

Lesson 5: Resistance - Ohm's Law

Resistance is a term used in current electricity to describe things like light bulbs, motors, heaters, stereos, etc. All of these things are called **Loads** and convert the energy the coulombs carry, into other forms.

In the wooden block model, resistance can be thought of as how hard it is to make things spin around. Things with a lot of resistance need a lot of energy to make them spin around. Things with little resistance don't need very much energy at all to make them spin. In the wooden block model this energy is represented by the total distance all Coulomb blocks have to drop before the load can spin around.

In the water model, resistance can be thought of as how well water leaks around gravel (or water wheels) in the pipes. Pipes with a lot of resistance don't let the water flow through very easily. They use the water's energy to move the water wheels (or gravel) around.

In both models **Resistance** makes it hard for the Coulombs to flow. **Resistance** is often described as an opposition to the flow of current.

Resistance is measured in units called **ohms (Ω)**.

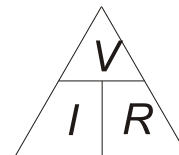
Ohm's Law

Ohm's Law shows how the voltage, current, and resistance affect each other. In a simple circuit, if the voltage increases, what would you predict would happen to the current.? If the resistance somehow was increased, and the voltage stayed the same, what would happen to the current through the circuit.? We can use our models to qualitatively predict what will happen in these cases.

If we wish to know the measured values for the different variables, we have to use **Ohm's Law**. This law puts three variables into the mathematical formula. $V = I \times R$ (Voltage = current X resistance)

The formula can be rearranged to look like $I = \frac{V}{R}$ or $R = \frac{V}{I}$

An easy way to remember the different forms of **Ohm's Law** is by using the mnemonic



Example Problem #1

Given $V = ?$
 $I = 3 \text{ A}$
 $R = 2 \Omega$
Find V
Use $V = IR$ (from the triangle)
 $= 3 \text{ A} \times 2 \Omega$
 $= 6 \text{ V}$

Example Problem #2




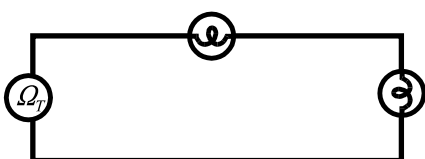
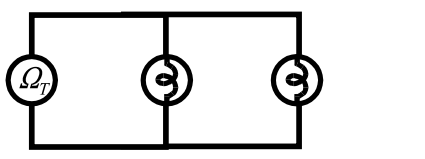
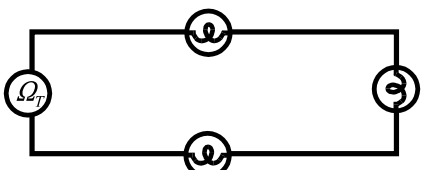
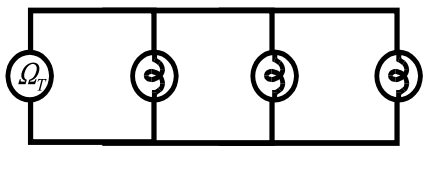
Given $V = 3 \text{ V}$
 $I = ?$
 $R = 2 \Omega$
Find I
Use $I = V/R$ $I = \frac{V}{R}$ (from the triangle)
 $= 3\text{V} / 2 \Omega$
 $= 1.5 \text{ A}$

TOTAL RESISTANCE OF CIRCUITS

Set up the following circuits.

Use the multimeter as an Ohmmeter to measure their total resistance.

Answer the questions on the following page.

Total Resistance			
Series Circuits	Total Resistance (Ohms) (Ω)	Parallel Circuits	Total Resistance (Ohms) (Ω)
RESISTANCE OF LEADS ONLY 			$\Omega_T = \sim 0 \Omega$
	$\Omega_T = \text{eg. } 2 \Omega$		$\Omega_T = \text{eg. } 2 \Omega$
	$\Omega_T = \text{eg. } 4 \Omega$		$\Omega_T = \text{eg. } 1 \Omega$
	$\Omega_T = \text{eg. } 6 \Omega$		$\Omega_T = \text{eg. } 0.6 \Omega$

Use the results from the notes and your table to answer the following;

1) What is the resistance?

Resistance describes how difficult it is for the current to flow through something. Things with high resistance make it very difficult for the current to flow. Current flows easily through things with little resistance.

2) What is the resistance of just a lead (or conductor)? **Close to zero Ω**

3) Is it easy or hard for a battery to push coulombs through the lead wires of the meter? **It's easy**

4) As more lights are connected in **SERIES**:

A) the total resistance of the circuit becomes **high** so we say the load becomes **large**

B) the (easier/**harder**/the same) for the battery to push coulombs through the circuit.

