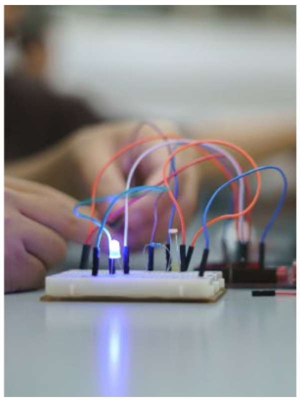
W 1048

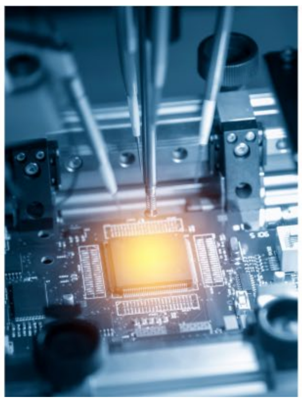
1-2 YEARS IN PROJECT

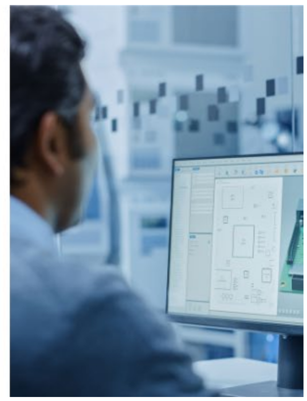
Understanding Electricity, Magnets and Circuits

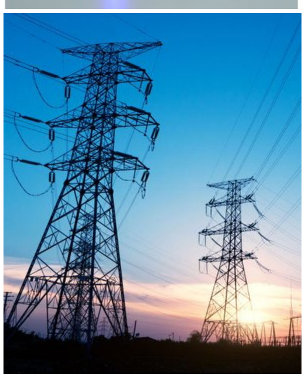
Electric Project Area Guide

Beginner Level









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Electric Project

CTRL+Click on each activity number below to be taken to where it appears in the document.

Project Outcomes

Section 1 – Electricity Basics

- Understand the important effects electric energy has on humans and their environment.

Section 2 – Electricity Safety

- Recognize that electricity can be dangerous if not used properly.
- Describe hazards involved when working with electricity.
- Demonstrate safe practices and procedures to prevent personal injury and property damage.
- Identify and collect basic tooling needed to work on residential electrical circuits.

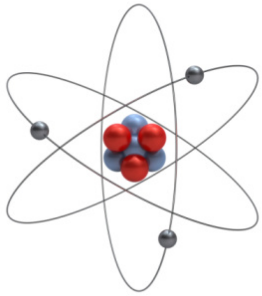
Section 3 – Currents, Conductors and Insulators

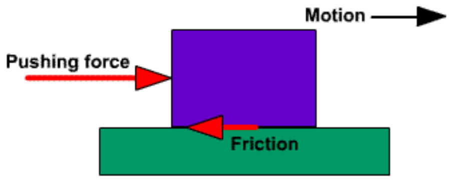
- Define voltage, resistance and current and identify the units of measure associated with each.
- Explain the difference between conductors and insulators.
- Describe the difference between AC and DC currents.
- Examine basic electrical circuits and components.
- Label the parts of a simple circuit.
- Draw examples of an open circuit and a closed circuit.
- Model how electricity flows through a circuit.

Section 4 – Magnets and Magnetic Fields

- Understand why magnets and magnetic fields are so important in our study of electricity.
- Explain the cause-and-effect relationship of magnets.
- Describe how magnets cause changes in the motion and position of objects, even when the objects are not touching the magnet.
- Learn how magnetic fields are used to generate electricity.

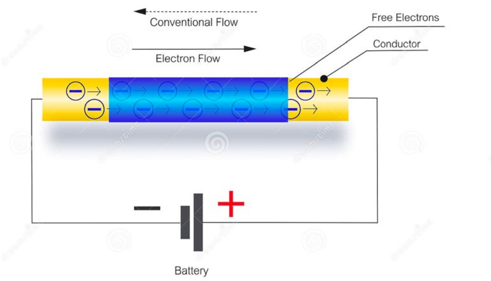
Vocabulary Words





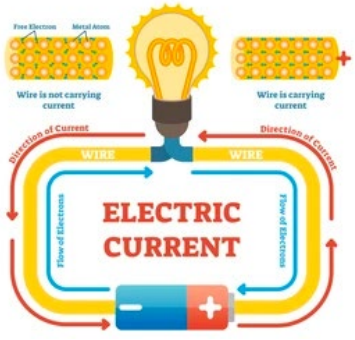
Atoms are so small you cannot see them with the eye or an ordinary

Friction is the action of one surface or object rubbing against



Flow of electricity is the result of electrons generally jumping in the

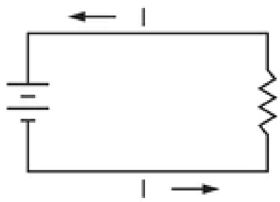
Electricity is a form of energy resulting from the existence of charged particles.



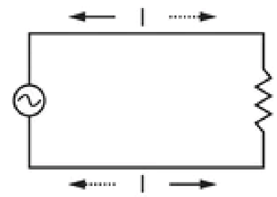
Electric current is the flow of electrons through a wire or solution.

Polarity is a term used throughout industries and fields that involve **electricity**.

DIRECT CURRENT (DC)

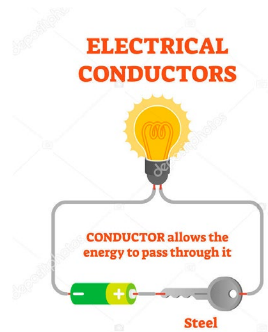


ALTERNATING CURRENT (AC)



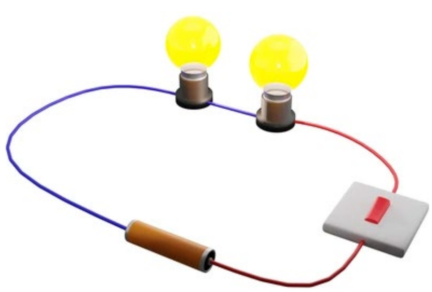
Direct current (DC) is an electric current flowing in one direction

Alternating current (AC) is an electric current that reverses its direction many



A *generator* is a device that converts mechanical energy

A *conductor* is an object or type of material that allows the flow of charge in one or more directions.

