

11

Electric Circuits

11.2

Simple Circuits

11.2.1

Components of Simple Circuits

Review



- The electric current in a wire is based on positive charge flow.
- An electric potential difference sets up an electric field in a wire.
- This electric field applies a force to the charges that causes them to move through the wire.
- Each charge in the wire moves in random directions with different speeds, but the presence of an electric field will cause them to drift from one end of the wire to the other.
- This drift velocity is in the direction of the electric field, which points from the end of the wire with the high electric potential to the end with the low electric potential.
- The actual charges that move in a wire are the electrons, which flow in the opposite direction of the conventional current.

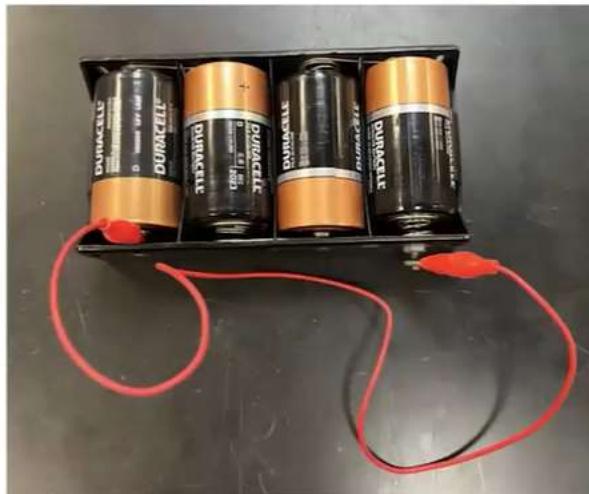
What is an electric circuit?



- Up to this point in the lessons, we have learned about electric current in a wire, but we have not been concerned with what the wire was connected to that causes the current.
- In order to have an electric current, there must be an electric potential difference across the ends of the wire.
- What causes this electric potential difference?
- In a prior video it was mentioned that the most common devices are batteries and generators.
- For simple circuits, the electric potential difference is most commonly provided by a battery.
- Once a wire is connected to a battery, the battery provides the electric potential difference that sets up the electric field in the wire to move the charges in the wire.

What is an electric circuit?

- In the photo, a wire is connected to a battery pack.
- With the wire connected to the battery pack, there is an electric potential difference across the wire.
- Therefore, there must be an electric current in the wire.
- Unfortunately, there is no evidence that there is a current in the wire.
- What can be done to provide this evidence?



Photograph by Jim Vander Weide

What is an electric circuit?

- Another device must be connected to the battery pack, along with the wire, to provide evidence that a current exists in the wire.
- The most common devices used to show current in a wire is a light bulb and a meter to measure current, otherwise known as an ammeter.
- In this first photo, the illumination of the light bulb is evidence of current in the wire.
- In this second photo, the reading on the ammeter is evidence of current in



Photograph by Jim Vander Weide

What is an electric circuit?



- In each of the previous photos there was a complete path for electric current to flow.
- Not only was there electric current in the wire, but there was also electric current in the light bulb, the ammeter, and the batteries.
- Each of these examples showed a complete loop through which electric charges could move.
- Any time there is a complete loop of conducting material thought which electric current can flow, it is called an electric circuit.
- For the purposes of this course, the focus will be on what are called simple electric circuits.

What is an electric circuit?



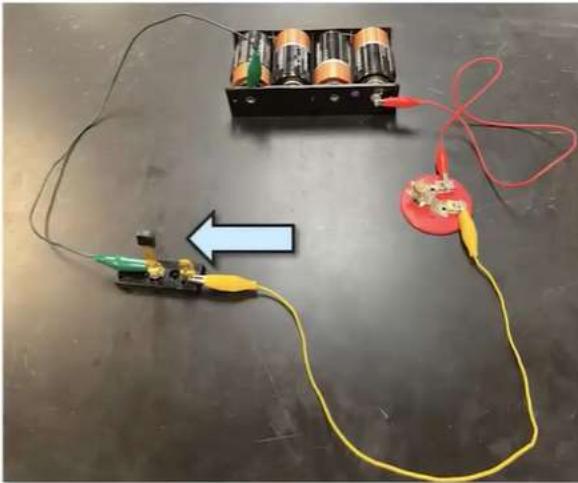
By definition, a simple electric circuit is composed of electrical loops, which can include the following either individually or in combinations:

Wires	Inductors
Batteries	Switches
Resistors	Ammeters
Lightbulbs	Voltmeters
Capacitors	

Each of these devices will be learned about at some point in this course.

