PHYS245 Lab: Resistors in parallel and resistors in series

Purpose

- Understand parallel and series circuits
- Use DMM as Ammeter or Voltmeter in d.c. circuits
- Understand combination rules.

Equipment list: ELVIS II, three 330 Ω resistors, and jump wires, cable with banana plugs, and banana-to-minigrabber cables.

You will be given three identical resistor Build a circuit in which the resistors are in series, and measure the voltage on each resistor, using the DMM as an Voltmeter. You will also put them in parallel, and measure the current through each branch, using the DMM as the Ammeter. Compare your results with related theories. Then you will construct a more complex circuit with both series and parallel resistors. Measure the voltage and current for each resistor in the circuit, and compare with the calculations using combination rules.

Yi Ji
Dept. of Physics and Astronomy
University of Delaware

Pre-Lab exercise

Thoroughly read through this brochure. For experiment I, II and III, sketch the wirings and the placement of the resistors on the picture (on page 3) of the prototyping board. You can print out multiple copies on the picture, and use one copy for each circuit.

For the following three circuits, calculate the current through each branch, and the voltage across each resistor.
The resistance of each resistor is 330 Ω

R = 330 Ω
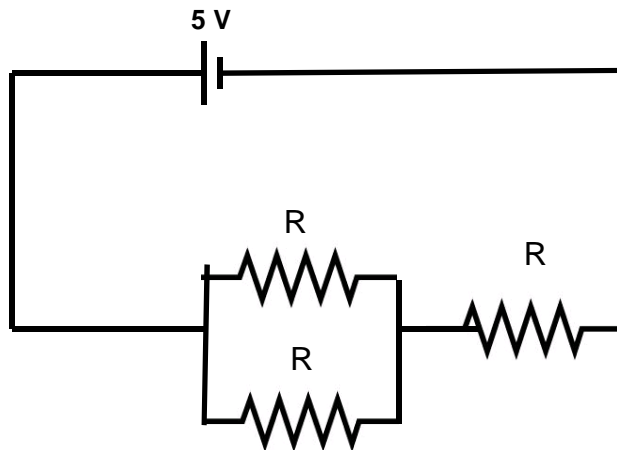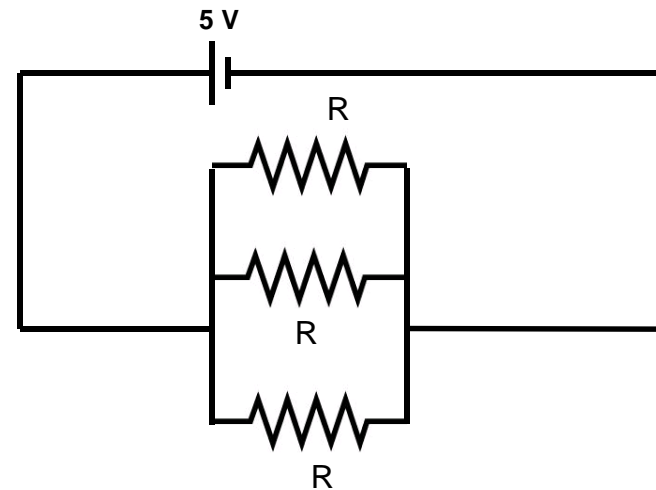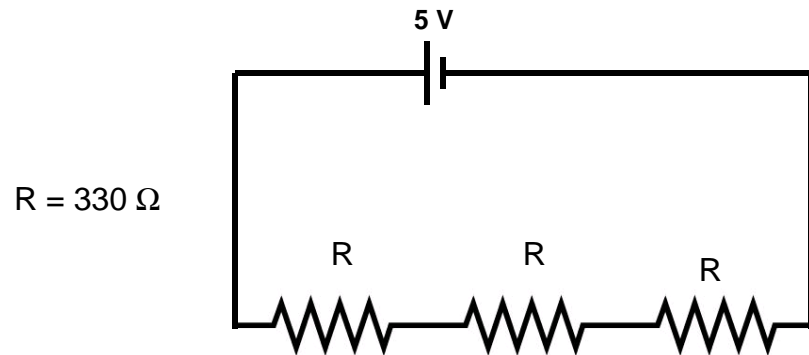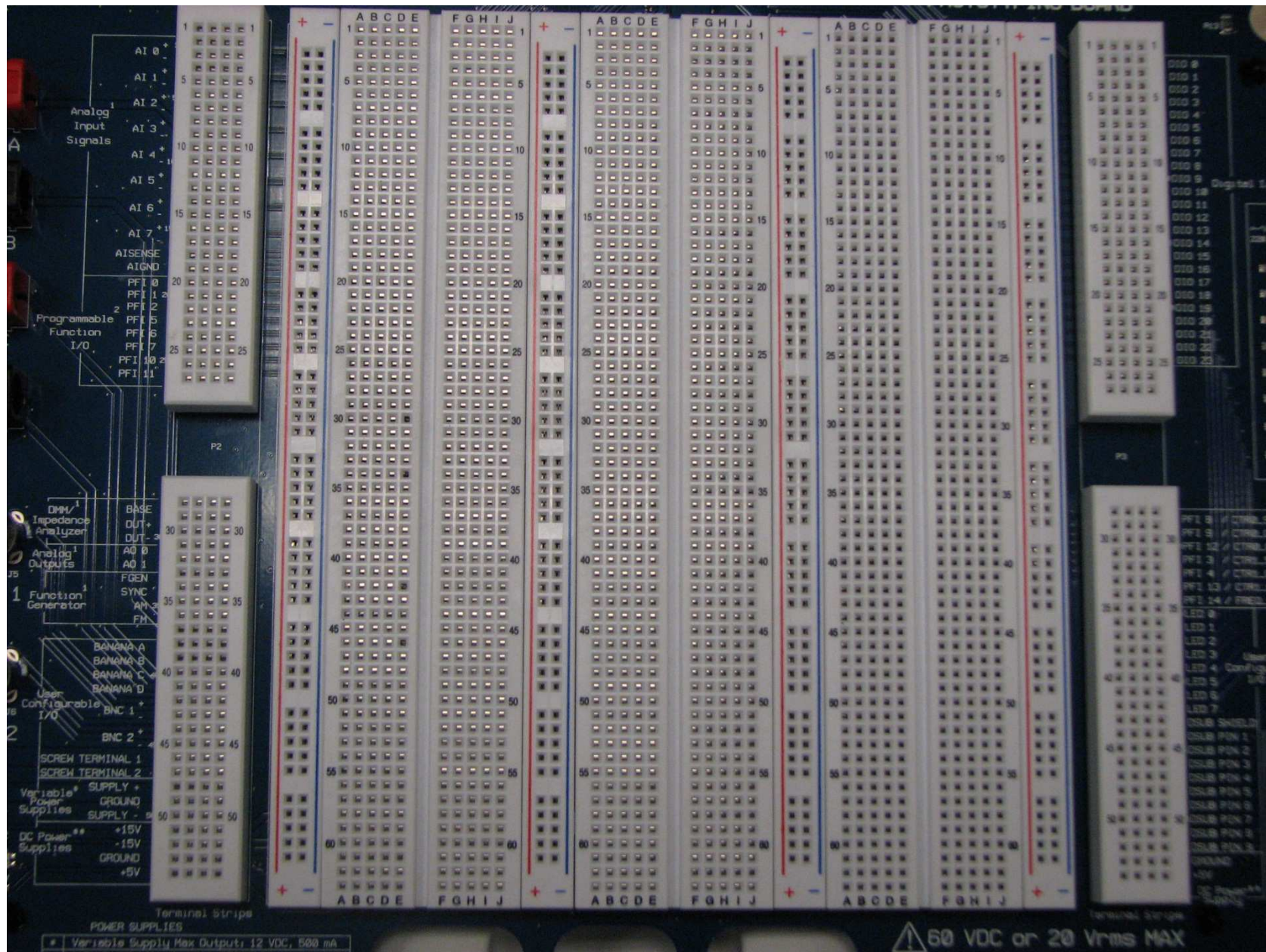
Experiment I: Identical resistors in series

