Laboratory 1:
Resistance, Current and Voltage

EQUIPMENT

A voltage source, voltmeters, ammeters,
Pick three different resistors from the available resistors

OBJECTIVE

The objectives of this laboratory are for the student to calculate, implement and measure resistance, current and voltage. In doing so the student will for the first time gain experience using the test and measuring equipment provided for the laboratory.

PROCEDURE

PLEASE READ THE PAGES AT THE BACK OF THIS HANDOUT

Part 1: Ohm's Law

You need to calculate the value of all the three resistors supplied using their colour-code and fill in the table accordingly. When reading resistors there is a figure for tolerance (the percentage error that this device is allowed to have). You can get the max and the min resistance values by taking the nominal "official" value and adding/subtracting the tolerance percentage.

You may measure the resistance by constructing a circuit with a supplied voltage of 5 Volt, a voltmeter and an ammeter. The circuit you need is shown below (Figure 1). Using ohm's law, calculate the real resistance (measured resistance) of the device and fill in the table shown. You must use an ammeter and a voltmeter to take your measurements. **DO NOT USE AN OHMMETER.**

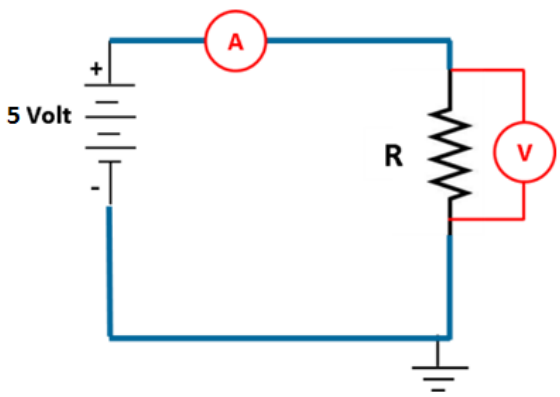

Figure 1

	Resistor Colour-Code	Colour-Coded Resistance	Colour-Coded Tolerance	Max Coded Resistance	Min Coded Resistance	Measured Resistance	Is the resistor within Tolerance
R_1							
R_2							
R_3							

Part 2: Resistors in Series

Part 2.1 On your bread-board connect the circuit shown in Figure 2. Calculate and then measure the total resistance. Show your calculation.

Calculated R_{total} =____

You may measure the resistance using the method from Part 1.

Measured R_{total} =____

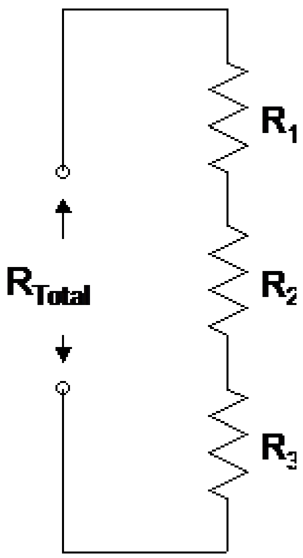

Figure 2

Part 2.2 Connect the circuit in Figure 3. Note that this circuit is the same as in Figure 2, except that there is now a DC supply voltage connected. Set the voltage source to 5.0 volts.

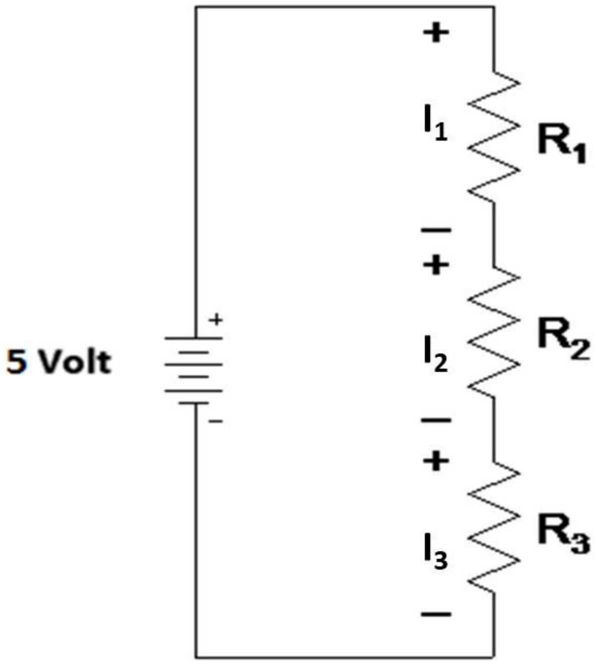

Figure 3

Break the circuit between the **POSITIVE side of the battery and resistor R_1**. Insert the ammeter and measure and record the current flow through this point.

