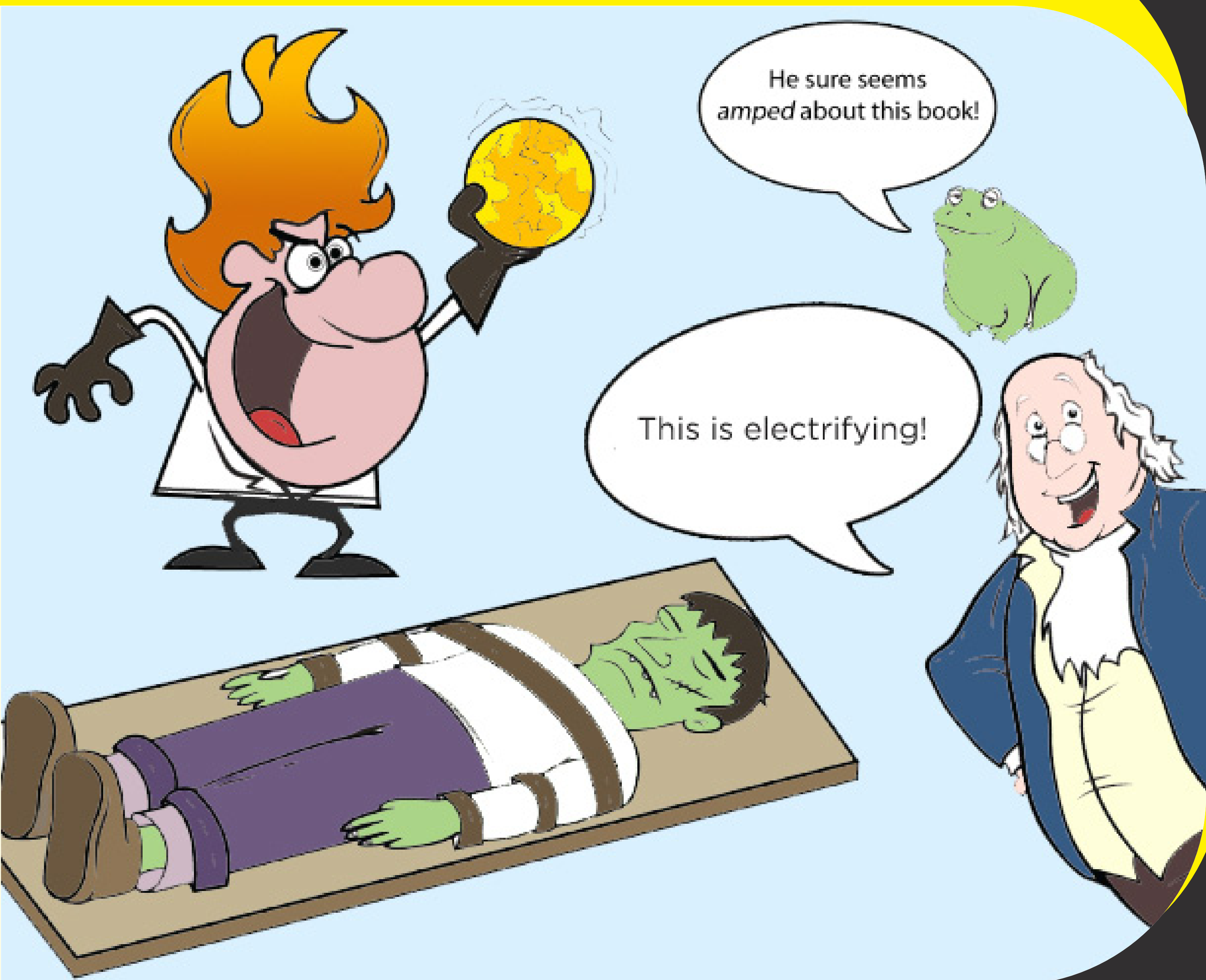
Electricity and Magnetism for Kids

4th Grade



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Electricity & Magnetism For Kids

** Has an Answer Sheet*

ELECTRICITY

From Life-Threatening to Life-Saving:

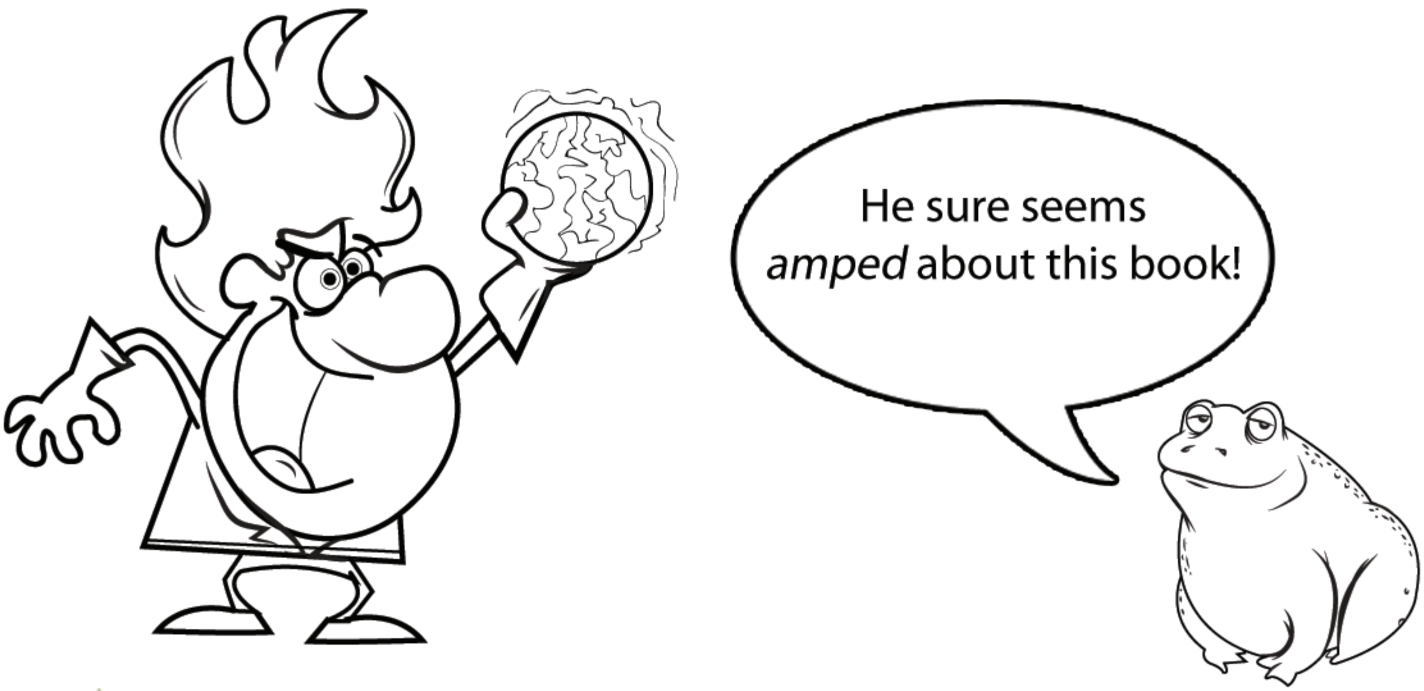
(Or: Why Should I Care About This?)