Put three identical resistors in series and connect them the 5 V power supply. Measure the voltage on each resistor using the DMM as a Voltmeter. Connect the circuits according to the diagram shown below. Measure the voltage. Do the same measurement for each of the three resistors.
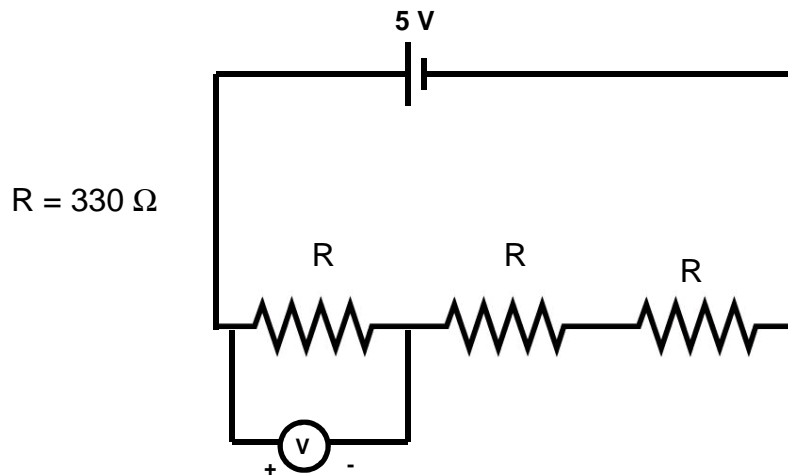
Since you have had some experiences with ELVIS II, pictures for circuit connections will not be given to you for this experiment. Translate circuit diagram on the left to the actual connections on ELVIS II by yourselves.

5 V

$R = 330\ \Omega$

For voltage measurement, the Voltmeter has to be put in parallel with the resistor to be measured.

R   R   R

Reminder for using DMM as a voltmeter: Route the voltage signal to banana plugs A and B, and use the cables with banana plugs to connect between A and B to the appropriate terminals on the DMM.

V
+   -

Compare the measurement results with the calculations in Pre-Lab

When you complete measuring all three resistor, try to answer the following questions:
1.   What is the sum of all three voltage values?
2.   Are the three voltages equal to each other?
3.   Are these results consistent with theories for resistors in series?

Yi Ji
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Now, you can proceed to measure the current in the circuit, according to the circuit diagram shown below. For resistors in series, the current is the same for each resistor in the branch. So you only need to do one measurement for the current. Compare the measurement with the calculation in Pre-Lab

5 V

- A +

R   R   R   R = 330 Ω
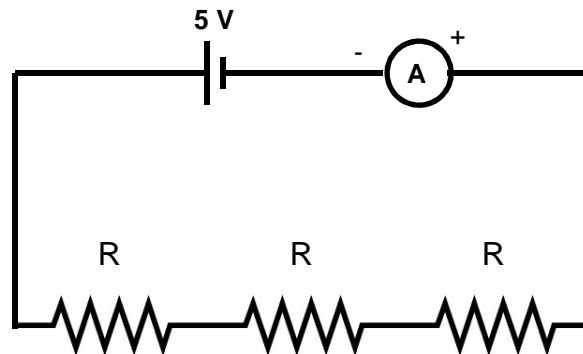
Note: Remember to switch the cable with banana plugs between different terminals of the DMM when you switch between Ammeter and Voltmeter capabilities.

When you complete the current measurement, try to answer the following questions:
1. What is the equivalent resistance for the three resistors in series?
2. If you multiply the current measured and the equivalent resistance, what voltage value do you obtain?
3. Divide the voltage you measured for each resistor (in the previous page) by the current you measured here, what resistance value do you obtain?
4. Are these results consistent with the theory for resistors in series?

