Engineering

Series Circuits

April 10, 2020

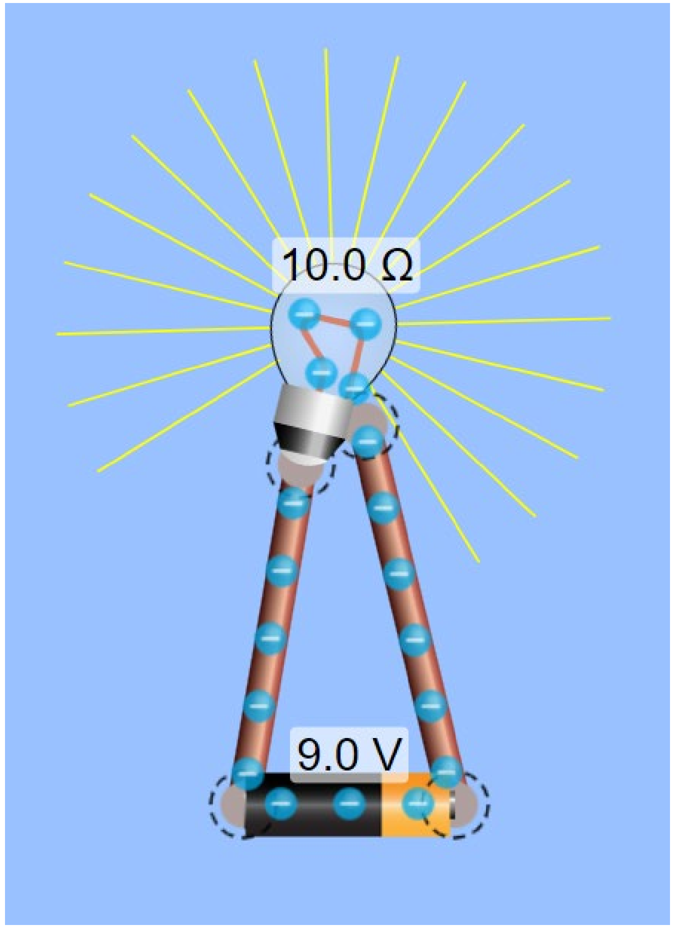
9-12/ Engineering
Series Circuits: [April 10, 2020]

Objective/Learning Targets:

1. Discuss basic electricity relationships
2. Build circuits from schematic drawings
3. Understand the attributes of Ohm's law in series circuits
4. Calculate Ohm's law in series circuits

Learning tools for today

- [Use this link and press play to enter a free simulator.]
- Select intro and build the simple series circuit included in this lesson. You will need to build circuits using a battery, light bulbs, and wires.
- Click the selection in the top right for labels and values.
- You will also be calculating Ohm's law to understand how attributes of the law apply in series circuits.



Relationships of Electrical Properties

Ohm's Law

- Ohm's Law is the mathematical relationship between current, voltage, and resistance.
- If you know two of the three quantities, you can solve for the third quantity.

