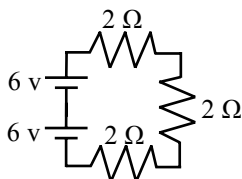


# V, R, and I in Series Circuits

## Total Voltage ( $V_T$ )

If the batteries are in series (in a line) then **add them together** to find the total voltage ( $V_T$ ).

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

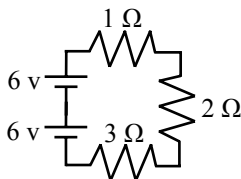


$$V_T = 6\text{ v} + 6\text{ v} = 12\text{ v}$$

## Total Resistance ( $R_T$ )

If the resistors are in series then **add them together** to find the total resistance ( $R_T$ ).

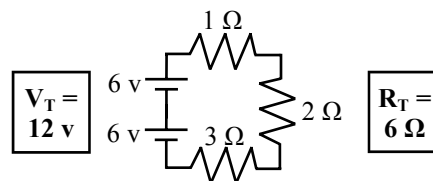
$$R_T = R_1 + R_2 + R_3 + \dots$$



$$R_T = 1\ \Omega + 2\ \Omega + 3\ \Omega = 6\ \Omega$$

## Total Current ( $I_T$ )

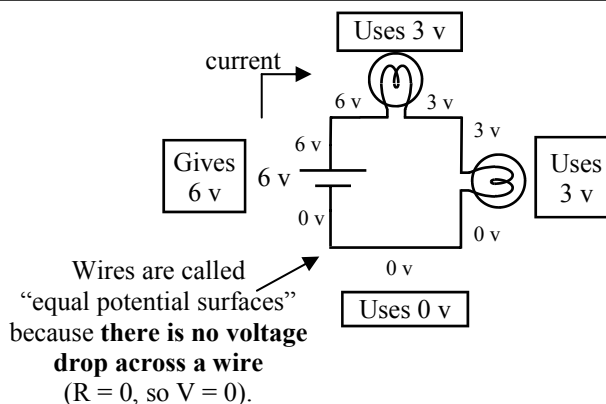
Use **Ohm's Law** to calculate the total current from  $V_T$  and  $R_T$ .



$$I = \frac{V}{R} = \frac{12\text{ v}}{6\ \Omega} = 2\text{ A}$$

## Voltage Drop

Each resistor in a series circuit "uses" part of the energy of the circuit, reducing the voltage. Eventually the voltage is back to zero at the negative side of the battery. Then the battery energizes the electrons again.



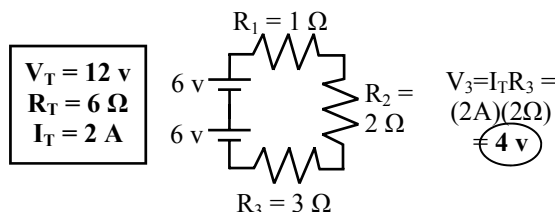
**A circuit uses up all the voltage given by the batteries. Batteries give voltage: circuits use voltage. The voltage at the negative end of the batteries is always zero!**

## Voltage Across a Resistor

Calculating Voltage over a particular resistor:

- 1) find the total current;
- 2) use Ohm's Law for that resistor.

$$V_1 = I_T R_1 = (2\text{ A})(1\ \Omega) = \mathbf{2\text{ v}}$$



Notice that each resistor uses up part of the voltage and that all of the individual voltage drops equal  $V_T$ .

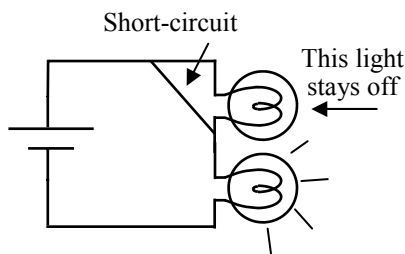
$$V_{RX} = I_T R_X, \text{ where } R_X \text{ is a particular resistor.}$$

$$V_3 = I_T R_3 = (2\text{ A})(3\ \Omega) = \mathbf{6\text{ v}}$$

## Short Circuits

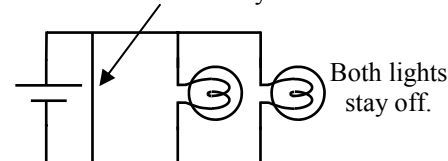
**A short-circuit is when a wire by-passes a device in a circuit.**

Electricity always chooses the path of least resistance. Since wires have virtually no resistance, electricity will go thru a wire instead of a device or circuit. This causes a short-circuit.