WARNING:

You should not attempt any of the mad science conducted by the folks featured in this workbook. Under no circumstances should you tie a piece of metal to a kite and go for a stroll in a thunderstorm, build what turns out to be a pretty effective earthquake machine in your New York City apartment, or try to revive dead frogs with electric shocks.

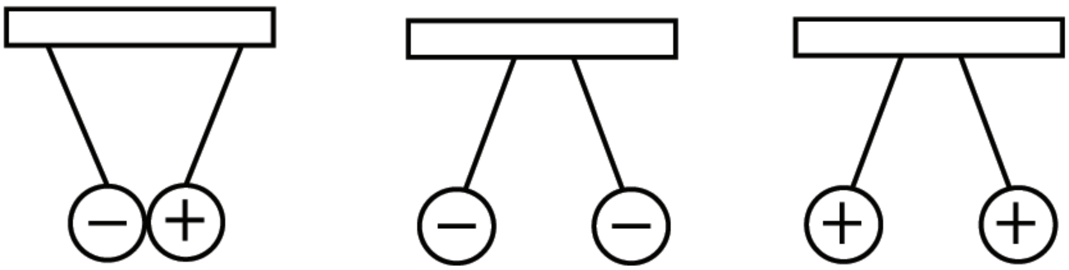
However, if the scientists featured in this book hadn't gone through the gross, gory, and downright dangerous stuff first, we wouldn't have a whole lot of awesome stuff today. The gruesome science in the 19th century with electricity and magnetism led to a lot of lifesaving inventions like cardiac defibrillators, X-rays, and pacemakers – the kind of stuff that saves countless lives every day. These creepy experiments also inspired countless works of fiction and created famous characters: we have people like Luigi Galvani to thank for Frankenstein, a character based on Galvani's experiments with electricity, created to warn the public about the dangers of taking science too far. Now, he's a movie star and a popular Halloween costume.

Read this manual carefully. Then ask a parent (or mischievous older sibling) for assistance in getting started changing the world of science – and later, the world.



ESCAPING ELECTRONS!

An atom usually has the same number of protons and electrons, but the electrons can separate from atoms. You may have heard the expression "opposites attract". In the case of atoms, unlike charges attract each other and like charges repel each other. The attraction between like charges (positive + positive, negative + negative) causes the movement of electrons between two objects.



An object is neutral and has no charge when it has the same amount of protons and electrons. But when the object loses or gains electrons it becomes unbalanced, and electrically charged. If there are more protons than electrons, the object carries a positive charge. If there are more electrons than protons, the object carries a negative charge.

Some materials allow electrons to pass through more easily than others. **Conductors** hold onto electrons loosely. Electrons move easily through these materials. Metal is a good conductor.

Insulators hold onto electrons tightly. Electrons do not move easily through these materials. Plastic, cloth, and glass are good insulators.

Circle the word that makes each statement true.

An object with a positive (+) charge will **attract repel** an object with a negative (-) charge.

An object with a negative (-) charge will **attract repel** an object with a negative (-) charge.

An object that gains electrons will have a **positive negative** charge.

An object that loses electrons will have a **positive negative** charge.

An **insulator conductor** ____.

ELECTRIC CURRENTS

It's common for electricity to move in a current. An **electric current** is formed when electricity moves in an orderly fashion from one place to another. When electricity is gathered in one place, it's **static electricity**. A lightning bolt is an example of an electric current – from the cloud to the ground. The cloud where the electricity gathers would be an example of static electricity.

Current electricity usually flows through a wire or some kind of **conductor**. When the electrons in the conductor move, they are powered by an energy source like a battery. Materials like copper or metal are great conductors – they allow electrons to move through them. Things like rubber or plastic make it a little harder for electrons to move – they are **insulators**.

For an electric current to happen, there must be a circuit. A **circuit** is a closed path through with the current flows – from one place to another.

Write the difference between static electricity and an electric current.

____

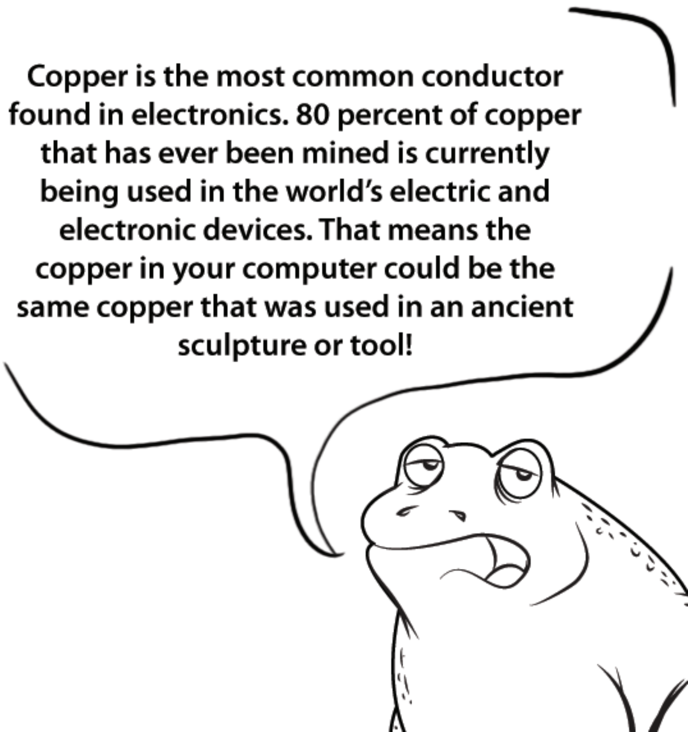
____

Find an example of an electric current that's not listed in the text. Remember, electricity must flow from one place to another.

