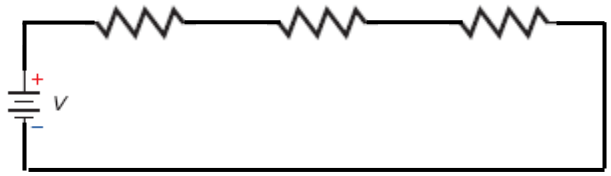
MND Physics

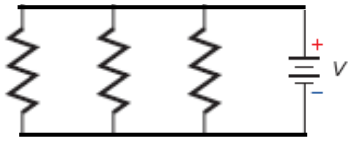
Building and Testing Electrical Circuits

The Series Circuit



A series circuit has two or more resistors connected end to end so that the current can flow through each resistor in turn. In a series circuit, the current flowing through each resistor will be equal. The equivalent resistance of the series circuit is simply the addition of each resistor value contained in the circuit.

The Parallel Circuit



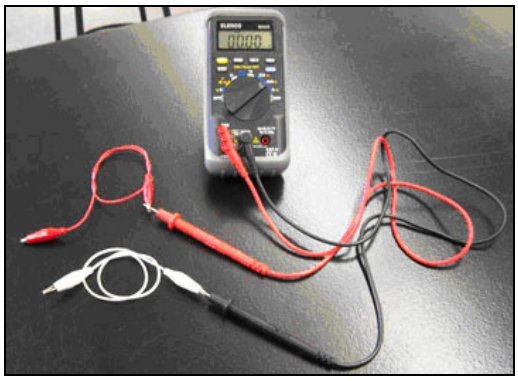
A parallel circuit has two or more resistors connected such a way that each resistor provides a separate path for the current to travel. Therefore the equivalent resistance in a parallel circuit is reduced compared to the same 3 resistors in a series circuit.

In this lab you will construct a series circuit and two parallel circuits. You will test Ohm's Law by both calculating and testing the equivalent resistance of each circuit.

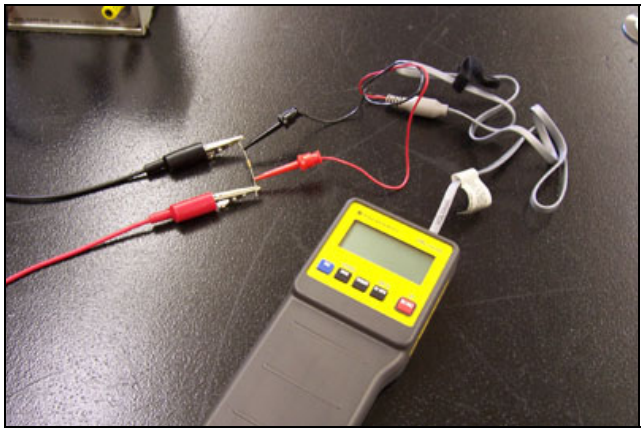
EQUIPMENT:
Variable voltage power source, wires, alligator clips, 3 resistors, voltmeter, ammeter.

PROCEDURE:
Lab Preparation:

- Prepare the AMMETER as shown here (place the black plug in the COM receptacle and the red plug in the 10A receptacle). Attach wires with alligator clips to the ends of the probes; the alligator clips help when making other connections. The loops in the cables are not necessary; they only help to keep access cord out of the way. Also, the color of the wires is not important. Rotate dial to "A" (amps).