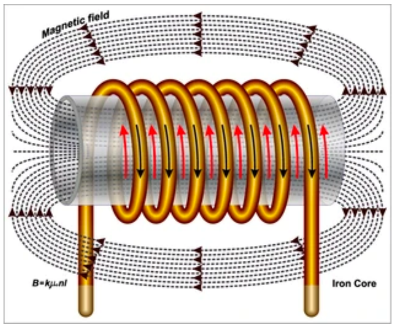


Paths are conductors that connect the other components of an

Voltage is an electromotive force or potential difference expressed

Magnetism is the force exerted by magnets when they attract or repel

Magnetic Compass is an object containing a magnetized pointer that



Solenoid is a cylindrical coil of wire acting as a magnet when carrying

A ***transformer*** is an apparatus for reducing or increasing the voltage of an

Section 1: Electricity Basics

Project Outcomes:
- Understand the important effects electric energy has on humans and their environment.

Electricity is not a human invention; it is a part of nature. Everything around us is made up of particles called ***atoms***. Atoms are so small you cannot see them with the eye or an ordinary microscope. Click or scan the QR Code to learn more about the foundations of electricity. Be sure to return to your project guide for activities!

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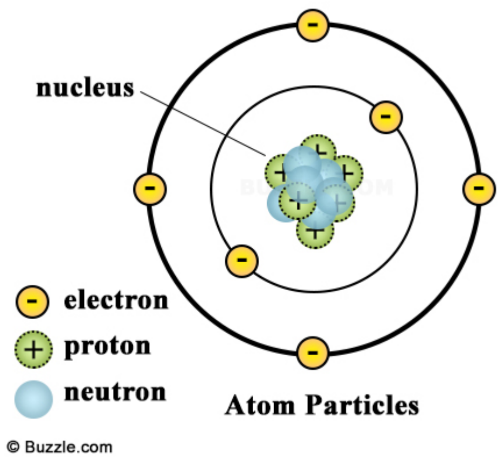
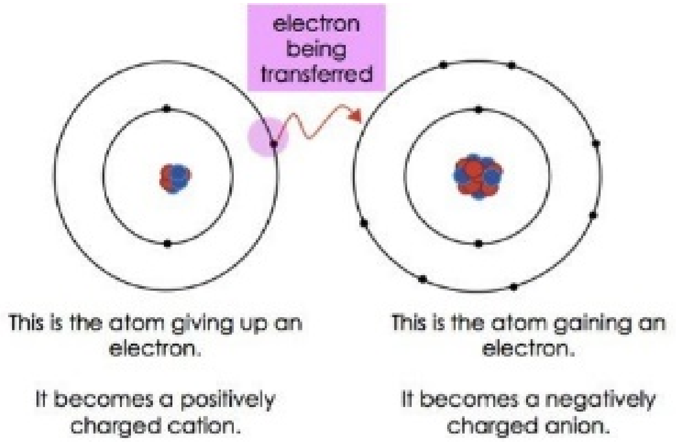
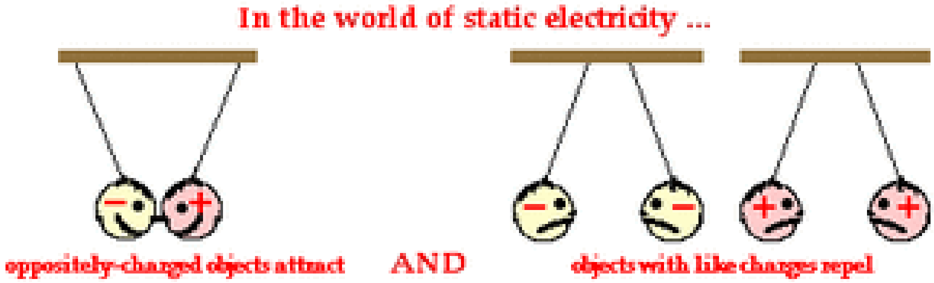
Learn more about atoms, protons, neutrons and electrons.



Static Electricity



The Law of Electrostatics



Activity: Static Electricity and the Law of Electrostatics

When you rub items together (*friction*), you cause electrons to fall off and create positive and negative ions to be created. Try this experiment and note what happens. The next page will explain what happened with the spoon, wool, plastic and tissue.

Materials Needed: plastic spoon, piece of wool, plastic wrap, tissue

Instructions:

1. Tear the tissue into tiny pieces and place on the table.
2. Rub the handle of the plastic spoon vigorously for 10-20 seconds with the plastic wrap.
3. Move the tip of the spoon very close to the pieces of tissue. What happens to the pieces of tissue? Write it or draw it in the space below.

4. Rub the spoon vigorously for 10-20 seconds with the wool and bring it close to the tissue pieces.

What happens to the pieces this time? Write it or draw it in the space below.

Try other static electric experiments by scanning or clicking the image. Make a video of the experiments, explain your results and upload this to your digital 4-H portfolio.

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With the spoon, tissue and wool, if the tissue and spoon have opposite charges, positive (+) and negative (-), the two objects are attracted and will move toward each other. If they have the same charge (positive/positive or negative/negative), the two objects repel and move away from each other. Watch the video below to learn more.