____

____

Find a battery-powered device in your home and open up the battery compartment. Draw a picture of the inside of the compartment and label the conductor and the power source.

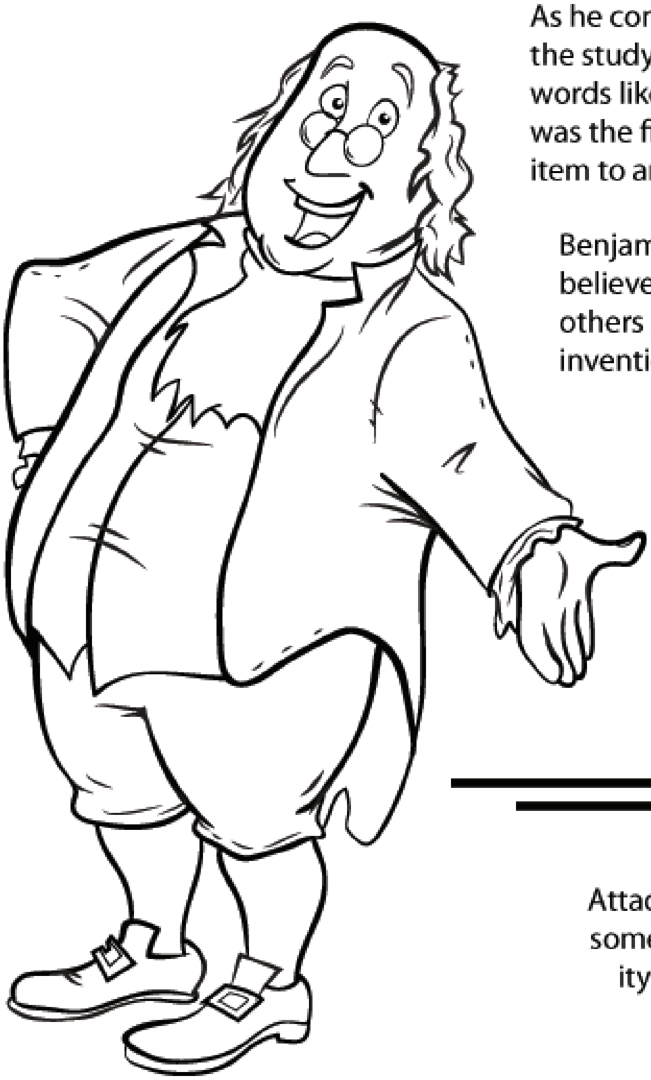


BENJAMIN FRANKLIN

Benjamin Franklin was one of the first celebrities in America! He was known for many things – he was a politician, a writer, a composer, and was the first Postmaster General of the United States. However, he is probably best remembered for his work with electricity.

Ben Franklin was born in Boston in 1706. He only went to school for two years, but was a curious kid. As a teen, he worked in his brother's printing shop, but after a falling out with his brother he went to Philadelphia to start over, where he started his own print shop.

By the 1740s, he owned his own publishing company and a newspaper business, but found himself drawn to science and conducted experiments at home. As the years went by, he continued to dabble in science, as well as in politics and the arts. In 1752, he conducted his most famous experiment yet: one night during a storm, he grabbed his kite, tied a key to the end, attached it to a **Leyden jar*** and rushed outside**. The kite wasn't struck by lightning that he could see, but the Leyden jar held a charge. This proved for the very first time that lightning was an electrical process. This discovery helped him invent the lightning rod, a fixture that could be attached to the top of buildings to draw lightning to it instead striking the building. At a time when most buildings were made wood, this was a big deal and surely saved lives.



As he continued his studies, he began to lay the groundwork for the study of electricity. His notes and letters are the first to use words like "positive", "negative", "charge" and "discharge." Franklin was the first to notice that electricity can be passed from one item to another.

Benjamin Franklin never patented any of his inventions as he believed they were for the public good, and ideas that helped others should be shared freely. Would you have patented your inventions, or do you agree with him?

***Leyden jar** – A tool that was used in early electricity research, similar to a battery. A Leyden jar was a glass jar with a rod inside that could be charged with static electricity. The glass jar would then hold the charge.

****Don't try this at home!** Exposing yourself to lightning is often a one-way ticket to the emergency room. Ben Franklin is lucky he survived, especially at a time when little was known about the dangers of lightning.

Maddest Science He Conducted:

Attaching wires to paralyzed limbs of patients. Doctors today will sometimes stimulate muscles of paralyzed patients with electricity to prevent the them from atrophying, or from getting too weak because they aren't being used.

EVOLUTION OF INVENTION:

Benjamin Franklin and Electricity

Use your imagination! Pretend you were someone who was born long ago. You don't know what electricity is, what it does, or where it comes from, but you've just heard that the famous Ben Franklin has proved that lightning is a form of it. What do you think this information could be used to make?

Flying a kite in a storm (which you should never do!) leads to…

AN UNDERSTANDING THAT LIGHTNING IS MADE OF ELECTRICITY.

Understanding that lightning is a form of electricity leads to…

SCIENTISTS FINDING WAYS TO HARNESS ELECTRICITY.

Finding ways to harness electricity leads to…

US BEING ABLE TO USE IT IN OUR HOMES.

Being able to use electricity in our homes leads to…

WHAT COMES NEXT?

Draw a device or plan here that uses electricity and explain what it does.

LIGHTNING

The flash you see when lightning strikes is a discharge of static electricity between a cloud and the ground. Moving air in a cloud causes ice and water droplets to rub together and build up an electrical charge. The whole cloud builds up with electric charge, with the lighter positive charges at the top of the cloud, and the negative charges at the bottom.

Since opposite charges attract, the negative charge at the bottom of the cloud seeks out the positive charge at the ground in the form of a bolt. At the same time, positive electrical charges build up in objects on the ground. In less than a second, the charge reaching down from the clouds meets up with the charge coming up from the ground, and lightning flashes.

DID YOU KNOW?

A bolt of lightning can carry up to 1,000,000,000 volts of electricity, with a temperature of up to 54,000 degrees F.

