
A FILM BY TIM BURTON
Disney
FRANKENWEENIE
ACTIVITY GUIDE

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Disney

FRANKENWEENIE

An Experiment That's Larger Than Life!

From creative genius Tim Burton comes **FRANKENWEENIE**, a heartwarming tale about a boy and his dog. After unexpectedly losing his beloved dog Sparky, young Victor harnesses the power of science to bring his best friend back to life – with just a few minor adjustments. He tries to hide his home-sewn creation, but when Sparky gets out, Victor's fellow students, teachers and the entire town all learn that getting a new "leash on life" can be monstrous.

Take an Electrifying Adventure Together: Explore the Real-Life Science Behind FRANKENWEENIE!

The **FRANKENWEENIE** Activity Guide introduces children to a series of three lesson adventures designed to help them step into Victor's shoes as a scientist. These electrifying explorations are aligned to National Science Education Standards and integrate hands-on experiments that focus on:

- Circuits and currents
- Static electricity
- Conductors
- Detecting electric charges
- Insulators
- Electromagnets

Activity Guide Objectives:

- Increase children's knowledge of electricity and the scientific method through interactive, inquiry-based lessons
- Connect electricity to the important role it plays in our every day life
- Develop a greater understanding for how using electricity wisely can positively impact wildlife and wild places
- Lessons align to National Science Standards

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SPARKY

ACKNOWLEDGEMENTS

The Walt Disney Studios would like to take this opportunity to thank the amazing teams at Underwriters Laboratories (UL) and School Family Media (SFM) for the opportunity to be a part of and contribute to this year's School Family Science Nights.

The FRANKENWEENIE Activity Guide was created with great care, talent and the hard work of many individuals.

At Disney's Animal Kingdom, Laurie Cummins worked side by side with the educational team to write and bring the Disney magic to the background information, the brilliant lessons and activity sheets. These activities and the holistic approach to this Activity Guide could not have happened without the special talents of the following subject matter experts: Drs Linda Labbo, Deborah Tippins, John Olive, John Hoge, NaJuana Lee, Carole Henry and Mike Orey from the University of Georgia and Dr. Wayne Nelson from Southern Illinois University. Additionally, big thanks to Ginger Sommer at Underwriters Laboratories and Leslie Mayer at School Family Media and their teams for their work and support of the creations of this guide.

Dr. Lizabeth Fogel
Director of Education
The Walt Disney Company

BACKGROUND INFORMATION

Everyday Electricity

Electricity is all around us! It allows us to read in bed at night, to see the cookies baking in the oven and to watch our favorite television shows. Your alarm clock, ceiling fan, car engine, computer, cell phone and refrigerator are just some of the things you probably used this morning that are all dependent on electricity. But it is important to remember, as helpful as electricity is, it can also be dangerous, particularly if we ignore good safety rules. So think smart and be smart when it comes to electricity – it is an important part of everyday life!

So What Is Electricity?

Electricity can seem like a strange and mysterious force. For over centuries, inventors and scientists such as Andre Marie Ampere, Charles Augustin de Coulomb, Thomas Edison, Benjamin Franklin, Michael Faraday, Steven Gray, Jean Antoine Nollet, Georg Simon Ohm, Nikola Tesla and Alessandro Volta have dedicated their lives to researching electricity and finding ways to control and harness its power. Their efforts have shaped the modern world as we know it and yet we are still investigating and learning! Hundreds of years ago, scientists believed electricity was a liquid. But after further research, scientists made a much bigger (or, technically, smaller) discovery! To truly understand electricity, we have to start with the atom. Everything in the universe is made of atoms – particles so small that millions could fit on the head of a pin. In the center of every atom is a nucleus, which is made up of protons that have a positive charge, and neutrons that have no charge. Spinning around the nucleus are even smaller particles called electrons that have a negative charge. In most cases, the protons and electrons are attracted to each other because opposite charges attract, giving the atom an overall neutral charge. Sometimes, though, forces can cause electrons in one atom to jump to another atom. The energy released by these jumping electrons creates electricity.

