

The circuit is in series, so the dark current is also .005mA and the maximum voltage we can get across the resistor by shining a flashlight on the photodiode is 5V, so according to V=IR the saturation current in the circuit is 5mA.