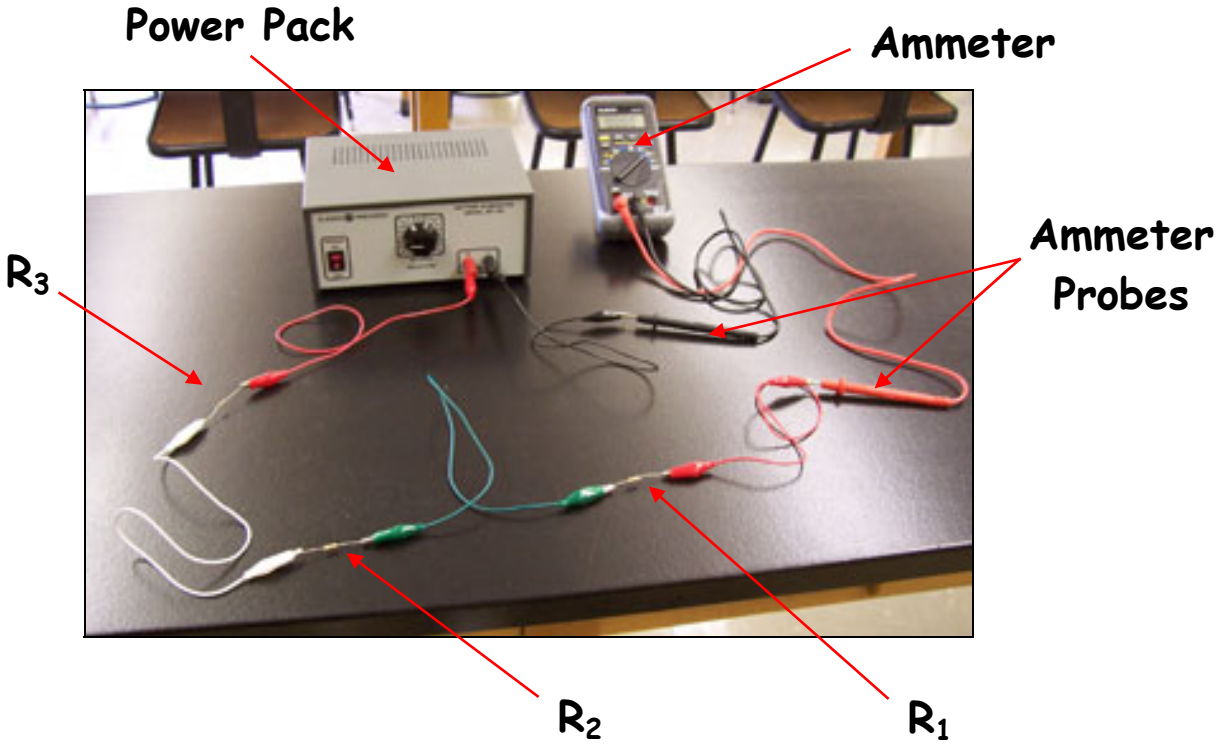


- Prepare the VOLTMETER by placing the batteries in the CBL unit and plugging the voltage probes into channel 1 located at the top-side of the CBL casing. NOTE: You always check the voltage <u>ACROSS</u> the resistor as shown here:



PART 1: Series Circuit

1. Select any 3 resistors with values of or between 100 Ω and 600 Ω.
2. Record the value and tolerance of each resistor in the data table.
3. Set up a series circuit using all three resistors connected end to end. Make sure the power source is turned off. Connect the ammeter in series between the power source and the first resistor. Set the dial to mA.
4. Set the voltage to 3 V.
5. Have Mr. Peppercorn check your circuit before turning the power on.
6. Turn on the power and measure the voltage across each resistor. NOTE: DO NOT LEAVE POWER UNITS TURNED ON FOR MORE THAN 30 SECONDS AT A TIME; RESISTORS CAN OVERHEAT QUICKLY.
7. Measure the current and record the value in your data table.
8. Turn off the power.

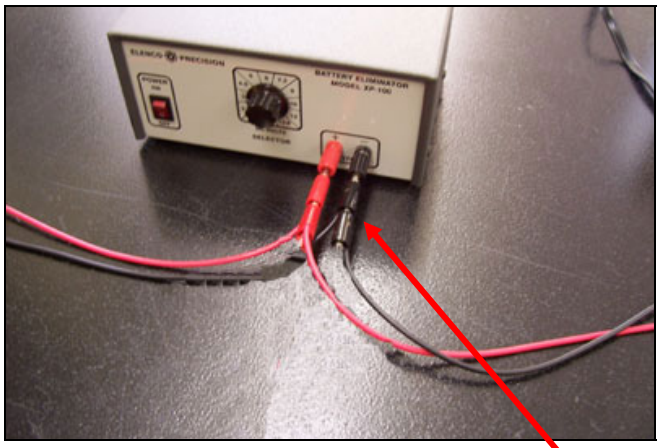


PART 2: Parallel Circuits – 2 resistors

1. Select any 2 resistors used in part 1 of this lab.

2. Record the value and tolerance of each resistor in the data table.

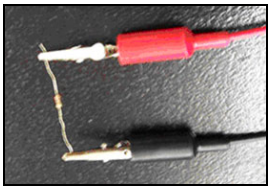
3. Set up a parallel circuit using the two resistors. Make sure the power source is turned off. You need 2 red wires with alligator clips and 2 black wires with alligator clips.

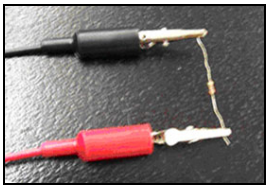


To resistor 1

To resistor 2

Two resistors wired in parallel.
Note how the red and black banana plug connectors stack, one inside another.





