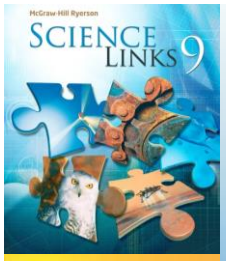


UNIT 4
Electrical Applications

- Topic 4.1: How do the sources used to generate electrical energy compare?
- Topic 4.2: What are charges and how do they behave?
- Topic 4.3: How can objects become charged and discharged?
- Topic 4.4: How can people control and use the movement of charges?
- Topic 4.5: What are series and parallel circuits and how are they different?
- Topic 4.6: What features make an electrical circuit practical and safe?
- Topic 4.7: How can we conserve electrical energy at home?

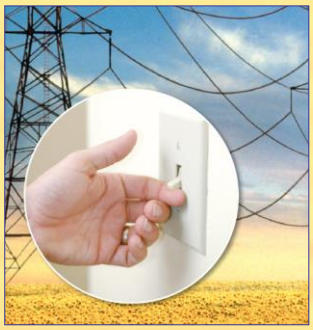
Topic 4.1 How do the sources used to generate electrical energy compare?

(Pages 244-51)

Key Concepts

- Different sources of energy can be converted into electrical energy.
- Renewable and non-renewable energy sources have advantages and disadvantages.

How do the sources used to generate electrical energy compare?

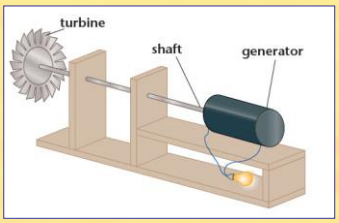


How do you use electrical energy in your life?

What impact does your use of electricity have on the environment?

Different sources of energy can be converted into electrical energy.

Most of the electrical energy in Canada is made by converting **kinetic energy** (the energy of motion) into electrical energy. This is done with a device called a generator. A simple model of a generator is shown below.



When the force of moving air, water, or steam spins a turbine, the generator produces electricity.

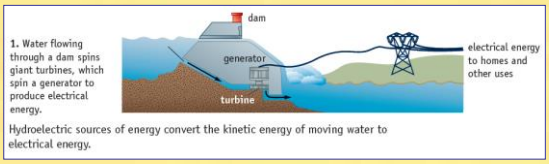
Resources for Generating Electrical Energy

Any type of energy that can be used to turn a turbine can be used to generate electrical energy.

The vast majority of electrical energy used in Ontario (and Canada) is generated using one of three sources of energy:

- falling water
- fossil fuels (coal, oil, natural gas)
- uranium

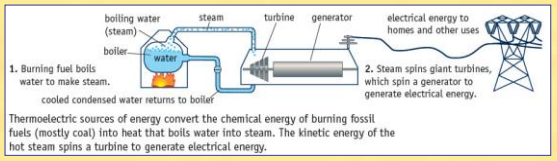
Hydroelectric Sources of Electrical Energy



Hydroelectric sources of energy convert the kinetic energy of moving water to electrical energy.

Moving or falling water spins the turbine to generate electrical energy.

Thermoelectric Sources of Electrical Energy

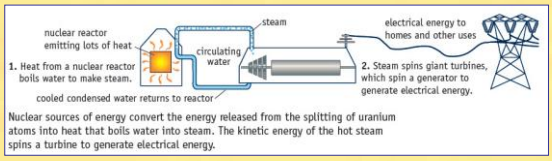


Thermoelectric sources of energy convert the chemical energy of burning fossil fuels (mostly coal) into heat that boils water into steam. The kinetic energy of the hot steam spins a turbine to generate electrical energy.

Steam produced from water heated by burning fossil fuels spins a turbine to produce electrical energy.

Credit: Ontario Power Generation

Nuclear Sources of Electrical Energy



Nuclear sources of energy convert the energy released from the splitting of uranium atoms into heat that boils water into steam. The kinetic energy of the hot steam spins a turbine to generate electrical energy.

Steam produced from water heated by a nuclear reaction spins a turbine to produce electrical energy.

Credit: Ontario Power Generation

Energy sources have advantages and disadvantages.

A **renewable energy source** is an energy source, such as moving water, that can be replaced or restocked within a human lifetime or less.

Examples of **renewable energy sources** include:

- wind
- solar
- biomass
- tides
- geothermal

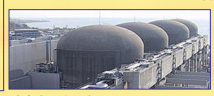
Energy sources have advantages and disadvantages.

A **non-renewable energy source** is an energy source, such as fossil fuels or uranium, that cannot be restocked within a human lifetime or longer.

Examples of **non-renewable energy sources** include:

- oil
- natural gas
- coal
- uranium

Credit: Ontario Power Generation



Credit: Ontario Power Generation

Energy sources have advantages and disadvantages.

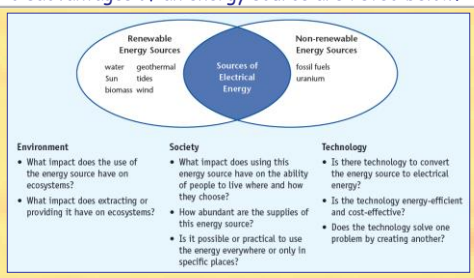
Whether an energy source is renewable or non-renewable, there are still always advantages and disadvantages to its use.

Finding out about the pros and cons of a particular energy source involves asking questions such as those listed below.

Research the Energy Source	**Advantages** of the Energy Source	**Disadvantages** of the Energy Source	**Decision**
(List key characteristics of using the energy source for electrical energy. Include effects on the environment, on society, and the economy.)	(Identify the characteristics that make this energy source an attractive choice.)	(Identify the characteristics that make this energy source an unattractive choice.)	(Weigh the advantages and disadvantages for this one energy source, and decide if it represents a good choice or a bad choice.)