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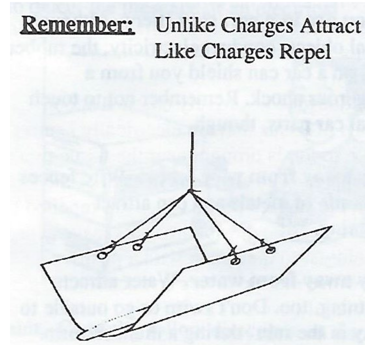
Activity: Opposites Attract



You can't just see the charge of an atom. We can use the law of electrostatics to determine the positive (+) or negative (-) charge.

Materials Needed:
Two plastic spoons, a sheet of paper, five paper clips, plastic wrap, pencil, ruler, heavy book, piece of wool, silk, nylon, cotton, newspaper, three 10-inch-long pieces of thread

Instructions:
Tie the ends of the thread to the unfolded paper clips as shown in the diagram. One end of thread should not have a paper clip. Tie this end to the pencil.

Place the pencil where the string dangles from the edge of a table but doesn't touch the floor. Use the book to weigh down the pencil. The paper clip should hang freely.

Make four small holes 3 inches from the top end and bottom end of the sheet of paper on the long slide as shown in the diagram. Hook the strings in the hanging paper clip. The paper sling should swing freely.

Rub a plastic spoon with wool and place it in the suspended paper holder so that is it is free to turn. Rub another plastic spoon with wool and bring it near the suspended spoon. Write or draw what happens below.

Rub a plastic spoon with wool and place it in the suspended paper holder so that is it is free to turn. Rub another plastic spoon with plastic wrap and bring it near the suspended spoon. Write or draw what happens below. Why did they attract?

Repeat this experiment with other materials (newspaper, silk, nylon cloth and cotton). Which materials leave the spoon positively (+) charged? Which materials leave the spoon negatively (-) charged?

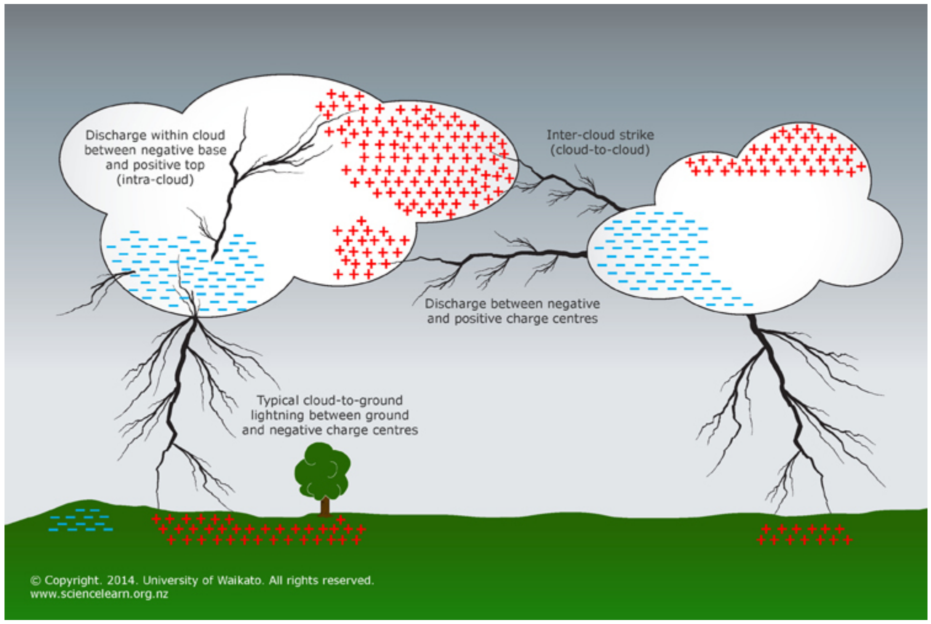
Circle One

Silk	Positive	Negative
Nylon	Positive	Negative
Cotton	Positive	Negative
Newspaper	Positive	Negative

Make a video of your experiments, explain your results, and upload this to your digital

Static Electricity in Nature: Lightning

Perhaps the biggest display of static electricity is lightning. Lightning is the jumping of tremendous quantities of electrons from cloud to cloud or from cloud to earth.



Clouds build up either positive or negative charges, which mount to a tremendous amount of power. When the force of attraction between opposite charges becomes powerful enough, a tremendous surge of electrons, an electrical current which we call lightning, leaps between the charged bodies.

Lightning bolts between clouds and ground may travel three miles or more. Between two clouds, they can flash a distance of 10 miles or more. Since it takes about 67,000 *volts* to leap 1 inch, a 10-mile flash indicates a tremendous amount of power.

Brain Teaser: 1 mile = 63,360 inches = 67,000 volts
3 miles = _______________ inches = _____________________ volts

10 miles = _______________inches= ______________________ volts

You do not see electricity in a lightning flash. You see the burning spark channel or burning air column about an inch in diameter. The heat of the flash causes the channel of air to expand or explode with a tremendous force. The airwaves produced from this explosion pounds against your eardrum to cause the sensation we call thunder.

If the discharge is close by, the thunder comes as a sharp, whip-like crack. You can determine the distance of lightning if you start counting the moment you see the flash. The sound wave it produces travels 1100 feet per second. If five seconds tick by before you hear thunder, the lightning bolt was approximately a mile (5280 feet) away. You'll learn more about lightning and safety in Section 2. Check out this website to learn more!

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Section 2: Electricity Safety

Project Outcomes:

- Recognize that electricity can be dangerous if not used properly.
- Describe hazards involved when working with electricity.
- Demonstrate safe practices and procedures to prevent personal injury and property damage.
- Explain the difference between conductors and insulators.
- Identify and collect basic tooling needed to work on residential electrical circuits.

Benjamin Franklin got lucky! His experiment with his kite could have killed him. Electricity has many benefits. It has allowed us many conveniences that we don't think about until the power goes out or the battery goes dead. Because it is so easy to turn on a light or plug in our devices, we can easily forget how powerful electricity can be. We must remember to be safe with electricity, as it can kill us in a second.