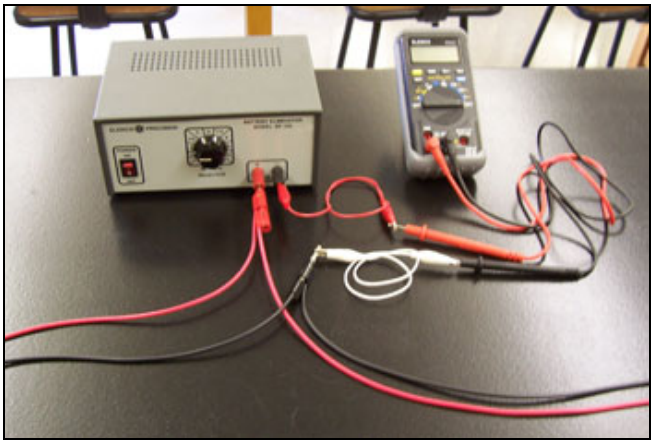
4. <u>Set the voltage to 6 V</u> and turn on the power source.

5. Measure the voltage across resistor #1, then resistor #2.

6. Turn off the power but keep the circuit intact.

7. Next, you need to measure the <u>current</u> at three locations; through the entire circuit at the power supply (I), through resistor #1 (I_1), and through resistor #2 (I_2).
    a. To measure the current I through the entire circuit, <u>remove both black plugs from the power pack,</u> leaving them "stacked".
    b. Attach the ammeter by plugging the ammeter wire into the black power supply as shown, and the other ammeter wire to the black banana plugs leading to the resistors.

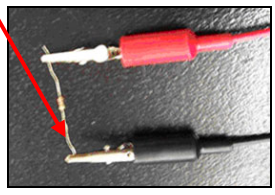
To resistor 1



To resistor 2

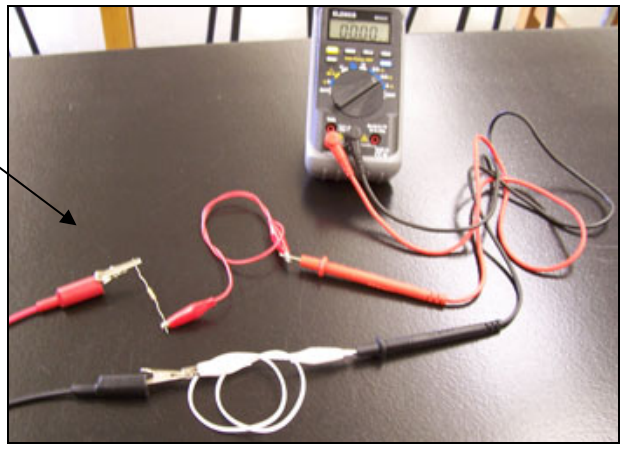
    c. IMPORTANT! Once you have measured the current I, turn off the power and remove the ammeter… make sure to reconnect the black wire plugs back into the power supply.
    d. To measure the current through the resistors (I_1 and I_2), disconnect the black alligator clip from resistor 1 and connect it to the ammeter as shown. Record the current I_1, turn off the power supply and reconnect the resistor to the alligator clip. REPEAT PROCESS FOR RESISTOR #2. Record all currents.