Going With The Flow

Electricity exists in two forms: current and static. Current electricity is what most of us are familiar with – it's the kind that powers our appliances and turns on our lights. Current electricity is part of a closed-loop circuit, meaning the electrons must move along a path. Every circuit must also have a conductor – a material, like most metals, that freely gives up electrons, allowing electricity to flow. Materials that hold their electrons tightly, such as rubber, cotton or glass are called insulators and electricity does not flow through these materials very well. Insulators are important for stopping the flow of electricity within a circuit. By combining conductors with insulators, inventors can use current electricity to design many tools and appliances that improve our lives.

I'm Shocked!

The other kind of electricity, static electricity, is what causes us to get a shock on a winter's day or makes our clean socks stick together in the dryer. Unlike current electricity, static electricity does not flow through a conductor (static means nonmoving). But, while it might be defined as nonmoving, a lot of invisible movement is required to generate static electricity! Static electricity occurs when friction or particle collisions cause electrons to jump from one object to another, creating an imbalance in charges. For example, when you walk across carpet on a dry day, electrons jump from the carpet onto you, giving you a negative charge. Then, when you touch a metal doorknob (a great conductor), the

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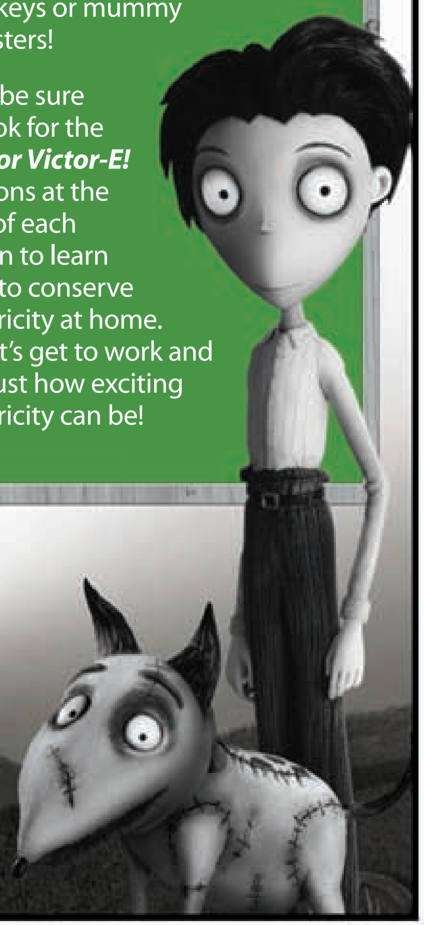
HI! My name's Victor and this is my dog, Sparky.

Sparky and I have been through a lot lately, and well, our experience has been electrifying! While experimenting in my attic workshop, I've learned some things that changed my world (and the town of New Holland) forever.

Through the experiments in this guide, young scientists like you can learn about the power of electricity in a fun, safe and appropriate way. After all we don't need any more sea monkeys or mummy hamsters!

Also, be sure to look for the ***V is for Victor-E!*** sections at the end of each lesson to learn how to conserve electricity at home. So, let's get to work and see just how exciting electricity can be!



BACKGROUND INFORMATION

electrons jump from you to the knob. Ouch! You feel the jumping electrons as a shock – a reminder of the invisible but very real presence of static electricity.

Electricity is Magnetizing!

Ding, dong! The familiar sound of a doorbell tells us a package is being delivered or a friend has come to visit. Did you know that the ringing of the doorbell is also an auditory reminder of the relationship between electricity and magnetism? As electric current flows through a wire wrapped around a metal rod, it generates an invisible magnetic field, creating a temporary magnet called an electromagnet. Unlike normal magnets, electromagnets loose their magnetic properties when the electric current is not flowing – meaning they can be turned on and off. That's a good thing when it comes to the dinging of a doorbell! In this case, pushing the doorbell activates an electromagnet that pulls a clapper against the bell. Releasing the doorbell stops the current, thereby stopping the electromagnet and the dinging sound. In addition to being found in electronic locks, TVs, speakers, computers and electric clocks, electromagnets are also the essential component to electric motors. Electric motors are found in many everyday appliances such as fans, washing machines and electric drills, and are even found in electric and hybrid cars! In many cases, electromagnets allow us to safely harness the power of electricity when the electrical current might otherwise be too large.

