Elliott Caton
Tina Jolly
Vivian Smart-Stewart

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?
    a. The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient?
        - *1/20 of an amp is sufficient.*
    b. What do you think might happen? Please don't actually do this.
        - *This will cause a short in the circuit as too much current will be drawn.*
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 evaluate the current across the resistor, is it what you expected?
        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

- *Current measured: 0.2 microamps μA at 2000Ω*

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 diode needs to be orientated in forward bias with the longer wire attached to the +5V side and the shorter wire attached to ground.*
    2. What is the voltage drop across the resistor? Was this what you expected?
        - *.44V*
    3. What is the voltage drop across the LED?
        - *3.15 V*
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?
    - *When the resistor is not included the LED is brighter than with a resistor.*
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?
        - *More resistance makes the LED dimmer*
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 expect the LED brightness to decrease as we decrease the input voltage*
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?
        - *We expect the LED to be brighter as we are increasing the input voltage from 5V to 10V*
        - *Experimentally, the LED is brighter than when we had the same resistor (that had yielded the dimmest configuration)*
6. How would you quantify the LED brightness changes?
        - *They can be quantified by the voltage drop*
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.
    - *Red 1.89 V Green 2.6 V and Blue 3.15 V*

Photo-cell:

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?
    - *2.5V for resistor, 2.44V across the diode*
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 diode: 4.08V*
- *Changing to 3.3V pin: 1.45V, and once covered: 2.54V*
- *We determine that more light implies more resistance*

1. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)
    - *In theory, it would be the difference between the measurements with and without light*
2. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
    - *Both work*
3. What happens if you attach the step-up circuit component to increase the supply up to 10V?
    - *When a step-up circuit is applied the Voltage measured will increase.*

4. What are the dark current and saturation current for the photo-diode?
    - *The dark current is the difference between no-light, it will only detect thermal energy as the input. Saturation current is the maximum current on the diode, and it's a component of dark current*

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?
    - *Across resistor: 0.036V*
    - *Across photo-diode: 5.08V*
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?
    - *On 3.3V and uncovered, voltage across resistor = 0.33V. Across photo-diode = 3.27V*
    - *Covered 3.3V: 3.31V*
    - *Covered 5V: unchanged ~5.1V*
    1. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)
        - *1.35 μA*
    2. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
        - *5V is not enough to see a signal from this diode.*
    3. What happens if you attach the step-up circuit component to increase the supply up to 10V?
        - Across resistor: 0.035V
        - Across photo-diode: 10.19V
        - Covered, across resistor: 2.7mV
4. What are the dark current and saturation current for the photo-diode?

- *The dark current is 1.35 μA and the saturation current would be the maximum current read based on the photo diodes properties.*