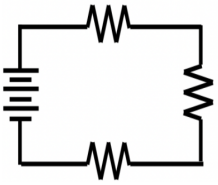
Series Circuit Relationships
Lesson Notes

Learning Outcomes
- What are the important mathematical patterns and relationships associated with series circuits?
- How do you use these relationships?

Review:

Series Circuit



Only 1 pathway.

Every charge that makes the loop passes through every resistor.

As the number of resistors increases …

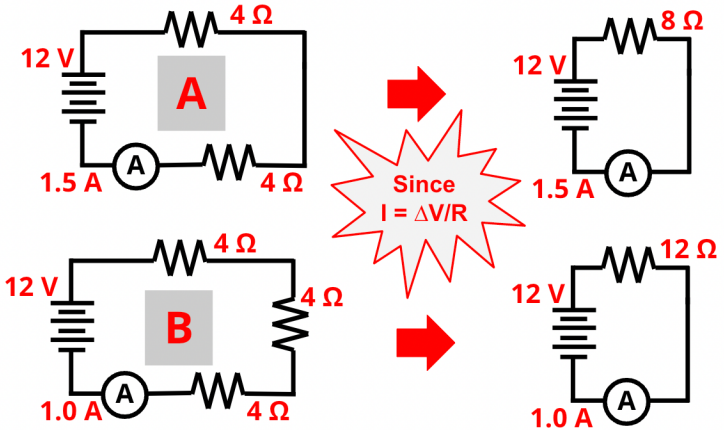
… current decreases, and

… total resistance increases

Removing a bulbs from its socket causes all the bulbs to be unlit.

Equivalent Circuits

In Circuit A, there are two 4-Ω resistors and a current of 1.5 A. In B, there are three resistors and a current of 1.0 A. As # of resistors ↑, the current ↓.



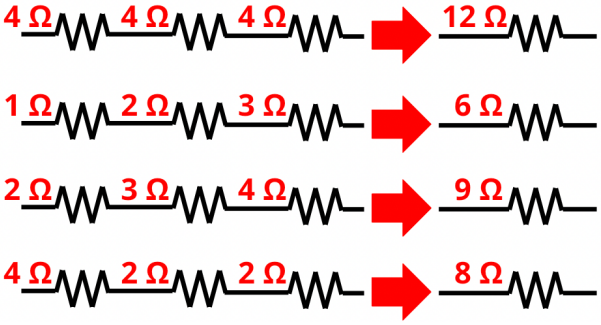
Having two 4-Ω resistors **is equivalent to** having one 8-Ω resistor. And having three 4-Ω resistors **is equivalent to** having a single 12-Ω resistor.

Equivalent Resistance

The **equivalent resistance** (R_{eq}) of a multiple-resistor circuit is the amount of resistance a single resistor must have to match the effect of the collection of resistors.

For series circuits:

$$R_{eq} = R_1 + R_2 + R_3 + \ldots$$



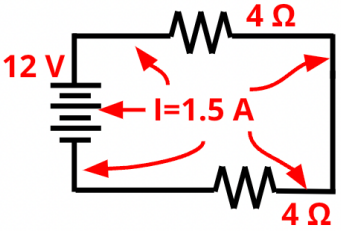
Current in Series Circuits

Current in a series circuit is everywhere the same.

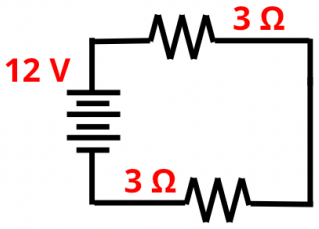
$$I_{battery} = I_1 = I_2 = I_3$$

Current can be calculated using $\Delta V = I \cdot R$:

$$I = \Delta V_{battery} / R_{eq}$$

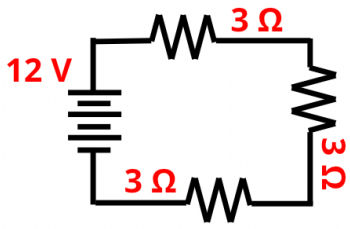


Practice



R_{eq} = 6 Ω

I = 2 A



R_{eq} = 9 Ω

I = 1.3̄ A

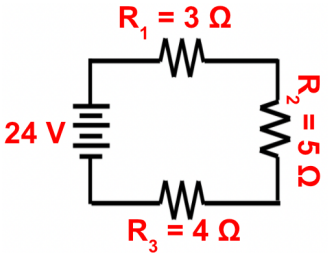
Electric Potential Difference

Every resistor causes a voltage drop or decrease in electric potential, represented by ΔV. The ΔV depends on the current and the resistance of the resistor.

$\Delta V_1 = I \cdot R_1$

$\Delta V_2 = I \cdot R_2$

$\Delta V_3 = I \cdot R_3$



R_{eq} = 12 Ω

I = 2.0 A

ΔV_1 = (2.0)•(3) = 6.0 V

ΔV_2 = (2.0)•(5) = 10.0 V

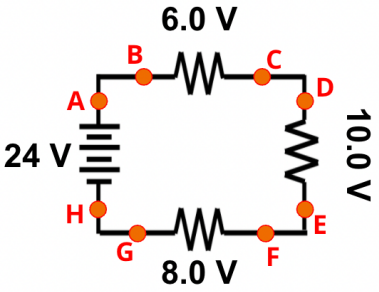
ΔV_3 = (2.0)•(4) = 8.0 V

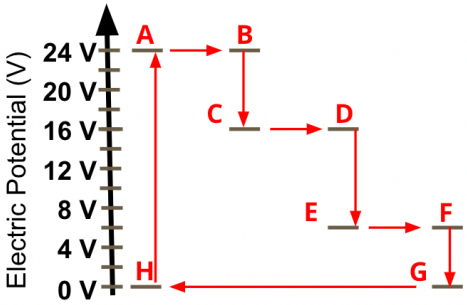
Note that the sum of all voltage drops (absolute value) is equal to the battery voltage.

$$\Delta V_{battery} = \Delta V_1 + \Delta V_2 + \Delta V_3 + \ldots$$

Electric Potential Diagrams

Electric potential diagrams are conceptual tools that represent the relative electric potential for various locations on a circuit.



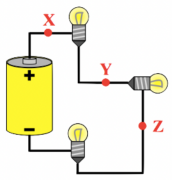


If charge gains 24 V of potential in the battery, it will lose a total of 24 V as it passes through the external circuit.

Concept Practice

Three identical light bulbs are connected to a battery as shown. Which adjustments could be made to the circuit that would increase the current being measured at Z?

a. Increase the resistance of one of the bulbs.
b. Increase the resistance of two of the bulbs.
c. Decrease the resistance of two of the bulbs.
d. Increase the voltage of the battery.
e. Decrease the voltage of the battery.
f. Remove one of the bulbs.



Three identical light bulbs are connected to a battery. Which one of the following statements about potential difference (ΔV) is **NOT** true? (Consider absolute value only.)

a. The ΔV from A to C is greater than that from B to C.
b. The ΔV from A to B is less than that from B to D.
c. The ΔV from B to C is less than that from B to D.
d. The ΔV from A to C is greater than that from B to D.
e. The ΔV from A to D is the same as that across the battery.
f. The ΔV from A to C is the same as that between B and D.