# Electronics Lab #1

Ohm's Law and Simple Circuits

In this laboratory, you will verify Ohm's law V=iR   where V is the voltage, i is the current and R is the resistance. You will learn how to make voltage, current and resistance measurements with a VOA meter. You will learn the resistance color code and make an inventory of the resistors in your parts kit.

Batteries and Power Supplies

Batteries or power supplies in the lab are sources of electrical potential and are measured with voltmeters. The unit of electrical potential is the volt.   The symbol for a single cell battery is
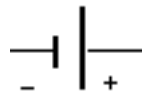
The longer side is positive and the shorter side is negative. Your instructor will show you how to measure the voltage of a dry cell battery and your power supply using a VOA (volt-ohm-ammeter). Make sure

1. the meter it's dial is to measures "volts"

2. the dial is set to a "scale" larger than the expected voltage (otherwise
    the meter reads "overload" and does not give a number. If you do not know what voltage to expect, it is   safest to start with the dial at the highest scale and work down.

3. the red and black "probes" are in the proper sockets (common and voltage). If
    the probes are in the current sockets you will not get a proper
    measurement.

The voltmeter is connected thus to make the voltage measurement
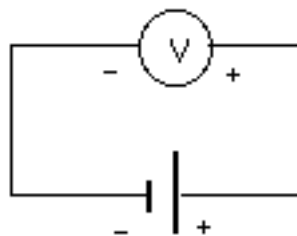
Notice the positive + side of the meter is attached to the positive + side of the cell or power supply to give a positive voltage measurement. If the leads on the voltmeter are reversed, the voltage read is

negative. What is the voltage of the power supply in PHYS 222? Measure it and see. Record the number below:

_____ Volts

  Two or more cells can be connected in series to increase the available potential. For example, the voltage of two equal 1.5 volt cells placed in series
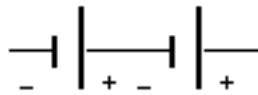
yields the a power sources equivalent to 2×1.5volts=3.0 volts. The two cells are considered in series because the same current goes through each cell.

Resistance and Resistors

        Resistors are physical devices having resistance or the ability to oppose the flow of current. Resistance is measured with an ohmmeter and the unit of measure is the ohm. Your parts kit has roughly 30 resistors which are cylindrical in shape and have two wires connected to a carbon material that supplies the resistance.

        There are three colored bands indicating the resistance of the resistor. The first two bands indicate the "significant digits" and the third band indicates the "power of 10" of the resistance. The resistor marking scheme or color code is

0	1	2	3	4	5	6	7	8	9
black	brown	red	orange	yellow	green	blue	violet	gray	white

        For example, you should have a resistor in your parts box having a brown band, black band, and red band. You should interpret this as (1) for brown, (0) for black, and (2) for red and the resistance of the resistor is (approximately)

$$10 \times 10^2 \text{ ohms } = \ 10 \times 100 \text{ ohms } = 1,000 \text{ ohms } = 1 \text{ k}\Omega \tag{1}$$

k is shorthand for kilo- or one thousand and Ω is the symbol for the unit of resistance. $1\text{k}\Omega = 10^3 \ \Omega$ Larger resistance are written in terms of Megohm=$10^6\Omega$. You can measure the resistance of the resistor with an ohmmeter connected in series with the resistor
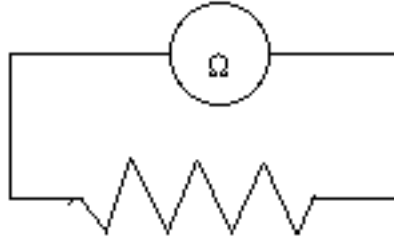
IMPORTANT NOTE: WHEN YOU USE A OHMMETER TO MEASURE A RESISTANCE, THE RESISTANCE MUST BE (1) REMOVED FROM THE CIRCUIT AND (2) DISCONNECTED FROM THE BATTERY OR POWER SUPPLY. OTHERWISE, YOUR READING WILL BE INCORRECT. WHY?