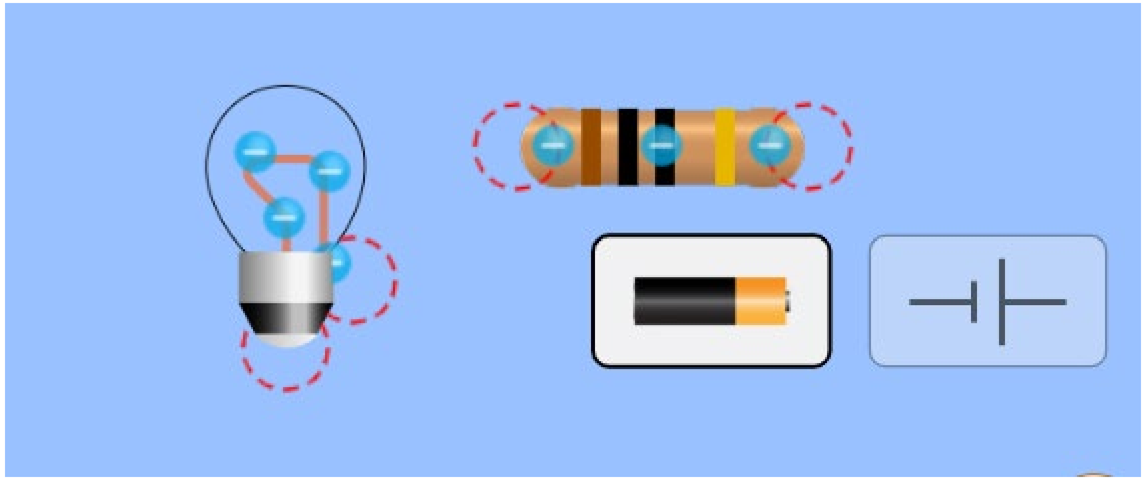
$V=IR$	$I=V/R$	$R=V/I$

Concept	Measurement	Symbol	Formula
Voltage	Volts	V	V
Current	Amperes	A	I
Resistance	Ohms	Ω	R

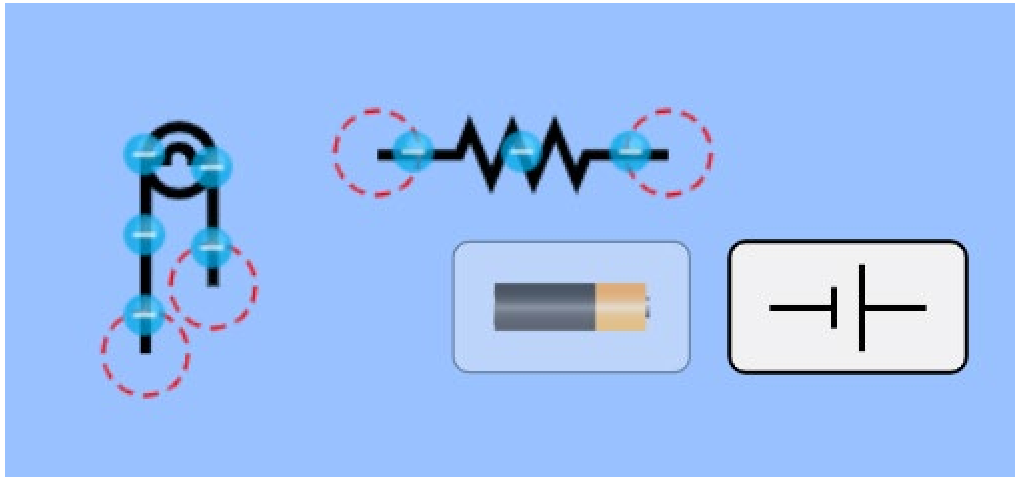
Series circuits

- **In simulation you can toggle the picture diagram to schematics with the button on the bottom right.**
- **Do you see the difference in the symbols?**
- **Schematics are used to simplify circuit drawings.**

Picture Symbols



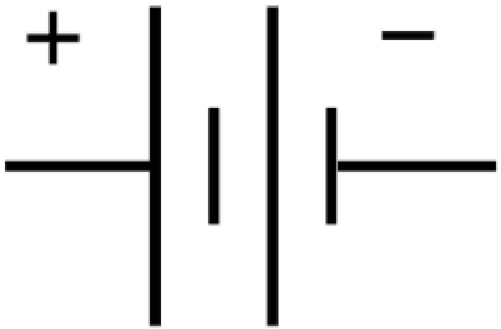
Schematic Symbols



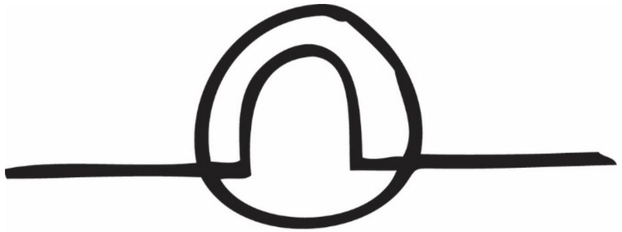
Series circuit schematics

- Schematic symbols are used to represent components in circuit drawings.