$I_{R1\text{-}TOP}$ =____

Now do the same for the points between the other resistors and the **resistor R3 and the negative side of the battery**.

$I_{R2\text{-}TOP}$ =____________________________________

$I_{R3\text{-}TOP}$ =_______________________________

$I_{R3\text{-}BOTT}$ =_______________________________

What conclusions can be made from these results?

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Part 2.3 Connect the circuit of Figure 3. Set the DC supply voltage to 5.0 volts.

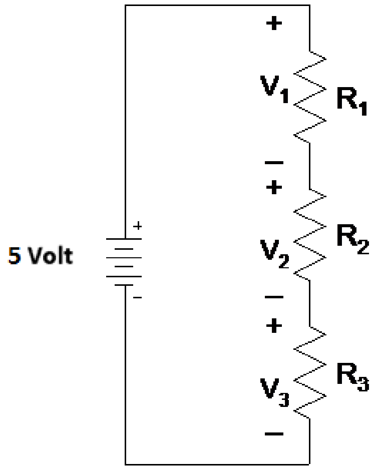

Figure 3

Measure the voltage drop across each resistor. Record.

V_1 =___________________________

V2 =___________________________

V3 =___________________________

Add the voltage drops together and record.

Total of voltage drops =_______________________

What conclusions can be made from these results?

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Part 3: Resistors in Parallel

Part 3.1 On your bread-board connect the circuit shown in Figure 4. Calculate then measure the total resistance. Show your calculation. For the measurement you may use the same technique as per question 1.

Calculated R_{total} =________________________________

Measured R_{total} =_________________________________

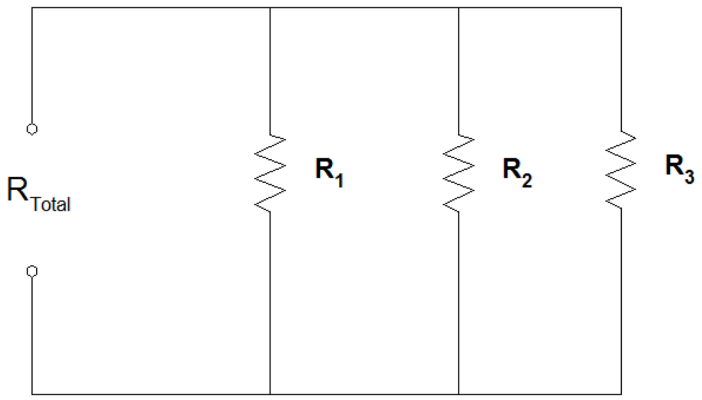

Figure 4

Part 3.2 Connect the circuit in Figure 5. Make sure that the source voltage is properly set to 5 volts with the circuit connected. Measure the current through each resistor and the total current. Record below.

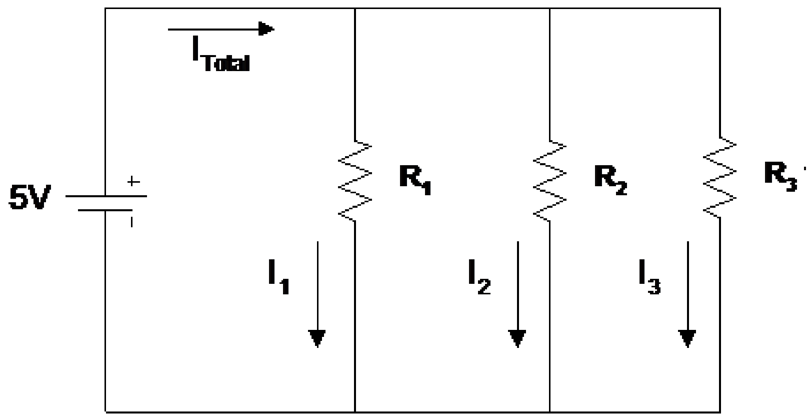

Figure 5

I_{R1} = ________________

I_{R2} = ________________

I_{R3} = ________________

I_{total} = ________________

Add the measured currents through R_1, R_2, and R_3 together and compare with the measured total current. Record the sum of measured currents.