Saving Electricity: Saving The Environment

Electricity is powerful and essential, but generating electricity also requires the use of Earth's natural resources. Most of our electricity comes from the burning of fossil fuels, such as oil, coal and natural gas. This can pose some challenges: since our supply is limited, we must use fossil fuels wisely. Fossil fuels also release pollutants into the air, which harms the environment. But the good news is, we can make a difference! Easy changes at home, such as unplugging electronics when not in use, choosing energy efficient appliances and swapping incandescent bulbs for CFL or LED lights, can reduce the amount of electricity your family uses (and save you money) each year. Many electric companies around the world are also generating electricity from a variety of sources, such as windpower, solar energy or hydropower, so ask if an alternate energy program is offered through your electric company. By doing our part to save electricity, we can do our part to save the environment too!

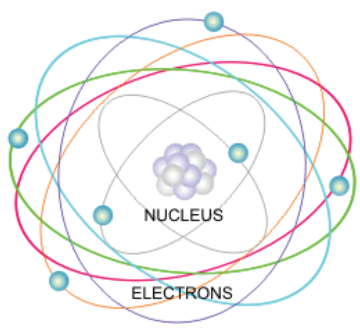
ADVENTURE ONE

Does Electricity Go With The Flow?

GRADE LEVEL: 5 - 8
TOPICS: Science, Art, History, Language Arts

ADVENTURE TOGETHER

1. To begin your adventure into electricity, visit **disney.go.com/frankenweenie/#/video** to view the video trailer for **FRANKENWEENIE**. What role do science and electricity play in Victor's successful attempt to reanimate his dog, Sparky?
2. Together, discuss the role electrical devices play in your life. Take a look around the room – how many electronics can you spot? How have you already used electricity today? What are some benefits and potential dangers associated with electricity? Where does electricity come from?
3. Explain that electricity is a form of energy created by tiny particles within atoms called electrons, protons and neutrons. Electrons have a negative charge, protons have a positive charge and neutrons have a neutral charge. When electrons and protons repel each other, this difference in electrical charges creates an electrical current. Complete the following experiment to learn more about electrical currents.



1

EXPERIMENT 1: CREATE AN ELECTRICAL CURRENT

a. Unscrew the flashlight and carefully remove the light bulb.

b. Tape the 2 batteries together, putting positive and negative ends together.

c. Wrap one end of the aluminum foil strip around the metal screw threads of the light bulb. Secure with a little tape. Do not cover the tip of the light bulb.

d. Tape the other end of the foil to the flat (negative) end of the stacked batteries.

e. Conduct the experiment. *What do you think will happen when you touch the metal tip of the light bulb to the post end of the battery stack?* Touch the metal tip of the light bulb to the post (positive) end of the battery stack. The light bulb should glow.

f. Now, try taping the free end to the positive end of the battery stack and touch the light bulb to the negative end. *Did the light bulb glow?* Try using only one battery. *What happened?* Ask children to record their findings in the ***Science Investigator's Journal***.

g. *What if the batteries were stacked flat end to flat end (negative to negative)?* Try the experiment with this set up. *Will the light bulb glow?* Ask children to record their observations.

Words to Know

current, circuit, conductor, electricity, electrons, insulator, neutrons, protons, volt

Children will be able to:

- Construct a simple electrical circuit
- Predict whether certain materials are conductors or insulators
- Test whether certain materials are conductors or insulators
- Create a circuit to show how a flashlight works
- Explain the concepts of electricity, current, conductor and insulator and how they are related

What You Need

- ***Science Investigator's Journal: Activity Sheet 1***

Experiment 1

✓ 2 D batteries
✓ Masking tape
✓ Flashlight that you can unscrew and take apart
✓ 12" strip of heavy-duty aluminum foil

Experiment 2

✓ The electrical circuit to light the bulb from Experiment 1
✓ Assorted materials with various conductive properties, such as:
- 12" length of copper wire
- 12" strip of paper
- Shoelace
- Pipe cleaner or chenille stem
- 12" length of yarn
- 12" uninflated balloon

Experiment 3

✓ 9V battery
✓ D battery
✓ Penny
✓ Thick rubber band

ADVENTURE ONE
Does Electricity Go With The Flow?

