Electronics Primer (Ver. 2.0)

Your Name _____

Partners' Names _____

_____

TA's signature allowing you to take the quiz or leave _____

Obtained reasonable experimental results?	yes ☐
Answered questions?	yes ☐
Cleaned your table?	yes ☐

Please turn off power of the Interface each time you put on and take off any wires to avoid damage to the device.

Introduction

To learn basic ideas of electricity, you need to know the practical tools and how they work. Some of procedures are not straightforward and require more knowledge than you learn in the lecture class. In addition, the basic skills you learn here can be beneficial in the future electronics labs. In this activity, you will be familiarized with how to make use of a breadboard, a multimeter (or other sensors), and circuit elements (resistors and capacitors). The breadboard is a substrate to implement a circuit. The multimeter measures the current going through the circuit, the voltage across a circuit element, and resistance of resistors. On the other hand, these tools can be useful for your daily life, such as knowing voltage from home outlets and checking a circuit whether or not the circuit works properly.

There are two types of power supplies. One is DC (Direct Current) and the other is called AC (Alternating Current). A DC power provides steady electricity and an AC power does constantly changing electricity. A cell battery is one of the DC power supplies. Electricity from home outlet is an AC power.

A multimeter has several modes for each purpose of measurements. The symbols labeled on the multimeter are, Ω, V, and A, and these represent a mode to measure resistance, voltage and current, respectively. For voltages and currents, the multimeter distinguishes DC and AC supplies. For DC measurement, you find a straight and dotted-line symbol besides V and A. For AC, a wiggled symbol can be found in the mode.

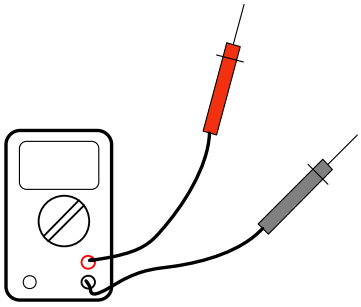
For AC power, an oscilloscope is a tool to see the voltage or current changes with respect to time.

It is also important to understand that measuring voltages needs a different method from measuring currents in a circuit element. A voltage can be measured with a parallel connection, but a current has to be measured with a series connection.

Objectives:

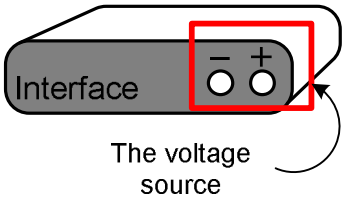
- To familiarize yourself with electronics equipment
- To master how to implement a circuit on the breadboard
- To master how to measure resistances, voltages and currents
- To learn about different power supplies (DC and AC)

1. Multimeter instruction and the power supply from the interface



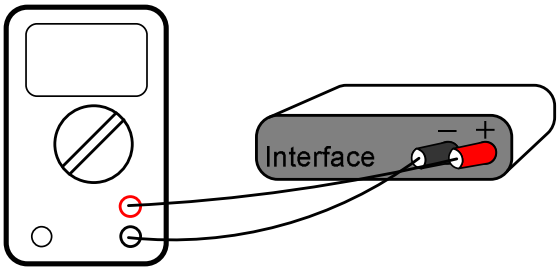
⇦ A multimeter looks like the figure. This can measure a voltage, a current, and a resistance.

The PASCO interface can also provide several types of voltage. ⇨



- Voltage measurement

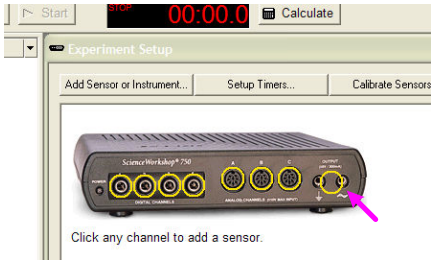
⓪ Set up the multimeter and interface as shown in the picture.



①Start up DataStudio and click "Create Experiment."

② Click the indicated circle in the right figure.

③ Then select DC voltage from the "Signal Generator."

