Introduction to Electronic Circuits

Overview:

This activity introduces electricity and electronics using the IoT Greenhouse hardware. Many STEM and DIY projects require you to understand DC current and voltage. Yes, physics classes do cover concepts, but typically lack practical knowledge and skill development. Without the ability to analyze basic electrical circuits, many struggle and either give-up or implement a solution that they don't understand. Even a basic understanding of electricity and electronics can make the difference and result in success.

This activity introduces concepts of current, voltage, and resistance. A meter is used to measure values using a the IoT Greenhouse hardware. Ohm's law and other circuit relationships are introduced.

Prerequisites:

Prior to beginning the instruction provided in this lesson you must have completed the following:

1. None

Performance Outcomes:

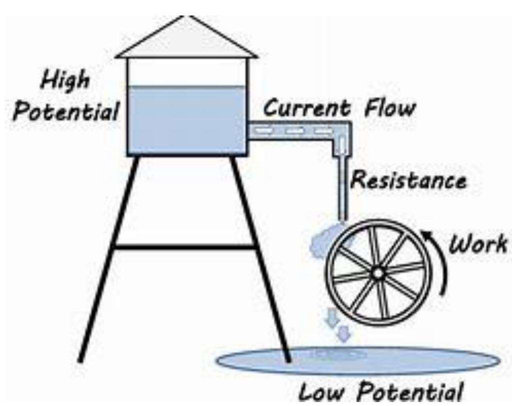
1. Visualize a model for voltage, current, and resistance
2. Check ratings on power supply
3. Use a meter to measure voltage
4. Use a meter to measure current
5. Use a meter to measure resistance
6. Use ohm's law
7. Determine power
8. Understand Raspberry Pi electrical characteristics and limitations

Resources:

1. IoT Greenhouse system including HDMI monitor, keyboard, and mouse
2. Multimeter

Activity:

1. The instructor will use the following image of a water tank to discuss the concepts of voltage, current, and resistance.



2. Inspect the power supply to your laptop or USB power source to the IoT Greenhouse. An example is below.

    a. What voltage level is available at the output?

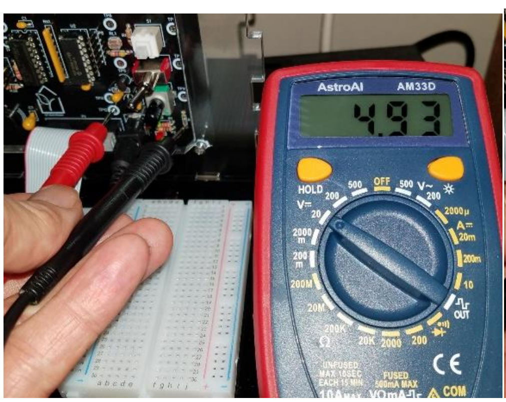
    b. What is the maximum current that can be supplied?

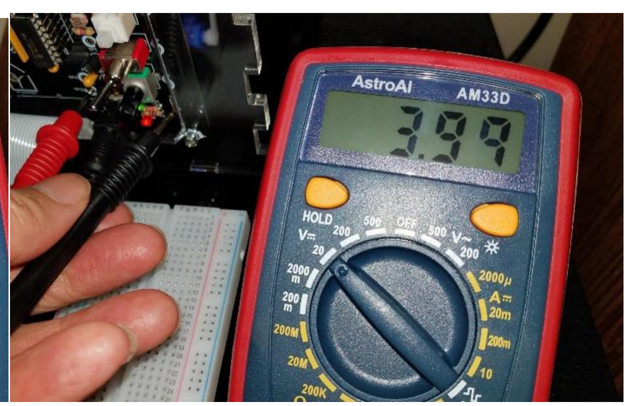
    c. If power is current multiplied by voltage, what is the power limitation of this power supply in Watts?