Experiment II: Identical resistors in parallel

Put three identical resistors in parallel and connect them to the 5 V power supply. Measure the current in each resistor using the DMM as a Ammeter. Then measure the total current through the power supply. Compare the experimental results with the calculations in Pre-Lab

R = 330 Ω
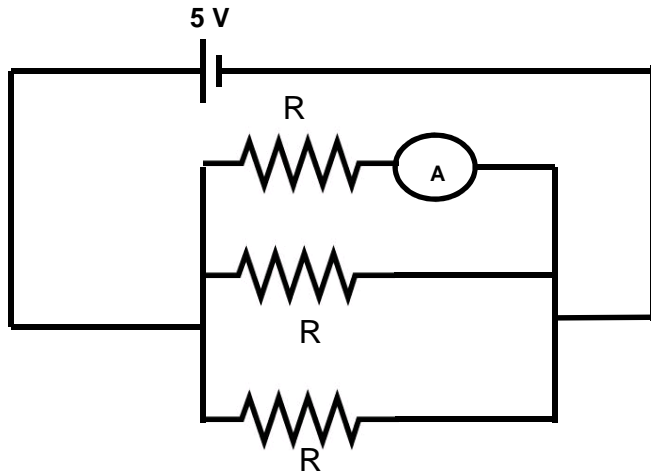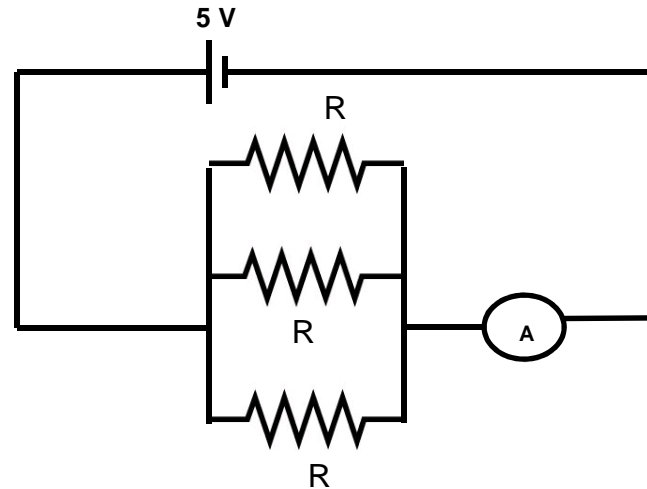
The above circuit diagram indicates the measurement of current through one resistor. Measure the currents through the other two resistors as well.

Use the above circuit diagram to measure the current through the power supply.

Answer the following questions:
1. What is the sum of the currents through the three resistors?
2. Is it equal to the current through the power supply
3. Is the current through each resistor equal to 5 V divided by the resistance?
4. What is the equivalence resistance of the three resistors in parallel?
5. Is the current through the power supply equal to 5V divided by the equivalent resistance?
6. Are these results consistent with the theory of resistors in parallel?

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# Suggestions for arrangements and wirings on prototyping board

This experiment involves putting three branches in series. The suggestion to you is that you may choose three separate sections of the terminal stripes and use each of them for each branch.

The red ink on the picture describes one possible arrangements of the resistors and the corresponding wirings. The current through the left-most resistor is routed to the banana jacks A and B, which will be connected to DMM.