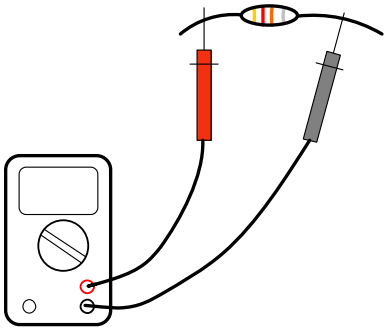


④ Change the "Amplitude" of the voltage and read the multimeter.

Voltage indicated in DataStudio	Reading from the multimeter
1 V	
2 V	
3 V	
4 V	
5 V	

Are the readings from the multimeter close to the output voltage?

- Resistance measurement (Select the resistance-measurement mode)



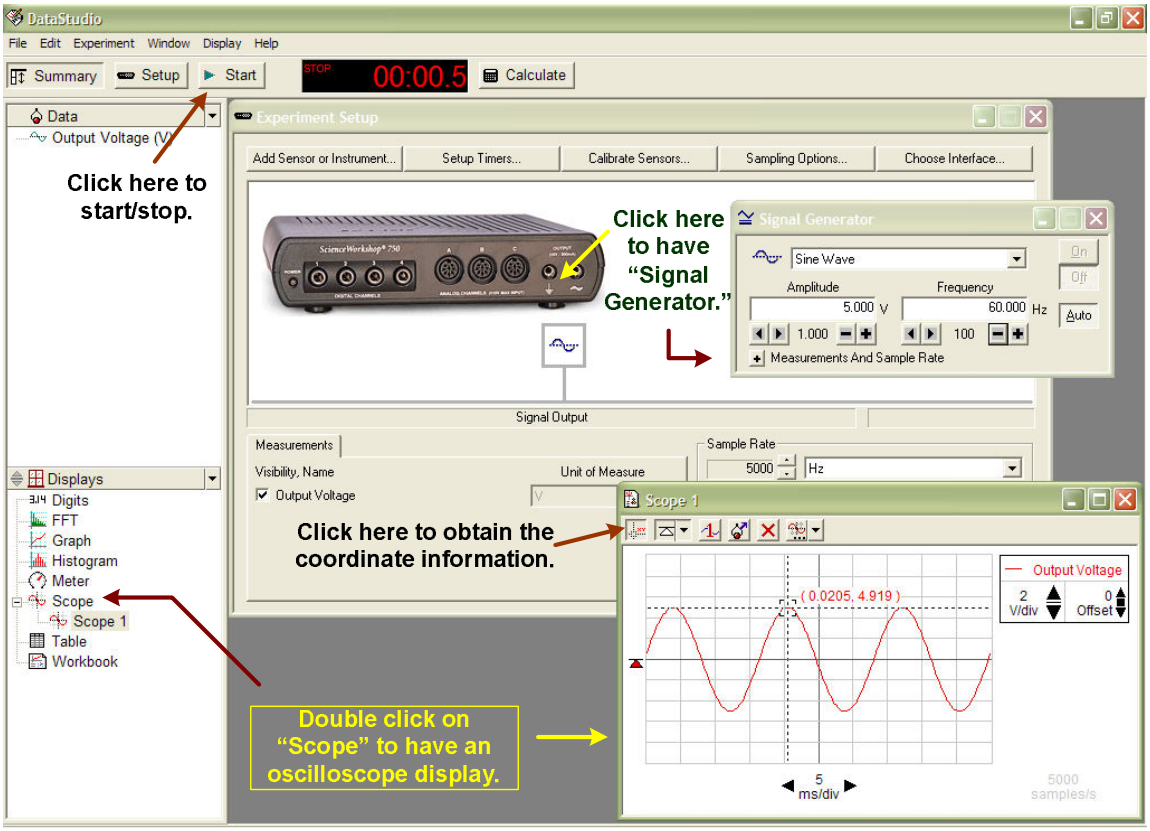
Write each color _____, _____, _____, Gold or silver
[Note: The set of colors varies with the value of resistance.]

What is the resistance from the multimeter?

