

# Circuits: Light-Up Creatures

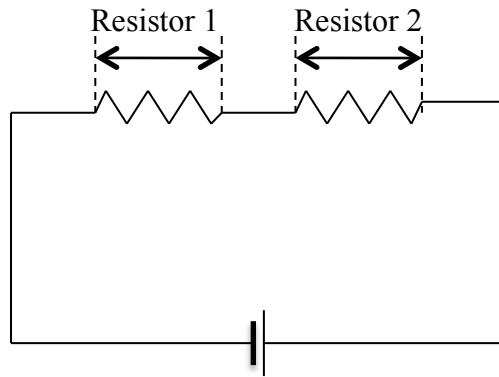
## Student Advanced Version

In this lab you will explore current, voltage and resistance and their relationships as given by the Ohm's law. You will also explore of how resistance can be arranged within circuits as well as be exposed to the concept of power.

### Part I: Resistance- Series and Parallel combinations

There are different ways in which we can set different resistances across our circuits. Two ways of combining resistors, which are electrical components with known values of resistance, are: 1) in series, and 2) in parallel.

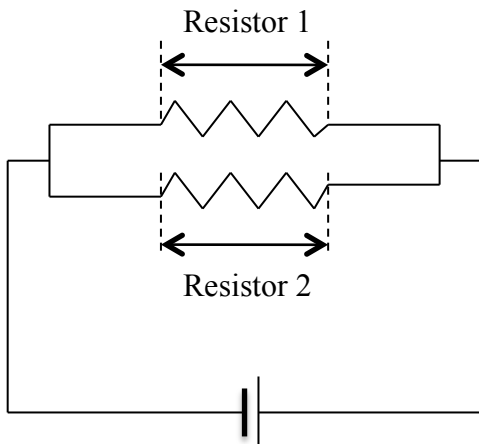
- 1) Resistors are said to be in series if they are placed one after another in a circuit as shown in the diagram below:



The same amount of current,  $I$ , flows through each resistor, but the total voltage,  $V$ , supplied from the battery gets divided amongst the two resistors.

$$\text{Total Resistance, } R_T(\Omega) = R_1(\Omega) + R_2(\Omega)$$

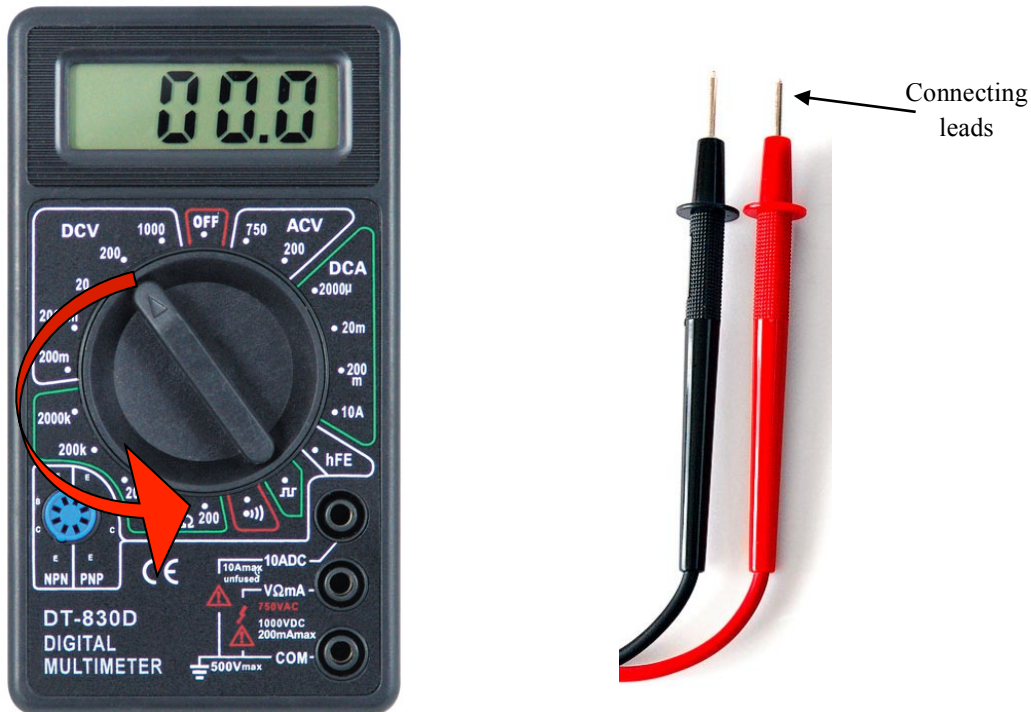
- 2) Resistors are said to be in parallel if they are arranged such that all resistors in parallel receive the same voltage with different amounts of current flowing through each of them, as shown below:



$$\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Tungsten bulbs are used as resistors in this experiment.