From now on, you can practice the placement of resistors and the wiring connections like this using a picture of the prototyping board.
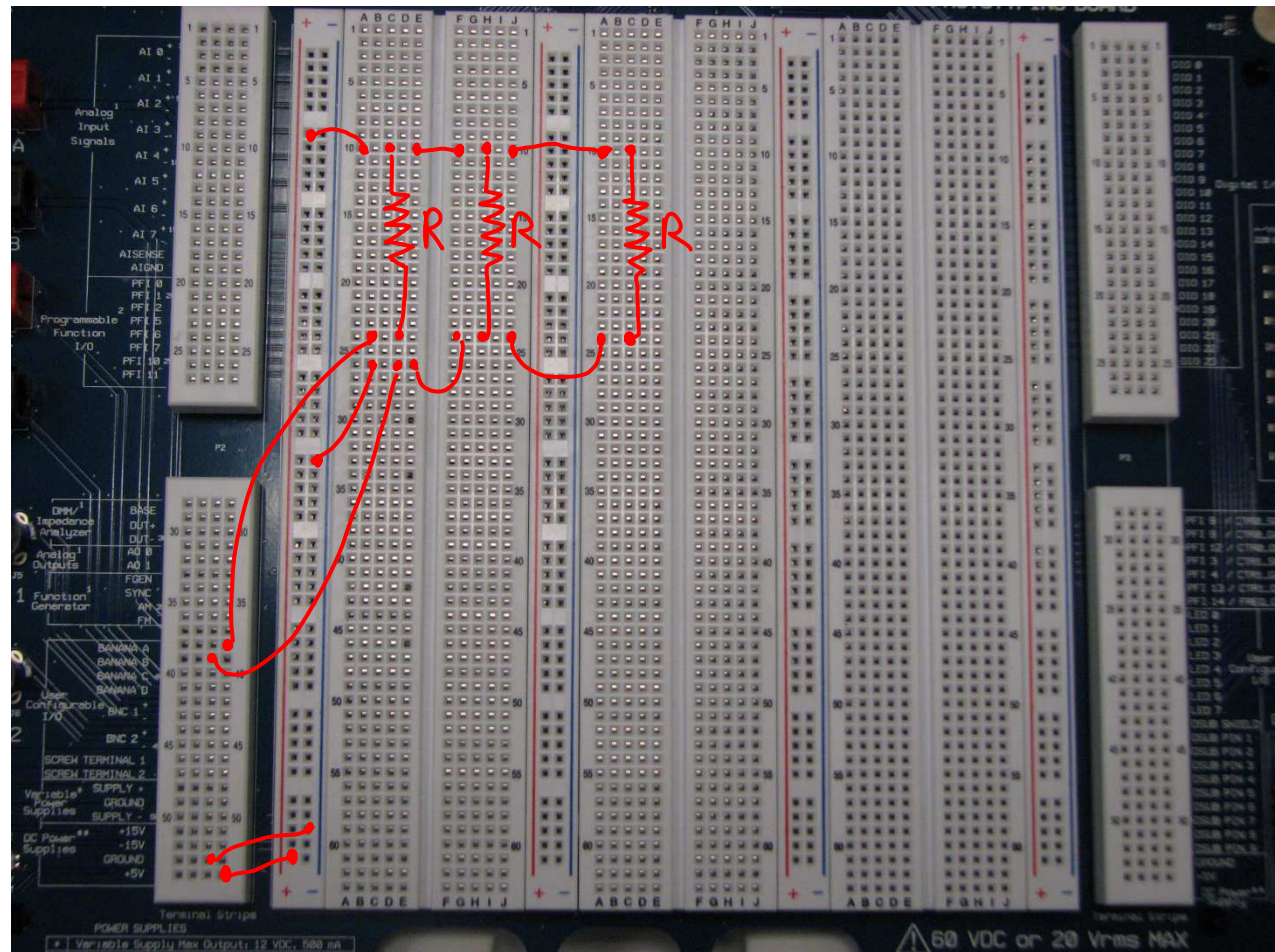
Experiment III: Verify combination rules

5 V

R

R

R = 330 Ω

R
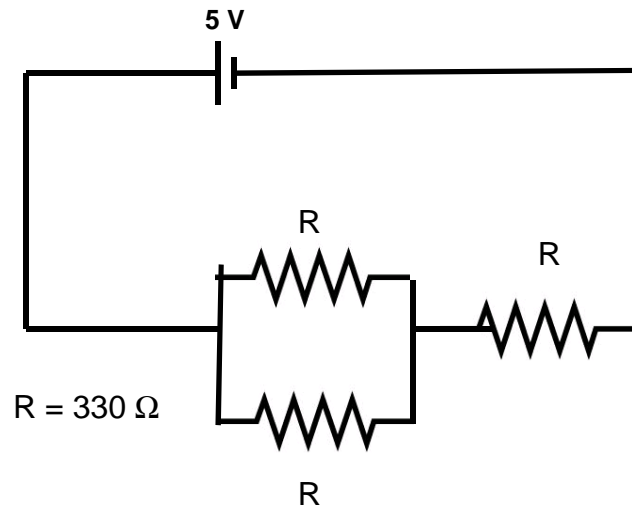
Wire three identical resistors to the 5 V power supply according to the circuit diagram on the left. Combination rules can be used to calculate the currents and voltages in the circuit. Use the DMM as Voltmeter and Ammeter to measure the current in each branch and voltage across each resistor. Then compare the experimental results with your calculations in the Pre-Lab.