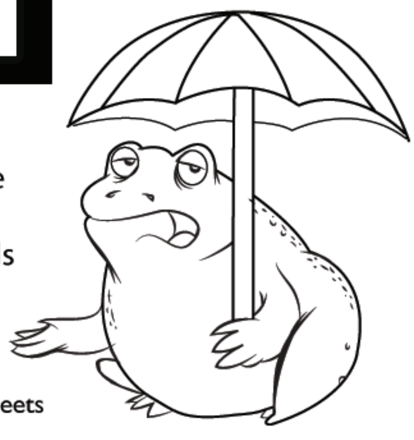
Find the words listed below !

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

WORDS

STATIC
CHARGE
POSITIVE
NEGATIVE
VOLTS
BOLT
DISCHARGE

To find out how far away a storm is, count the seconds between a flash of lightning and a thunder clap. It is thought that every 5 seconds equals a distance of 1 mile.

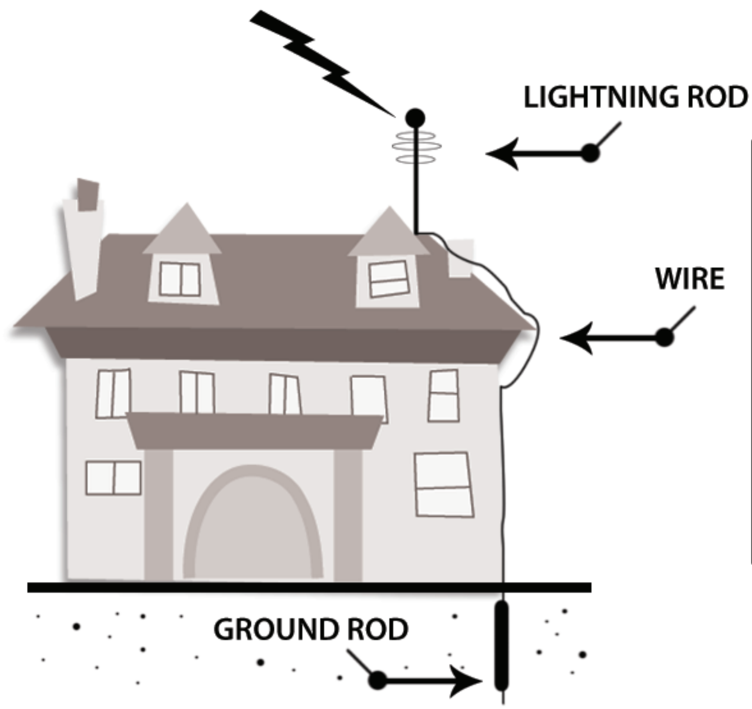


LIGHTNING RODS

Lightning rods are metal poles placed on buildings to divert lightning strikes, invented by Benjamin Franklin in the mid-1700s as a direct result of his famous kite experiment. In Franklin's time, a lightning storm meant the possibility of damage to homes and property because citizens had no way of protecting themselves from lightning strikes.

When lightning strikes, it begins looking for a path to connect to the ground. If it happens to deem a nearby building the perfect path, the building could very easily catch fire, as lightning can get up to tens of thousands of degrees Fahrenheit. A lightning rod is put in place so that, if lightning were to strike the building, it would attach itself to the far more conductive metal rod instead of the wood.

Despite what many people believe, lightning rods don't "attract" lightning -- they simply divert it away the flammable structure in the event of a strike. The lightning rod is important because it's one of the first examples of humans "outsmarting" a destructive natural force.



The lightning rod is actually a very simple construction: the spike sticks out of the top of the building and is connected to a conductive wire that leads to a large metal grid or rod in the ground. When lightning strikes the rod, it follows the path of the wire into the ground, where it is rendered harmless.

You may have heard someone refer to another person, usually a celebrity or public figure, as a "lightning rod" – it's often used to describe someone whose actions attract or inspire controversy.

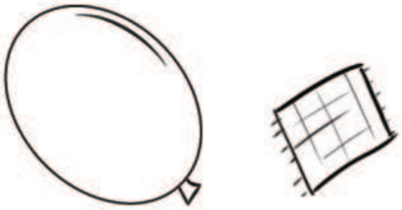
STATIC ELECTRICITY

Hair stands up when you take off your wool hat, shock when you cross the rug and touch a doorknob or person, socks stuck to clothes from the dryer...all examples of static electricity.

Static electricity is the imbalance of **positive** and **negative** charges. Static electricity is created when an object loses or gains electrons. Rubbing surfaces of two insulators (materials that hold electrons tightly) gives that object a negative charge, which will attract any object with a positive charge.

It is called "static" electricity because the charge is not moving through a conductor.

TRY THIS!



- Get two balloons and blow them up.
- Rub one of them against a piece of cloth or clothing made from synthetic fabric, like wool or polyester.
- With the side you've rubbed against the cloth facing it, press the balloon up against the wall. What happened?
- Try pressing the "charged" balloon on other surfaces. Where does it stick? Where does it not stick?
- Now try to press it against the other balloon. What happens?

What Happened?

When two different insulators rub together, electrons are set in motion and a charge is built up. When you rubbed the cloth against the balloon you gave it a negative static charge. If there is enough of a charge, the balloon will stick to surfaces that are neutrally charged, such as a wall, by attracting the positive charge in the wall to the surface. Since the balloon is so light, this attraction is strong enough to cause the balloon to stick to the wall.

What If?

If left on the wall, eventually the balloon will fall to the ground. Why?

____

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What would happen if you charged both the balloons? Would they stick together or push away from one another?

____

____

MICHAEL FARADAY

Standing Room Only Science

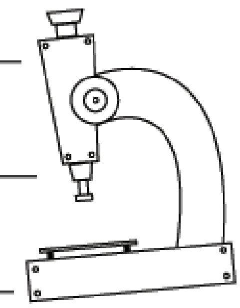
Michael Faraday was an English physicist and chemist who studied electricity. He learned a lot about how electrical currents and studied electromagnetism. He was one of the first scientists to find out that electricity could be generated by moving a magnet inside a wire coil.

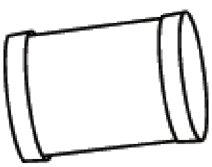
Faraday was born in London in 1791. Though his family did not have much money and was not able to afford a full education for him, he was a curious child. He grew up working as an apprentice to a bookbinder and while working there read books on a variety of subjects. In 1812, he attended lectures by famous chemist Humphrey Davy and became interested in his job. He later wrote Davy a letter asking him for a job as his assistant, and Davy turned him down at the time, but a year later one of the assistants was fired, and Davy remembered Faraday's enthusiasm for the job. He appointed him as chemical assistant to the Royal Institution, an organization devoted to scientific study. As an assistant, he started out working with chemicals in Davy's lab but soon became a popular and entertaining speaker. He achieved celebrity status in London and England for his groundbreaking discoveries and his public persona. Faraday gave lectures about the latest scientific discoveries every year on Christmas, open to children who were interested in science. The Royal Institution still holds Christmas Day lectures today.