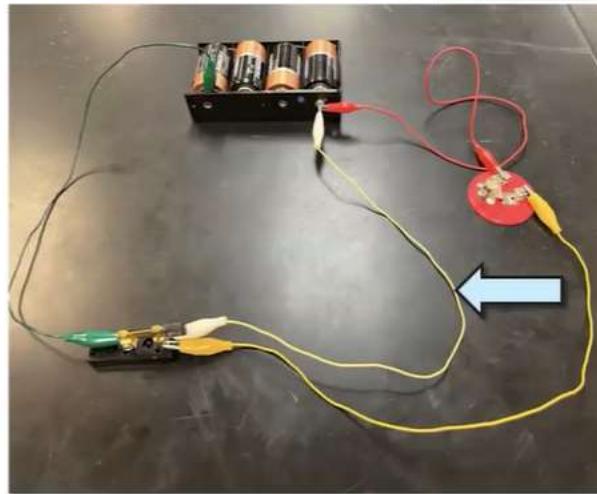
What is an electric circuit?

- In this photo, a switch has been added between the light bulb and the battery pack.
- In the photo, the switch is considered to be open.
- Notice that with the switch at the open position, the light bulb does not light.
- This is because there is no complete loop through which the current can flow.
- This is known as an open circuit.



What is an electric circuit?

- Notice in this photo that the light bulb does not light up even though the switch is closed.
- Why does the light bulb not light even though the switch is closed and the circuit is complete?
- Notice the extra wire in the photo.
- This wire causes what is known as a short circuit.
- The extra wire provides another loop for all the electric current to flow that has no change in electric potential difference.
- As a result, no current flows through the light bulb.



Photograph by Jim Vander Weide

Which of the following would be considered a circuit that does not provide a complete path in which electric charges are able to flow?

- A** Closed circuit
- B** Open circuit
- C** Simple circuit
- D** Short circuit

Which of the following would be considered a circuit that does not provide a complete path in which electric charges are able to flow?



- A Closed circuit
- B Open circuit
- C Simple circuit
- D Short circuit

Closed and short circuits both provide a complete path in which electric charges are able to flow. A simple circuit refers to any of the types of circuits studied in this course. Open circuits are the only simple circuits that do not have a complete path through which electric charges can flow.

Which of the following devices could be used to make an open circuit?

- A** Ammeter
- B** Lightbulb
- C** Resistor
- D** Switch

Which of the following devices could be used to make an open circuit?



- Ammeter
- Lightbulb
- Resistor
- Switch

Ammeters, lightbulbs, and resistors all allow charges to flow through them. A switch will also allow charges to flow through it as long as it is closed. An open switch will not allow charges to flow through the circuit, thus creating an open circuit.

Takeaways



- A simple electric circuit is any electric loop that consists of a variety of devices through which electric current could flow.
- An open circuit is an electric circuit through which electric charges are not able to flow.
- A closed circuit is an electric circuit through which electric charges are able to flow.
- A short circuit is an electric circuit through which electric charges are able to flow but with no change in electric potential difference.

11.2.2

Symbols for elements in an electric circuit and
how circuits are represented using schematic
diagrams

Review



A simple electric circuit is any electric loop that consists of a variety of devices through which electric current could flow.

Electrical loops can include the following either individually or in combinations:

- Wires
- Inductors
- Batteries
- Switches
- Resistors
- Ammeters
- Lightbulbs
- Voltmeters
- Capacitors

Many of these will be covered in more detail in later units and lessons.

