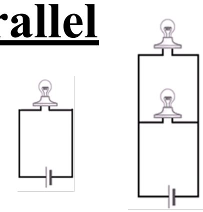
Combining Light Bulbs in Parallel



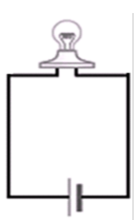
1. Build a circuit with one light bulb and observe its brightness.
2. Add a second bulb in parallel. Observe or infer what happens to the:

Power of an individual bulb (= brightness)		Same
Total power of the circuit		↑
Resistance of an individual bulb		same
Total resistance of the circuit		↓
Total potential difference across the circuit		Same
Potential difference across an individual bulb		Same
Total current in the circuit		↑
Current through an individual bulb		Same

3. Unscrew one light bulb from its base (but leave the base in the circuit). What happens to the other light bulb? Why?

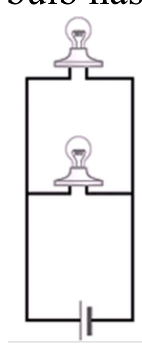
Combining Light Bulbs in Parallel

4. Assume each light bulb has a resistance of 10Ω. Analyze each circuit.



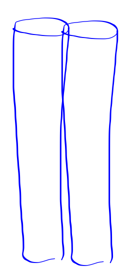
3 V

R	10Ω
V	3v
I	.3A
P	.9w

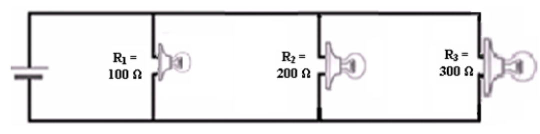


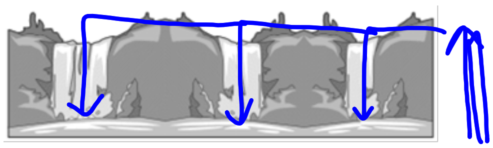
	Bulb #1	Bulb #2	Circuit Total
R	10Ω	10Ω	5Ω
V	3V	3V	3V
I	.3 A	.3 A	.6 A
P	.9w	.9 w	1.8 w

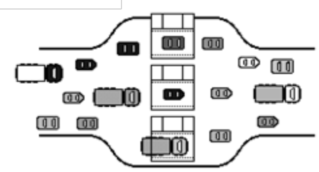
$$R = \frac{\rho L}{A}$$



Analyzing Parallel Circuits







Three Resistors Placed in Parallel

1. **Voltage:** The increase in potential provided by the battery is equal to the potential drop across each resistor.

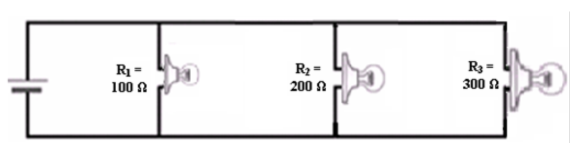
$$V_T = V_1 = V_2 = V_3 = \dots$$

2. **Current:** The total current coming out of (and going back into) the battery is equal to the sum of the individual currents going through each resistor.

$$I_T = I_1 + I_2 + I_3 + \dots$$

NOTE: conservation of electric charge

Analyzing Parallel Circuits



NOTE:

3. **Power:** The total power used in the circuit is the sum of the power used by the individual resistors.

$$P_T = P_1 + P_2 + P_3 + \dots$$

4. **Resistance:** The reciprocal of the total resistance is equal to the sum of the reciprocal of the individual resistances.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

NOTE: the total resistance is less than the resistance of any individual resistor

Analyzing Parallel Circuits

5. A 3.0 Ω and a 6.0 Ω resistor are connected in parallel. What is their equivalent resistance?

$$R_{\parallel} = \left(\frac{1}{3\Omega} + \frac{1}{6\Omega}\right)^{-1} = 2\Omega$$

