

## Power and Voltage Drops

### Electrical Power

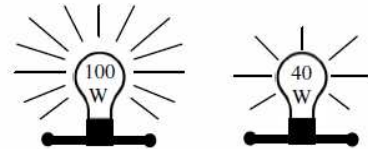
Electrical power tells us how fast electricity is being used in a circuit or resistor. A more powerful device uses the same amount of electricity, just faster.

Electrical Power:  
 Power (in watts) →  $P = VI$  ← Current (in amps)  
 Voltage (in volts)

*Electrical Power equals the voltage times the current.*

*Ex. A 12 V battery pushes 3 A thru a light bulb. How much power does the light bulb use?*

$V = 12 \text{ v}$	$P = VI =$
$I = 3 \text{ A}$	$P = 12(3) = 36 \text{ w}$
$P = \underline{\hspace{2cm}}$	

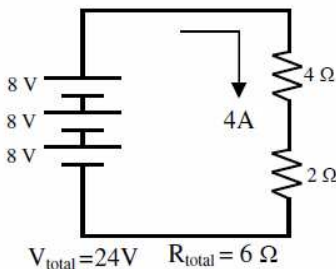


A brighter bulb uses more power. Since  $P = VI$ , a bulb could be brighter because it uses more voltage with the same current OR because it uses more current with the same voltage.

### Voltage Drops

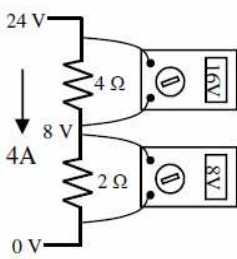
Batteries add voltage, resistors subtract voltage, and wire don't change voltage at all. To find the voltage used by a particular resistor, you have to know the current running thru it.

1. Find the total current ( $I_T$ ).



$$I_T = \frac{V_T}{R_T} = \frac{24}{6} = 4 \text{ A}$$

2. Use  $V = IR$  for each resistor.



$$V_1 = I_1 R_1 = 4(4) = 16 \text{ V}$$

$R_1$  uses 16 V, leaving 8 V.

$$V_2 = I_2 R_2 = 4(2) = 8 \text{ V}$$

$R_2$  uses 8 V, leaving 0 V.

Notice  $V = 8 \text{ V}$  between the resistors. Also, the total voltage used by the resistors must equal the total voltage given by the batteries: 24 volts.

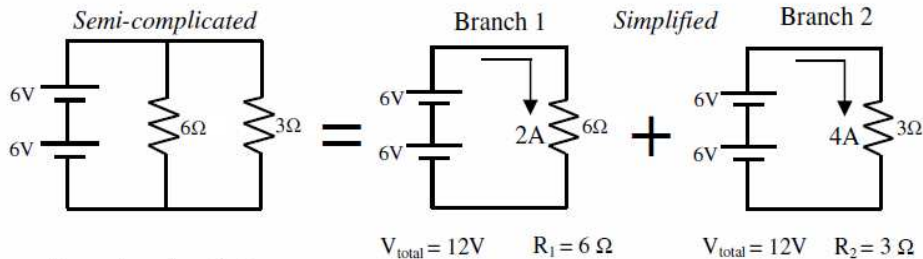
**For objects in series the biggest resistor uses the most voltage and the most power.**

$P_1 = V_1 I_1$	$P_1 = 16(4)$	$P_1 = 64 \text{ w}$
$P_2 = V_2 I_2$	$P_2 = 8(4)$	$P_2 = 32 \text{ w}$
$P_T = V_T I_T$	$P_T = 24(4)$	$P_T = 96 \text{ w}$

*Both light bulbs have the same current, but the one with more resistance is brighter because it uses more voltage and uses more power.*

### Simplifying Parallel Circuits

Finding the total current and power in a parallel circuit is much easier if you think of it as two independent series circuits.



Remember that devices in parallel have the same voltage, but they have different current.

$$I_1 = \frac{V_1}{R_1} = \frac{12}{6} = 2 \text{ A}$$

$$I_2 = \frac{V_2}{R_2} = \frac{12}{3} = 4 \text{ A}$$

$$I_T = 2 + 4 = 6 \text{ A}$$

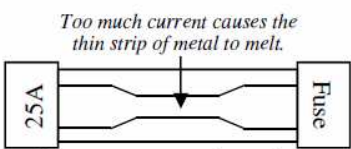
**For objects in parallel, the one smallest resistor uses the most current and the most power.**

$P_1 = V_1 I_1$	$P_2 = V_2 I_2$
$= 12(2) = 24 \text{ w}$	$= 12(4) = 48 \text{ w}$

*Both light bulbs have the same voltage, but the one with less resistance is brighter because it has more current and uses more power (this is how your house works).*

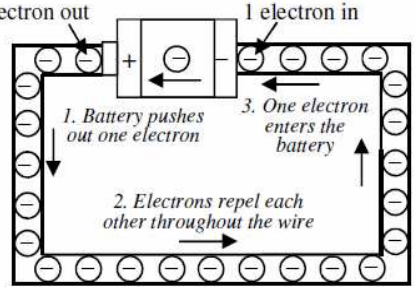
### Fuses


Electricity causes heat. Fuse melt (or break) when too much current passes through them, protecting expensive electronic equipment. Like fuses, circuit breakers protect against too much current, also, but can be reset, instead of replaced.