Short-circuiting a device just by-passes it: it stays off. It is easier for the current to go thru the wire than the light bulb.

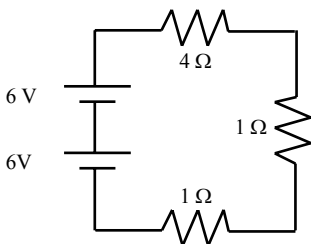
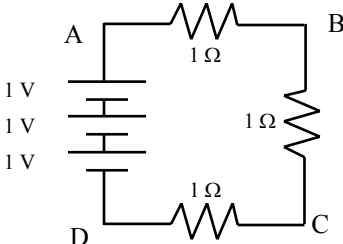
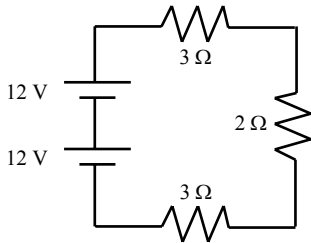
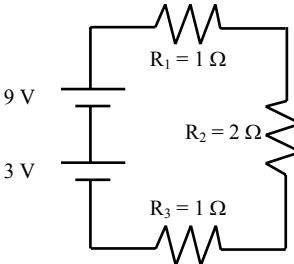
Short-circuit of battery



Short-circuiting a battery can be dangerous: it will drain the battery quickly and can lead to a melted wire or even a fire!

Name: \_\_\_\_\_

Period: \_\_\_\_\_

|                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Find the following quantities:</p> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <math>V_T =</math><br/> <math>R_T =</math><br/> <math>I_T =</math> </div> </div> | <p>Label the voltages at the letters.</p> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <math>V \text{ at A} =</math><br/> <math>V \text{ at B} =</math><br/> <math>V \text{ at C} =</math><br/> <math>V \text{ at D} =</math> </div> </div>                                          |
| <p>Find the following quantities:</p> <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <math>V_T =</math><br/> <math>R_T =</math><br/> <math>I_T =</math> </div> </div> | <div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <math>V_T =</math> _____<br/> <math>R_T =</math> _____<br/> <math>I_T =</math> _____<br/> <math>V \text{ over } R_1 =</math> _____<br/> <math>V \text{ over } R_2 =</math> _____         </div> </div> <p>Series or parallel? _____</p> |

Draw all circuits.

**In the Lab**

|                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Circuit 1: battery; light bulb; green resistor; switch.</p><br><br><br><br><br><p>Notice how bright the light bulb is.</p>                                                                             | <p>Rank the three resistors from lowest to highest:</p><br><br><p>Use an ohm meter to check for the actual resistances:</p> <p>Green: _____ Red: _____; Blue: _____</p>                                                                                                              |
| <p>Circuit 2: battery; light bulb; red resistor; switch.</p><br><br><br><br><br><p>Compare the brightness of the light bulb to circuit 1.</p> <p>Which has more resistance the red or green resistor?</p> | <p>Circuit 4: 2 batteries; 2 light bulbs; switch.</p><br><br><br><br><br><p><b>CAUTION!</b></p> <p>It is important that you are exact in how you do this next step:</p> <p>Short circuit one of the light bulb (NOT THE BATTERY).</p><br><br><p>What happens to that light bulb?</p> |
| <p>Circuit 3: battery; light bulb; blue resistor; switch.</p><br><br><br><br><br><p>Compare the brightness of the light bulb to circuit 1.</p> <p>Which has more resistance the blue or red resistor?</p> |                                                                                                                                                                                                                                                                                      |