Energy sources have advantages and disadvantages.

Specific questions that may help determine the advantages and disadvantages of an energy source are listed below.



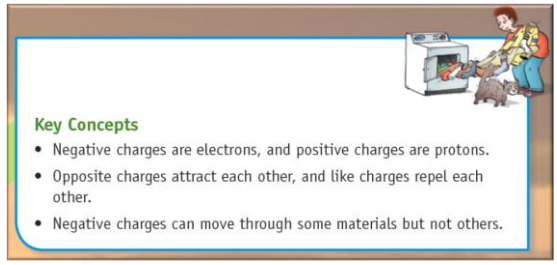
Topic 4.1 Review

Key Concepts to be reviewed:

- *Different sources of energy can be converted into electrical energy.*
- *Renewable and non-renewable energy sources have advantages and disadvantages.*

Topic 4.2 What are charges and how do they behave?

(Pages 252-61)



Key Concepts

- Negative charges are electrons, and positive charges are protons.
- Opposite charges attract each other, and like charges repel each other.
- Negative charges can move through some materials but not others.

What are charges and how do they behave?

Have you ever had your hair stick to a sweater when you took it off? Do your clothes stick to each other when you remove them from the dryer?

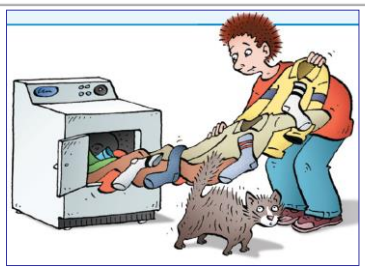
What are charges and how do they behave?

What will happen when a balloon you have rubbed against your hair is held against a wall?

Explain your prediction.

What are charges and how do they behave?

Why are the clothes sticking together as they come out of the dryer?

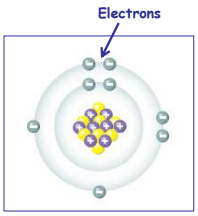


Negative charges are electrons, and positive charges are protons.

Negative charges are the type of electrical charges that can be rubbed off a material.

-ve

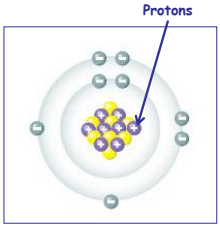
The **negative charges** are parts of atoms called **electrons**. These charges are found outside of the nucleus.



Negative charges are electrons, and positive charges are protons.

Positive charges are one type of electrical charges that are left behind when negative charges are rubbed off a material.

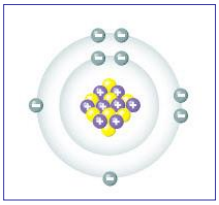
+ve



The **positive charges** are parts of atoms called **protons**. These charges are found inside the nucleus.

Negative charges are electrons, and positive charges are protons.

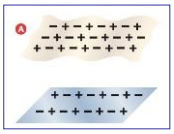
Electrically neutral describes materials that have equal numbers of negative and positive charges.



The atom shown above has 8 negative charges (electrons) and 8 positive charges (protons), so it is **electrically neutral**.

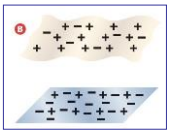
Negative charges are electrons and positive charges are protons.

The process of charging materials by rubbing them together is called **charging by friction**.



(equal numbers of +ves and –ves in each material)

The materials shown in image **A** are both **electrically neutral**. When the two materials are rubbed together, their charges change as shown in image **B**.

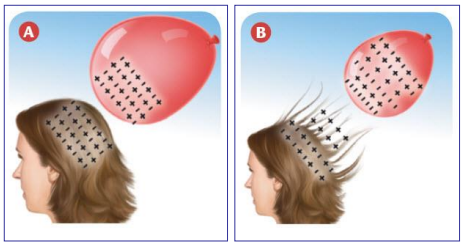


(excess +ves in the top material and excess –ves in the bottom material)

What is the electrical charge of the two materials after they have been rubbed together?

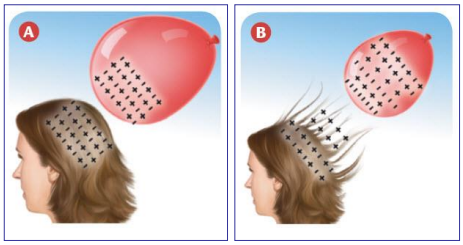
Explaining Why Rubbed Hair Is Attracted to a Balloon

What has happened to the charges of the hair and of the balloon after they have been rubbed together?



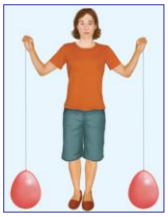
Explaining Why Rubbed Hair Is Attracted to a Balloon

Why is the hair attracted to the balloon?

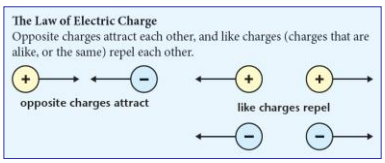


Opposite charges attract each other, and like charges repel each other.

Depending on the charges given to the two suspended balloons, they will either repel (move apart), attract (move together), or do nothing.



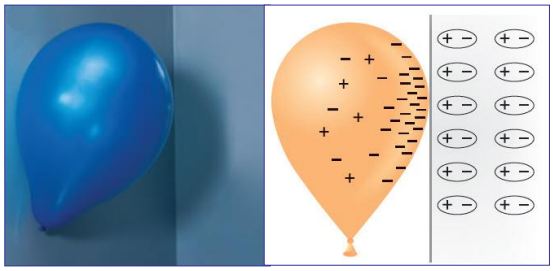
The balloons will behave according to **The Law of Electric Charge**.