In this section you will explore:

Electrical Safety 101

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Underground Utility Line Safety

How Does Electricity Cause Harm?

Boating Safety Tips

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Electrical Safety Tips

SCAN ME

Safety Treasure Hunt

SCAN ME

The Legend of Benjamin Franklin

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Safety Games

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plug into safety

Activity: Build an Electrical Tool Kit

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Having the right tools for electrical projects can help you properly work on common electrical problems. See what items you have and add these items to your home tool kit for electricity experiments and home projects.

Make a video to show your toolkit for your digital 4-H portfolio.

There are likely to be various things that could be found around your house that could be used for electrical experiments. Go on a search and see if you can find any of the following:

AA Batteries	AAA Batteries	9-Volt Battery
Magnet	Flashlight	Safety Pin
Extension cord	Marker	Masking tape

Think about how you could use each of the items listed above to conduct an experiment. Write your ideas in the blanks below.

AA Batteries: ______________________________

AAA Batteries: ______________________________

9-Volt Battery: ______________________________

Magnet: ______________________________

Flashlight: ______________________________

Safety pin: ______________________________

Extension cord: ______________________________

Marker: ______________________________

Masking tape: ______________________________

Activity: Home Safety Hazard Hunt

LOOK, but don't touch! Look for hazards in your home, barn, garage and other places where you use electricity. Encourage your parents to do the same at work.

*Remember to unplug items before inspecting. For outside items such as a tree, tv antenna, ball goal or other item, be sure to look from a distance. Do not climb or touch.

- Power cords for appliances and power tools – look for defects in cords.
- Trees, TV antennas, ball goals or other items touching, very close or could fall on power lines.

Make a photo presentation of what you find. Talk with an adult to make plans to correct these items. You or your adult can call the electric company to set a time they can turn off power before you and an adult or professional company move any items near utility lines.

I love playing in the snow and watersports in the summer! You may farm or enjoy other outside activities like flying drones or kites. Think about the activities you enjoy like playing in the snow, swimming, boating, etc. How could electricity be involved in these events? How can you plan to be safe? Make plans with your family for the following events and others that may happen.

- An item falls on the power line.
- The power is out in a snowstorm or summer storm.
- A car wreck with a power line.
- A power line falls in a snowstorm or summer storm.
- You are swimming or boating and a summer storm starts.
- You are flying something or driving with something that is tall. How do you stay safe?

Make a video to explain your tips and upload this to your digital 4-H portfolio.

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Section 3: Currents and Electrical Circuits

Project Outcomes

- Define voltage, resistance and current.
- Identify the units of measure associated with each.
- Describe the difference between AC and DC currents.
- Examine basic electrical circuits and components.
- Label the parts of a simple circuit.
- Draw examples of an open circuit and a closed circuit.
- Model how electricity flows through a circuit.

The fact that electrons can jump with ease from one atom to another within material is important to us. This jumping of electrons can be controlled in different materials. When the electrons are generally jumping in the same direction, the result is a ***flow of electricity.*** This movement of electrons from atom to atom in the same direction is called ***electric current.*** In using ***electricity,*** we are controlling the flow of electrons to make ***electric current.***

In this section you will explore current, voltage and resistance.

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More about Voltage

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More about Resistance

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Scientists of Electricity

Generating Electricity

Electricity is a form of energy. When you use a battery to power a light bulb or device, you are changing electricity from one form of energy to another. To produce electricity in the first place, it is necessary to change another form of energy (motion, heat, light or chemical reactions) to electricity.

Batteries

Can you imagine having to plug everything you use into a wall outlet to have electricity? That would make most items we use today inconvenient. Batteries allow us to make electricity mobile.

Learn more about batteries and try making a lemon battery here! Be sure to video your experiments for your digital 4-H portfolio!

AC and DC Currents

There are two ways in which electrons flow through wire. The electron flow in a circuit connected to a battery is always in the same direction, called ***direct current (DC).*** Voltage in direct current always pushes the electrons in the same direction.

The other kind of electricity is called AC current or ***alternating current (AC).*** AC current causes electrons to flow in one direction, come to a complete stop and then go in the opposite direction. This change of direction happens because of *polarity*, which means the poles change locations or flip. This is the type of electricity that comes to homes, schools and businesses. In the United States, it can also be called ***60 cycle*** AC because the direction changes 60 times per second. This change in direction is so fast, you don't notice the lights flicker at this brief stop between each cycle.

Check out these videos to learn more. You can click on the "Scan me" or use your camera to open in a separate window.

Activity: Potato Battery

Just like in the video, you can make batteries from lemons, potatoes or other vegetables and fruit. Try it out by following this link or the video above!

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Activity: Conductors and Insulators

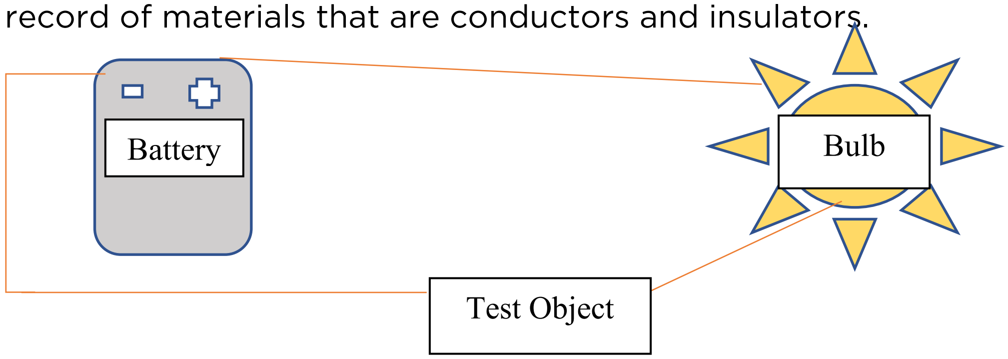
> Make a video to show your experiment for your digital 4-H portfolio.