Electric Circuit Element Symbols

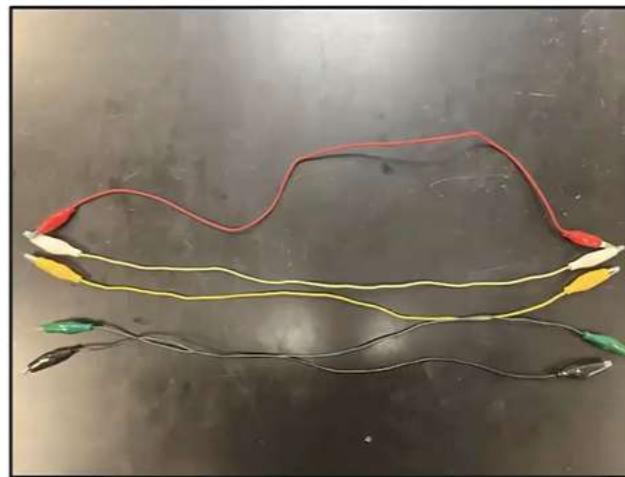


- In the previous lesson, we learned about what makes up an electric circuit and even saw a few pictures of different wired circuits.
- What if we wanted to draw these circuits or represent them in a diagram instead of showing them in a picture?
- We would need what is called an **electric circuit schematic diagram**.
- Many times these are just called circuit schematics, circuit diagrams, or schematic diagrams.
- The circuit schematic shows how the electric circuit elements are connected or wired together.
- They are used to describe and analyze electric circuits, which will be done in later units.
- To make a circuit schematic, certain symbols are used for the electric circuit elements.

Electric Circuit Element Symbols



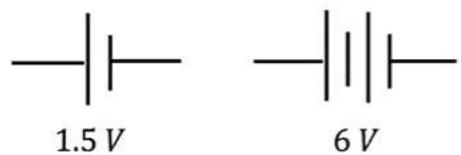
- In the photo, there are several colored wires.
- Any wire in a schematic diagram is represented by straight lines that connect from one element to the next, typically at right angles.
- The lines in the diagram do not need to be colored to match the actual wires.
- Even if a wire is curved in a circuit, it is drawn straight in the diagram.



Photograph by Jim Vander Weide

Electric Circuit Element Symbols

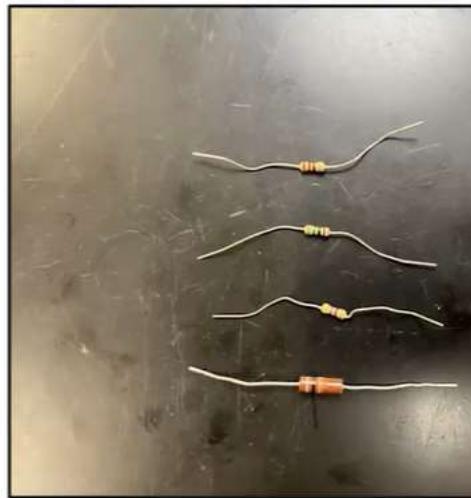
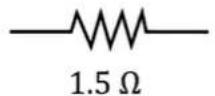
- In the photo there is a single battery and a battery pack.
- The symbol for a battery, or series of batteries, uses a long line to represent the high electric potential side of the battery and a short line for the low electric potential side.
- Typically, the value of the battery voltage is written near the symbol on the diagram.



Photograph by Jim Vander Weide

Electric Circuit Element Symbols

- In this photo there are several different resistors shown.
- The colored bands on each resistor are used to determine the value of the resistance using a color code.
- It is not necessary to know the color code for this course.
- The symbol for any resistor is a jagged line.
- The value of the resistor can also be written near the symbol.



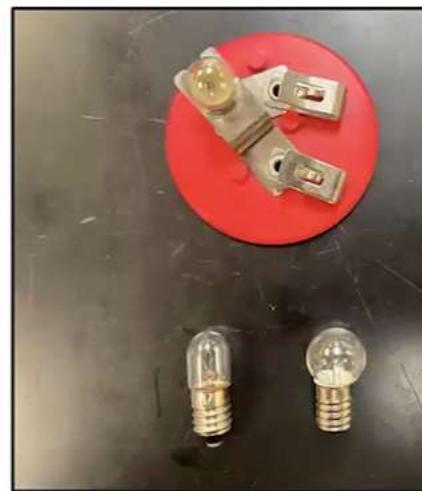
Photograph by Jim Vander Weide

Electric Circuit Element Symbols

- In this photo there are several different lightbulbs shown.
- The symbol for any lightbulb is a circle with a loop in the circle.
- The value of the lightbulb wattage and/or the amount of voltage dropped across the lightbulb is sometimes written near the symbol.
- The concept of voltage drop will be covered in a later lesson.