DISCONNECT BLACK CLIP HERE



RECONNECT AMMETER AS SHOWN

TO POWER SOURCE

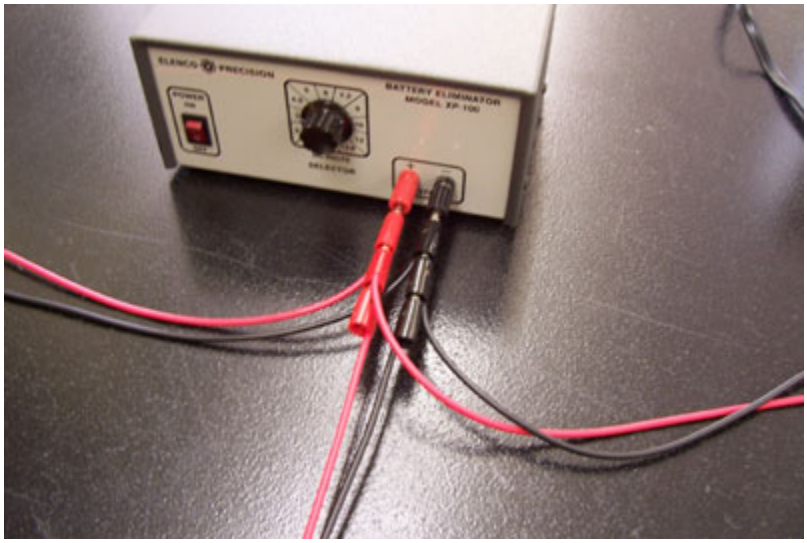


PART 3: Parallel Circuits – 3 resistors

1. Use all 3 resistors from part 1.

2. Record the value and tolerance of each resistor in the data table.

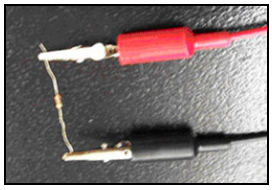
3. Set up a parallel circuit using the three resistors. Make sure the power source is turned off. You need 3 red wires with alligator clips and 3 black wires with alligator clips.

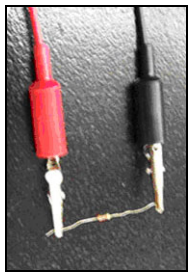


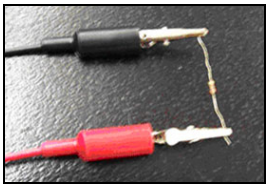
To Resistor 1

To Resistor 2

To Resistor 3







4. Set the voltage to 6 V and turn on the power source.

5. Measure the voltage across resistor #1, resistor #2 and resistor #3.

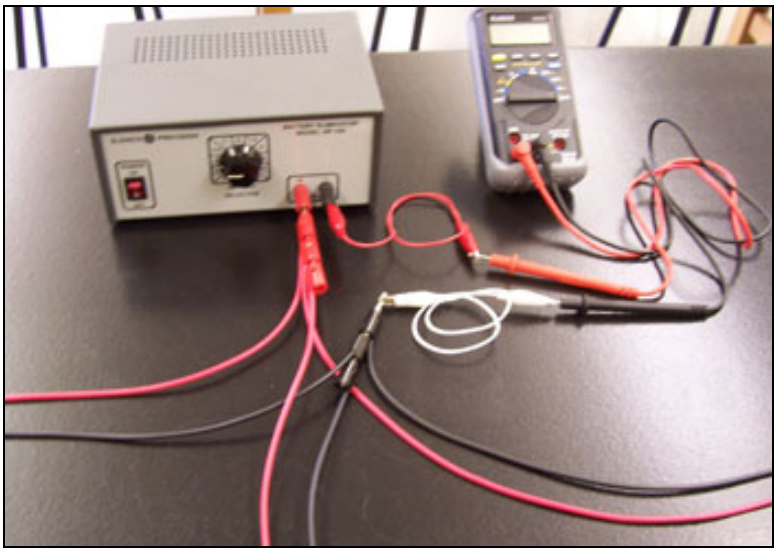
6. Turn off the power.

7. Next, you need to measure the <u>current</u> at **FOUR** locations; through the entire circuit at the power supply (I), through resistor #1 (I_1), through resistor #2 (I_2), and through resistor #3 (I_3)

    a. To measure the current I through the entire circuit, <u>remove all three black plugs from the power pack</u>.

    b. Wire the ammeter by plugging the black ammeter wire into the black power supply as shown, and the red ammeter wire to the black banana plugs leading to the resistors.

To Resistor 1



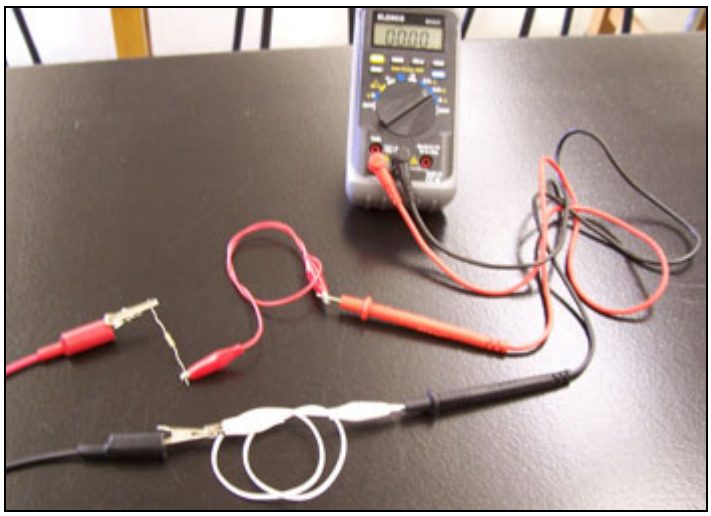
To Resistor 3

To Resistor 2

    c. IMPORTANT! Once you have measured the current I, turn off the power and remove the ammeter… make sure to reconnect the black plugs back into the power supply.

