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Basic circuit:

6. 5 amps of current flow V = IR -> 5 = I * 1 -> I = 5 amps

a) **Yes, this current is sufficient**
b) **The resistor would burn because there is a lot of current flowing through it.**

7.

a) **Yes, it is what we expected. The resistor is 220 ohms, and 5/220 = 0.0227 amps. We got a multimeter result with 0.023 amps as well to agree with this.**

LED Circuit:

1. Add an LED to your circuit
    a. Put it in series with the resistor and move the +/- connectors to the RPi 5V supply as needed
        i. 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?
            1. **The longer side needs to be connected to the positive while the shorter side has to be connected to the negative(ground).**
    b. What is the voltage drop across the resistor? Was this what you expected?
        i. **The voltage drop is approximately 1.9 volts, a little lower than expected but still close enough.**
    c. What is the voltage drop across the LED?
        i. **The voltage drop across the LED is 3.3 volts.**
2. Try removing the resistor from the circuit, keeping the circuit closed - the LED is just in series with the 5V supply.
    a. What do you think will happen to the LED brightness?
        i. **The brightness should increase as the voltage across the LED increases, meaning the power dissipated is also higher.**
3. Try including resistors of different values - how does LED brightness change vs resistor strength?
    a. Do the voltage drops across the resistors and LED change?
        i. **Yes, the voltage drops across the LED change because we effectively deal with a voltage divider circuit since elements are connected in a series.**
4. Using the configuration with the highest LED brightness now move the 5V connection on the RPi to one of the 3.3V pins.
    a. What do you expect to happen to the LED brightness?
        i. **We expect the LED brightness to go down as the voltage decreases because as the voltage decreases from 5 volts to 3.3 volts, the power dissipated across the LED also decreases. Since the power decreases, the brightness also decreases.**
5. Add a step-up circuit components to increase your RPi voltage from 5V to 10V but do not close your circuit yet
    a. Using the dimmest configuration for the LED explored previously (meaning select the appropriate resistor from those you tried previously) now.

   b. How will the LED brightness change?
      i. **Increasing voltage with the same resistor increases LED brightness since the current rises. With different resistances, brightness depends on power dissipation, and a higher voltage with a larger resistor may still result in more power and brightness than a lower voltage with a smaller resistor.**
6. How would you quantify the LED brightness changes?
   a. **Using a 220 ohm resistor with 5 volts results in a power of 25/220 = 0.11W (from P = V^2/R). Using a 660-ohm resistor with 10 volts results in 100/660 = 0.15 W. Therefore, the LED brightness is higher, but not by much.**
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.
   a. **Yes, different color LEDs have different forward voltage drops, which affect brightness and power dissipation. Since power is given by $P = V^2 / R$, the voltage drop across the resistor decreases when the LED's forward voltage is higher. This reduces the current flowing through the circuit and, consequently, the brightness.**

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Photo-diode:

1. Replace the LED with a photo-diode (remove the step-up component as well if you had one included previously
    a. NOTE: photo-diodes operate in reverse bias mode so you will need to orient the diode accordingly
2. When connecting the 5V supply to close this circuit, what is the voltage across the resistor?
    a. ~0.03 V
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 the photo-diode, the voltage drop across the resistor becomes very small (almost 0) since the current decreases significantly. If we change it to 3.3V, the voltage drop stays the same at ~0.03 V.**
    a. What is the dark current for this photo-diode? (Use the voltage across the resistor to determine diode current)
        i. 0.03/660 = 4.54545455e-5 A
    b. Is 5V enough supply voltage to see a signal from this diode? Is 3.3V?
        i. Yes, 5V and 3.3V are enough to see a signal from this diode.
    c. What happens if you attach the step-up circuit component to increase the supply up to 10V?
        i. The voltage drop across the resistor incerases by roughly .01 to 0.04 V from 0.03 V.
4. What are the dark current and saturation current for the photo-diode?
    a. Dark current =0.03mv/660 = 4.54545455e-8 = basically 0
    b. Saturation current = 0.04/660 = 6.06060606e-5 A