Charged Objects and Neutral Objects

The charged balloon is attracted to the neutral wall, and the charged comb is attracted to the neutral water.

Charged Objects and Neutral Objects



Use the diagram above to explain why the charged balloon sticks to the wall.

Negative charges can move through some materials but not others.

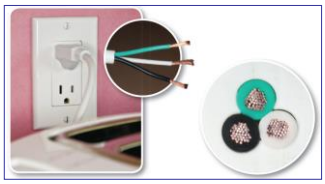
A **conductor** is a material in which electrical charges can move easily. Most metals, such as copper, iron, gold, and silver, are conductors.

The **conductivity** of a material relates to how easily charges move within a material.

What part of the electrical wire shown above is made of a conductor?

Negative charges can move through some materials but not others.

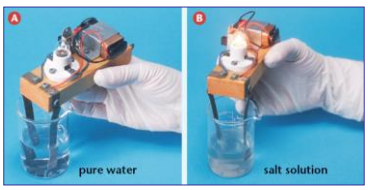
An **insulator** is a material in which electrical charges cannot move easily. Materials that are not metals, such as glass, plastic, wood, and Styrofoam®, are insulators.



What part of the electrical wire shown above is made of a insulator?

Conductors or Insulators

One way to test whether a material is an insulator or a conductor is to test it with a **conductivity meter**. If charges are moving through the material, the meter will give a reading. In some meters a light will turn on, indicating the movement of charges. If the material is an insulator, there will not be a reading or a light.



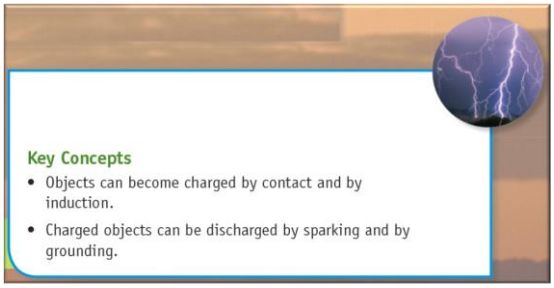
Which of the two materials shown is a conductor?
An insulator?
How do you know?

Topic 4.2 Review

Key Concepts to be reviewed:

- *Negative charges are electrons, and positive charges are protons.*
- *Opposite charges attract each other, and like charges repel each other.*
- *Negative charges can move through some materials but not others.*

Topic 4.3 How can objects become charged and discharged? (Pages 264-73)



How can objects become charged and discharged?

If you walk across a carpet wearing wool socks or rubber-soled shoes, charges build up on your body with each step you take.

The charge you have built up on your body can easily be discharged (released) into objects such as a metal doorknob.

Why do you think the spark jumps to the doorknob?

How can objects become charged and discharged?

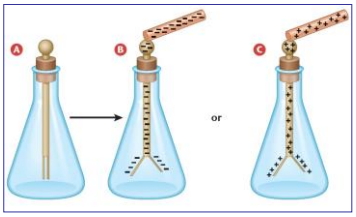
Lightning, the most spectacular example of static discharge you can observe, looks like a giant spark.

Scientists know that the bottoms of clouds are negatively charged and the tops of clouds are positively charged.

Why do you think the lightning bolts reach Earth?

Objects can become charged by contact and by induction.

Charging by contact occurs when you give a neutral object a charge by touching it with a charged object.

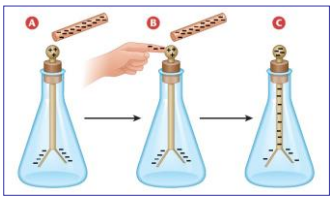


The image on the left shows an **electroscope** being charged by contact. The leaves of the electroscope repel each other when they have the same charge.

Electroscopes are devices that can test an object's charge.

Charging by Induction: Objects Don't Touch

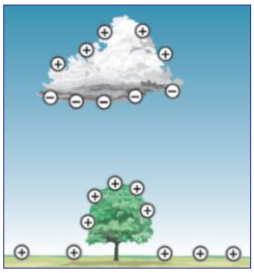
Charging by induction occurs when a neutral object becomes charged by a charged object that is brought near to it but does not touch it.



The negatively charged rod repels the negative charges in the ball, and they move to the leaves. This leaves the ball positively charged. No charges are transferred from the rod.

Charged objects can be discharged by sparking and by grounding.

The negative bottoms of the clouds induce a positive charge on the ground and objects on the ground.



When the attraction between charges on the bottom of the cloud and the charges on the ground are great enough, charges jump between the cloud and the ground, creating a lightning bolt.

How Grounding Discharges an Object

Grounding involves connecting a conductor to Earth's surface so that charges can flow safely to the ground.

Why are fuel trucks always grounded before they deliver their gasoline to the gas station fuel tanks?

How Grounding Discharges an Object

Metal **lightning rods** connect houses (usually in country (rural) areas) to the ground. When lightning hits the rod, the electric charges are carried through a cable connected to the rod down to the ground.

What do lightning rods prevent from happening?

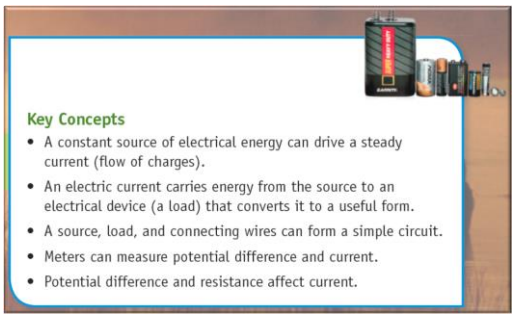
Why are lightning rods rarely found on houses located in cities (urban areas)?