Parallel relationships

$$\frac{R_1}{R_2} = \frac{I_2}{I_1} = \frac{P_2}{P_1}$$

6. In a parallel circuit, which resistor, if any, will . . .

a) have the greatest potential difference across it? same

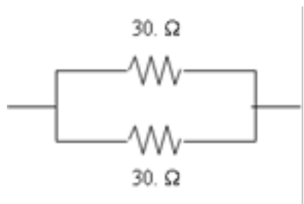
b) have the most current running through it? smallest

c) dissipate the most power? smallest

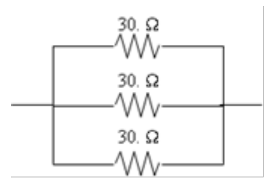
d) shine brightest (if it is a light bulb)? smallest

Analyzing Parallel Circuits

7. Calculate the equivalent resistance of each resistor segment below.



15Ω

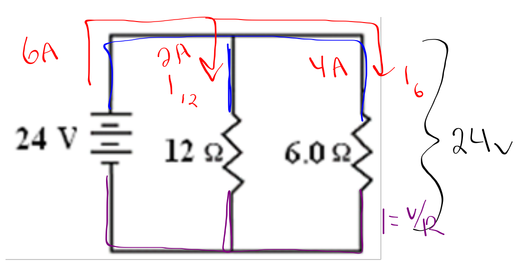


10Ω

Shortcut for identical parallel resistors

Analyzing Parallel Circuits

8. Calculate the voltage drop across each resistor and the current through each resistor. Calculate the total current in the circuit and the equivalent resistance of the circuit.



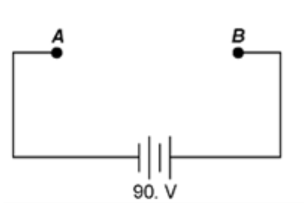
$R_{eq} = \left(\frac{1}{6\Omega} + \frac{1}{12\Omega}\right)^{-1} = 4\Omega$

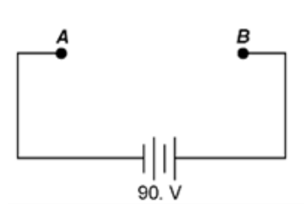
$I_T = V_T / R_{eq} = 24v / 4\Omega = 6A$

$I_6 = \frac{V_6}{R_6} = \frac{24v}{6\Omega} = 4A$

$I_{12} = \frac{V_{12}}{R_{12}} = \frac{24v}{12\Omega} = 2A$

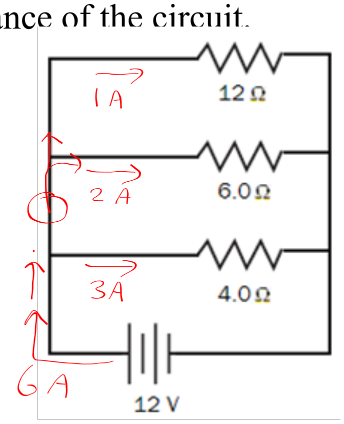
9. A 50. Ω, a 100. Ω and a 150. Ω resistor are to be connected in a circuit. What type of connection will give the highest resistance? The lowest resistance?
Complete each circuit and calculate each current.





Analyzing Parallel Circuits

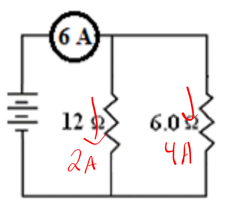
10. *Calculate* the voltage drop across each resistor and the current through each resistor. Calculate the total current in the circuit and the equivalent resistance of the circuit.



$R_T = 2\,\Omega$

$I_T = 6\,A$

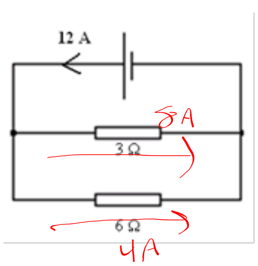
11. Determine the current through each resistor by using a *proportion.*

