Basic Circuit Activity:

Q: 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? The Rpi adaptor provides 5V and up to 2 Amps, is this current sufficient? What do you think might happen?

A: $V = IR \rightarrow 5V = (1\Omega)I \rightarrow I = 5A$.

The Rpi doesn't provide sufficient current. 2A<5A, which the 1Ω needs. We think that there will end up being no current throughout the circuit.

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

A: $V = IR \rightarrow 5V = (100\Omega)I \rightarrow I = 0.05A$.

This is enough resistance according to Ohm's Law. 0.05A < 2A, so current will be able to flow through the system.

We grabbed a 150Ω resistor so I should be 0.03A.

Actual current across the system: 0.1A, not really seeing anything.

We were unable to get a clear reading of any current on the multimeter.

LED in a Circuit Activity:

Q: 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?

A: It needs to be oriented with the long leg of the LED with the positive wire (+5V side). The shorter leg goes to GND.

Q: What is the voltage drop across the resistor? Was this what you expected?

A: V= -2.4 with a 330Ω resistor. We expected a drop of 2 from the resistor because the LED has a 3V drop, and the total is 5V.

Q: What is the voltage drop across the LED?

A: We measured -2.7V and expected 3V.

Q: Try removing the resistor from the circuit, keeping the circuit closed - the LED is just in series with the 5V supply. What do you think will happen to the LED brightness?

A: The bulb should get brighter. There is less resistance, so more current will reach the LED. Experimentally it did get brighter!! 😄

Q: Try including resistors of different values. How does LED brightness change vs. resistor strength? Do the voltage drops across the resistors and LED change?

A: Lower resistors will lead to a brighter bulb, while higher resistors will lead to dimmer bulbs because of the inverse proportionality between I and R, as well as P = IV. Across the resistor V does change because it's a different value resistor; across the LED V, lowering resistance means a higher voltage drop.

Q: Using the configuration with the highest LED brightness now move the 5V connection on the RPi to one of the 3.3V pins. What do you expect to happen to the LED brightness?
A: When the circuit is lowered by voltage, the bulb will be dimmer overall regardless of the resistance in series with it.

Q: Add a step-up circuit component to increase your RPi voltage from 5V to 10V but do not close your circuit yet. Using the dimmest configuration for the LED explored previously (meaning select the appropriate resistor from those you tried previously), now. How will the LED brightness change?
A: We will have a lot more voltage in the system. Since P = IV, the component of V will increase P to some extent, but the current through the bulb will be less because of the large resistor. Overall, the bulb was brighter.

Q: How would you quantify the LED brightness changes?
A: We can measure the voltage drop on the LED when we use the step-up converter compared to when we connect to the Raspberry Pi directly and compare the voltage drops. We can use the relationship P = IV to quantify the change in brightness.

Q: 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.
A: Blue LED: V = 3.1V, White LED: V = 2.7V, Red LED: V = 2V. The brightness is relatively similar across the red and blue bulbs, and the white was very bright, but the voltage drops differ.

Photo-diode Activity

Q: What is the voltage across the resistor when you simply connect the 5V supply to close this circuit?
A: We measured V = 0.5V across a 47kΩ resistor.

Q: 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?
A: When covered, the voltage across the resistor was 0.02V. When connected to the 3.3V pin, the voltage across the resistor is very low and fluctuating, around 0.03V. It is probably not enough voltage for the photodiode.

Q: What is the dark current for this photo-diode?
A: The 3.3V pin didn't give us a real reading so dark current is presumably very low or zero.

Q: Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
A: Yes 😄, 5V is enough voltage to see a signal from the diode since we were able to get a clear reading of 0.5V across the resistor. 3.3 V is not enough supply voltage to see a signal from the diode since we were not able to get a reading of any voltage across the resistor in this case.

Q: What happens if you attach the step-up circuit component to increase the supply up to 10V?
A: Voltage across the resistor is 0.87V when we attached the step-up circuit component.

Q: What are the dark current and saturation current for the photo-diode?
A: Voltage from the 5V pin when covered is 0.043V. So, dark current is equal to 0.043/47kΩ = 0.0009mA.
Noncovered (saturation current0: 0.6 , I = 0.6V/ 47kΩ = 0.127 mA