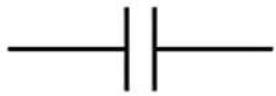
5 mW, 2 V



Photograph by Jim Vander Weide

Electric Circuit Element Symbols

- In this photo there are several different capacitors shown.
- The symbol for a capacitor has two parallel equal length lines.
- This represents the parallel plates of a capacitor.



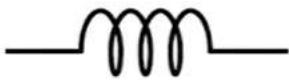
$5 \mu F$



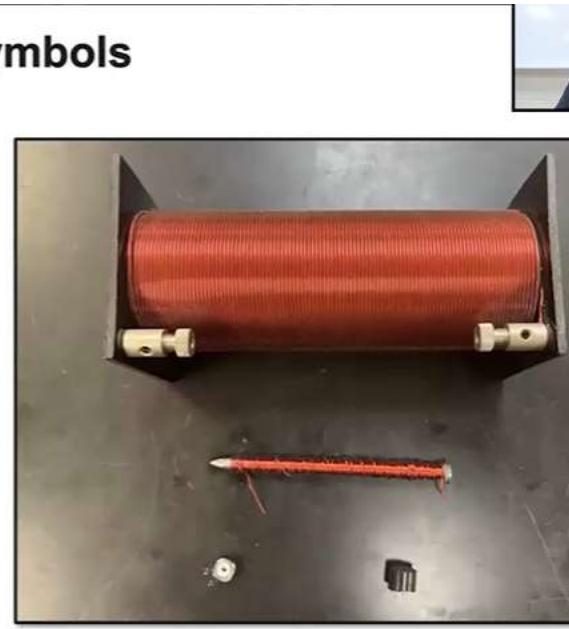
Photograph by Jim Vander Weide

Electric Circuit Element Symbols

- In this photo there are several different inductors shown.
- The symbol for any inductor is a coil between two lines.
- This represents the coil of wire used to make an inductor.



10 mH



Photograph by Jim Vander Weide

Electric Circuit Element Symbols

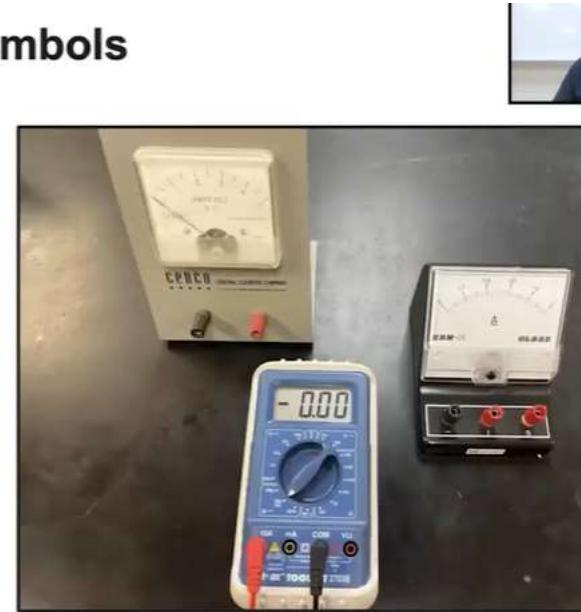
- In this photo there are several different switches shown.
- The symbols for open and closed switches are similar but different.
- An open switch is shown in this diagram.
- And here is the symbol for a closed switch.
- In some electric circuit diagrams, the dots are not included in the symbol for a switch.



Photograph by Jim Vander Weide

Electric Circuit Element Symbols

- In this photo there are several different ammeters shown.
- The symbol for an ammeter is a circle with the letter "A" in its center.