_____ (Ω)

2. Oscilloscope with various voltage sources:

① After starting up DataStudio and clicking “Create Experiment”. Follow the picture instruction below to have oscilloscope.

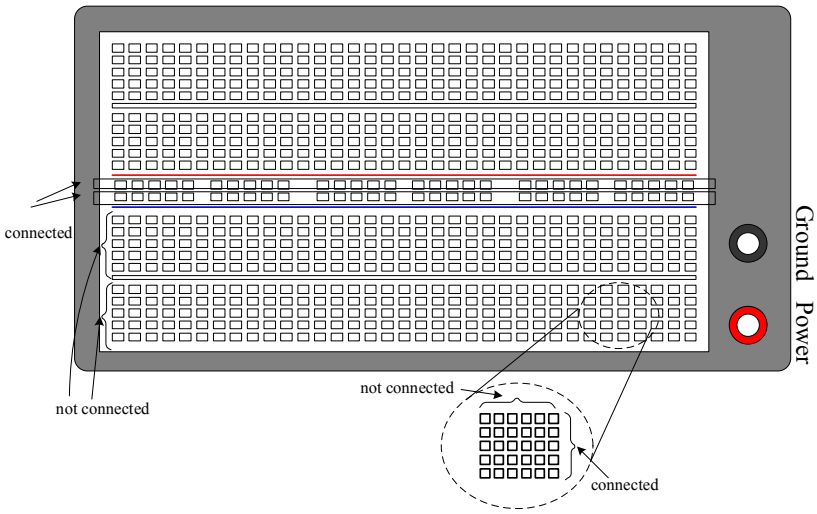


② Select “Sine Wave” (AC voltage) from the signal generator. Try following conditions. Draw the pictures by looking at what the scope shows.

Amplitude = 5 V Frequency = 60 Hz	Amplitude = 2 V Frequency = 60 Hz	Amplitude = 5 V Frequency = 120 Hz

Compare the above graphs. When you increase (decrease) the amplitude, what will be the visual change? When you increase (decrease) the frequency, what will be the visual change?

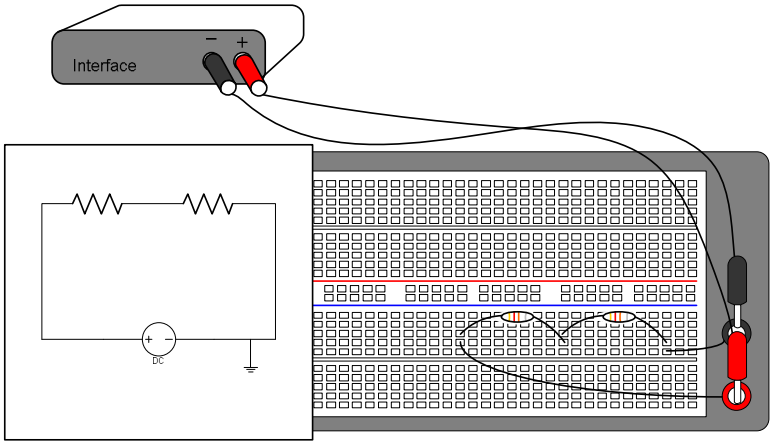
3. Breadboard instruction



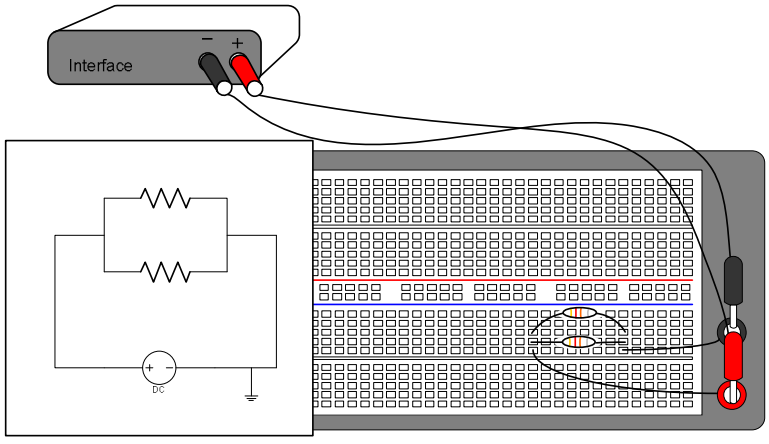
This is called a breadboard. There are one power connection and one ground. As you can see, five holes consist of one unit. These are connected and a different unit is disconnected from the other.