American style resistor



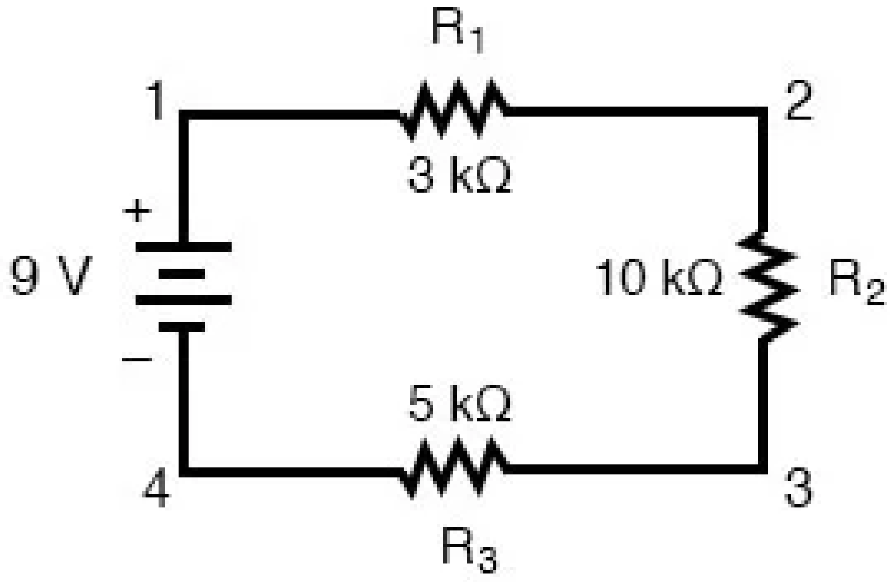
The battery symbol

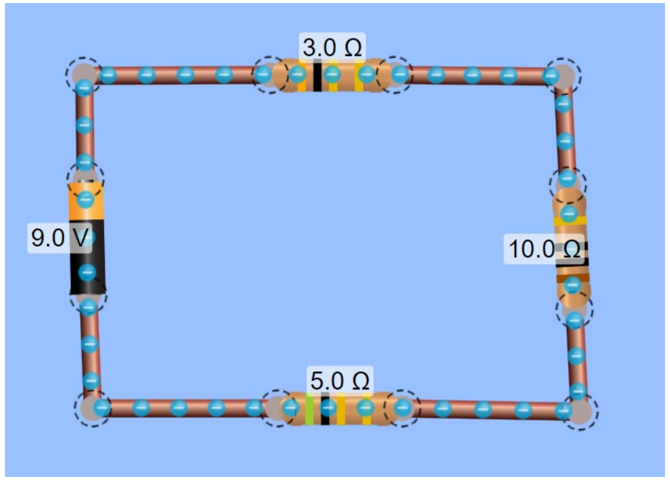


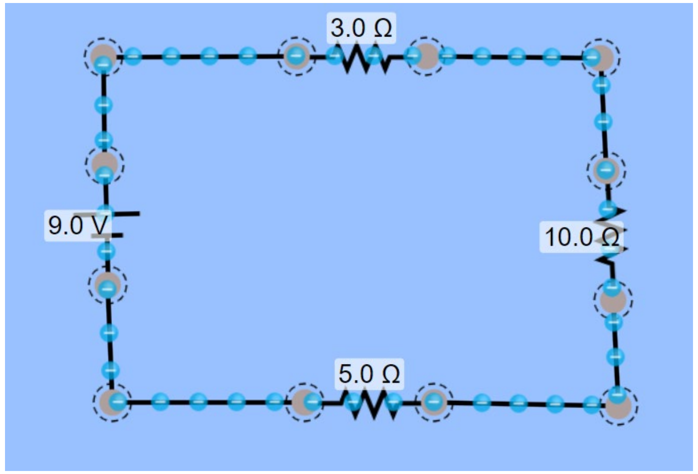
lightbulb

Series circuits

- **Build this circuit, turn on labels and values, use sliders to change the values to match the schematic, ignore the k in ohms. Each version is the same circuit. We can now make some observations.**