Materials Needed:
9-volt battery and 9-volt battery clip
Three 12-inch pieces of insulated copper wire
7.5-volt E-10 threaded light bulb
One holder for the E-10 miniature threaded-base lamp
Scissors

Testing Materials: Penny, aluminum foil, paper clip, glass, paper, plastic spoon, cloth, dry wood, wet wood, fruit, potato

Instructions:

1. Remove 1 inch of insulation from both ends of the three wires. Use the scissors to do this. Carefully cut only the insulation surrounding the wire, leaving bare wire.
2. Make a small loop in one end of two wires. Connect them to the screw terminals of the lamp holder. Connect one of the wires from the lamp holder to the positive lead of the battery clip.
3. Connect the third wire only to the negative terminal of the battery. You should have two wire ends that are not connected to anything. Place the bulb in the holder.
4. Test each material. Touch the loose ends of the two wires to each material. If the material is a conductor, the light bulb will light up. Keep a record of materials that are conductors and insulators.



HYPOTHESIS:

____

RESULTS:

____

Activity: Which Pole is What?

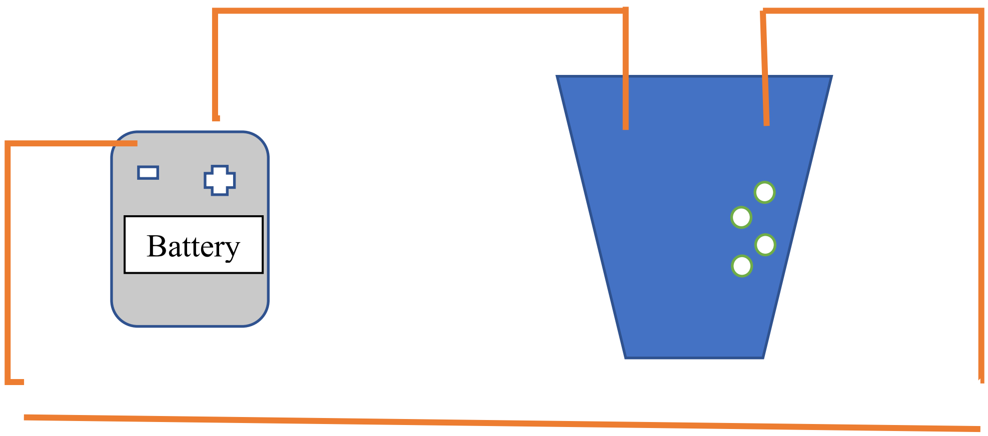
A battery always has two poles or terminals. One is a positive pole and the other is a negative one. When connected to a complete circuit or path, a battery produces an electrical current called direct current (DC). If the poles weren't clearly marked on the battery, we could use this experiment to find the positive (+) and negative (-) poles.

Make a video to show your experiment for your digital 4-H portfolio.

Materials Needed:
9-volt battery and 9-volt battery clip
Two 12-inch pieces of insulated wire
A drinking glass
Water (3/4 full glass)
2 tbsp. vinegar
Scissors

Instructions:
1. Remove 1 inch of insulation from both ends of the three wires. Use the scissors to do this. Carefully cut only the insulation surrounding the wire, leaving bare wire.
2. Fill a glass 3/4 full of water and add two tablespoons of vinegar.
3. Connect the wire to each lead from the battery clip.
4. Place the battery clip on the battery.
5. Stick the two wires from the battery into the water. Place the wires close together but not touching.
6. Describe what happens to the wires.

A chemical reaction took place. The water (conductor) created a complete circuit (path) for the electrical current to flow through. The wire that made the bubbles led to the battery's negative (-) pole. The other wire led to the positive pole. Did this match your findings?



Activity: Electroplating

Electroplating is a process in which we use electricity to put a thin coat of metal on a key, jewelry or another metal object. This is very important in industry where we apply a thin coat of metal to make automobile accessories shine with chrome finishes or apply protective coatings to metals for use on buildings. It also makes jewelry appear gold without being completely solid gold. Electroplating works much like recharging a wet cell battery — we use electricity to force the chemical reaction. Try electroplating at home following these steps.

Make a video to show your experiment for your digital 4-H portfolio.

Materials Needed:
9-volt battery and 9-volt battery clip
Two 12-inch pieces of 22-gauge insulated wire
Small wide mouth glass jar
4-inch piece of 12-gauge bare copper wire
Old key or small metal object
Salt
Vinegar
Scissors

Instructions:

1. Remove about 3 inches of insulation off one end of each wire. Remove about 1 inch off the other ends and attach to the black and red leads from the battery clip.
2. Wrap the uninsulated end of the wire from the positive lead (red) of the battery clip around the 12-gauge bare copper wire.
3. Wrap the uninsulated end of the wire around the negative lead (black) through the keyhole and twist it. The key must be clean and dry.
4. Fill the glass jar a little more than half full of vinegar. Add a tablespoon of salt and stir. If it all dissolves, keep adding salt (at which point the salt will begin to settle to the bottom).
5. Place the copper wire and the key into the vinegar-salt solution. Make sure the copper wire and the key are across from one another in the glass and do NOT touch. Soon you will notice bubbles forming on the key and the color of the electrolyte changing. Wipe the bubbles off every few minutes or the electroplating action will slow down.
6. After a while, you should see a thin coating of copper form on the key.

Learn more about electroplating here:

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The Highways for Electricity

For electricity to be useful, it needs somewhere to start, someplace to go and a way to flow back to where it started or to the ground. If electrons do not have a place to go after flowing, they bunch up and the flow stops. Electron flow is *current*, but to be useful, electrons must flow in a complete path called a *circuit.*

Simple Circuits

Flick a switch, push a button or plug in a power cord. Light, heat, motion and technology are all at your fingertips because of electrical circuits. You control the flow of electricity in these and other devices that serve you daily. You are the traffic engineer, or the stop light, in the flow of electrical current. When you throw the switch, you are completing a pathway over which electrons flow, an *electrical circuit*.

