Edgenuity

Warm-Up | Electric Circuits

Lesson Question

How do electric circuits vary?

Lesson Goals

Interpret circuit diagrams.

Identify circuits as open, closed, or short.

Compare and contrast parallel and series circuits.

Apply Ohm's law to calculate voltage, current, or resistance in a parallel or series circuit.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

ammeter	a device that measures the amount of current in a circuit
closed circuit	a continuous loop of conducting material that allows current to flow
open circuit	a loop of conducting material with a break or gap that prevents the flow of current
resistor	a device that slows the flow of current in a circuit
short circuit	a disrupted circuit caused by the flow of charge through an unintentional path of low resistance, thus causing the current to bypass its proper path

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Words to Know

voltmeter	a device that measures the amount of voltage in a circuit
parallel circuit	an electric circuit that has multiple paths along which current can flow
series circuit	an electric circuit that has only one path along which the current can flow

Ohm's Law

- Ohm's law states that current is equal to voltage (V) divided by resistance (R).
  - I = current, measured in amperes (A)
  - V = voltage, measured in volts (V)
  - R = resistance, measured in ohms (Ω)

$$I = \frac{\Delta V}{R}$$

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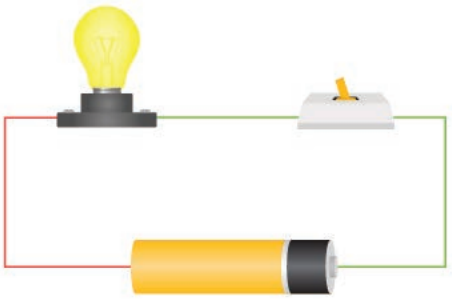
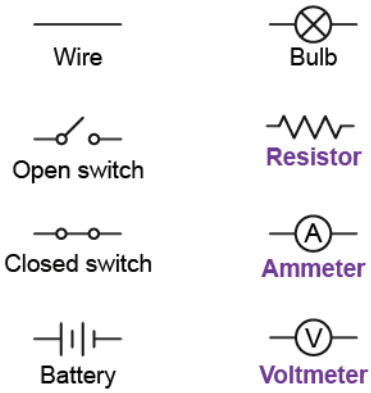
Parts of an Electric Circuit

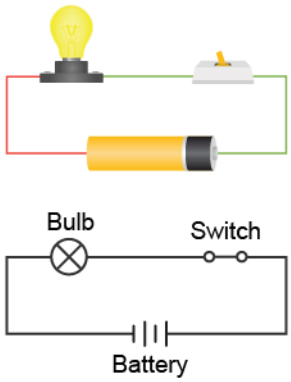
- An electric circuit has four basic features:
  - A source of electrical energy, such as a [battery] or generator
  - Devices that need electrical energy to operate, such as a computer, [lightbulb], or hair dryer
  - [Conducting] wires
  - A switch



Circuit Diagrams

- [Electric] circuits are represented by circuit diagrams.





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More about Resistors

- All resistors transform electrical energy into other forms of energy:
  - Light
  - Mechanical
  - Thermal
    - A by-product of all resistors is the transformation of electrical energy into thermal energy, which causes resistors to warm up.

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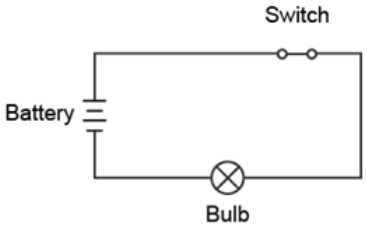
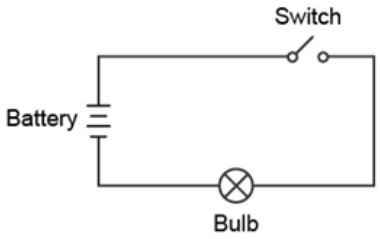
Types of Circuits

- Circuits generally fall into one of three categories based on the movement of current through the circuit.





- A closed circuit is a continuous loop that allows the flow of current.
- An open circuit is a noncontinuous loop that prevents the flow of current.

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Short Circuits

- A **short circuit** is a disrupted circuit in which the current [bypasses] its proper path.
- Short circuits are dangerous because less resistance leads to more [current], which causes excess [heating] around the circuit.

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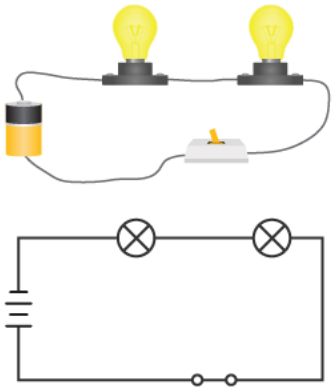
Series Circuits

- In a **series circuit**, there is only [one] path for the current to travel.
- All parts of the circuit are connected, one after another, in a single path.
- When any part of a series circuit is disconnected, no [current] can flow.



Series Circuit

Advantages and Disadvantages of Series Circuits

Advantages

- Series circuits are simple to design and build.
- Each added [source] of current adds more current to the circuit.
  - If you use three 1.5 V batteries, the total voltage will be 4.5 V.

Disadvantages

- If one bulb goes out, they all go out.
- Lightbulbs become dimmer as [more] bulbs are added to the circuit.
  - Each added bulb adds [resistance] to the circuit, which decreases the current.