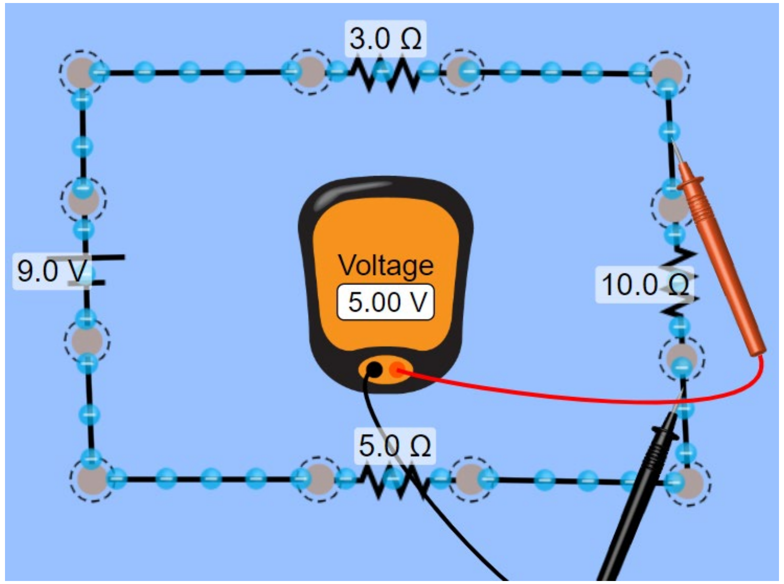




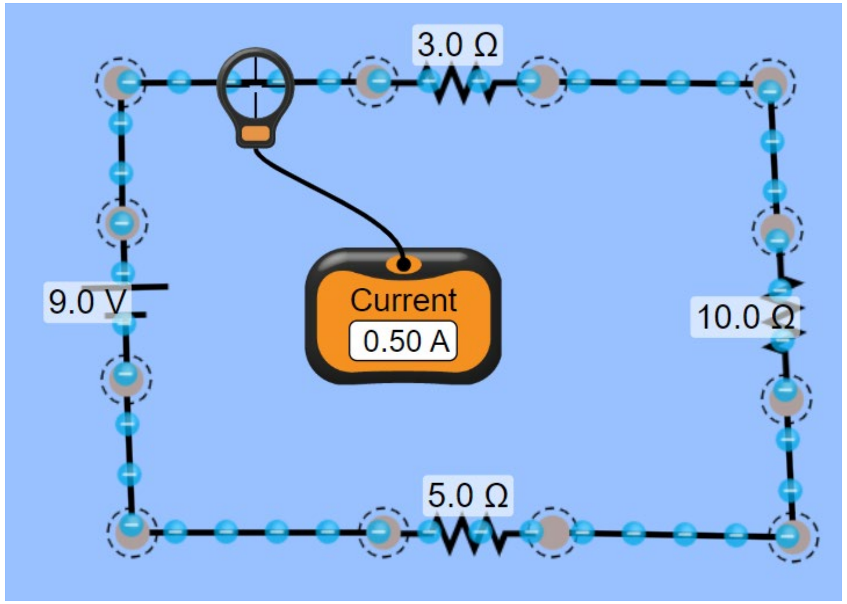


Investigate Series circuits

- Use the multi-meter to make measurements around each resistor as shown.
- What are you measuring for?
- What did you notice?

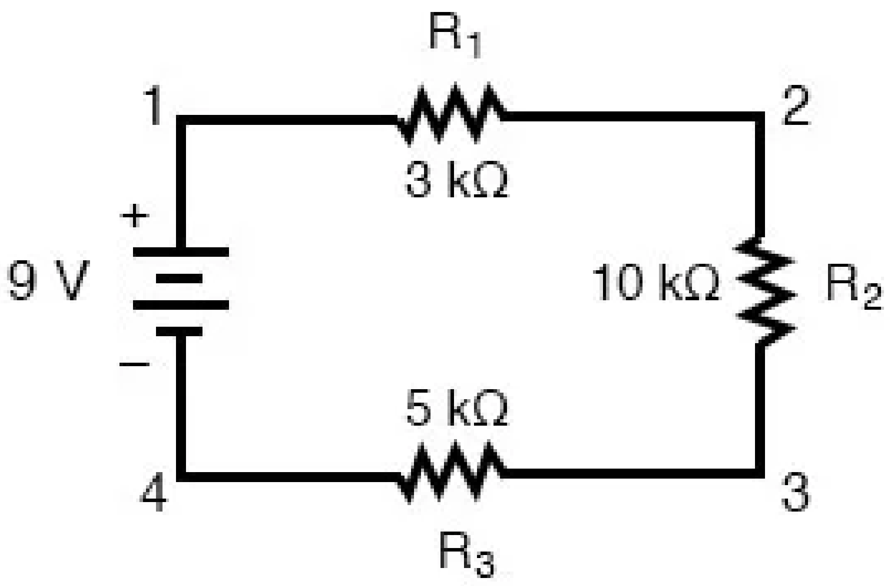


- Use the ammeter to make measurements between each resistor as shown.
- What are you measuring for?
- What did you notice?