Electric Circuit Element Symbols

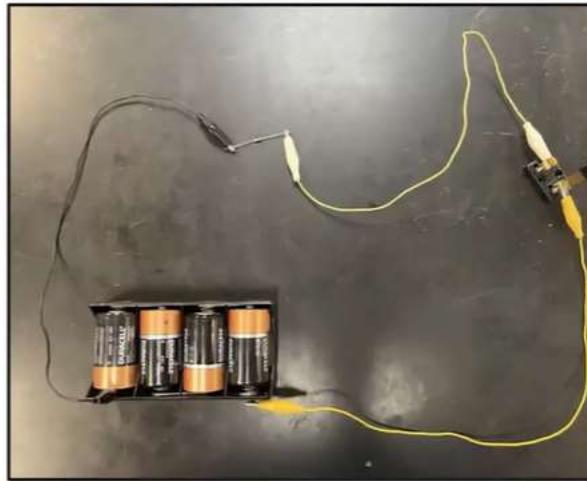
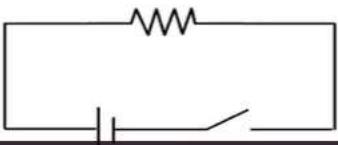
- In this photo there are several different voltmeters shown.
- The symbol for a voltmeter is a circle with the letter “V” in its center.



Electric Circuit Schematic Diagrams



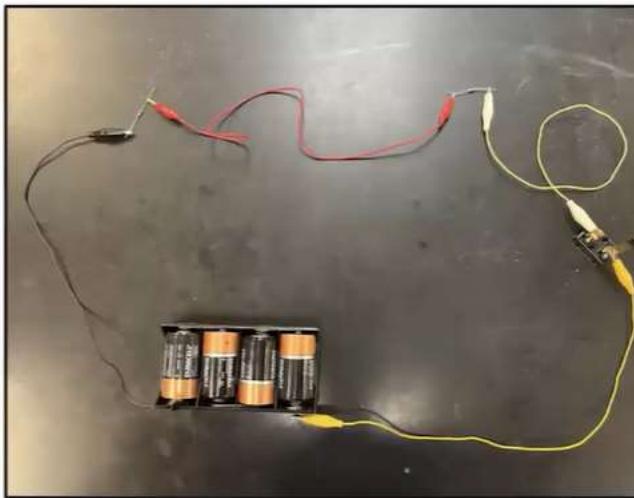
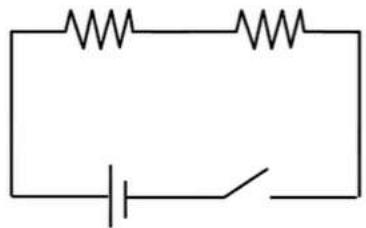
- Now let's combine some of these elements to make representations of different circuits.
- The photo shows a resistor, an open switch, and a battery pack wired together.
- The diagram below is the schematic diagram of this circuit using the symbols we have learned.



Photograph by Jim Vander Weide

Electric Circuit Schematic Diagrams

- This photo shows two resistors, an open switch, and a battery pack wired together.
- This is the schematic diagram that matches the circuit in the photo.

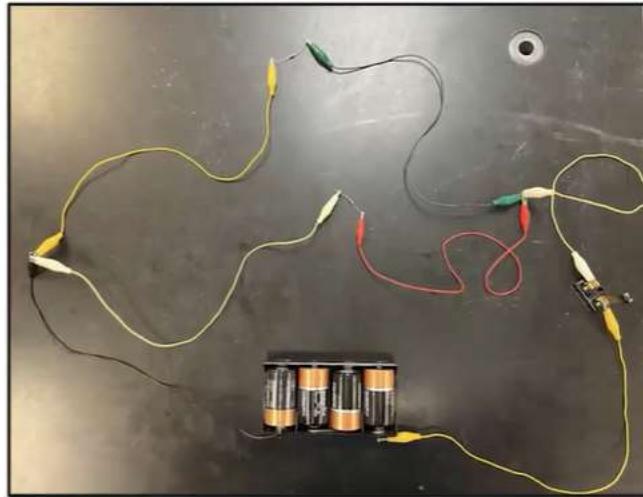
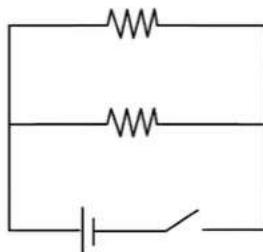


Photograph by Jim Vander Weide

Electric Circuit Schematic Diagrams



- This photo shows the same two resistors wired differently than the previous photo, an open switch, and a battery pack.
 - This is the schematic diagram that matches the circuit in the photo.