2

EXPERIMENT 2: CONDUCTORS & INSULATORS

Discuss the terms conductor and insulator. Conductors are materials through which electrons move easily and electric current flows without much resistance. Insulators are materials that resist the flow of electric current. Atoms that are reluctant to give up their electrons are called insulators. Atoms that easily give up their electrons are called conductors. Together, create a list of materials you use every day (such as glass, water, air, plastic, metal, cotton, wood, shoelaces, paper, wire, etc.) and predict whether these materials would be good insulators or good conductors. Then, try out different materials to decide which make the best conductors. Have children record their findings in their ***Science Investigator's Journal***.

3

EXPERIMENT 3: ELECTRICAL ENERGY

a. An insulator is often used to cover a conductor to protect the environment (and us!) from electricity. To demonstrate how an insulator works, test a circuit with and without an insulator.

b. Look carefully at the markings that indicate the negative (-) post and the positive (+) post on the 9V battery. Predict what will happen if the penny is laid across the battery's posts. Try it by holding the penny on the battery for about 15 seconds.

   1. ***What is happening?*** Placing the penny on the battery posts creates a simple closed circuit by connecting the two posts with a conductor.
   2. ***Can you feel the heat? What is producing this heat?*** The heat is energy formed by the electrical current flowing through the battery and the penny. Instruct students to remove the penny.

c. Now, wrap the rubber band around the battery, being sure to cover the terminals. Predict what will happen when the penny is placed on the battery again. Have them record their predictions and findings in their ***Science Investigator's Journal***. *Children should conclude that the rubber band acts as an insulator, which does not allow current to freely flow. Because there is no current, no heat is produced.*

Note

The 9V battery will drain of power with the penny experiment. Don't leave the penny on for more than a few seconds - just long enough to feel the heat. If more than one child will be conducting this experiment, have extra 9V batteries on hand.

SAFETY SMART!®

You can touch this electrical current without danger because the amount of electricity flowing is so small. But never, ever try this with larger batteries or touch the electrical socket of a real lamp.

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TALK ABOUT YOUR ADVENTURE

After completing all three experiments, talk about your adventure into electricity:

- **What happened in each of the three experiments?**

  a. ***In Experiment 1***, the batteries produced a little bit of electricity called a current. The aluminum foil strip provided a pathway for the current. The light bulb glowed only if there was an electrical current flowing through it. The foil was the conductor of electricity. The foil conductor connected the electricity from the batteries to the light bulb so the current could flow through and light the bulb.

  b. ***In Experiment 2***, some materials acted as conductors and some materials acted as non-conductors in the circuit. The conductors allowed current to flow through and light the bulb. Non-conductors did not allow the current to flow, so the bulb did not light.

  c. ***In Experiment 3***, when the penny was placed directly onto the battery terminals it created a "short" circuit that allowed the current produced by the battery to flow. The current was felt as heat. Because rubber is an insulator, when the rubber band was placed between the battery and the penny, the circuit was broken and there was no current. Weak current meant there was no heat produced.

- **Why is it unsafe to use electrical appliances near water?**
  Water is an excellent electrical conductor, which is why using electrical appliances near water is dangerous and should always be avoided.

- **Why does wrapping a metal wire in rubber or plastic make it safer to use?**
  In order to protect the surroundings from the heat of electricity (and in some cases, to protect the wiring from exposure to water), we wrap the wire in an insulator material such as rubber or plastic (the rubber or plastic is also durable and can be waterproof).

ELECTRICITY IN NATURE

Have you ever heard of the Northern Lights, or Aurora Borealis? This colorful phenomenon (which is called Aurora Australis when it occurs in the Southern Hemisphere) is the result of electrical currents that are created as particles from the sun enter Earth's atmosphere.

If you live in an area where the Northern or Southern lights are visible, spend time as a family outside observing this amazing example of electricity in nature. If the lights aren't visible where you live, learn more about them by researching online. They are proof that electricity can be fascinatingly beautiful!

SAFETY SMART!®

If an electrical cord or appliance is damaged, the electricity can shock you, burn you or even cause a fire. If you touch electricity you become part of the circuit, which can be very dangerous. We did not need an insulator in our experiment because of the small amount of electricity used.

However, home appliances use a great deal of electricity. Never touch a damaged electrical cord.

