Name: _____

Period: _____

Power and Voltage Drops

8.5

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.

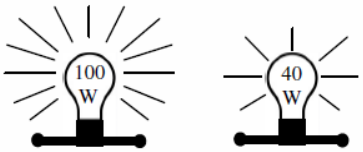
Electrical Power:

Power (in *watts*) → **P = VI** ← Voltage (in *volts*), Current (in *amps*)

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 v I = 3 A P = ____	P = VI = P = 12(3) = (36 w)

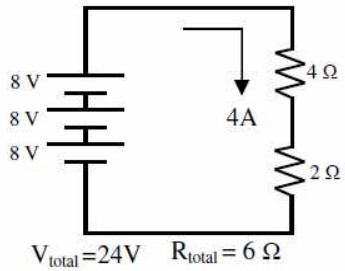


A brighter bulb uses more power. Since P= VI, a bulb could be brighter because it uses more voltage with the same current OR because it uses more current with the same voltage.

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.

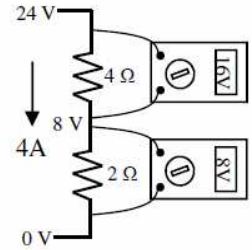
1. Find the total current (I_T).



V_{total} = 24V R_{total} = 6 Ω

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

2. Use V = IR for each resistor.

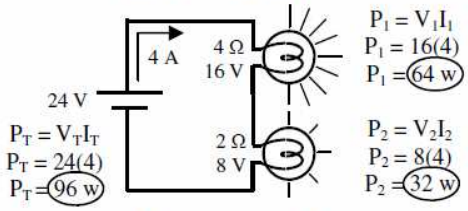


$V_1 = I_1R_1$
$= 4(4) = 16$ V
R_1 uses 16 V, leaving 8 V.

$V_2 = I_2R_2$
$= 4(2) = 8$ V
R_2 uses 8 V, leaving 0 V.

*Notice V = 8 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.



$P_1 = V_1I_1$
$P_1 = 16(4)$
$P_1 = (64$ w$)$

$P_2 = V_2I_2$
$P_2 = 8(4)$
$P_2 = (32$ w$)$

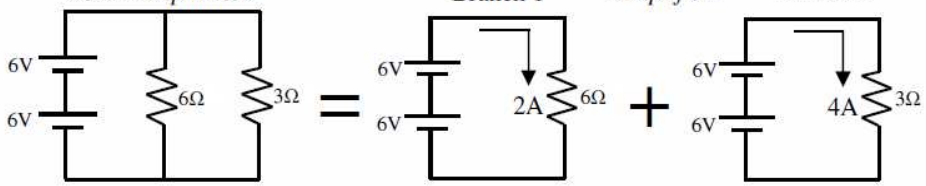
$P_T = V_TI_T$
$P_T = 24(4)$
$P_T = (96$ w$)$

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.

Semi-complicated = Branch 1 + Branch 2 *Simplified*



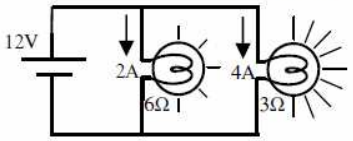
V_{total} = 12V R_1 = 6 Ω V_{total} = 12V R_2 = 3 Ω

$I_1 = \frac{V_1}{R_1} = \frac{12}{6} = 2A$ $I_2 = \frac{V_2}{R_2} = \frac{12}{3} = 4A$

I_T = 2 + 4 = 6A

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

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

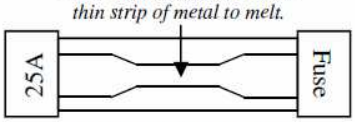


$P_1 = V_1I_1$
$= 12(2) = (24$ w$)$

$P_2 = V_2I_2$
$= 12(4) = (48$ 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).

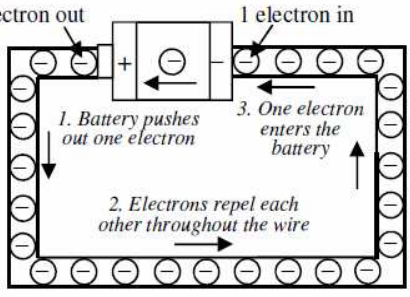
Fuses



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.



Name: _____

Period: _____

Electrical Power

1. A 400Ω resistor has 0.5A flowing thru it. If P = VI, how much power does it dissipate (release into its surroundings)?

2. A 12V battery has 3 amperes flowing thru it. If P = W/t, how much time is necessary for it to produce 60J of energy?

3. Substitute V = IR into P = VI and create a new equation for power that does not have voltage in it.

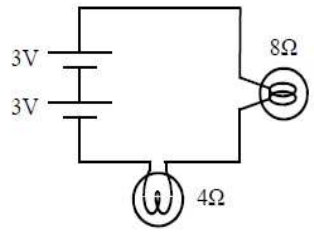
4. In V = IR, solve for I and substitute that into P = VI to create an equation for power that does not have current in it.

5. Given $P = VI = I^2R = V^2/R$, how does the power change if:
   A. The voltage is doubled. (*Something else will change, too, so use the equation where only V changes*).
   B. The current is doubled and the resistance is doubled.
   C. The voltage is doubled and the resistance is halved.

6. A 4Ω resistor has 300mA flowing thru it. How much power does it use?

7. A 12kΩ (12,000Ω) resistor uses 1.5V. How much power does it dissipate?

Let's discover how power works in circuits.



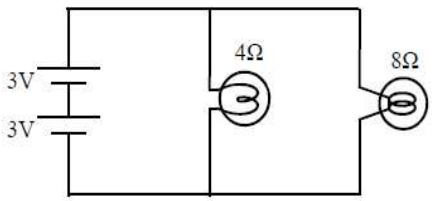
8. Two light bulbs are in the circuit shown.
   A. Are the bulbs in parallel or series?
   B. Calculate the current flowing thru each bulb.
   C. Calculate the voltage used by each bulb.
   D. Which light bulb has the most current?
   E. Calculate the power used by each.

F. Brightness is about power. So which bulb is brighter?

In series, the resistors have the same current, but the bigger resistor uses more voltage and more power.

G. Calculate the power generated (created) by the batteries.

Notice that the power generated by the battery equals the power used by the resistors.



9. The circuit is then reconfigured as shown.
   A. Are the bulbs in parallel or series?
   B. What is the voltage across each bulb?
   C. Which light bulb has the most current?
   D. Calculate the power used by each bulb.

E. Brightness is about power. So which bulb is brighter?

In parallel, the resistors have the same voltage, but the smaller resistor has more current and more power.

F. Calculate the power generated by the batteries.

So, the power generated by the battery equals the power used by the resistors in both parallel and series.

10. Three light bulbs of equal resistance are configured as shown. Which one is brightest and why? (*Think voltages and currents.*)