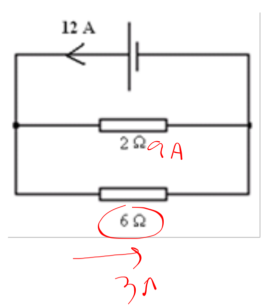


$$\frac{6\,\Omega}{12\,\Omega} \Rightarrow$$

$$\frac{I_2}{I_1} = \frac{R_1}{R_2}$$

12. Determine the current through each resistor in the circuits below using a *proportion.*





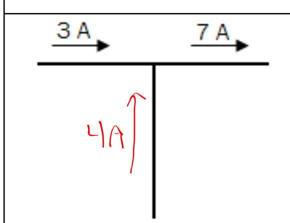
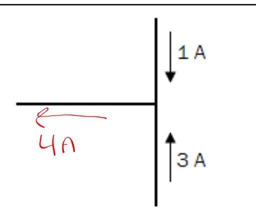
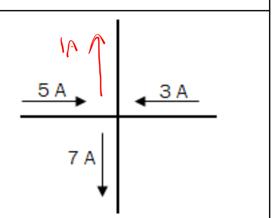
$$\frac{R_2}{R_6} = \frac{I_6}{I_2}$$

13. A 12 Ω heater, a 20 Ω hair dryer, and a 25 Ω toaster are connected in parallel to a 120. volt power source. Sketch an appropriate schematic. Include a meter capable of measuring the total current and a meter capable of measuring the voltage drop across the heater. Find the reading on each meter.

<u>Junctions</u>

<u>Junction</u>: spot where two or more wires meet in a circuit

1. Determine the magnitude and direction of the current in the unlabeled wire.

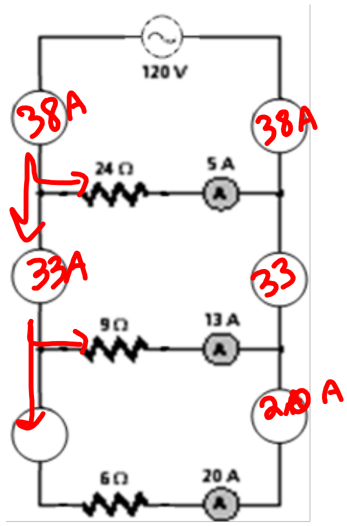
Junction A	**Junction B**	**Junction C**
		

<u>Kirchhoff's First Law (Current Law, Junction Rule)</u> - The total current directed into a junction must equal the total current directed out of the junction.

Note: Conservation of electric charge principle

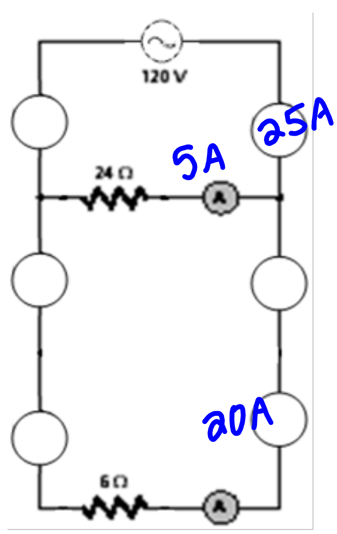
Junctions

2. Determine the reading on each blank ammeter.



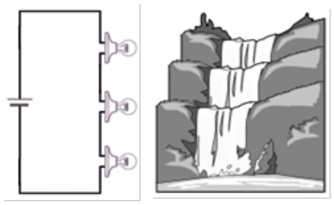
Junctions

3. Determine the new readings now that the 9 Ω resistor is removed.

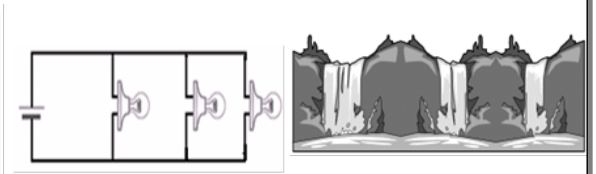


Review - Resistors in Series or in Parallel

Series Connection



Parallel Connection



Characteristic	Series Circuit	Parallel Circuit
Number of pathways for current	1	many
Current	same	split
Potential Difference (Voltage)	split	same
Overall resistance	high	low
Power	low	high

Review - Resistors in Series or in Parallel

Influencing the Flow Rate on a Tollway