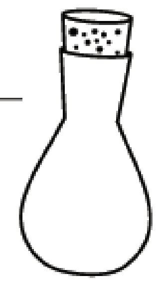
Over his lifetime, Faraday built the first electric motor, and later the generator and transformer. He was also the first to use many words we use to describe electrical science, Without him, we would not be able to power our cars, clocks, airplanes, and many other important things!

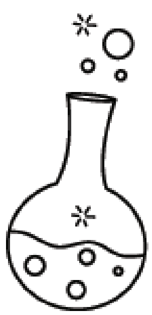
YOUR TURN!

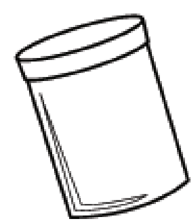
Imagine that you are a scientist, and this is your lab. You're about to leave to give a public demonstration of your latest discovery. What would you take with you? Remember, you need to enlighten and entertain!

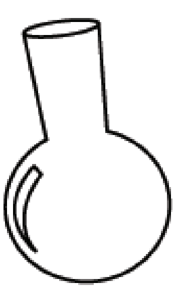








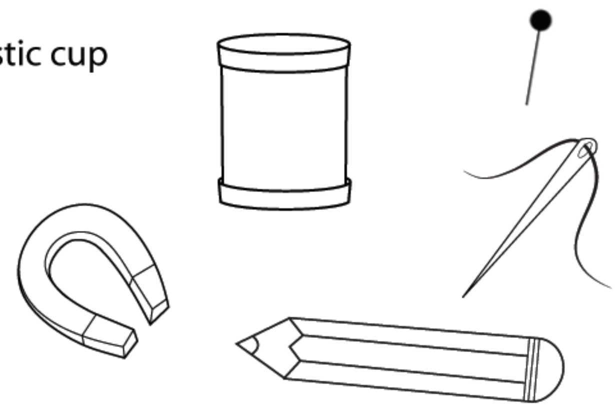




EXPERIMENT WITH MAGNETISM: MAKE A HANGING COMPASS

WHAT YOU NEED:

- Clear wide-mouthed glass jar or plastic cup
- Pencil
- String
- Large steel sewing needle
- Smaller steel needles
- Magnet



WHAT YOU DO:

1. Carefully rub the pointed end of the needle on one end of the magnet 30 to 50 times. This will align the electrons in the needle, magnetizing it.

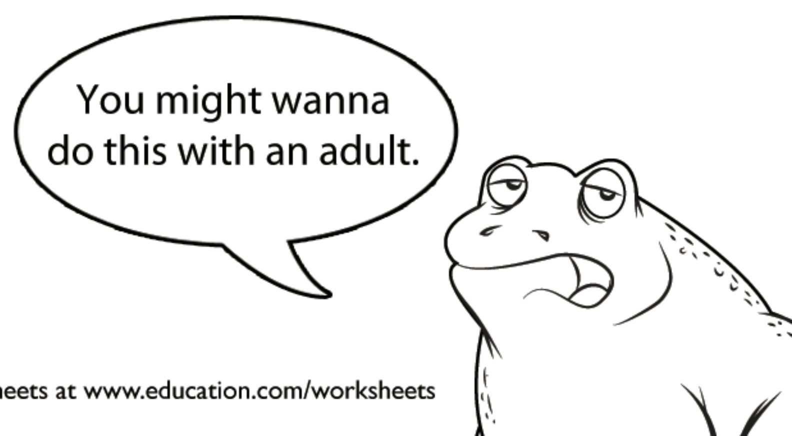
2. To test that the large needle is magnetized, place one of the smaller steel needles on the tabletop. Have your child try to pick up the small needle with the large one. If it works, the large needle is magnetized. If it doesn't work, repeat step 1, making sure to rub in only one direction to keep from mis-aligning the electrons.

3. Once the needle is magnetized, have your child knot one end of a piece of string around the middle of the large needle. Adjust the placement of the knot so that the needle hangs level from the string.

4. Have your child knot the other end of the string around the middle of the pencil.

5. Have your child lay the pencil across the mouth of the jar or cup so that the needle is hanging inside. Shorten the string if the needle is touching the bottom of the jar. The needle will now turn to point to magnetic North.

6. Watch as the needle turns to point to magnetic North. You've created a compass!



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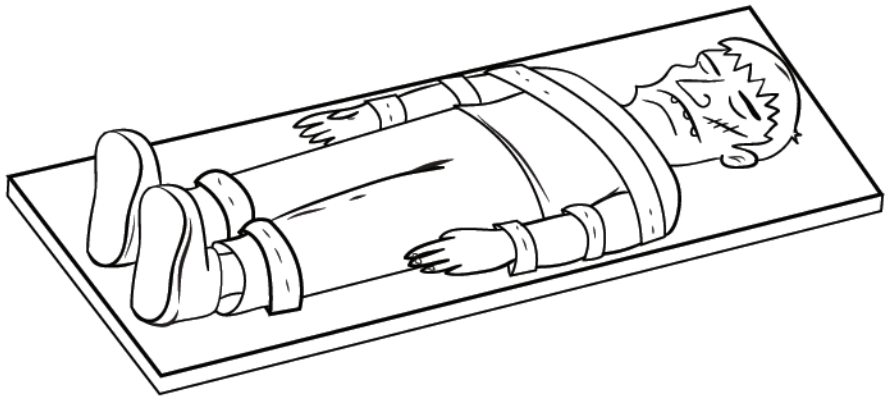
FRANKENSTEIN

Frankenstein was written at a time when scientists were keenly interested in the nature of electricity. Public interest in science was high, and scientists often conducted lectures and demonstrations that were equal parts science and entertainment. Luigi Galvani was one such scientist.

Galvani discovered that our brains send electric signals to our bodies. He began to experiment with sending electrical currents through brains and bodies, a practice later known as **Galvanism**. The sometimes gruesome practice would cause slight movement in the dead body of an animal (or human), which led some to conclude that living things could be reanimated with an electric charge.