I_{total} ______________

What conclusions can be made from the above procedures?

____
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Part 3.3 Connect the circuit in Figure 6. Adjust the voltage source to a value of 5 volts (with the circuit connected). Using the voltmeter, measure the voltage across each resistor. Record below.

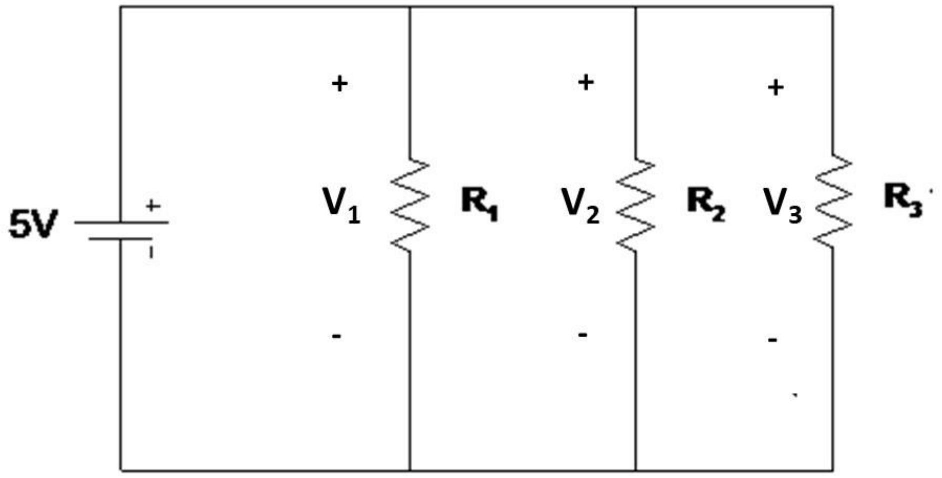

Figure 6

V_{R1} =________________

V_{R2} ________________

V_{R3} ________________

What conclusion can be made from these procedures?