3. Set your multimeter to measure DC voltage up to 20 volts. See the image below.

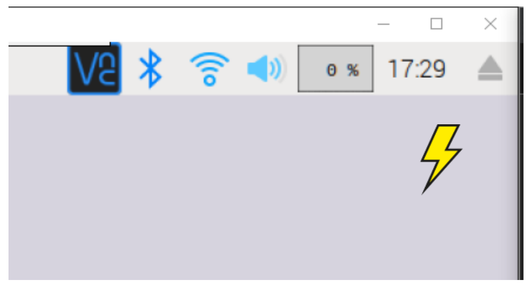
4. Measure the voltage being supplied by the USB power supply to the IoT Greenhouse by connecting the meter to the R0 reference point and test point TP12. What is your USB supply voltage?

5. Look at the samples below. What would you say about the quality of the USB power supply used in the image on the right?



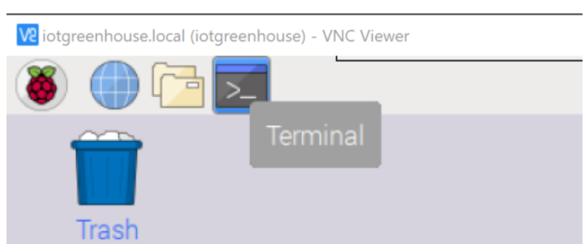


6. The USB power supply with low voltage shown on the prior page will likely not provide enough power for the Raspberry Pi. Connecting this supply to the PI would likely cause the red power LED to blink or be off, and a lightning bolt may appear in the upper right-hand corner of the screen.



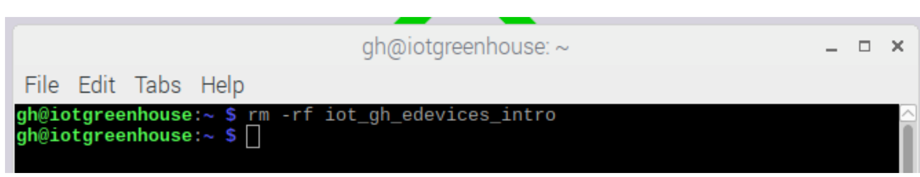
7. The low voltage does not impact the IoT Greenhouse control board. The board the voltage levels for control that the Raspberry Pi does, 3.3 volts. The input voltage from the USB power connection is regulated down to 3.3 volts. This voltage can be measured at TP11.
8. Next, you'll investigate the electrical characteristic of the IoT Greenhouse switches and LED lights by downloading

9. Boot the Raspberry Pi by applying power. Log in using the following credentials.
   a. User: **gh**
   b. Password:
10. Select the icon on the taskbar to open a Terminal window.



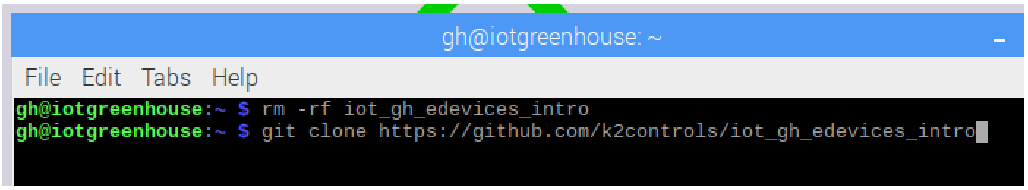
11. Enter the following command at the terminal prompt to remove any prior work associated with this introductory activity.

```
rm -rf iot_edevices_intro
```

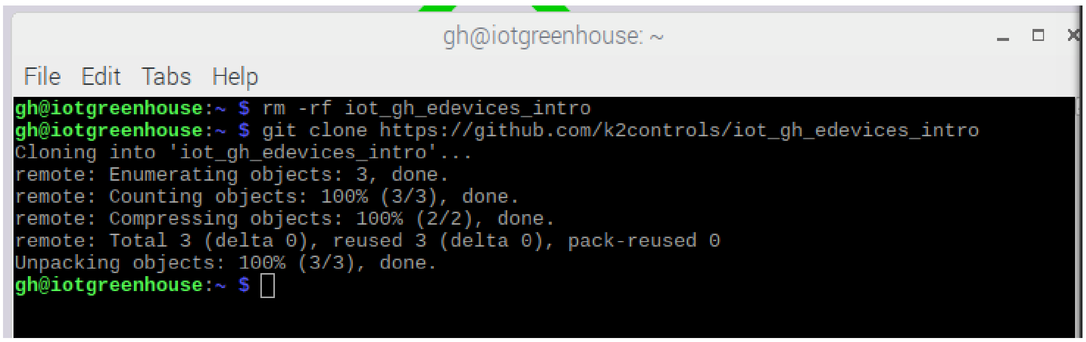


12. Enter the following command at the terminal prompt to create the initial Python code file for this activity.

```
git clone github.com/k2controls/iot_gh_edevices_intro
```