When you actually measure the resistance of the above resistor, you probably will NOT get EXACTLY 1,000 ohms and instead you will something like for example 960 ohms. The reason is that the resistances in your parts box only are guaranteed to approximately agree with the first three bands of the color code. There is actually a fourth band called the "tolerance" which if gold is 5% and if silver is 10%. Suppose your 1 kΩ has a silver fourth band, then the tolerance is 10%. Now 10%=0.1 so the uncertainty in the resistance is 0.1×1,000=100 ohms. The resistance you measure can be anywhere between 1,000-100=900 ohms and 1,000+100=1,100 ohms. The resistance is usually stated 1,000±100 Ω.

A second example, is (5) green, (4) yellow, and (3) orange which means the resistance is

$$54 \times 10^3 \text{ ohms} = 54 \times 1000 \text{ ohms} = 54 \text{ k}\Omega \tag{2}$$

If the tolerance band is gold or 5% then 0.05×54,000 is 2700.

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0.05 × 54 000

2700.
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So you can expect the resistance you measure to be in the range

(54 ±2.7) kΩ

Resistance Inventory

Make a list of the resistances you have been given in your parts box. Record the value of the resistance according to the first three bands. Also include the uncertainty in the resistance according to the fourth band or tolerance. Finally, actually measure the resistance with the ohmmeter. Does the ohmmeter measured agree with the theoretical resistance if you include the tolerance? NOTE: All your work in

PHYS 222 Electronics Lab should appear in your lab notebook.

Current Measurements

You learned Ohm's law in the Introductory Physics Course PHYS 120/121 and this was also discussed in the Electronics Lecture part of the course PHYS 221. Ohm's law for the simplest circuit
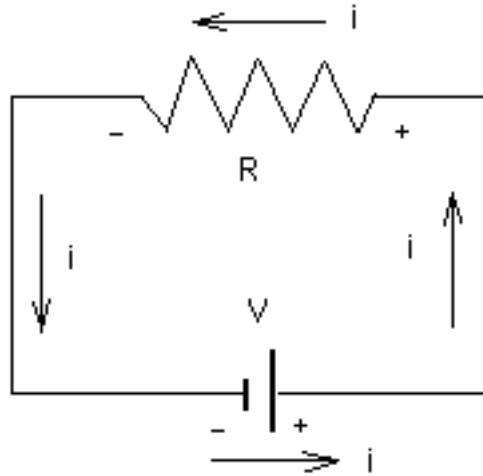
The current i is the same value in each element of the above circuit. There are two places to place the ammeter in the above circuit: One place is indicated below.
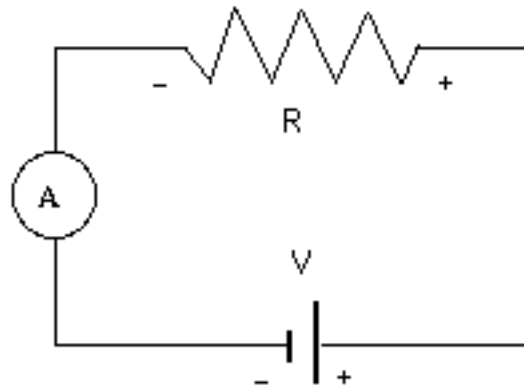
Suppose R=1,000 Ω and your power supply has a voltage V=12 Volts. Ohm's law gives a current

$$i = \frac{V}{R} = \frac{12 \, \text{Volts}}{1000 \, \Omega} = 12 \times 10^{-3} \, \text{A} = 12 \, \text{mA} \tag{3}$$

where mA=10^{-3}Amps. This calculation will roughly give the value you measure with the ammeter. However, your resistance will NOT be exactly be 1000Ω and your voltage will NOT be exactly 12 Volts so your answer will be a little different. What value did you get for the current theoretically? What value

did you get from the ammeter? Do the two values of the current agree?

Calculated (Theoretical) Current: _____ Amps

Measured Current: _____ Amps

Note the ammeter measurement has some experimental uncertainty as well. This is true even though the digital meters have a large number of significant digits. All these significant digits are not meaningful. What is the uncertainty in your meter according to the manufacturer?

Meter Uncertainty: _____ Amps

Laboratory Work

Calculate the theoretical current and the measured current for each of five resistors (in your parts box) connected to your voltage source. In each case, does the theoretical current agree with the measured current to within the theoretical uncertainty?