Topic 4.3 Review

Key Concepts to be reviewed:

- *Objects can become charged by contact and by induction.*
- *Charged objects can be discharged by sparking and by grounding.*

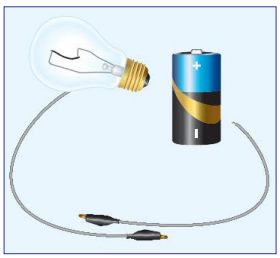
Topic 4.4 How can people control and use the movement of charges? (Pages 274-91)



How can people control and use the movement of charges?

Canadians depend on electrical energy to run homes, communities, and the whole country.

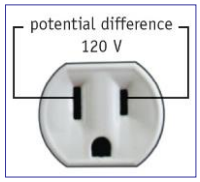
How can people control and use the movement of charges?



How many ways can the electrical components shown in the diagram above be connected so that the bulb lights?

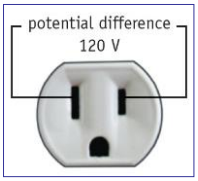
A constant source of electrical energy can drive a steady current (flow of charges).

A source is a device that supplies electrical energy. The most common sources of electrical energy that Canadians use are electrical outlets or batteries (cells).



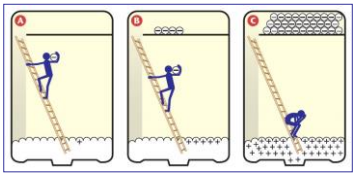
A constant source of electrical energy can drive a steady current (flow of charges).

A potential difference (voltage) is the change in the energy of a unit of charge after passing through a source or a load. Potential difference (V) is measured in volts (V).



How Potential Difference across a Battery Works

The image below shows how charges are separated in a battery. The positive charges at the bottom attract the negative charges at the top. This makes it harder and harder to separate the charges.



The potential difference across the battery represents the amount of energy it took to carry the last unit of charge up the ladder.

Battery Size

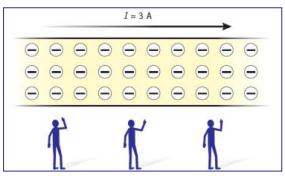
Batteries come in a variety of different potential differences (voltages). The image below includes five 1.5 V batteries, one 3 V battery, one 6 V battery, and one 9 V battery.

Which potential differences go with which batteries in the image on the left?

Is the size of a battery related to its potential difference?

An electric current carries energy from the source to an electrical device (a load) that converts it to a useful form.

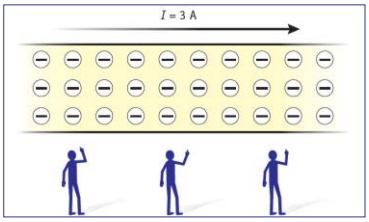
In order for a device to use energy from a source, it must be connected, usually with wire conductors made of metal.



The energy from the source causes charges to move through the wires. The moving charges are called an electric current.

Current: The Flow of Charges

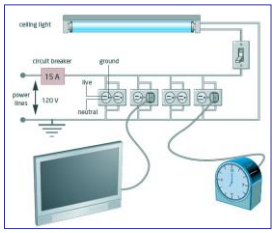
The amount of current flowing through a wire is measured in units called amperes (A).



The 3 A of current shown in the image on the left means that 3 units of charge are passing each point in the wire each second.

The Load: An Energy Converter

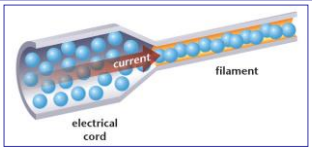
A load is a device that converts electrical energy into another form of energy.



Name loads that convert electricity in your home. What energy forms do they convert electrical energy into?

The Load and Resistance

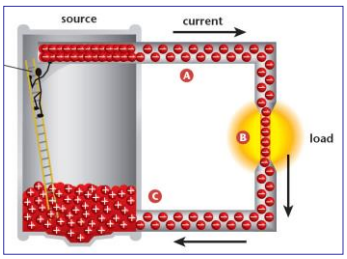
Resistance describes the amount that current is hindered by a load. Resistance is measured in a unit known as the ohm (Ω).



As charges pass through a load, they lose energy. This lost energy has been converted to light, heat, sound, or mechanical energy. The filament in the light bulb shown above hinders the flow of electrical energy, thus converting it into light and heat energy.

A source, load, and connecting wires form a simple circuit.

When a source, load, and conductor are connected in a way that can allow current to flow, an electric circuit is formed.



All charges that leave the source must return to the source. Therefore, a circuit must form a closed loop.

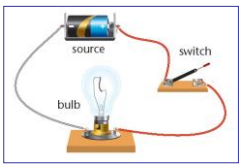
A source, load, and connecting wires form a simple circuit.

All circuits, even the most simple ones, must include a source, conductor, and a load.

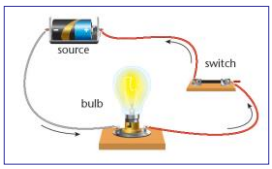
Identify the source, conductor, and the load in the image on the left.

A Switch: Controlling the Flow of Current

Switches are components of a circuit that allow you to start or stop the flow of charges.



When the switch is open the circuit is not a closed loop, so current does not flow.



Closing the switch closes the loop, allowing the current to flow.