A resistor looks like this. It is one of the circuit elements.

Examples:

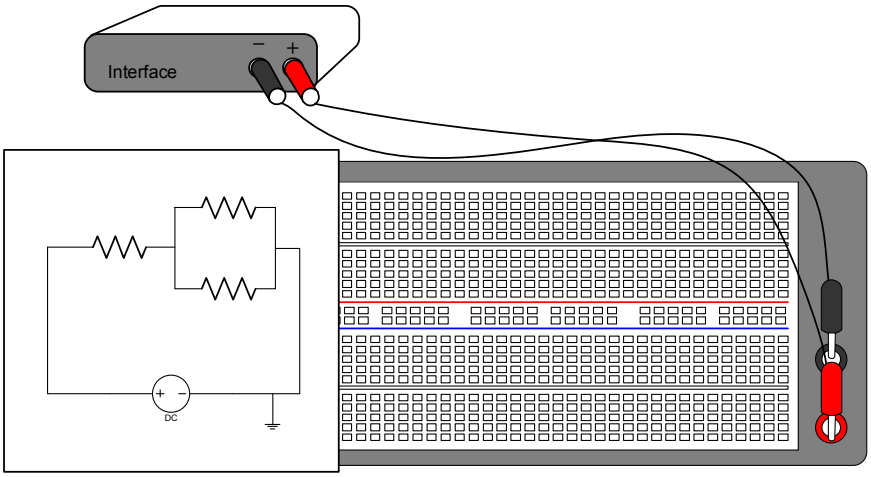


This is a series connection of two resistors. Check out which hole each terminal is plugged in.

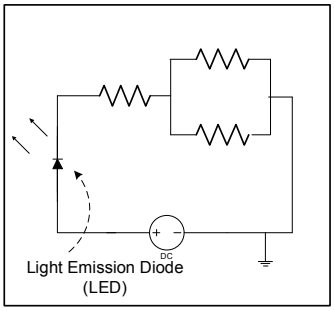


This is a parallel connection of two resistors.

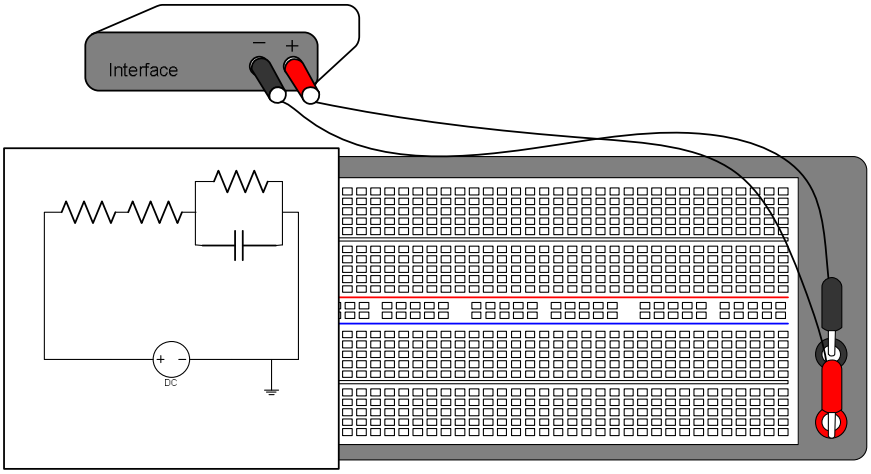
Now, it's your turn!