In your experiments with conductors and insulators, you were creating simple open and closed circuits. When a conductor, such as the penny, was attached to both wires, the circuit was *closed,* and electrons could flow and light the bulb. When you removed the object, the circuit was *open*, meaning electrons flowed but could not return and complete the path so they bunched up on the end of the negative wire.

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Explore series and parallel circuits and how they work.

Short Circuit

When working with circuits, it is important to avoid the dangerous hazard of short circuits. Take a look here to learn more!

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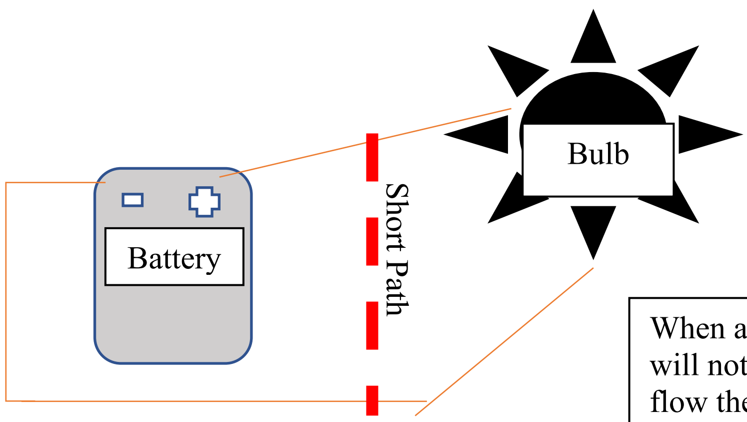
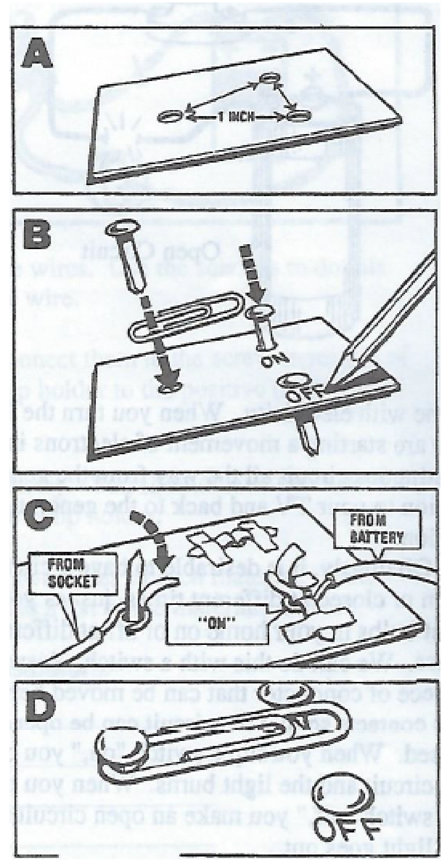


When a short is created, the bulb will not light because electrons flow the shortest path back to the source.

Activity: Building a Switch



Materials Needed:
9-volt battery and 9-volt battery clip
Three 12-inch pieces of insulated wire
7.5-volt E-10 threaded light bulb
One holder for E-10 miniature threaded base lamp
One piece of cardboard 4 inches by 2 inches
One 2-inch paper clip
Two I-inch brass fasteners
Masking tape
Scissors

Instructions:

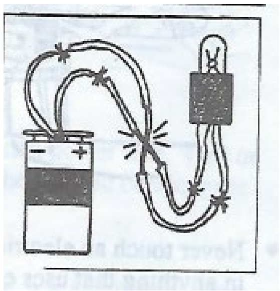
1. Remove 1 inch of insulation from both ends of all wires. Use the scissors to do this. Carefully cut only the insulation surrounding the wire, leaving bare wire.
2. Punch three small holes 1 inch apart in the cardboard in a triangle pattern (See A). Write ON and OFF next to the holes as shown in the diagram (See B). Attach the paper clip as shown in the diagram. Point the paper clip towards OFF.
3. Follow the instructions in the Conductors and Insulators activity above and make the same open circuit.
4. Attach the loose wire from the negative terminal (black) of the battery to the fastener labeled ON. Attach the loose wire coming from the socket to the unlabeled fastener. Open and flatten the fasteners as shown on the back of the cardboard (see C). Make sure they do NOT touch. Use tape to hold them in place.
5. Turn the switch on by moving the paper clip so it touches the fastener labeled ON (see D). Be careful — this switch may get hot if left in the ON position for long.
6. When finished observing, turn switch to OFF and disconnect the battery wires completely for safe storage.

Make a video to show your experiment for your digital 4-H portfolio.

In your video:
Tell us the parts of your circuit.
Tell us when the circuit is open and closed.
Tells us what type of current is used (AC or DC).
Tell us the direction of electricity flow.
Bonus Points: Tell us about current, voltage and resistors.

Activity: Short Circuits

Electricity will follow the path of least resistance to complete the circuit. Things can block the circuit and prevent electricity from reaching its work.



Materials Needed:
9-volt battery and 9-volt battery clip
Two 12-inch pieces of insulated wire
7.5-volt E-10 threaded light bulb
One holder for E-10 miniature threaded base lamp

Instructions:

1. Remove 1 inch of insulation from both ends of all wires. Use the scissors to do this. Carefully cut only the insulation surrounding the wire leaving bare wire.
2. Also, remove about 1 inch of insulation from the middle of each wire.
3. Connect one end of each wire to the screw terminals of the lamp holder. Connect one of the wires from the lamp holder to the positive (red) lead of the battery clip. Connect the other wire to the negative end (black) lead of the battery clip.
4. HOLD THE INSULATED PART OF THE WIRE!!! The bare wire may get HOT!!
5. Very quickly touch the bare middle sections of the wires together. Do this for only a second or two.