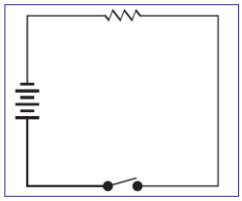
Using Circuit Diagrams To Represent the Parts of a Circuit

Simple symbols are used to make it easier to draw representations of circuits. The table below lists the symbols for the basic parts of a circuit.

Component of Circuit	Component Symbol	Quantity	Unit of Measurement
Source (battery)		Potential difference (*V*)	Volt (V)
Conducting wire		Current (*I*)	Ampere (A)
Load (resistance)			Ohm (Ω)
Switch: open closed			

Using Circuit Diagrams To Represent the Parts of a Circuit

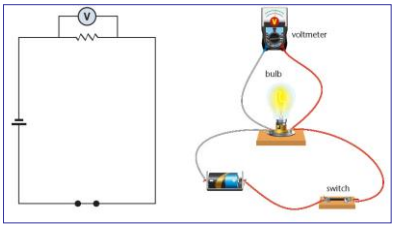
The circuit diagram below uses symbols to represent the parts in a simple circuit.



Name the circuit components represented by the symbols in the circuit diagram above.

Meters can measure potential difference and current.

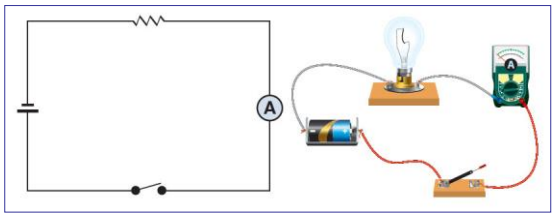
A voltmeter is an instrument that measures the potential difference between two points in a circuit.



Voltmeters must be connected around the component.

Meters can measure potential difference and current.

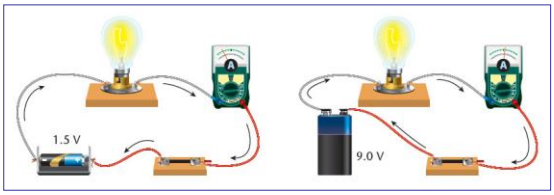
An ammeter is an instrument that measures current.



An ammeter is connected into the circuit so that all current flows through it.

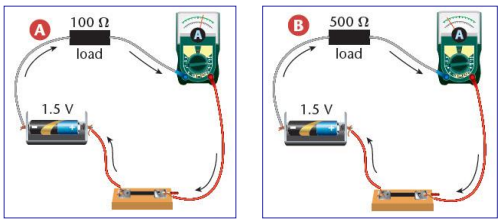
Potential difference and resistance affect current.

If potential difference is increased and resistance is kept the same, the current will increase.



Potential difference and resistance affect current.

If resistance in a circuit is increased and potential difference is kept the same, the current will decrease.



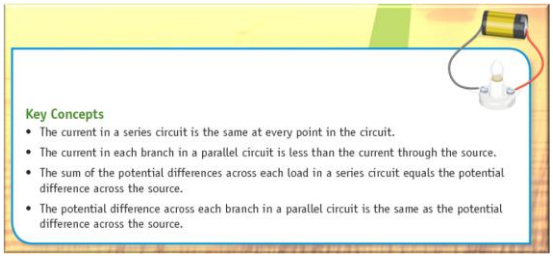
Topic 4.4 Review

Key Concepts to be reviewed:

- *A constant source of electrical energy can drive a steady current (flow of charges).*
- *An electric current carries energy from the source to an electrical device (a load) that converts it to a useful form.*
- *A source, load, and connecting wires can form a simple circuit.*
- *Meters can measure potential difference and current.*
- *Potential difference and resistance affect current.*

Topic 4.5 What are series and parallel circuits and how are they different?

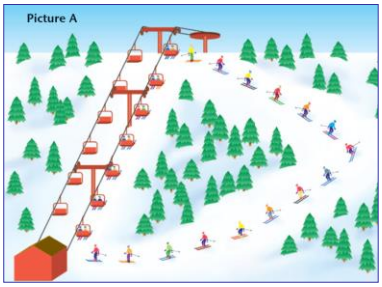
(Pages 292-303)



Key Concepts

- The current in a series circuit is the same at every point in the circuit.
- The current in each branch in a parallel circuit is less than the current through the source.
- The sum of the potential differences across each load in a series circuit equals the potential difference across the source.
- The potential difference across each branch in a parallel circuit is the same as the potential difference across the source.

What are series and parallel circuits and how are they different?



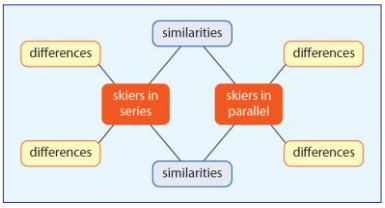
The skiers in the image are all following the same path. You could say that they are skiing in **series**.

What are series and parallel circuits and how are they different?

The skiers in the image are following a variety of paths. You could say that they are skiing in **parallel**.

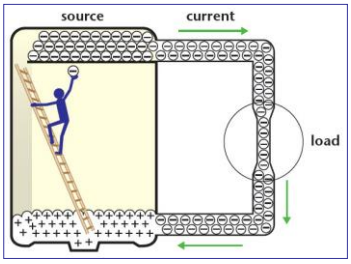
What are series and parallel circuits and how are they different?

Re-examine the images of the skiers skiing in series and in parallel. Describe the differences and similarities between the two images.



The current in a series circuit is the same at every point in the circuit.