Series circuits Rules

- **Current**: The amount of current is the same through any component in a series circuit.
- **Resistance**: The total resistance of any series circuit is equal to the sum of the individual resistances.
- **Voltage**: The supply voltage in a series circuit is equal to the sum of the individual voltage drops.



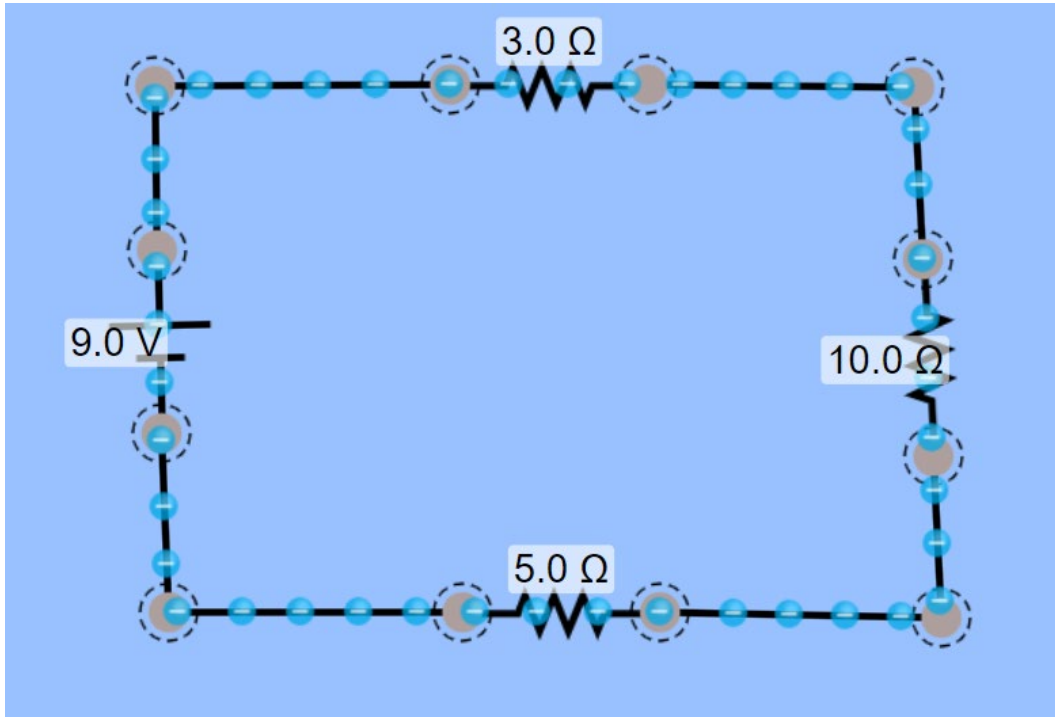
Series Circuit Rules and Calculations

- Ohm's law in series circuits
- Components in a series circuit share the same current:
  - $I_{Total} = I_1 = I_2 = . . . I_n$
- The total resistance in a series circuit is equal to the sum of the individual resistances:
  - $RTotal = R_1 + R_2 + . . . R_n$
- Total voltage in a series circuit is equal to the sum of the individual voltage drops *Kirchoff's Voltage Law*
  - $V_{Total} = V_1 + V_2 + . . . En$
- Additional Resources

Ohm's Law in series circuits

- Step 1
- Identify all knows and unknowns
- All known values are in bright blue
- All unknown values need to be calculated for.
- T = total, R1= Resistor etc., R_T=Resistance total, I_T = Current total