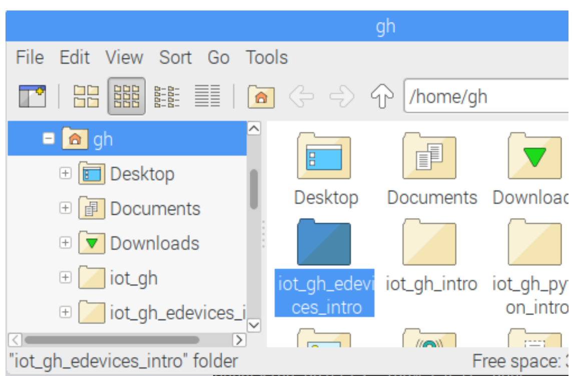


13. The required **iot_gh_edevices_intro** folder and file are created.

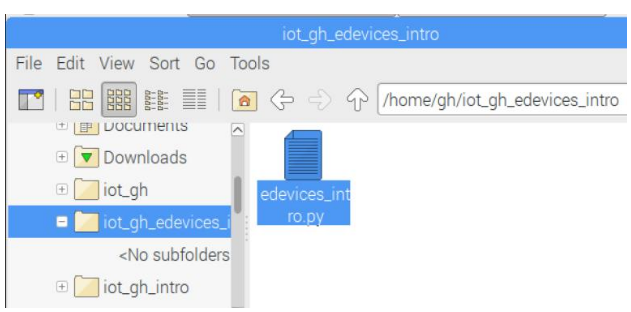


14. Close the terminal window.

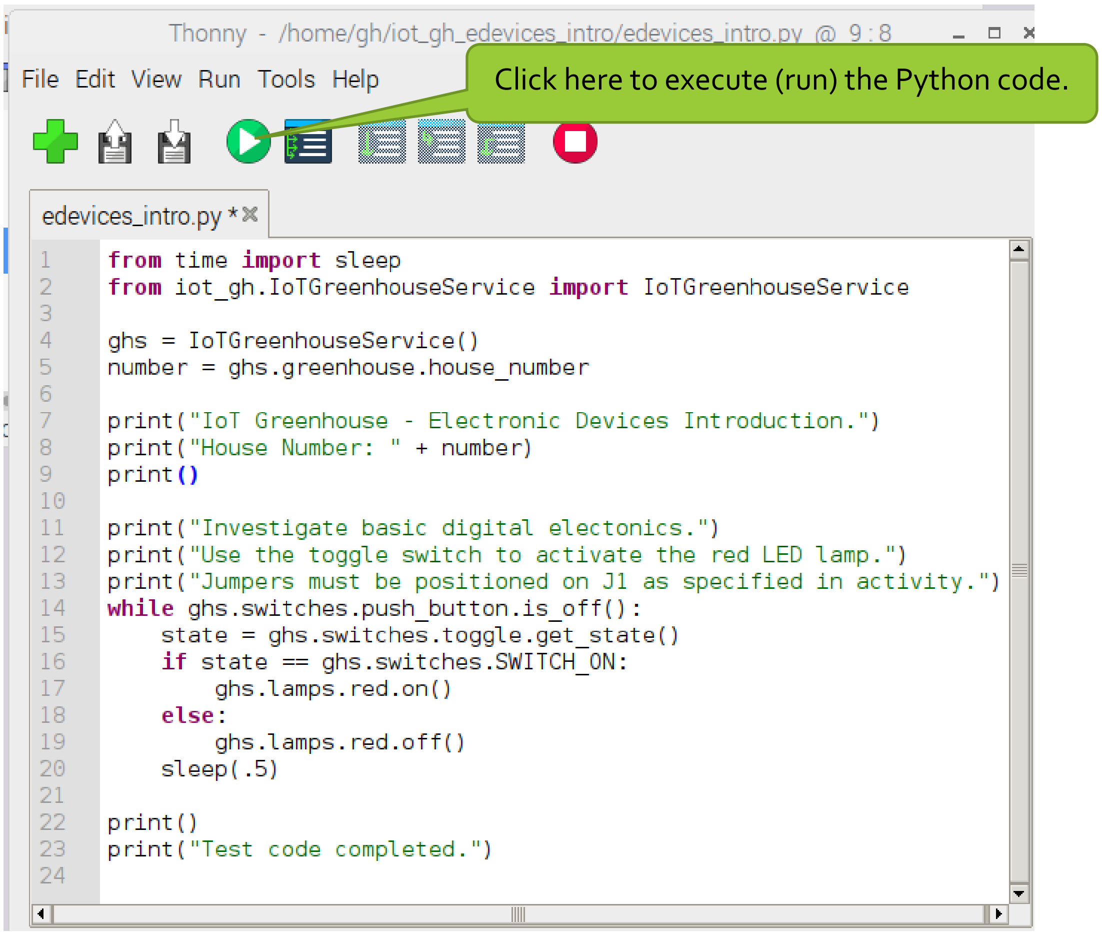
15. Open the File Manager window using the taskbar. A new **iot_gh_edevices_intro** folder is created.