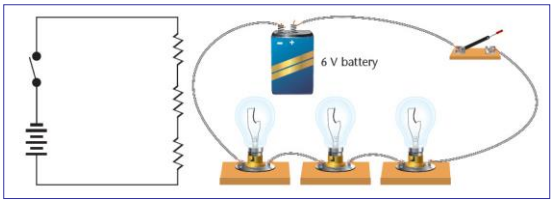
A **series circuit** is a circuit that has only one path for current to follow.



The current is moving at the same rate after it leaves a load as it was when it entered the load.

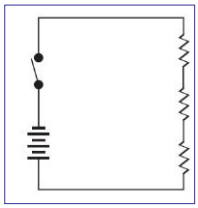
The current in a series circuit is the same at every point in the circuit.

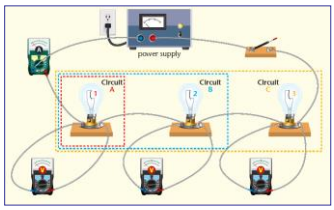
In a series circuit, all of the loads must be on and working at the same time. If one of the loads stops working, the circuit is broken and all the other loads stop working as well.



Characteristics of Series Circuits

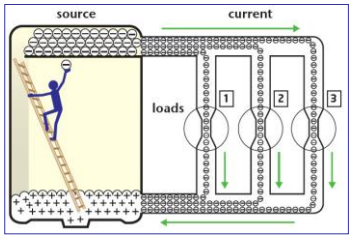
- As more loads are added to a series circuit, each load receives less current. Bulbs will get dimmer as more are added to the circuit.
- All loads must function in order for the circuit to work since they all rely on the same pathway for electric current.





The current in each branch in a parallel circuit is less than the current through the source.

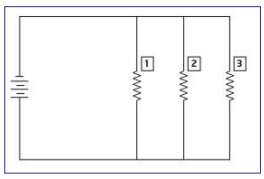
A **parallel circuit** is a circuit that has two or more paths for current to follow.

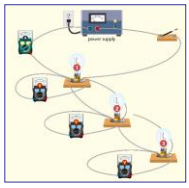


The amount of current that follows each of the paths is less than the amount of current that left the source. The same amount of current leaves or enters the source.

Characteristics of Parallel Circuits

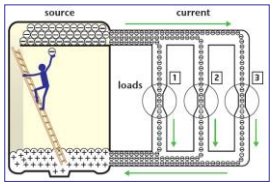
- As more loads are added to a parallel circuit, the amount of current delivered by the source increases. Current will not decrease as loads are added. Bulbs are the same brightness.
- Each of the loads receives electric current along a separate pathway, so each will continue to function even if some of the loads stop functioning (burn out).

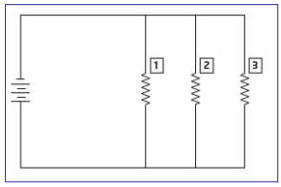




The current in each branch in a parallel circuit is less than the current through the source.

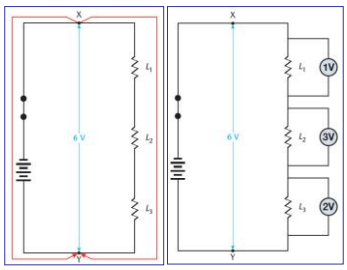
The same circuit is shown in each of the diagrams below.





Examine the two images, noting the similarities between them. Remind yourself of the symbols for sources and loads.

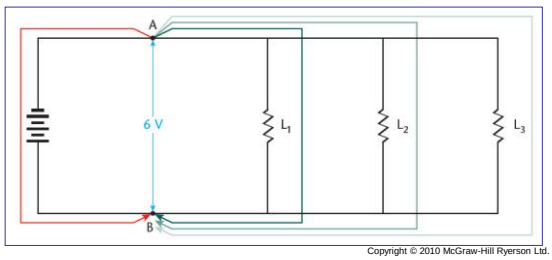
The sum of the potential differences across each load in a series circuit equals the potential difference across the source.

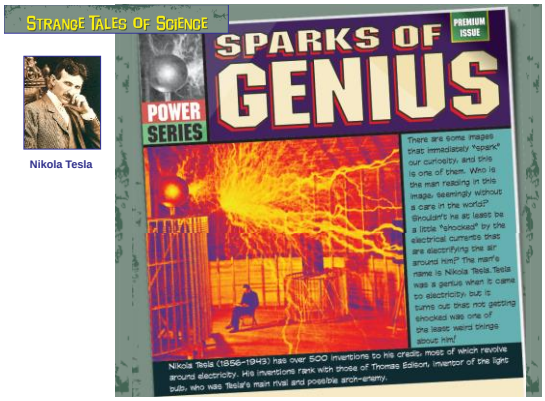


If you measure the potential difference across each of the three loads and add them together, they will equal the potential difference across the source.

The potential difference across each branch in a parallel circuit is the same as the potential difference across the source.

The potential differences across each branch and across the source are all equal.





Nikola Tesla

STRANGE TALES OF SCIENCE

So... What do you think?

1. Find out why Tesla was perfectly safe while posing for this photograph!
2. Tesla would only stay in a hotel room with a number that could be divided by three. Find out three other really weird things about Tesla's life.
3. Tesla's contributions to the world of electricity may have even surpassed those of his rival Thomas Edison. Find out three things Tesla invented.
4. The machines generating the sparks in this photo are called Tesla coils. What are Tesla coils and how do they generate electricity?