- 3) Measure the resistance of each of the two bulbs provided. In order to do this, turn your multimeter dial setting to 200  $\Omega$  range as shown in the picture below:



Attach the positive and negative terminal leads (silver metallic parts at the end of multimeter connecting wires) to two different connecting wires with crocodile clips. Attach the remaining free crocodile clips to either metallic attachments on the bulb. Record the resistance reading from the multimeter display.

Bulb 1 resistance – \_\_\_\_\_  $\Omega$

Bulb 2 resistance – \_\_\_\_\_  $\Omega$

Q1. Predict total resistance of the two bulbs if placed in series in a circuit.

Q2. Now predict the total resistance with the bulbs in parallel.

Q3. Which of the two arrangements of bulbs do you think will give a higher resistance?

- 4) Setup the circuit with the light bulbs in series and measure the total resistance of the bulbs using the multimeter.

*Total resistance of bulbs in series – \_\_\_\_\_  $\Omega$*

- 5) Setup the circuit with the light bulbs in parallel and measure the total resistance of the bulbs using the multimeter.

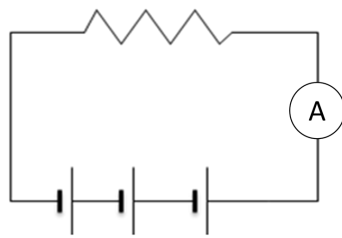
*Total resistance of bulbs in parallel – \_\_\_\_\_  $\Omega$*

*Q4. Which arrangements of the bulbs gives a higher resistance? Does your measurement agree with the predicted results?*

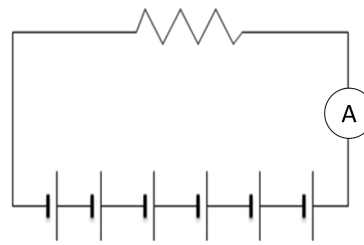
## Part II: Ohm's Law- Relationship of Current (I), Voltage (V) and Resistance (R)

Ohm's law states that  $V=I \cdot R$ , i.e. I is directly proportional to V, and inversely proportional to R. Direct proportionality means that when V increases, I is expected to increase with a constant ratio. Inverse proportionality means that when R increases, I is expected to decrease by a constant ratio.

- 1) Set up the following circuit and observe the brightness of the bulb when lighted using three 1.5V batteries and six 1.5V batteries. Measure the current flowing through the bulb in both cases using the multimeter.



Circuit 1



Circuit 2



$$\text{Total Voltage Circuit 1} = 3 \times 1.5V = 4.5V$$

$$\text{Total Voltage Circuit 2} = 6 \times 1.5V = 9V$$

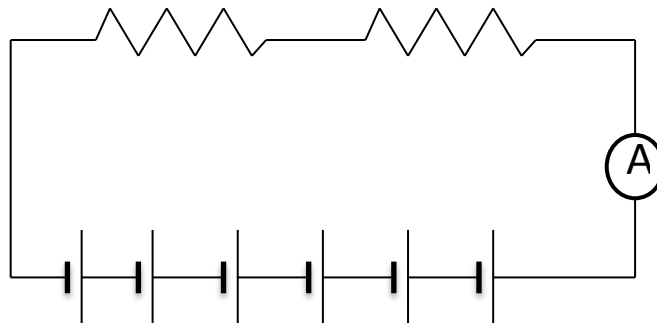
Current through circuit with 3 batteries – \_\_\_\_\_ Amps

Current through circuit with 6 batteries – \_\_\_\_\_ Amps

Q5. Which battery arrangement gave a higher current reading, three or six?

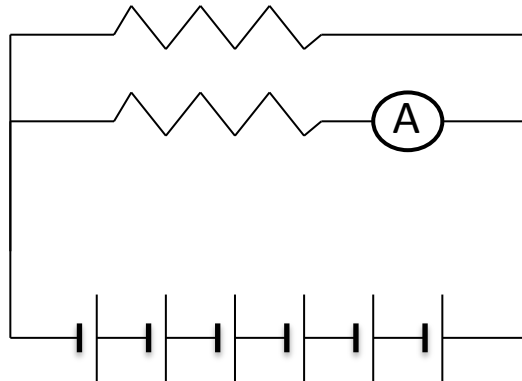
Q6. Calculate the ratio of voltage to current for both circuits. What does this number represent?

- 2) Set up the two bulbs in series as was done in part one and connect the free end of one of the connecting wires to the negative terminal of a battery in series with five other batteries. Attach the other free end to the negative lead of the multimeter set at 10  $\Omega$  range. Take another connecting wire and attached the positive lead of multimeter to the positive terminal of the battery series. Record the current reading.



Current through circuit in series – \_\_\_\_\_ Amps

- 3) Repeat step 2 for circuit in which the bulbs are arranged in parallel. Read current flowing through each of two bulbs and record observations.



*Current through circuit in parallel – \_\_\_\_\_ Amps*

*Q7. Which resistor arrangement gave the higher current reading?*

*Q8. What does this tell us about the relationship of current with respect to the resistance?*

*Q9. Find the ratio of voltage to current for each resistor arrangement. What does the ratio represent?*