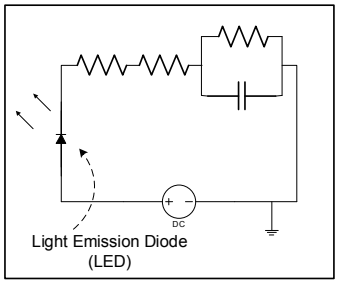
Draw pictures on the figure of the breadboard. Then, implement the circuit on the real breadboard.



After doing the above, why don't you include a LED which gives you light when the circuit is connected properly? Try it by connecting it to a power supply. The diagram is following:



Draw pictures on the figure of the breadboard. Then, implement the circuit on the real breadboard.



After doing the above, why don't you include a LED which gives you light when the circuit is connected properly? Try it by connecting it to a power supply.The diagram is following:

Show the pictures and circuits implemented on the board to your TA.

TA's signature

4. Voltage and current measurement

When a voltage and a current are measured, the way you set up each sensor is different. The voltage and current sensors below can be replaced by a multimeter with voltage and current modes.

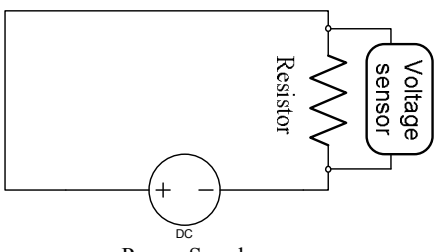


Fig. 1

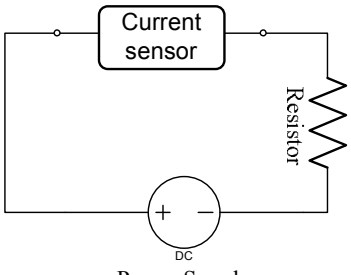
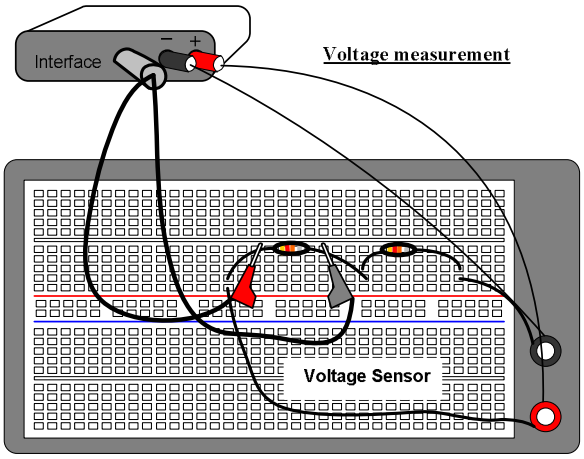


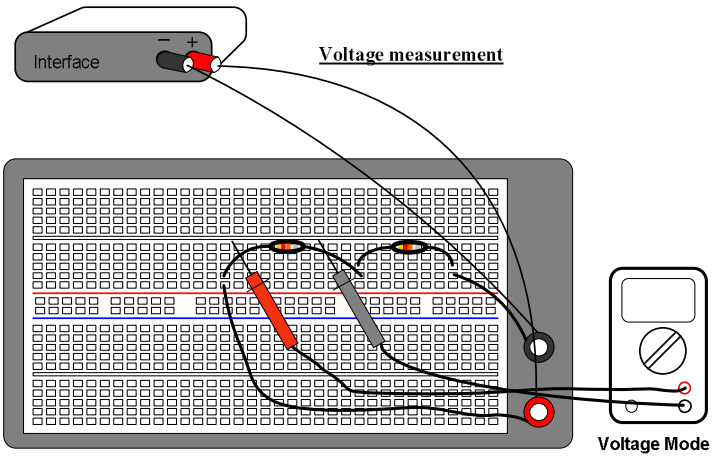
Fig. 2

In the voltage measurement across the resistor, the voltage sensor (or multimeter) has to be set as shown in figure 1. The current measurement is different. The current sensor (or multimeter) must be connected in series as shown in figure 2.