Topic 4.5 Review

Key Concepts to be reviewed:

- *The current in a series circuit is the same at every point in the circuit.*
- *The current in each branch in a parallel circuit is less than the current through the source.*
- *The sum of the potential differences across each load in a series circuit equals the potential difference across the source.*
- *The potential difference across each branch in a parallel circuit is the same as the potential difference across the source.*

Topic 4.6 What features make an electrical circuit practical and safe? (Pages 304-13)

Key Concepts

- Practical wiring for a building has many different parallel circuits.
- Circuit breakers and fuses prevent fires by opening a circuit with too much current.
- Higher-voltage circuits, larger cords and cables, and grounding help make home circuits safe.

What features make an electrical circuit practical and safe?

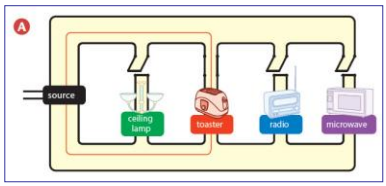
What type of electrical circuit connects all of the devices in the picture above? Explain your answer.

What features make an electrical circuit practical and safe?

What might happen if all of the devices in a room were connected in a circuit like the one above?

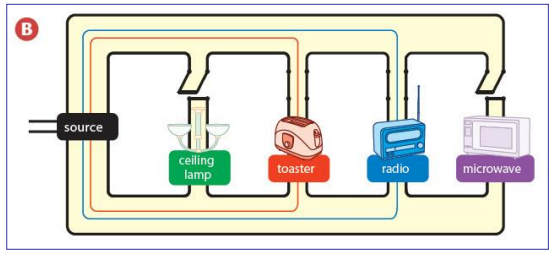
Practical wiring for a building has many different parallel circuits.

Any device in a parallel circuit can be controlled by its own switch. All devices do not have to be on in order for the other devices to function.



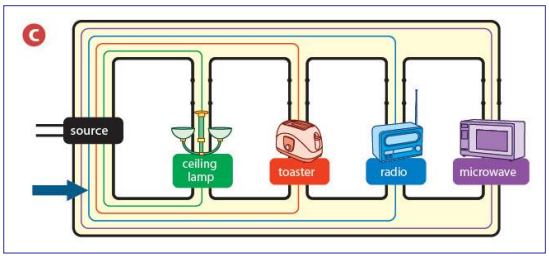
Which of the devices in the image above are functioning?

Practical wiring for a building has many different parallel circuits.



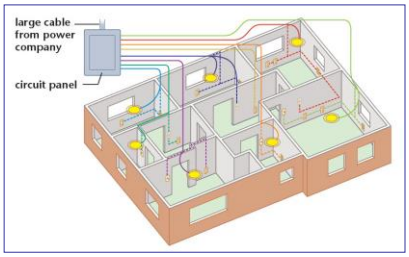
Which of the devices in the image above are functioning?

Practical wiring for a building has many different parallel circuits.



Which of the devices in the image above are functioning?

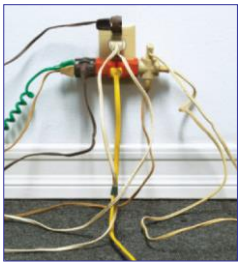
Practical wiring for a building has many different parallel circuits.



Each colour in the diagram on the left represents one small parallel circuit.

What would happen if all of the electrical devices in an entire home were connected to the same parallel circuit?

Circuit breakers and fuses prevent fires by opening a circuit with too much current.



The current that flows through a wire conductor can become very high if too many electrical devices are connected to it.

Too much current flowing through a conductor can cause the wire to heat up, perhaps causing a fire.

What type of circuit draws more current with more sources?

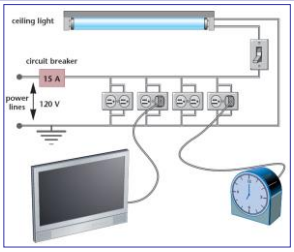
Circuit Breakers

A **circuit breaker** is a safety device that opens a circuit if the current gets too high; it can be reset. The circuit breaker will prevent any circuit from carrying too much current and starting a fire.

Circuit beakers are usually housed in a breaker panel with each switch controlling one parallel circuit.

Circuit Breakers

When a circuit breaker opens the switch, you can close it by going to the breaker panel and pushing the switch back into place. Some devices may need to be turned off so the circuit breaker doesn't open again.



Fuses

A **fuse** is an older safety device that opens a circuit if the current gets too high. Fuses must be replaced after they have "blown" (opened the circuit once).

Fuses such as the one shown above have labels that tell how much current they can handle before they melt.

Fuses such as the one shown above are commonly used in cars.

Make and Break the Circuit

Most circuit breakers in homes are designed to open if the current becomes greater than 15 A.

Device	Approximate Current (A)
coffee maker	10
microwave oven	6.25
clothes iron	15
laptop computer	0.4
toaster	6.5
toaster oven	10
refrigerator	6
ceiling fan	1.5
dishwasher	20
clock radio	0.1

Examine the chart shown on the left and determine which combinations of devices can operate on the same circuit at the same time.

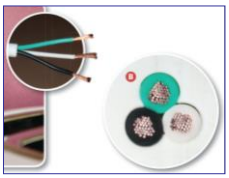
Higher-voltage circuits, larger cords and cables, and grounding help make home circuits safe.

Some electrical appliances (electric stoves, water heaters, air conditioners, and dryers) use so much current that they must have their own circuit.

These appliances usually work on circuits with double the potential difference (240 V instead or 120 V). They require larger special conductors, plugs, and outlets.

Safety Features

Larger Cables – Larger cables can carry more current safely. High current circuits are wired with larger cables.



Grounding – One of the two wires for every parallel circuit is grounded at the source. Any excess current can then flow safely into the ground.