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Voltage, Resistance, and Current in Series Circuits

- The voltage in a series circuit is equal to the voltage of the [power supply].
- The resistance in a series circuit is equivalent to the [sum] of all of the resistors in the circuit.
  - Known as equivalent resistance

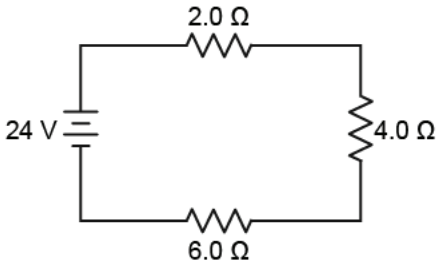
$$R_{eq} = R_1 + R_2 + R_3 + \ldots R_n$$

- The current in a series circuit can be calculated by using the [equivalent] resistance.
  - Since there is only one path, there is only one current to calculate.

$$I = \frac{V}{R_{eq}} = \frac{V}{R_1 + R_2 + R_3 + \ldots R_n}$$

Voltage Drop

- In a series circuit, the voltage drops after the current flows through each resistor.
  - Each resistor experiences a [different] voltage (electric potential difference).
- The voltage across each resistor can be determined by using Ohm's law.
  - $V =$ [RI]
- The sum of the voltages across each resistor is equal to the voltage of the power supply.



$$I = \frac{V}{R_{eq}} = \frac{[24\ \text{V}]}{2+4+6=12\Omega} = 2\ \text{A}$$

$$V = RI = 2\Omega \times 2\ \text{A} = [4\ \text{V}]$$

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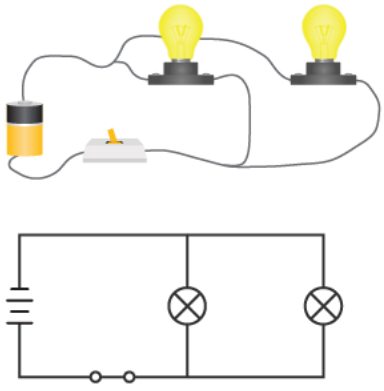
Parallel Circuits

- In a **parallel circuit**, there are multiple branches for the [current] to travel.
- When one branch of the circuit is [disconnected], the current continues to flow through the other branches.
  - If one of the lightbulbs in the parallel circuit burns out, the other bulbs remain lit.



Parallel Circuit

Advantages and Disadvantages of Parallel Circuits

Advantages

- If there is a break in one branch of the circuit, [current] can still flow through the other branches.
- When you add a branch to a parallel circuit, the current has more paths to follow, so total resistance [decreases].
  - If resistance decreases, the amount of current [increases].
- All bulbs shine at maximum brightness, regardless of what happens in the other branches.

Disadvantages

- A parallel circuit is more complicated to design and build.

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Voltage, Resistance, and Current in Parallel Circuits

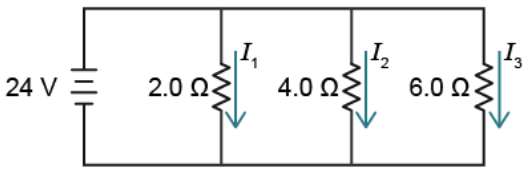
- The voltage is the [same] across each branch.
  - The voltage across each branch is equal to the voltage of the power supply.
- The resistance in a parallel circuit is equivalent to the sum of the [inverse] resistance of the resistors in the circuit.
- The current is different in each branch so the total current in a parallel circuit is equal to the [sum] of the current in each branch.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \frac{1}{R_n}$$

$$I = I_1 + I_2 + I_3 + \dots I_n$$

Current in a Parallel Circuit

- The total current in a parallel circuit can be found by:
  - determining the equivalent resistance and plugging it into [Ohm's law].
  - calculating the current in each branch separately and adding them.



$$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6} = 0.5 + 0.25 + [0.17] = 0.92\,\Omega$$

$$R_{eq} = 1.1\,\Omega$$

$$I = \frac{V}{R_{eq}} = \frac{24\text{ V}}{1.1\,\Omega} = [22\text{ A}]$$

Summary | Electric Circuits

Lesson Question

How do electric circuits vary?

Answer

(Sample answer) Electric circuits vary based on how the power source(s), conductors, and resistors are connected together. Electric circuits can be set up as series, with all elements in line with each other and only one path for the electricity to flow through, or electric circuits can be set up in parallel, with more than one path for the electricity to flow through.

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Review: Key Concepts

- Types of circuits:
  - Closed circuits: have resistance with some current
  - Open circuits: have [infinite] resistance and no current
  - Short circuits: have no resistance and very [high] current
- In a series circuit, there is only one current throughout the entire circuit.
- In a parallel circuit, there is only one voltage across any resistor.

Summary | Electric Circuits

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Circuit Type	Voltage (V)	Current (I)	Resistance (R_{eq})
Series	$V = V_1 + V_2 + V_3 + \ldots V_n$	$I = I_1 = I_2 = I_3 = \ldots I_n$	$R_{eq} = R_1 + R_2 + R_3 + \ldots R_n$
Parallel	$V = V_1 = V_2 = V_3 = V_n$	$I = I_1 + I_2 + I_3 + \ldots I_n$	$\frac{1}{R_{eq}} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \frac{1}{R_n} \right)$

Use this space to write any questions or thoughts about this lesson.