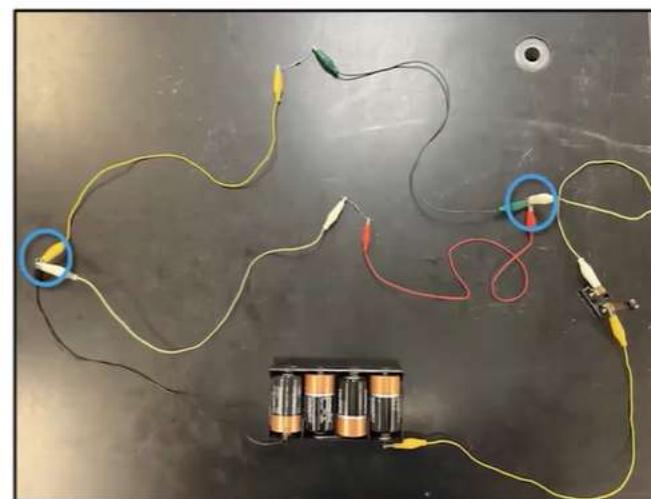
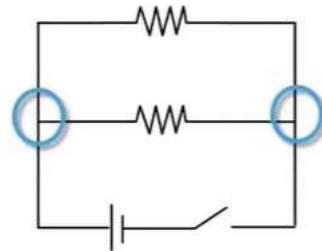


Photograph by Jim Vander Weide

junctions

Electric Circuit Schematic Diagrams

- This photo shows the same two resistors wired differently than the previous photo, an open switch, and a battery pack.
- This is the schematic diagram that matches the circuit in the photo.

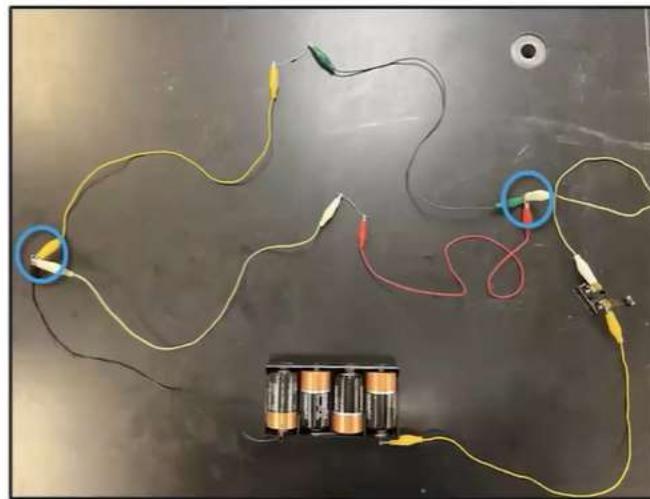
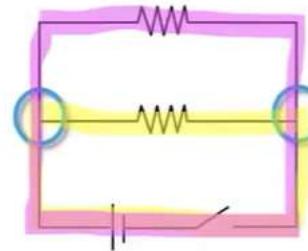


Photograph by Jim Vander Weide

Electric Circuit Schematic Diagrams



- This photo shows the same two resistors wired differently than the previous photo, an open switch, and a battery pack.
- This is the schematic diagram that matches the circuit in the photo.