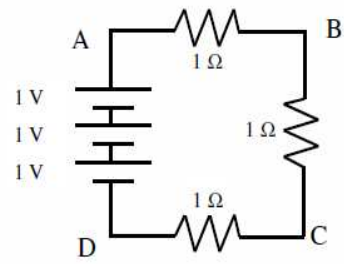
### Electrons

The electrons that move to make electricity do not come from the battery: they are already in the wires of the circuit. Metals are good conductors because their electrons move easily.




1. Fuse	A. An independent path in a parallel circuit.	Which is brighter: a 60 W or a 100 W bulb? Which one uses more power? 
2. Circuit breaker	B. A device that breaks to protect against excessive current. Must be replaced.	
3. Wire	C. Where branches join or split.	
4. Branch	D. Protects against high current, but can be reset.	
5. Power	E. Where most of the electrons in a circuit come from.	
6. Junction	F. The product of voltage and current.	

Label the voltages at the letters. 

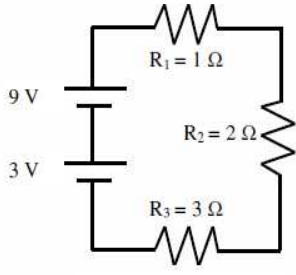


V at A = \_\_\_\_\_  
 V at B = \_\_\_\_\_  
 V at C = \_\_\_\_\_  
 V at D = \_\_\_\_\_

The electricity in your house is 120 volts. How many amps does a 60 watt light bulb use? 

How much power is used by a 120 V circuit using 6 amps?

A 240 volt circuit (like your dryer) has 20 amps flowing through it. How much power is it using?




V<sub>T</sub> = \_\_\_\_\_  
 R<sub>T</sub> = \_\_\_\_\_  
 I<sub>T</sub> = \_\_\_\_\_  
 V over R<sub>1</sub> = \_\_\_\_\_  
 V over R<sub>2</sub> = \_\_\_\_\_  
 V over R<sub>3</sub> = \_\_\_\_\_  
 P<sub>2Ω</sub> = \_\_\_\_\_  
 P<sub>3Ω</sub> = \_\_\_\_\_  
 P<sub>T</sub> = \_\_\_\_\_

Series or parallel?

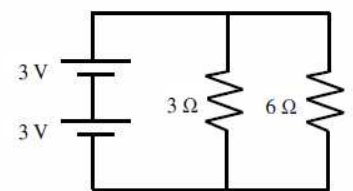
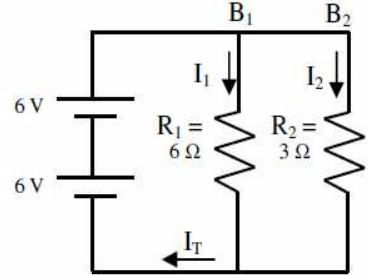
Which resistor uses the most power?

Why?

35 amps of current goes through a 40 amp fuse. What happens? 

25 amps of current goes through a 15 amp fuse. What happens?

Split the following parallel circuit into two independent series circuits.

V<sub>T</sub> = \_\_\_\_\_  
 V<sub>Branches</sub> = \_\_\_\_\_  
 I<sub>1</sub> = \_\_\_\_\_  
 I<sub>2</sub> = \_\_\_\_\_  
 I<sub>T</sub> = \_\_\_\_\_  
 R<sub>T</sub> = \_\_\_\_\_  
 P<sub>6Ω</sub> = \_\_\_\_\_  
 P<sub>3Ω</sub> = \_\_\_\_\_  
 P<sub>T</sub> = \_\_\_\_\_

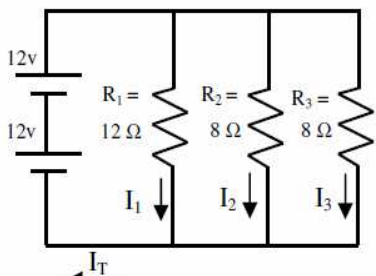
Series or parallel?

Which resistor will use more power?

Find the current in each circuit.

Find the total current.

Find the total resistance.



V<sub>T</sub> = \_\_\_\_\_  
 V<sub>Branches</sub> = \_\_\_\_\_  
 I<sub>1</sub> = \_\_\_\_\_  
 I<sub>2</sub> = \_\_\_\_\_  
 I<sub>3</sub> = \_\_\_\_\_  
 I<sub>T</sub> = \_\_\_\_\_  
 R<sub>T</sub> = \_\_\_\_\_  
 P<sub>T</sub> = \_\_\_\_\_

Which resistor uses the most power?