Make a video to show your experiment for your digital 4-H portfolio.

In your video:
Tell us the parts of your circuit.
Tell us about the path of electricity flow.
when the middles touch and do not touch.
Bonus Points: Give examples of when shorts can occur in your home appliances or electrical cords.

Activity: Holiday Card Circuits

Create festive holiday cards that will light up anyone's day using circuits! Be sure to note this citizenship project in your digital 4-H portfolio.

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Activity: More At Home Circuits

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Section 4: Magnets and Magnetic Fields

Project Outcomes

- Understand why magnets and magnetic fields are so important in our study of electricity.
- Explain the cause-and-effect relationship of magnets.
- Describe how magnets cause changes in the motion and position of objects, even when the objects are not touching the magnet.
- Learn how magnetic fields are used to generate electricity.

Magnets and Magnetism

Long ago, people discovered the ability of certain stones to attract certain kinds of metals. They called these rocks "lodestones," and the strange power of these rocks is called ***magnetism.*** No one is exactly certain what causes magnetism, but it only occurs in certain metals: iron, steel, nickel, cobalt and combination metals called alloys. Most scientists believe it is caused by the way molecules are arranged. The Chinese were the first to use these stones for practical purposes to navigate. They found that if they hung one of these stones by a string, it would always point toward the North Star, thus creating what would come to be called the ***magnetic compass.*** Earth is a large natural magnet which is of great benefit.

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Learn more about magnets, magnetic fields and Earth as a magnet here at the QR code to the right.

Activity: Magnetic Slime, Mariners Compass and Other Magnetic Experiments

Try out a host of magnetic experiments here. As you explore you may learn more about certain experiments as you continue your project. Be sure to look at the "How It Works" section and teach others.

Make a video to show your experiments for magnets for your digital 4-H portfolio.

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Activity: Magnetic Compass

The Earth has the North Pole, the geographical location on the map, but it also has a magnetic north pole that creates a force that attracts a magnet, just like a bar magnet attracts other magnets and metal objects. Try this experiment to learn more about compasses.

Materials Needed:
A bar magnet
6-8 inches of string
A ruler
Several heavy books
Tape

Instructions:

1. Wind one end of the string several times around the middle of the bar magnet and tie it in a knot. Hold the other end of the string. The magnet should hang parallel to the ground and be balanced. Adjust the string's location until the magnet is balanced.
2. Tape the other end of the thread to the end of the ruler so that the magnet hangs from the ruler.
3. Put the ruler between the stack of heavy books so the magnet hangs and moves freely.
4. Wait until the magnet stops moving. Take note of which direction the magnet is pointing.
5. Spin the magnet gently. Where does it come to rest?
6. Repeat the experiment in different places and note the resting position of your magnet.

The north pole of your magnet always points toward the earth's magnetic north pole. The south pole of your magnet points in the opposite directions. The poles of a magnet are named by the direction they point.

Activity: Magnetic Chains

You will need a horseshoe magnet, a large nail and metal paper clips. Touch the items together, noticing which attract together and which do not. Hold the nail in one hand and the magnet in the other. Stroke the north pole of the magnet along the nail, from the middle to the end point 50 times in the same direction. When you reach the pointed end, do not go backwards, but put the magnet back at the middle and rub to the end each time. Touch the nail to the paper clips. What happened? Why do you think this happened?

By stroking the magnet on the nail in the same direction, you magnetized the nail by causing the molecules to line up north to south. This can occur in some but not all magnetic materials and can last for various amounts of time.

Electromagnet

Did you know that electricity can produce magnetism? This is what makes electric motors run. It can be found in everything from doorbells to automatic washers and many everyday products. Electromagnets are a temporary magnet made by wrapping a coil of insulated wire around a soft iron core. These magnets can be made much stronger than permanent magnets by adjusting the components such as the current or wire coil.

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Learn more about electromagnets here:

Activity: Magnetic Energy in Motion

Electromagnets are in many objects because they can be switched on and off. Electromagnets are used in a device called a *solenoid.* A solenoid is an electromagnet in which the core is free to move in and out of the coil due to the magnetic field. These solenoids are used in items such as doorbells, buzzers and your washing machine to switch it from soak to wash to rinse and so on. Make a solenoid and watch it turn magnetic energy to motion!

Try out more electromagnetic experiments with motion here:

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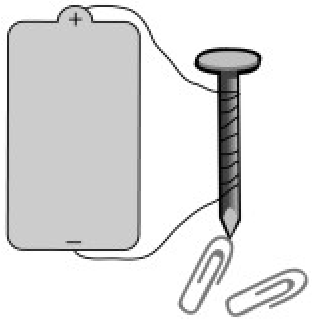
Activity: Make an Electromagnet

Electromagnets are used in many places because you can adjust the level of magnetism. Large electromagnets lift cars and are used in cranes because they can pick up extremely heavy objects with a very strong electromagnet and then open the switch, turning off the magnetism, and drop the object where they want it to fall. Try out making electromagnets here. You will need this electromagnet to try an experiment in the Electric Motor section next.



Materials Needed:
Large nail
3 feet of insulated wire
D-cell battery
Paper clips
Electrical Tape

Make a video to show your experiments for your digital 4-H portfolio.

Instructions:

1. Remove 1/2 inch of insulation from ends of the wire.
2. Wrap the wire tightly around the nail (about 25 turns). Leave enough wire to connect to the battery.
3. Tape each end of wire to the battery. Be careful as the bare wire may get hot.
4. Touch the end of the nail to paper clips. What happens?
5. Remove one of the ends of the wire from the battery and touch the paper clips. What happens?

As the battery sends electrical current through the coil of wire wrapped around the nail, the nail becomes magnetized. The molecules in the nail lined up in the presence of the magnetic field. The nail stays magnetic until the current stops.