16. Open the **iot_gh_edevices_intro** folder. It contains a single **edevices_intro.py** file that is used in this activity.



17. Double click on the **edevices_intro.py** file to open in the Thonny editor. Review the code and run.

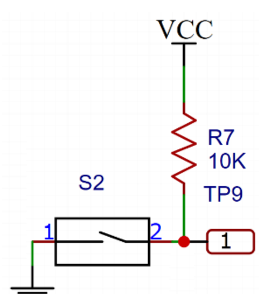


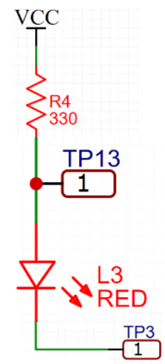
18. Move the toggle switch from off to on. The red LED should light.

19. Move the toggle switch to the off position (left) and measure the voltage at TP9. This voltage is supplied to the Raspberry Pi as a digital input. Anything more than around 2 volts is logic high value.

20. Move the toggle switch to the on position (right) and measure the voltage at TP9. You should read around 0 volts (or ground). This means the switch is active low. Turning the switch on sends a logic low value to the Pi.

21. The schematic for the switch is shown below. The instructor will review.





22. The schematic for the red LED is shown on the right. A 330-ohm resistor is shown but the value of this resistor can be selected by moving the jumpers on J1.
23. With the toggle switch off, measure the voltage at TP3 and TP13.
24. Vcc is 3.3 volts. Is there any difference in voltage across components in this circuit?
25. Turn the toggle switch on and again measure the voltages at TP3 and TP13.
26. What voltage does the Raspberry Pi output at TP3 to turn the LED on?
27. How much voltage is dropped across the red LED?
28. Determine the voltage drop across the 330-ohm resistor by subtracting the voltage at TP13 from the supply voltage, VCC.
29. The instructor will introduce Ohm's law. Use this equation to determine the current flowing through the LED when it is on.
30. The value of your currently limiting resistor is likely not 330 ohms. The value depends on the position of the jumpers on J1. Shut the Pi down and remove power to both the Pi and the IoT Control board.
31. All power to the unit must be off before you proceed.
32. Switch your meter to measure resistance up to 2000 ohms. Measure the current limiting resistor value by measure between TP 13 and TP11. What is your resistance?
33. Use Ohm's law to calculate the actual current flowing through your LED when it is on.
34. Research red LED on the web. What is the maximum current that a typical LED can handle?
35. Research the GPIO pins on the Raspberry Pi. What is the maximum current that any GPIO pin on the Raspberry Pi can source or sink?