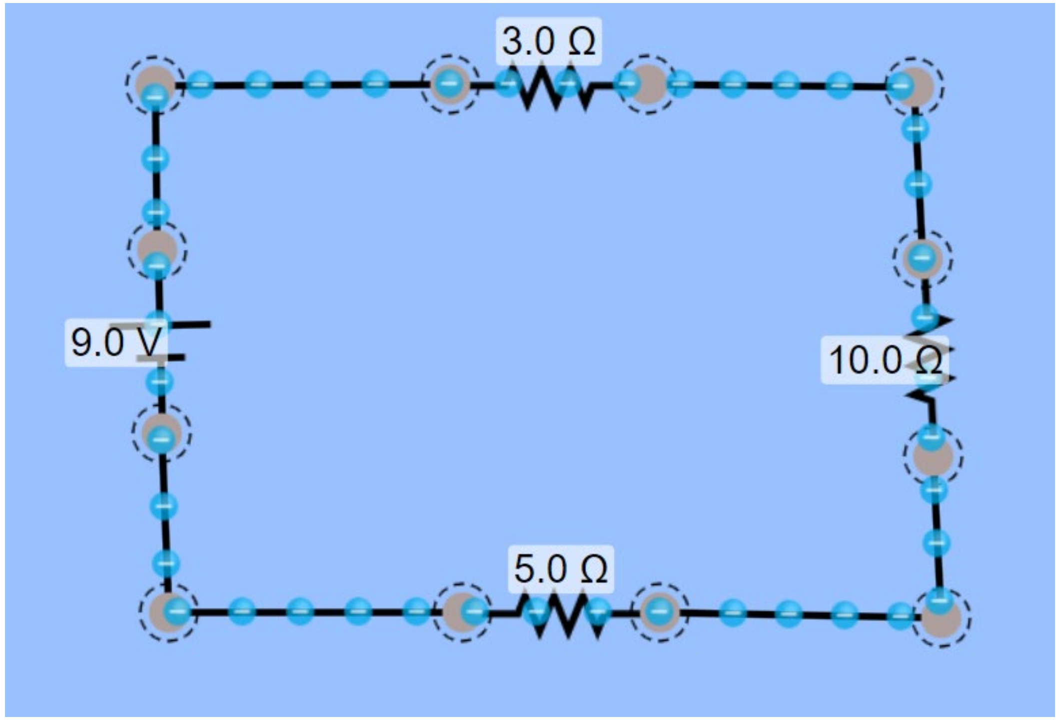
V_T 9V	V_{R1}	V_{R2}	V_{R3}
I_T	I_{R1}	I_{R2}	I_{R3}
R_T	R_1 3Ω	R_2 10Ω	R_3 5Ω



Ohm's Law in series circuits

- Step 2
- In series circuits Resistance adds
- R_T=$R_1 + R_2$+R_3
- R_T=3Ω + 10Ω+5Ω
- R_T=18Ω

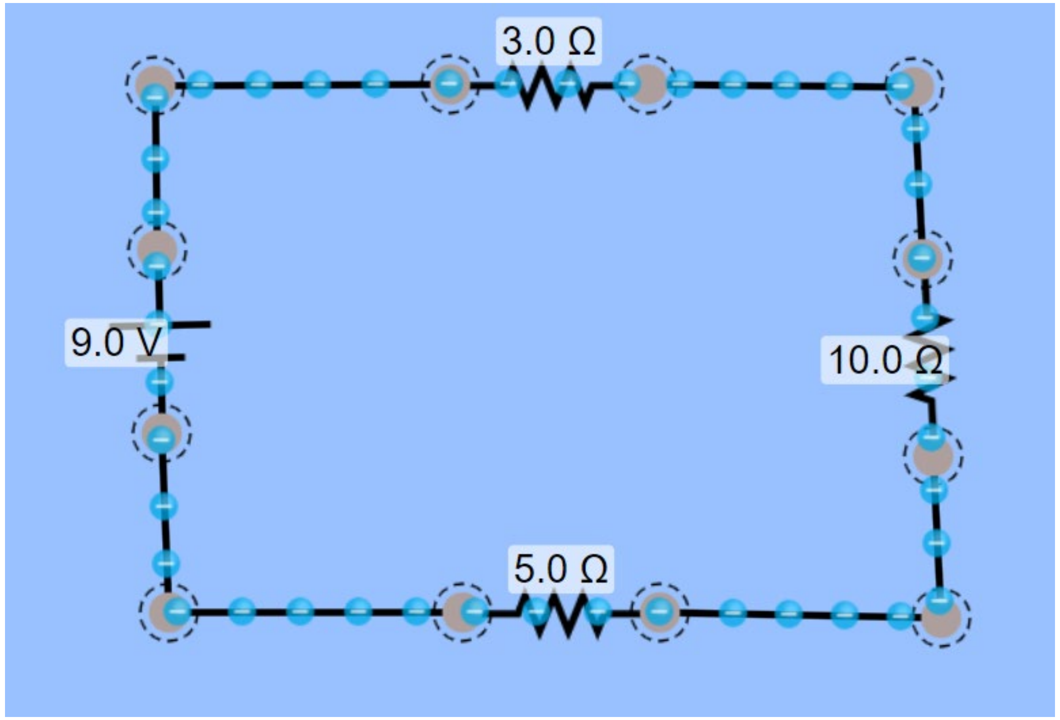
V_T 9V	V_{R1}	V_{R2}	V_{R3}
I_T	I_{R1}	I_{R2}	I_{R3}
R_T 18Ω	R_1 3Ω	R_2 10Ω	R_3 5Ω