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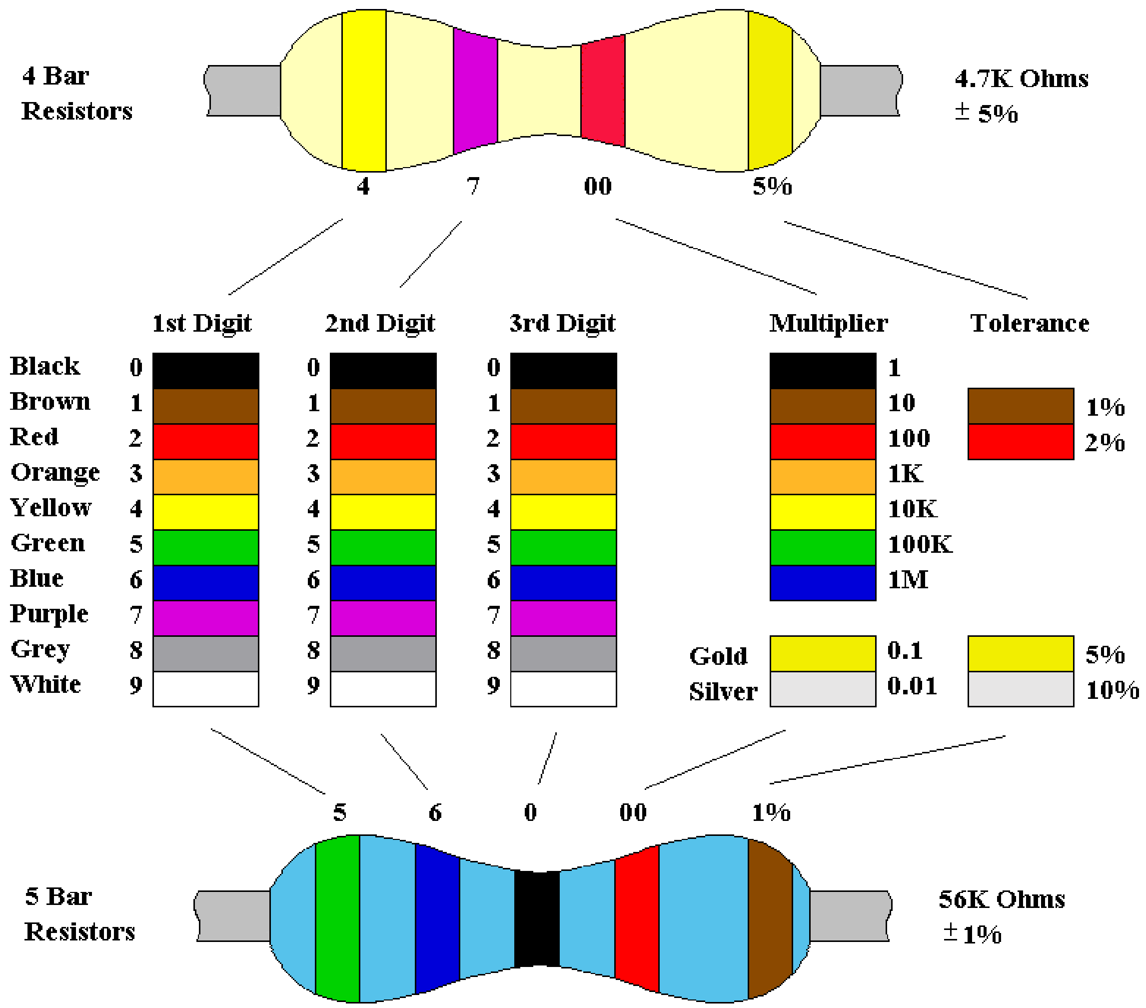
____
____
____
____

Information

1. Always use the measured value of resistance for all calculations.
2. Always adjust the power supply voltage with the circuit connected.
3. When measuring voltage, the voltmeter must be connected across the circuit.
4. When measuring current, you must **break the circuit** and the current meter must be inserted into the circuit (in series).
5. Remember the resistor colour-code!



Notes on using Breadboards and Wiring

Safety Considerations

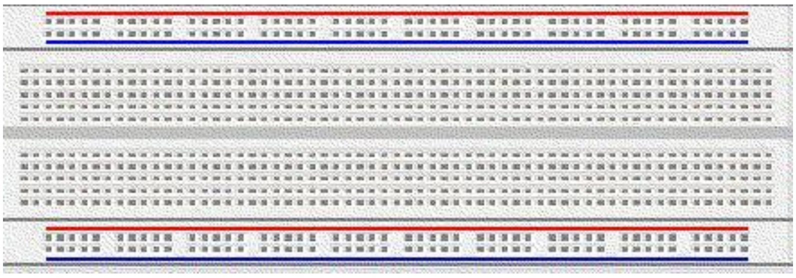
In these labs, there should be no dangerous voltages and currents involved. However, you should still use common sense when dealing with electricity. The biggest hazard is the 220V AC voltage at each socket. If you see any damaged plugs, power cords, or equipment, then notify the instructor or technician. Also if you see sparks, smell burning, or get an electric shock (no matter how small), notify the instructor or technician.