- C) the current in the circuit becomes lower.
- 5) A short circuit could just be described as a circuit which has very low resistance and causes the current to rapidly rise when the switch is closed.
- 6) As more lights are connected in **PARALLEL**:
- A) the total resistance of the circuit becomes low so we say the load becomes small.
 - B) it is (easier/harder/the same) for the battery to push coulombs through the circuit.
 - C) the higher the current in the main circuit.
- 7) An Overload is a parallel circuit which has very low total resistance because of too many loads connected. This causes the current to slowly rise as more loads are connected..
- 8) If several appliances (like a stereo, CD player, lamp, and a computer) are all connected to one extension cord or "power bar" an Overload circuit can be created.
- A) Compare the voltage of the electricity going through each appliance in an overload circuit to the voltage if only one appliance were connected. The voltage is the same in the overload circuit.
 - B) Compare the current going through the extension cord in an overload circuit to the current expected if just one appliance were connected. The current is higher in the overload circuit.
- 9) Household plugs offer some resistance to current flow because the connections are never completely clean and tight. From your knowledge of what happens when current flows through a site of resistance, which part of such an overload circuit would be most likely to overheat and cause a fire?

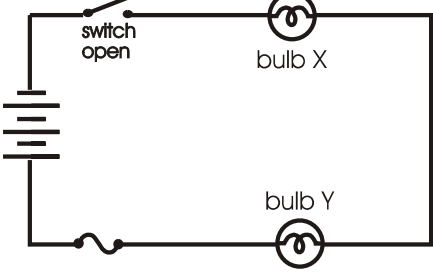
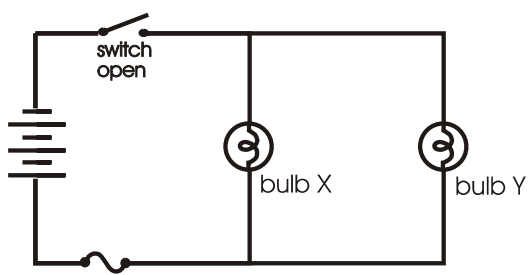
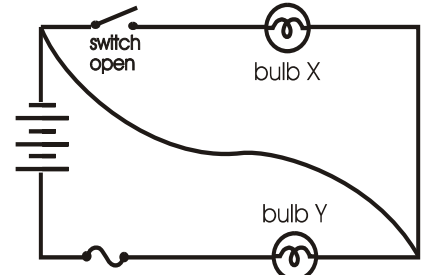
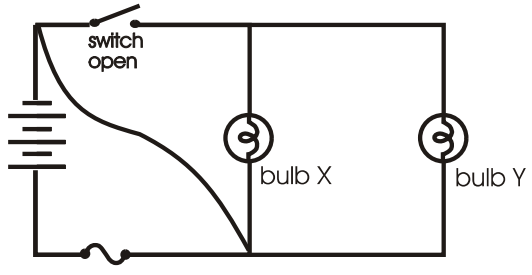
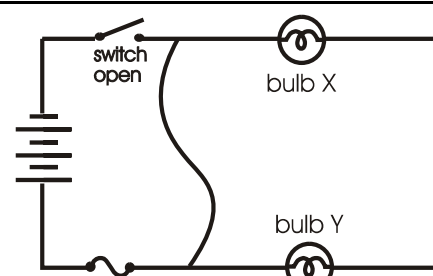
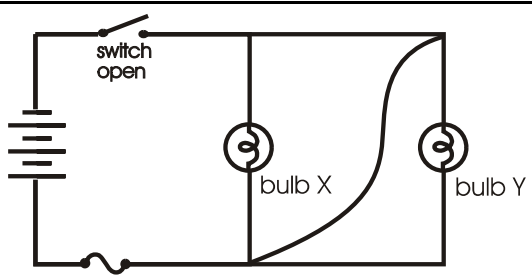
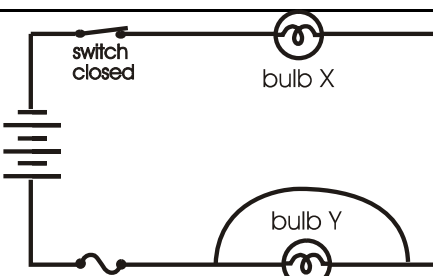
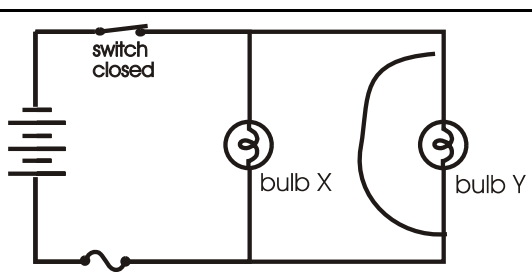
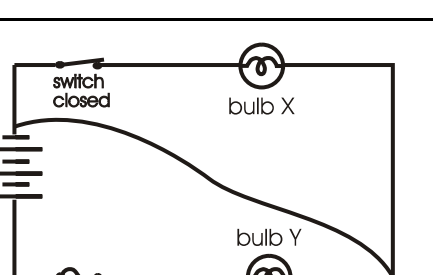
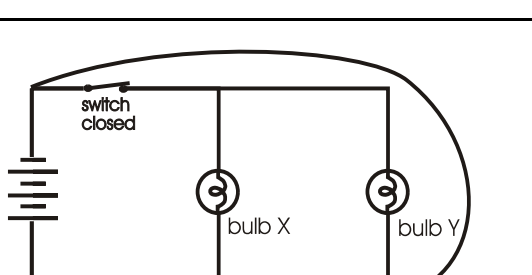
The connections will become hotter than other parts of the circuit