Ohm's Law in series circuits

- Step 3
- Calculate the easiest unknown, Current Total
- $I_T = V_T$ 9V / R_T 18Ω
- I_T=.50A

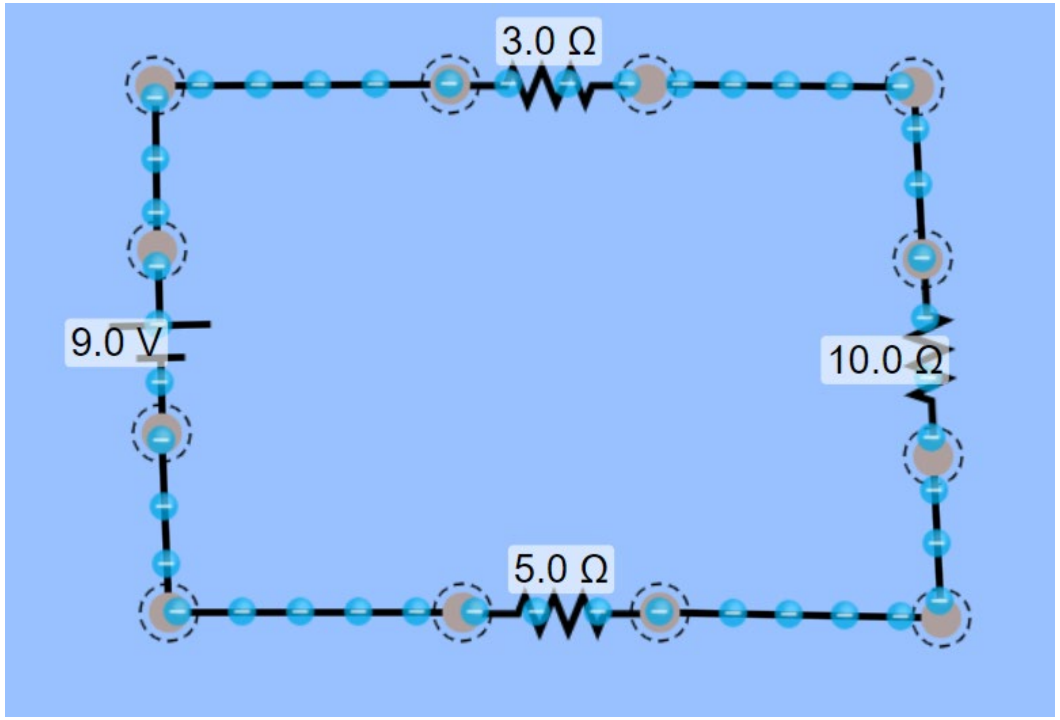
V_T 9V	V_{R1}	V_{R2}	V_{R3}
I_T .50A	I_{R1} .50A	I_{R2} .50A	I_{R3} .50A
R_T 18Ω	R_1 3Ω	R_2 10Ω	R_3 5Ω



Ohm's Law in series circuits

- Step 4
- Calculate for the voltage of each resistor using V=IR
- Check your work with the simulation after you finish
- All values will check themselves using Ohm's law.
- IF you add all Resistor voltages they equal Voltage total.

V_T 9V	V_{R1} 1.5V	V_{R2} 5V	V_{R3} 2.5V
I_T .50A	I_{R1} .50A	I_{R2} .50A	I_{R3} .50A
R_T 18Ω	R_1 3Ω	R_2 10Ω	R_3 5Ω



Ohm's Law in series circuits

- Your turn
- Solve for all of the unknown circuit values.
- Follow the steps to find each value.
- Use the simulation to check your work.

V_T	V_{R1}	V_{R2}	V_{R3}
I_T	I_{R1}	I_{R2}	I_{R3}
R_T	R_1	R_2 1	R_3