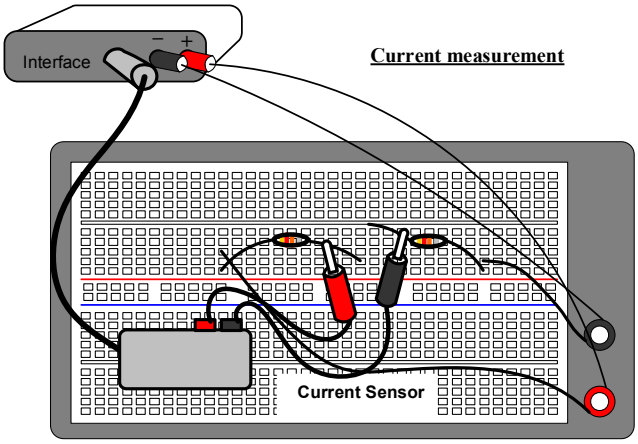
- **Practical measurement of voltage and current**

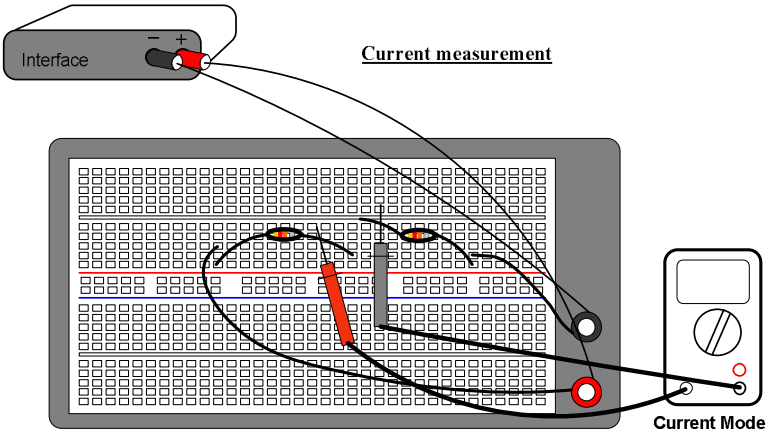
When you measure the voltage across one resistor, you put the probes as shown (the left figure uses PASCO voltage sensor, and the right figure uses a multimeter):





When you measure the current through the circuit, you have to take out a terminal of a resistor to connect the current sensor in series as follows (the left figure uses PASCO current sensor, and the right figure uses a multimeter):

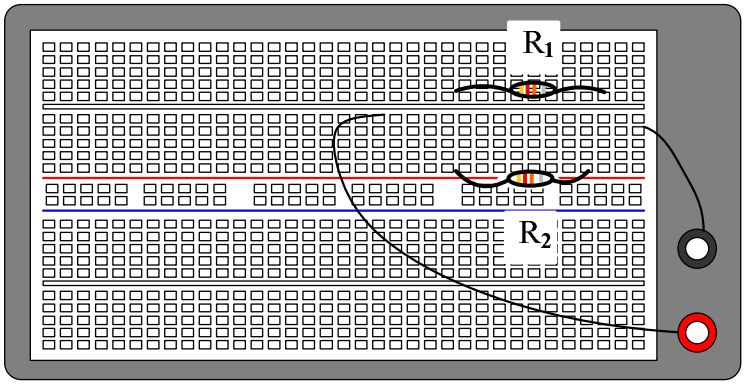




Instruction of answering following questions

The circuits are supposed to be parallel connections of two resistors. What you have to do is to **draw** an extension of the wires **on the following pictures** to complete the circuit. Think about which hole can be used. **Draw the sensor or multimeter**, and then, **implement** the circuit on the **real breadboard**. **See the above example and guess the connections for the parallel case.**

❶ Measure the voltage across R_2. ⓘ The following circuit is **incomplete!** **Draw the wiring and sensors first, and then implement circuit on the board.** . (Hint: Connect the resistors, a power supply, and a ground properly. Then, put the probes across the resistor R_2.)



❷ Measure the current going through R_2. ⓘ The following circuit is **incomplete!** **Draw the wiring and sensors first, and then implement circuit on the board.** . (Hint: Pull out the wire, which is going to the ground, from the breadboard. Then, connect the probes of a current sensor or a multimeter in series, namely, between one wire of R_2 and the ground.)