Mary Shelley wrote ***Frankenstein*** around this time, the story of a scientist who builds a creature from old body parts, then brings it to life. The scientist is horrified by the gruesome monster he creates and the tragedies that result from it. Many believe that Shelley's story was a statement on the dangers and questionable ethics of the scientific practices of the time.

Reread the passage, paying particular attention to the underlined words. Circle the word that could replace the underlined word without changing the meaning of the passage.

keenly:	intensly	barely	cautiously
conducted:	played	led	followed
gruesome:	uninteresting	horrifying	original
conclude:	decide	worry	hope
reanimated:	harmed	revived	helped
questionable:	uncertain	proven	known
ethics:	tools	experiments	values

MAKE A MAGNETIC MONSTER

Imagine you made a monster that had the power of magnetism! What would he look like?
Draw a picture of him below.

How did you bring him to life?

What is his day to day life like? What can he do more easily than most humans?

What can't he do easily? How do his magnetic powers get in the way of simple everyday tasks?

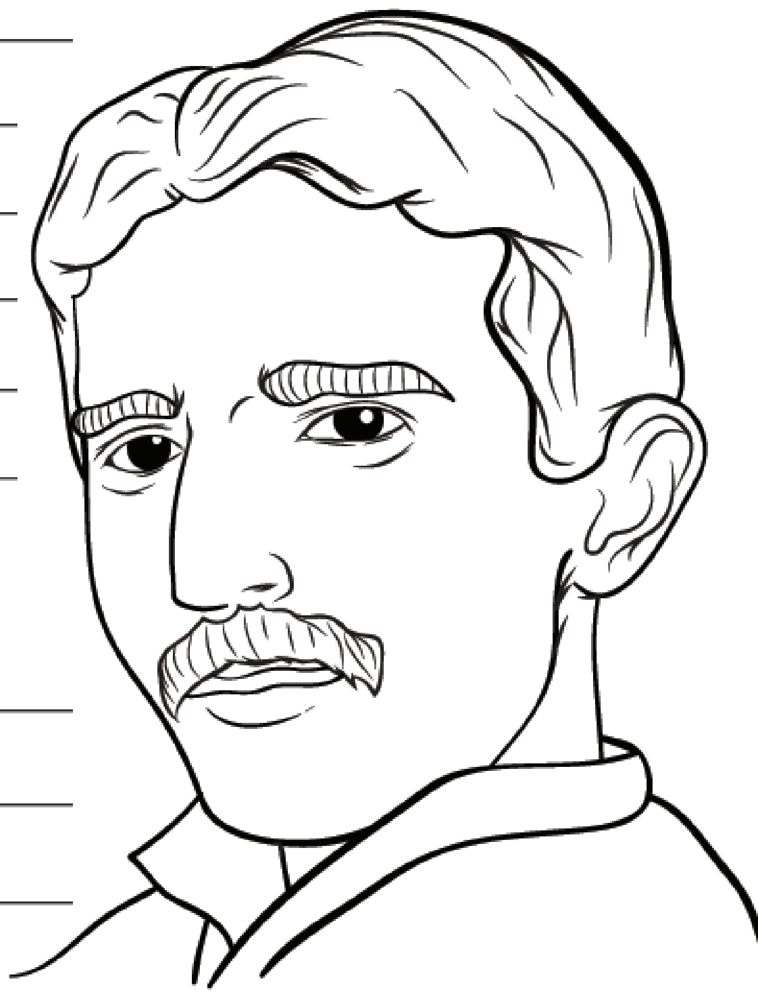
NIKOLA TESLA

Nikola Tesla is often considered a real-life mad scientist! He did many experiments with electricity and made several groundbreaking discoveries about how it works and how it can be used.

Born in Croatia in the mid-1800s, Tesla was always a curious and intelligent person. He attended university where he studied math and science. While in school, he came up with the idea for a new kind of motor and was hired by electric companies across Europe to improve their machines. It was there that he began forming the idea for the alternating current -- AC. At age 28, he moved to New York City. Thomas Edison got wind of Tesla's genius and hired him to be his assistant. However, when he learned that Tesla had developed a different type of electrical current from the one he used, he began to view Tesla as competition and refused to pay Tesla for his work. The two ended up in a lifelong rivalry with each other.

Tesla is remembered for conducting experiments on a grand scale and for his eccentric ideas, which, though considered outlandish at the time, often lead him to make important discoveries. By the end of his life he held over 100 patents. Tesla's legacy is everywhere: not only do all modern homes run on AC, he also pioneered hydroelectric power, radio, robotics, and wireless communication.

Do you think it was fair of Thomas Edison to refuse to pay Tesla? What would you have done if you were in Tesla's shoes?



Name three places you might see electricity, wireless communication, or robotics today.

1.)

2.)

3.)

CONTROL A COMPASS

Make a compass do your bidding with nothing but a wire and a magnet!

WHAT YOU NEED:

* A compass
* A strong magnet
* 100' small-gauge insulated copper magnet wire (#25)

WHAT YOU DO:

Wrap the wire around and around about 40 times to make a coil and cut it from the spool. Then, wrap another length of wire around the compass about 25 times and cut it from the spool. Take all 4 free ends of the coils and connect them to make a complete circuit.

Wave the magnet back and forth through the center of the first coil you made – the one without the compass in it. Keep an eye on the compass needle. What happens?

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Try waving the magnet in another direction. What happens now?

____

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When the magnet moves, electrons in the coil are disturbed. This is an electric current. When you wound the coil around the compass, you created a magnetic field around it. This field caused the arrow in the compass to move, just like the earth's natural magnetic field causes a compass needle to move when you use one on hiking trips.

MAKE AN ELECTRICITY MONSTER

Imagine you made a monster that was made of electricity! What would he look like?
Draw a picture of him below.

How did he come to life?

What is his day to day life like? What can he do more easily than most humans?

What can't he do easily? How do his electric powers get in the way of simple everyday tasks?

SCIENTIFIC MATCH-UP

Many units of electricity, power, and more are named after a scientist that discovered it or was helpful in later scientists' understanding of it. Using the clues below, match each unit with the scientists it is named after.

1. *ampere* - A unit of electric current. ________________________________

2. *coulomb* - A unit of electric charge. ________________________________

3. *farad* - A unit of electric charge. ________________________________

4. *joule* - A unit of energy. ________________________________

5. *volt* - A unit of electricity mainly used to describe the amount of power in batteries. ________________________________

6. *watt* - A unit of power. ________________________________

SCIENTISTS

Michael Faraday, a scientist who made great advances in electromagnetism.