Safety Features

Outlets – Three-prong outlets (like the one pictured below on the right) are required by law in newer homes. The third prong on a plug is connected to metal parts on a lamp or appliance. When plugged in, these metal parts are grounded. The older two-prong outlets (like the one on the left) do not contain this safety feature.

Safety Features

The outlet on the right is a ground fault interrupter (GFI). It is a special safety device that is installed in bathrooms and other locations near water faucets.

If water is accidentally splashed on an appliance and on a person, it can cause a current to flow through the person's body, with deadly consequences.

The **GFI** senses the increase in current and opens the circuit, stopping the flow of electricity. The buttons in the middle of the outlet allow you to reset and test the outlet.

Topic 4.6 Review

Key Concepts to be reviewed:

- *Practical wiring for a building has many different parallel circuits.*
- *Circuit breakers and fuses prevent fires by opening a circuit with too much current.*
- *Higher-voltage circuits, larger cords and cables, and grounding help make home circuits safe.*

Topic 4.7 How can we conserve electrical energy at home?

(Pages 314-23)

Key Concepts

- Conserving energy at home requires an understanding of how energy is measured.
- People can conserve energy by making informed choices.

How can we conserve electrical energy at home?

All Ontarians draw on the same overall "pool" of electrical energy.

It is up to everyone, as individuals and as a provincial community, to use their share of electrical energy wisely.

How can we conserve electrical energy at home?

What are some examples of sustainable uses of electricity?

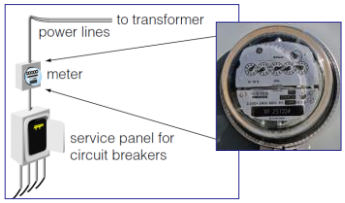
How could the examples of electricity use shown on the left be made more sustainable?

Conserving energy at home requires an understanding of how energy is measured.

The electrical energy that you use at home is measured in units called **kilowatt hours** (**kWh**).

The images above all represent 1 kWh of energy use. (A) A 100 W bulb on for 10 hours (B) Ironing for 1 hour (C) Jogging for 1 hour (D) Having a hot shower for 3 minutes

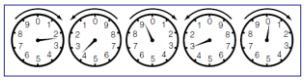
Meters for Measuring Home Energy Use



Electric meters, such as the one shown on the left, continuously measure the amount of electrical energy that is used in a building.

Meters for Measuring Home Energy Use

A meter reading person (from the power-supply company) either visually or electronically reads the meter each month in order to determine how much electrical energy you have used.



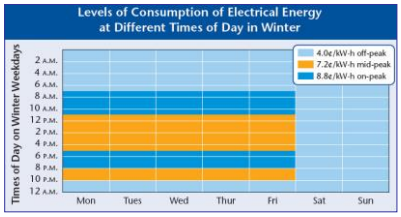
The lower number closest to each dial pointer is recorded to determine the number of kWhs used. The number of **kWhs** used is then multiplied by the **price of electricity per kWh** to determine your electrical bill.

Time-of-Use Prices

Modern electrical meters, called smart meters, allow power companies to charge different prices for electricity, depending on the time of day it is used. Smart meters measure the amount of energy that is used every hour.

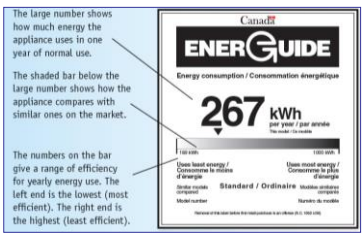
Time-of-Use Prices

Electricity is more expensive during peak use periods and less expensive during off-peak periods. Smart meters encourage people to use less electricity during peak periods. This conserves resources, and saves people money.



People can conserve energy by making informed choices.

Not all appliances are as efficient in their use of electrical energy. Consumers can determine which appliance are most energy efficient by reading the appliance's **EnerGuide Label**.



EnerGuide labels are labels that give details about the amount of energy an appliance uses in one year of normal use.

People can conserve energy by making informed choices.

ENERGY STAR® labels identify a product as meeting or exceeding certain standards for energy efficiency. Products with this label use 10 to 50% less energy than a standard product in the same category.

Fight the Phantom Load

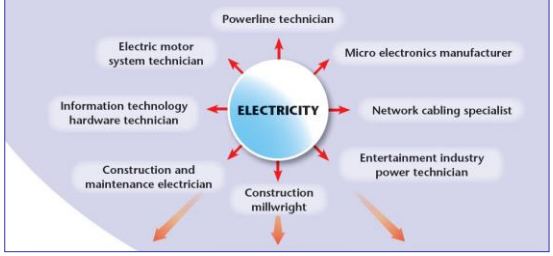
A **phantom load** is electrical energy that is used by a device when it is turned off. Clock displays on appliances and external power adapters require phantom loads to function.

People can save the money that phantom loads cost them by unplugging devices when they are not in use. Surge protectors, such as the one on the left, allow you to turn off several devices at once.

How many phantom loads are running in your home?

Electricity at Work

The study of electricity contributes to these careers, as well as many more!



Electricity at Work

▲ Construction and maintenance electricians set up, test, maintain, and fix electrical equipment, fixtures, wiring, and other systems in homes, offices, and industrial buildings. They make sure electrical systems are safe in renovations or new construction projects.

▲ Construction millwrights install and fix machines during the construction of new plants and other facilities. They may be involved in the maintenance of machines and equipment.

▲ Entertainment industry power technicians plan, build, set up, maintain, and take apart power distribution systems. They work in film, television, live theatre, trade shows, and musical events.

Topic 4.7 Review

Key Concepts to be reviewed:

- *Conserving energy at home requires an understanding of how energy is measured.*
- *People can conserve energy by making informed choices.*