Activity: How Motors Work

In a motor, you will use what you know about how poles repel and attract and how permanent magnets and electromagnets work to understand an electric motor.

Make a video to show your experiment and explanations for your digital 4-H portfolio.

Materials Needed:
Electromagnet you made from the activity on page 23
Bar magnet with poles marked

Instructions:

1. Lay the electromagnet on the table. Bring the north pole of the bar magnet near the north pole of the electromagnet. Note what happens.
2. Bring the south pole of the bar magnet near the north pole of the electromagnet. Note what happens.
3. Place the electromagnet and bar magnet on the table so unlike poles are end to end and cling together. Carefully reverse the leads of the electromagnet to the battery. Note what happens.
4. Again, reverse the leads to the battery. What happens?

You will learn more about electric motors in the next section. After you learn more, try this experiment again and see what you observe differently.

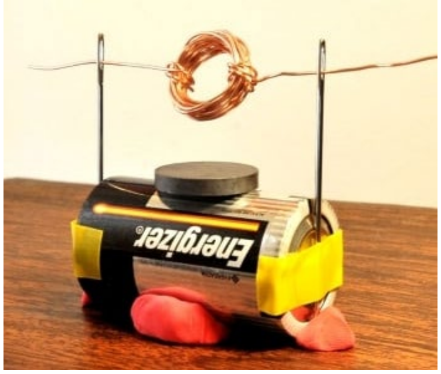
Write down your hypothesis of what will happen and then document your results.

HYPOTHESIS:

____

RESULTS:

____



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Motion from Electricity

Since we know magnets can move pieces of metal around, and since magnetism can be produced by electricity, we already have some idea of how electricity can produce motion. The electric motor combines what you know about electricity and magnets to create motion in the smallest toys to large trains and everything in between.

Learn more about electric motors at the QR code above.

Be sure to try the experiment on page 24 a second time after learning more, then make an electric motor at the links below.

Activity: Spinning Electric Motor

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Activity: Electric Motor Optical Illusion

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Electric Generators

We know that we can make magnetism from electricity. We can also make electricity from magnetism. Electric generators use mechanical energy and magnets to generate electricity.

Learn more about electric generators here:

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Activity: Homemade Electric Generator from Recycled Parts

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Learn to turn mechanical energy into electrical energy by using recycled materials to make a homemade electric generator.

Other Ways Electricity and Magnetism Work Together

It goes without saying that electricity is part of everything we use, and now we know that magnetism plays a large role in electricity. The two work together to produce motion and to allow us to have modern conveniences.

Transformers and Loudspeakers

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Transformers are used to step up or step down the voltage so we can use the right amount for all our products. Transformers take the large amount of voltage from power stations to the right amount for our homes, but also even adjust the voltage amount from our wall outlet to our appliances and devices.

Similarly, in speakers of all types, the same principles are used for our listening pleasure. Learn more about transformers and loudspeakers here:

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Activity: Word Search

Below is a word search containing all the vocabulary words you have learned in this guide. Search up, down, forward, backward and on the diagonal to find the hidden words. Once you find the word, circle it and cross it off from your word bank!

N	G	S	E	C	M	Q	P	Y	Z	C	S	T	P	S	L	D	H
P	L	G	L	O	M	A	P	X	Q	O	O	E	O	D	C	B	F
A	O	E	E	M	E	A	P	G	K	N	L	I	L	B	H	M	V
T	D	N	C	P	T	I	G	J	J	D	E	F	A	C	A	Q	F
H	A	E	T	A	C	V	O	N	N	U	N	L	R	Y	V	D	R
S	T	R	R	S	Q	U	P	D	E	C	O	O	I	C	O	H	I
V	O	A	I	S	T	H	R	G	U	T	I	W	T	N	L	C	C
E	M	T	C	C	Q	G	Q	R	W	O	D	Z	Y	B	T	H	T
L	S	O	I	Y	C	O	N	G	E	R	V	J	Z	M	A	J	I
E	P	R	T	M	V	G	W	R	B	N	H	K	N	Z	G	P	O
N	K	H	Y	W	A	C	Z	A	H	I	T	Z	I	B	E	E	N
Y	Y	A	V	T	R	A	N	S	F	O	R	M	E	R	T	Z	J

Find the following words in the puzzle.
Words are hidden → ↓ and ↘ .

AC
ATOMS
COMPASS
CONDUCTOR
CURRENT
DC
ELECTRICITY
FLOW
FRICTION
GENERATOR
MAGNET
PATHS
POLARITY
SOLENOID
TRANSFORMER
VOLTAGE

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Demonstrations

- Teach any of the activities and experiments you have conducted in your project work or create them as a display for other members, students or audiences.
- Work with your local electric co-op or company to conduct safety demonstrations or conserving electricity demonstrations.

Leadership

- Teach your classmates about electricity by giving a demonstration.
- Give an electricity demonstration at a local community space or group.
- Convince others to join this project.
- Teach younger students about electricity.
- With adult support, use digital methods to teach others about electricity.

Careers

- There are many interesting careers with electricity ranging from power company workers to medical professionals. Learn more about these careers here.

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Citizenship

- Make the Electric Current Holiday Cards for local groups (veterans, first responders, front line workers, patients in care settings).
- Teach others about safety with electricity and how to conduct a hazard hunt.
- Display safety posters in local businesses and assist with safety programs.
- Speak to a civic group about ways they can help spread the word about electrical safety.

Camps and Project Work

- Learn from professionals in the field and continue learning in 4-H through these excellent experiences.
    - 4-H Electric Camp
    - 4-H Academic Conference
    - 4-H Digital Portfolio
    - 4-H Project Work and much more!
- Click or scan here to learn more.

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Congratulations!

You have now completed the Beginner Electric Project curriculum.

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