James Watt, who invented the steam engine and the idea of horsepower.

Alessandro Volta, a physicist who invented the battery.

Andre-Marie Ampere, a physicist who was one of the first to study electromagnetism.

James Prescott Joule, a scientist who studied energy and found ways to turn heat into power.

Charles-Augustin de Coloumb, a physicist who worked with electrostatic science. He developed the concept of attraction and repulsion.

ELECTRIFYING WORD SEARCH

Find the words related to electricity and magnetism in the word search below!

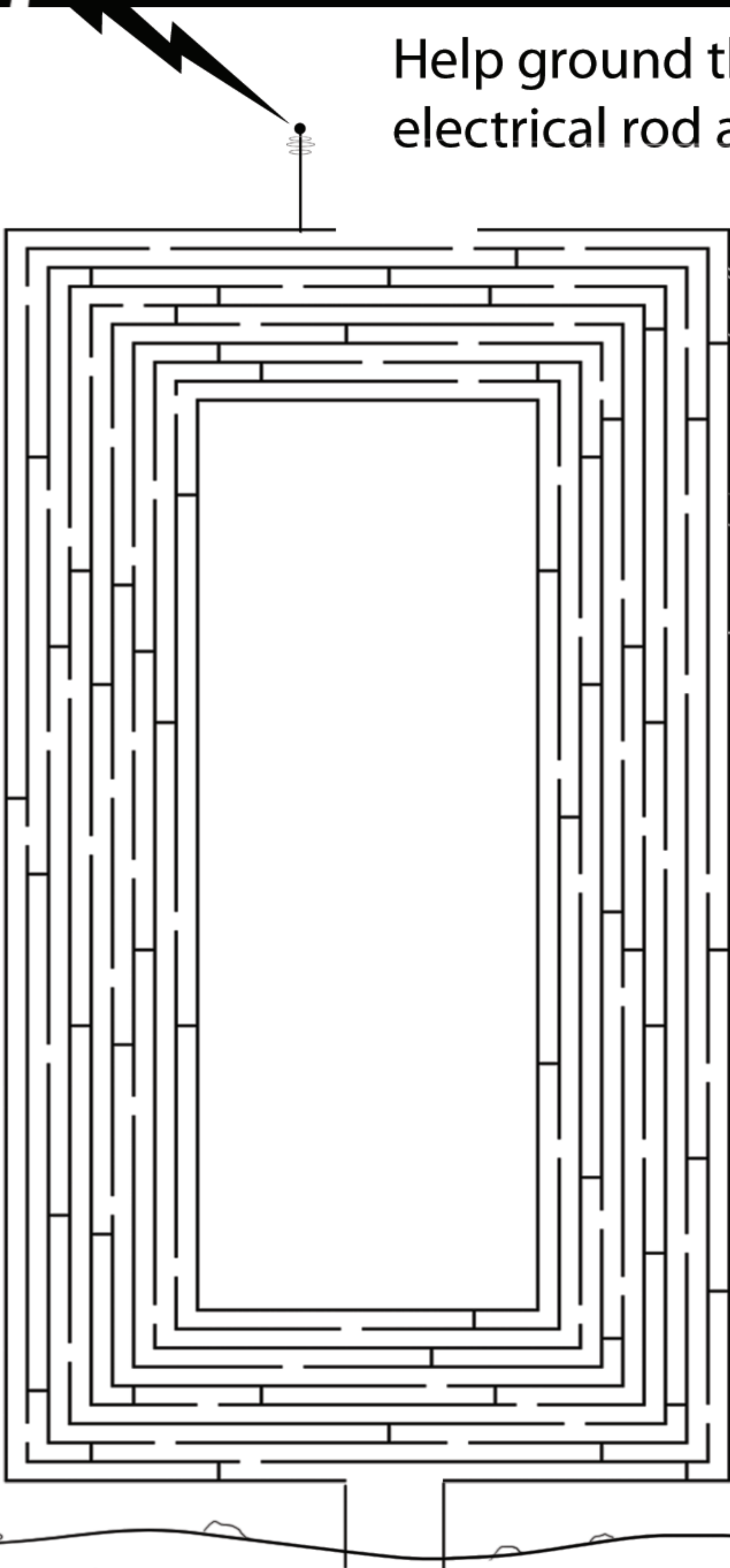
E	L	E	C	T	R	I	C	I	T	Y	U	A
H	S	W	I	N	S	U	L	A	T	O	R	H
J	F	G	L	D	I	R	Y	Y	I	W	S	G
C	E	A	M	I	Z	C	H	S	R	G	T	N
T	S	L	R	K	I	S	B	O	R	B	L	I
F	I	V	O	A	V	T	E	S	L	A	R	N
B	U	A	S	P	D	Q	V	N	K	S	X	T
N	G	N	R	G	L	A	S	E	O	T	U	H
S	T	I	O	V	N	F	Y	R	K	O	O	G
D	O	R	O	T	C	U	D	N	O	C	D	I
M	N	A	Y	V	J	X	J	S	E	Z	U	L
A	G	P	M	S	I	T	E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