Here are some other safety considerations:

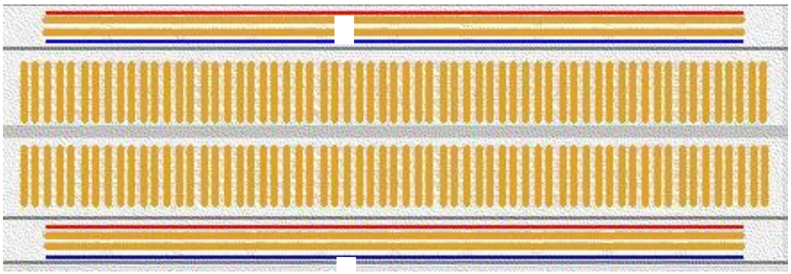
- Be careful inserting and removing plugs. Do not pull on the cord.
- When making connections on your circuit board, make sure the power is off. Only switch power back on when you think your circuit is correct.
- Do not touch bare wires and parts, unless the power is off.
- Do not work when your skin is wet.
- Do not place food or drink on your bench.
- Be very careful to observe polarity of electrolytic capacitors as they can and do explode violently if connected the wrong way.
- Be aware that electronic components such as resistors can get very hot.
- Be careful with sharp objects such as wire-ends.
- When using a Digital Multimeter, make sure its dial is at the correct setting. If measuring current, set it to “A” first. Similarly, with ammeters and voltmeters, set them to the largest setting first. This prevents the instrument from getting damaged.

Breadboarding

In your leads kit, you will find a breadboard. It consists of lots of holes where you can plug in components such as resistors and wires, in order to build circuits. Note carefully the way in which the holes are connected.

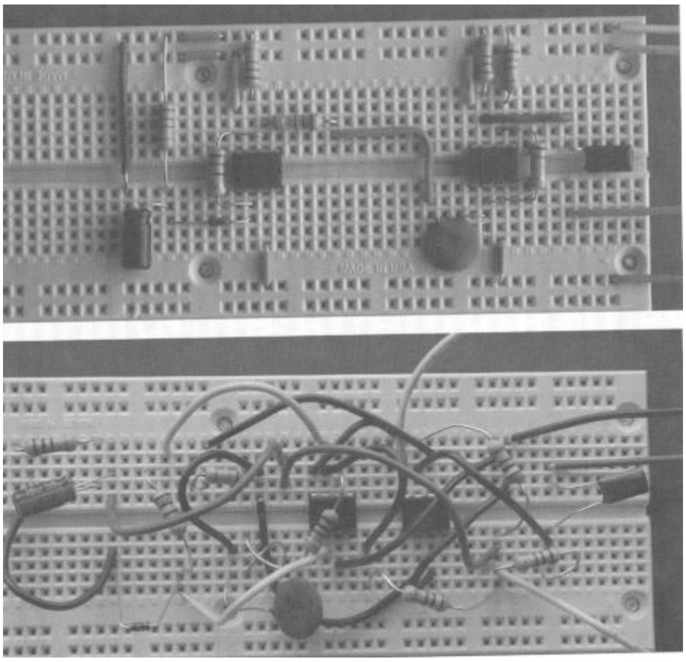


Top View



Internal Copper Connections

It is important to get into the habit of making neat well-laid out circuits. If a circuit is well laid out, it is less likely to contain mistakes.



Breadboarding Tips

- Use connections as short as possible. Long wires contribute to messiness and can cause interference through undesirable capacitive, inductive, or electromagnetic interaction with other parts of the circuit. (This suggestion does not imply that you need to cut each wire exactly to size; for this lab, it will be sufficient to choose the right length among several pre-cut wires commonly found in a lead kit.)

- Keep wires down, close to the board's surface.

- As a rule, if you can connect components such as resistors or capacitors directly (without extra wires connected to them), do so.

- Plug in chips so that they straddle the troughs on the proto board. In this way, each pin is connected to a different hole set.

- Do not pass wires over components (or over other wires, if you can avoid doing so without significantly lengthening a connection). This makes the circuit difficult to figure out, and it makes it difficult to remove a component if you have to replace it.

- Be sure that bare wires or component terminals are clear of each other so that they cannot become accidentally shorted together if something is moved.

- Do not use more wires than you have to. The more connections, the more likely it is that something can go wrong (e.g., a wiring error can occur, or a connection in the proto board can be loose).

- Use color coding for your wire connections (e.g., **red** for all wires connected to the positive power supply and **black (or green)** for all wires connected to "ground"). This makes it easier to inspect and debug the circuit.