

Simple Electrical Circuits

- Purpose:**
1. To verify series and parallel resistance
 2. To build a two way switching circuit

Equipment: light bulb circuit board, ammeter, voltmeter, connecting wires and jumper leads, three 6 v light bulbs, DC power supply, two single pole-double throw switches, light bulb sockets

Introduction:

Often, circuits are designed to carry current to various components in differing amounts. To accomplish this, a combination of resistances are often used to direct the flow of electrical charge. These resistances are most commonly wired together in parallel or in series. An example of each is shown in Figure 1 and Figure 2 with the resistances connected to a battery of voltage, V. The currents flowing in each circuit are shown with arrows.

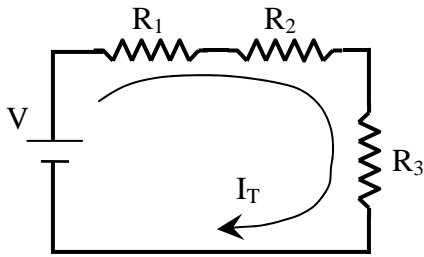


Figure 1 Resistances in Series

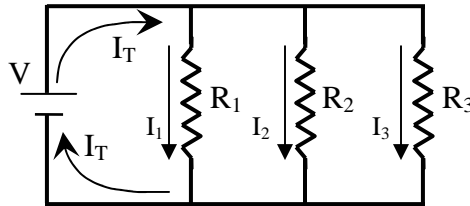


Figure 2 Resistances in Parallel

Notice that in Figure 1, the same total current, I_T , that flows through the battery also flows through each resistance. In Figure 2, however, the current, I_T , that flows through the battery divides into three separate currents which eventually recombine into I_T again as the current completes its path around the circuit. In each case, the battery “feels” connected to an equivalent resistance, R_{eq} , that determines the total current, I_T , that the battery delivers to the circuit. This idea is shown in Figure 3. It is important to understand that R_{eq} is quite different for each of the above two circuits.

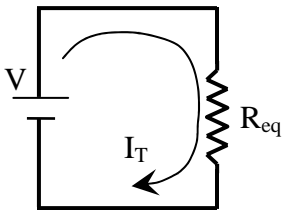


Figure 3

1) For series resistances, $R_{eq} = R_1 + R_2 + R_3$

2) For parallel resistances, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Procedure:

1. Place a single light bulb in its socket and wire it *in series* with a ammeter and power supply as shown in figure 4. Place a voltmeter *in parallel* with the light bulb. Before turning on the power supply, set the voltage dial to zero. Now turn on the power supply and slowly increase the voltage until the voltage, as read on the voltmeter, is 5.0 volts. You should see the bulb burning brightly. Record both the voltage (in volts) and the current (in amps) in the table on the next page.

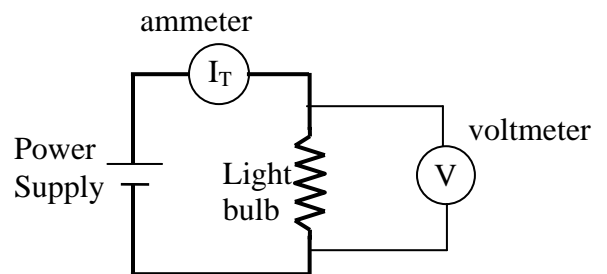


Figure 4

2. Determine the resistance of the light bulb by using Ohm's law ($R = V/I$). Record the value for R in the table.

V (volts)	I (amps)	R (Ohms)

3. Reset the power supply voltage to zero. Now put three light bulbs in series by arranging the connections on the circuit board appropriately. Connect the bulbs in series with the power supply and the ammeter. On the back of this page, draw a circuit diagram to show your circuit. Adjust the power supply so that the same current that you measured in part 1 again flows through all three bulbs. Use the voltmeter to measure the voltage across all three resistances together. Show on your circuit diagram the placement of your voltmeter in the circuit. Record your data. Using Ohm's law, as in part 2, calculate R_{eq} "experimental" for this series circuit and record your answer. Using equation 1, on the previous page, find the value for R_{eq} "predicted" and determine the percent difference between the two values of R_{eq} .
4. Reset the power supply voltage to zero. In a similar way as in part 3, place three bulbs in parallel by rearranging the connections on the circuit board. Connect the ammeter in series with the bulbs and the power supply. On the back of this page, draw a circuit diagram to show this circuit. Place the voltmeter in parallel with the light bulbs (include the voltmeter on your circuit diagram). Adjust the power supply so that the voltmeter reads 5.0 volts. This will ensure that the current through each bulb is the same as in parts 1 and 3 above. Read, from the ammeter, the total current, I_T , flowing through all three bulbs. Can you see why the ammeter measures the total current? Record the current and voltage in the table at the right. Using Ohm's law, as in part 2, calculate R_{eq} "experimental" for this parallel circuit and record your answer. Using equation 2, on the previous page, find the value for R_{eq} "predicted" and determine the percent difference between the two values of R_{eq} .

Series Circuit Data

V (volts)	I_T (amps)

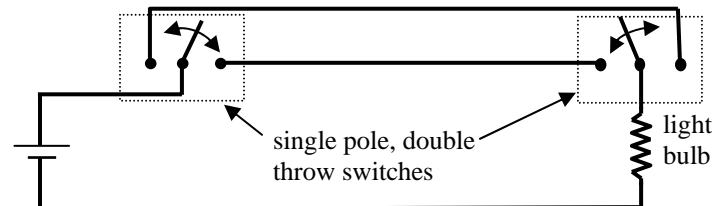
R_{eq} "experimental" (Ohms)	R_{eq} "predicted" (Ohms)	Percent difference

Parallel Circuit Data

V (volts)	I_T (amps)

R_{eq} "experimental" (Ohms)	R_{eq} "predicted" (Ohms)	Percent difference

two way switch circuit



5. Reset the power supply voltage to zero. Using a separate light bulb socket and the two switches provided (these are called single pole double throw switches), build the circuit shown to make a "two way switch." This is the circuit electricians use in house wiring when it is desired to have switches at each end of a room control a single light. Trace the flow of current with your pencil through the above circuit with the switches in various positions so that you understand its operation. Adjust the power supply to provide approximately 5 volts and check out the operation of your two way switch. Show your instructor that your circuit works properly. Can you design a *three way circuit*?