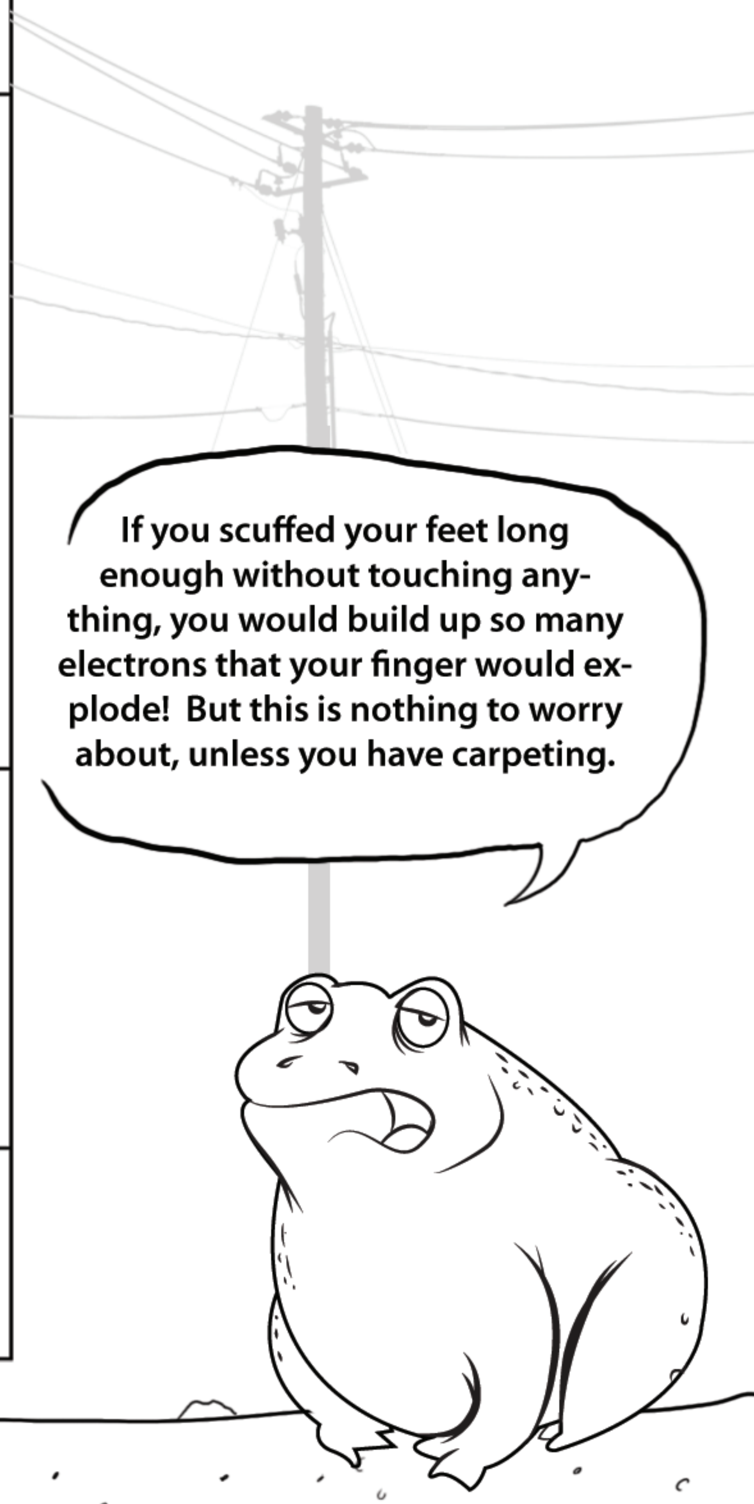
WORDS

INSULATOR
FARADAY
STATIC
ELECTRICITY
MAGNETISM
GALVANI
TESLA
LIGHTNING
CONDUCTOR

ELECTRIC ROD MAZE

Help ground the electricity from the electrical rod all the way to the ground.





Great job!

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Answer Sheets

Electricity & Magnetism For Kids

Lightning
Static Electricity
Electrifying Word Search

Answer Sheet

LIGHTNING

The flash you see when lightning strikes is a discharge of static electricity between a cloud and the ground. Moving air in a cloud causes ice and water droplets to rub together and build up an electrical charge. The whole cloud builds up with electric charge, with the lighter positive charges at the top of the cloud, and the negative charges at the bottom.

Since opposite charges attract, the negative charge at the bottom of the cloud seeks out the positive charge at the ground in the form of a bolt. At the same time, positive electrical charges build up in objects on the ground. In less than a second, the charge reaching down from the clouds meets up with the charge coming up from the ground, and lightning flashes.

DID YOU KNOW?

A bolt of lightning can carry up to 1,000,000,000 volts of electricity, with a temperature of up to 54,000 degrees F.

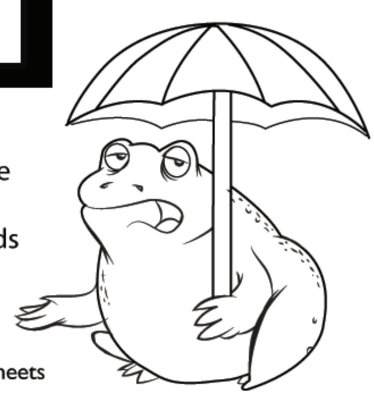
Find the words listed below !

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

WORDS

STATIC
CHARGE
POSITIVE
NEGATIVE
VOLTS
BOLT
DISCHARGE

To find out how far away a storm is, count the seconds between a flash of lightning and a thunder clap. It is thought that every 5 seconds equals a distance of 1 mile.



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Answer Sheet

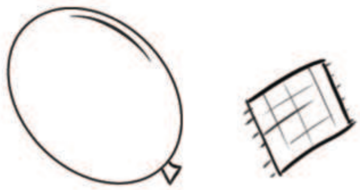
STATIC ELECTRICITY

Hair stands up when you take off your wool hat, shock when you cross the rug and touch a doorknob or person, socks stuck to clothes from the dryer...all examples of static electricity.

Static electricity is the imbalance of **positive** and **negative** charges. Static electricity is created when an object loses or gains electrons. Rubbing surfaces of two insulators (materials that hold electrons tightly) gives that object a negative charge, which will attract any object with a positive charge.

It is called "static" electricity because the charge is not moving through a conductor.

TRY THIS!



- Get two balloons and blow them up.
- Rub one of them against a piece of cloth or clothing made from synthetic fabric, like wool or polyester.
- With the side you've rubbed against the cloth facing it, press the balloon up against the wall. What happened?
- Try pressing the "charged" balloon on other surfaces. Where does it stick? Where does it not stick?
- Now try to press it against the other balloon. What happens?

What Happened?

When two different insulators rub together, electrons are set in motion and a charge is built up. When you rubbed the cloth against the balloon you gave it a negative static charge. If there is enough of a charge, the balloon will stick to surfaces that are neutrally charged, such as a wall, by attracting the positive charge in the wall to the surface. Since the balloon is so light, this attraction is strong enough to cause the balloon to stick to the wall.

What If?

If left on the wall, eventually the balloon will fall to the ground. Why?

Static charge fades over time, so when the balloon loses its charge it unsticks from the wall.

What would happen if you charged both the balloons? Would they stick together or push away from one another?

When both balloons are charged, they push away from each other. Like charges repel each other.

Answer Sheet

ELECTRIFYING WORD SEARCH

Find the words related to electricity and magnetism in the word search below!

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

WORDS

INSULATOR
FARADAY
STATIC
ELECTRICITY
MAGNETISM
GALVANI
TESLA
LIGHTNING
CONDUCTOR