d. To measure the current through the resistors (I_1, I_2, I_3), disconnect the black alligator clip from resistor 1 and connect it to the ammeter as shown. Record the current I_1, turn off the power supply and reconnect the resistor to the alligator clip. REPEAT PROCESS FOR RESISTOR 2 & 3. Record all currents.

TO POWER SOURCE



DATA:

Series Circuit

	Resistance (Ω)	Resistor Tolerance (%)	Voltage (V)	Current (A)
Resistor 1				
Resistor 2				
Resistor 3				

ANALYSIS:

1. Calculate R_{eq} ($R_{eq} = R_1 + R_2 + R_3$)
2. Calculate V_{TOTAL} ($V_{TOTAL} = V_1 + V_2 + V_3$)
3. Show $V_{TOTAL} = R_{eq} I$
4. Calculate and discuss error. Can you prove Ohm's Law works for series circuits?
5. Make a schematic (drawing) of your series circuit. Label all components and clearly indicate the direction of the current flow.

DATA:

Parallel Circuit – 2 resistors

DATA TABLE – 2 RESISTORS IN PARALLEL							
			Ammeter			*Voltmeter*	
	R1 (Ω)	R2 (Ω)	I (A)	I1 (A)	I2 (A)	V1 (V)	V2 (V)
Resistance							
Tolerance (%)							

ANALYSIS:

1. Calculate R_{eq} using the actual printed values on the resistors. ($1/R_{eq} = 1/R_1 + 1/R_2$)

2. Calculate R_1 using $R_1 = V_1/I_1$, and compare to the printed value of R_1 Is this value within the printed tolerance range of R_1?

3. Calculate R_2 using $R_2 = V_2/I_2$, and compare to the printed value of R_2 Is this value within the printed tolerance range of R_2?

4. Calculate R_{eq} using $R_{eq} = V_{TOTAL} / I$

5. Step 4 represents your <u>calculated</u> equivalent resistance for the circuit. Compare this <u>calculated</u> equivalent resistance to the <u>accepted</u> equivalent resistance from step 1.

6. Calculate and discuss your error. Can you prove Ohm's Law works for parallel circuits utilizing 2 resistors?

7. Make a schematic (drawing) of your parallel circuit. Label all components and clearly indicate the direction of the current flow.

Parallel Circuit – 3 resistors

DATA TABLE – 3 RESISTORS IN PARALLEL										
				Ammeter				*Voltmeter*		
	R1 (Ω)	R2 (Ω)	R3 (Ω)	I (A)	I1 (A)	I2 (A)	I3 (A)	V1 (V)	V2 (V)	V3 (V)
Resistance										
Tolerance (%)										

ANALYSIS:

1. Calculate R_{eq} using the actual printed values on the resistors. ($1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$)

2. Calculate R_1 using $R_1 = V_1/I_1$, and compare to the printed value of R_1. Is this value within the printed tolerance range of R_1?

3. Calculate R_2 using $R_2 = V_2/I_2$, and compare to the printed value of R_2. Is this value within the printed tolerance range of R_2?

4. Calculate R_3 using $R_3 = V_3/I_3$, and compare to the printed value of R_3. Is this value within the printed tolerance range of R_3?

5. Calculate R_{eq} using $R_{eq} = V_{TOTAL} / I$

6. Step 5 represents your <u>calculated</u> equivalent resistance for the circuit. Compare this <u>calculated</u> equivalent resistance to the <u>accepted</u> equivalent resistance from step 1.

7. Calculate and discuss your error. Can you prove Ohm's Law works for parallel circuits utilizing 3 resistors?

8. Make a schematic (drawing) of your parallel circuit. Label all components and clearly indicate the direction of the current flow.

REFERENCE:

Resistance Color Codes (ohms)			
COLOR	DIGIT	MULTIPLIER	TOLERANCE
Black	0	1	
Brown	1	10	
Red	2	100	
Orange	3	1,000	
Yellow	4	10,000	
Green	5	100,000	
Blue	6	1,000,000	
Violet	7	10,000,000	
Grey	8		
White	9		
Gold			5 %
Silver			10 %