Fuses & Circuit Breakers

- 3) A short circuit causes the current to rapidly rise when the switch is closed. It is the result of a path with very little resistance around the light bulb.
- 4) Fuses (and Circuit Breakers) are connected in series to the rest of the circuit, because if too much current flows, the fuse will melt and stop the current.
- 5) The more lights that are connected in **SERIES**, the less likely a short circuit will occur.
- 6) The more lights that are connected in **PARALLEL**, the more likely an overload circuit will occur.

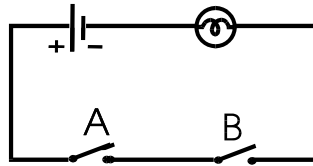
REVIEW

1) What happens to the bulbs in the following table after the described changes

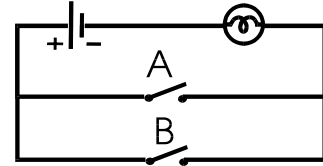
<p>Circuits are shown to the right</p>		
<p>The switch is open. A piece of copper wire is connected as shown. Which bulb, if any, is ON or OFF ?</p>	 <p style="text-align: center;">bulb X is <u>OFF</u> bulb Y is <u>ON</u></p>	 <p style="text-align: center;">bulb X is <u>OFF</u> bulb Y is <u>OFF</u></p>
<p>Note; In the diagram to the far right Bulb X might have flickered on briefly but then would have gone out when the fuse blew due to the short circuit</p>	 <p style="text-align: center;">bulb X is <u>OFF</u> bulb Y is <u>OFF</u></p>	 <p style="text-align: center;">bulb X is <u>OFF</u> bulb Y is <u>OFF</u></p>
<p>The copper wire is removed and the switch closed. Both bulbs light up. The copper wire is connected as shown.</p> <p>Choose from the following words to describe the bulbs gets brighter stays the same gets dimmer goes out</p>	 <p style="text-align: center;">bulbX <u>gets brighter</u> bulbY <u>goes out</u></p>	 <p style="text-align: center;">bulb X <u>goes out</u> bulbY <u>goes out</u></p>
<p>Note; In the diagrams to the far right Bulb X might have flickered on briefly but then would have gone out when the fuse blew due to the short circuit</p>	 <p style="text-align: center;">bulb X <u>goes out</u> bulb Y <u>gets brighter</u></p>	 <p style="text-align: center;">bulb X <u>goes out</u> bulb Y <u>goes out</u></p>

2) Study these two circuits.
 Complete the following sentences,
 choosing words from the list to fill in the
 blank spaces.

**AND, BUT, EITHER,
 NEITHER, NOR, OR,**



circuit 1



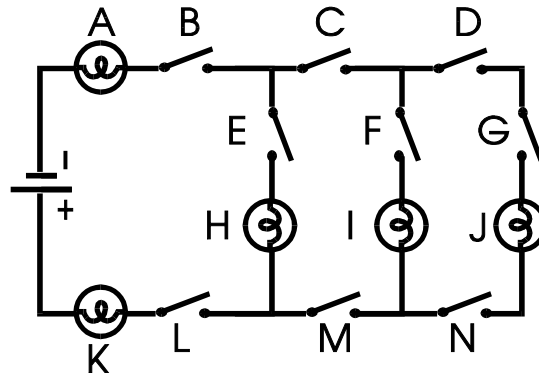
circuit 2

In circuit 1, for the lamp to be on
 A AND B must be on

In circuit 2, for the lamp to be on A OR B must be on

3) Use the diagram below to answer the following questions

NOTE More than one bulb is affected for most questions.
 Make sure you state all bulbs that are affected
 Assume all switches are closed except the one being discussed.



- a) Switch B affects light bulbs ALL BULBS
- b) Switch C affects light bulbs I AND J
- c) Switch D affects light bulbs ONLY J
- d) Switch E affects light bulbs ONLY H
- e) Switch G affects light bulbs ONLY J
- f) Switch L affects light bulbs ALL BULBS
- g) Switch M affects light bulbs I AND J
- h) Switch N affects light bulbs ONLY J
- i) If light bulb K burns out, it affects light bulbs ALL BULBS
- j) If light bulb H burns out, it affects light bulbs NO OTHER BULBS
- k) If light bulb I burns out, it affects light bulbs NO OTHER BULBS