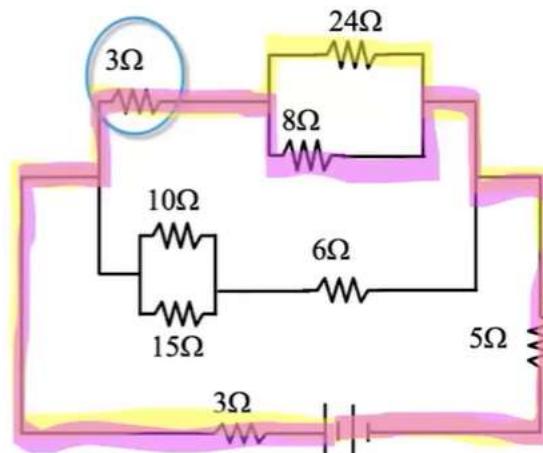


Photograph by Jim Vander Weide

Electric Circuit Schematic Diagrams



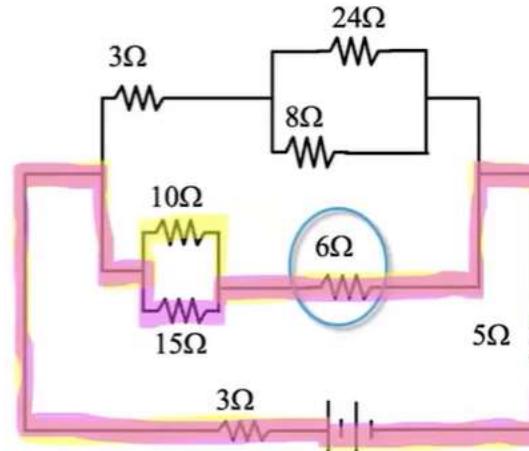
- Here is a more complicated electric circuit diagram.
- Notice that there are multiple different loops.
- Also notice that some of the resistors are included in more than one loop.
- For example, the $3\ \Omega$ resistor in the top left corner is part of two different loops.





Electric Circuit Schematic Diagrams

- In the same diagram, the $6\ \Omega$ resistor is in two different loops that are separate from the $3\ \Omega$ resistor.



Electric Circuit Schematic Diagrams

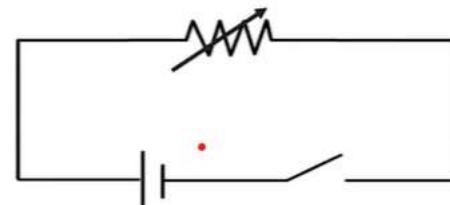


- How these types of circuits are analyzed in more detail will be covered in later units.
- For now, if we close the switch in the circuits we have seen in the lesson, electric current will flow through each circuit.
- Since each circuit we have seen so far are connected differently, the circuits do not behave the same.
- For example, the first circuit with only one resistor will not have the same current as the second circuit with two resistors with the same battery pack.
- Also, the third circuit with the same two resistors that was wired differently, will have an even different current in the circuit.
- The current in each circuit depends on the physical arrangement of the resistors in the circuit.
- This is also true of other quantities that will be covered in later units.

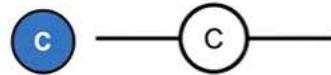
Electric Circuit Schematic Diagrams



- There is one more thing we need to know about what is included in a schematic diagram.
- Here is a diagram seen earlier in this lesson.
- The resistance of this resistor is constant.
- However, there are such things as variable resistors – resistors that can have the resistance changed.
- If one of those is connected in a circuit, how would it be represented in a schematic diagram?
- We would include an arrow that “strikes through” the symbol.
- This same method is used for any element in a circuit that varies in value.



Which of the following is the correct symbol to use for a capacitor in an electric circuit diagram?



Which of the following is the correct symbol to use for a capacitor in an electric circuit diagram?



The symbol in choice A is for a battery and the symbol in choice B is for a resistor.



The symbol in choice C is not one of the symbols covered in this lesson, but does represent what is known as a capacitance meter.



The two parallel lines in the symbol of choice D represent the parallel plates of a capacitor.

Which of the following is a correct statement about electric schematic diagrams?

- A** More than one electric loop can be included in a schematic diagram.
- B** A single electric element cannot exist in more than one loop in a schematic diagram.
- C** No matter how circuit elements are shown to be connected in a schematic diagram, the current in each circuit will be the same.
- D** Schematic diagrams are only used to show closed circuits.

Which of the following is a correct statement about electric schematic diagrams?

- A** More than one electric loop can be included in a schematic diagram.
As seen in the schematic diagrams in this lesson, several loops can be represented in the same diagram.
- B** A single electric element cannot exist in more than one loop in a schematic diagram.
Each electric element can be included in more than one loop depending on how the circuit is connected.
- C** No matter how circuit elements are shown to be connected in a schematic diagram, the current in each circuit will be the same.
The amount of current that flows in a circuit is dependent on how the circuit is connected.
- D** Schematic diagrams are only used to show closed circuits.
And, circuit diagrams can be used to represent any kind of simple circuit.



Takeaways



- Each electric element connected into an electric circuit is represented by a specific symbol in an electric schematic diagram.
- Schematic diagrams are used to represent a physical circuit and how the elements are connected together.
- A schematic diagram is typically drawn with straight lines and right angles no matter the physical orientation of the circuit.
- The properties, such as current, of an electric circuit are dependent on the physical arrangement of its constituent elements.
- Variable elements in an electric circuit are indicated by a diagonal strikethrough arrow across the standard symbol for that element.