Adults should discard and replace damaged cords.

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KEEP THE ADVENTURE GOING

- **SCIENCE:**
  Look closely at the battery. It is labeled "1.5V" or 1.5 volts. But what are volts and how do they relate to current? A volt is a measure of electromotive force, or in other words, a measure of the battery's power. Other common batteries, like AA and AAA, are also 1.5V batteries. If a D battery is so much bigger than an AAA Battery, why do they provide the same number of volts? Could you use a D battery to power something that normally uses AA batteries? This would be a great science fair project!
- **ART:**
  Based on what you know about the properties of electrical conductors and insulators, create advertising posters to teach others about staying safe around electricity (examples might include: keeping electrical appliances away from water; inspecting electrical cords and appliances for damage; not overloading extension cords; not hiding electrical cords under carpets or drapes; and not touching exposed wires or electrical outlets).
- **LANGUAGE ARTS:**
  Write a poem, song or rap to explain electrical currents and conductivity or about how electricity was used in the FRANKENWEENIE movie. Be sure to include ways that we use electricity every day and tips for living and working safely around electricity. Perform your finished composition for friends, family or classmates.
- **HISTORY AND LANGUAGE ARTS:**
  Andre Marie Ampere, Charles Augustin de Coulomb, Thomas Edison, Benjamin Franklin, Michael Faraday, Steven Gray, Georg Simon Ohm, Nikola Tesla and Alessandro Volta are just a few of the notable scientists who have worked to understand electricity over the years. Choose one of these famous scientists to research and write a story that allows the reader to step into the shoes of the scientist or an important day of discovery. Or create a short skit where two scientists are talking to each other and explaining and commenting on their discoveries and contributions to the world.

ADVENTURE ONE: RESOURCE GUIDE

BrainPop. *Current Electricity*. 31 October 2012. www.brainpop.com/science/energy/currentelectricity/

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KS2 Bitesize. *Electrical Conductors*. BBC. 31 October 2012. www.bbc.co.uk/bitesize/ks2/science/physical_processes/circuits_conductors/play/

Kids Korner. *Conductors and Insulators*. Marietta Power. 31 October 2012. www.c03.apogee.net/contentplayer/?coursetype=kids&utilityid=mp&id=16185

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ADVENTURE TWO

Can We See Electricity At Work?

GRADE LEVEL: 5 - 8
TOPICS: Science, Math, Language Arts, Art

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ADVENTURE TOGETHER

1. Have you ever walked across carpet and touched a doorknob, receiving a shock? Have you ever felt the cling of clothes fresh out of the dryer? On a cold morning, has your hair ever stood on end after removing a knit hat? What happens? Explain that these events are a result of static electricity! But what is static electricity exactly?
2. First, review the concepts of atoms, protons, neutrons and electrons and the basic physics principle of "opposites attract, like charges repel." Discuss that atoms are neutral when they have an equal number of protons and electrons. Sometimes atoms have loosely held electrons that may get transferred from one object to another. For example, if you walk across a rug, some loose electrons may transfer to your shoes. Your shoes gain electrons and have a negative charge. The rug looses electrons and has a positive charge. Since the loose electrons are now transferred to your body there is an overall negative charge which we call static electricity. Complete the following experiment to investigate static electricity.

1

EXPERIMENT 1: STATIC ELECTRICITY AT WORK

a. Inflate the balloons.
b. Draw an "X" on the balloon with the marker.
c. Predict how long the balloon will cling to the wall. Record your predictions in the second column of the table on Activity Sheet 2.
d. Firmly stroke the wool fabric once over the "X".
e. Start a stopwatch as you immediately press the "X" to the wall. When the balloon falls, stop timing. Record the actual time the balloon clings to the wall in column 3.
f. Wipe the area around the "X" on the balloon with the dryer sheet.
g. Repeat the experiment with three strokes, six strokes, and 12 strokes. Record each time on Activity Sheet 2.

Note

You may need to vary the spot where you stick the charged balloon to allow the wall time to re-neutralize.

Words to Know

atom, electrons, electroscope, friction, neutrons, particle, protons, static electricity

Children will be able to:

- Recognize the role of protons, neutrons and electrons in producing static electricity
- Conduct two experiments to investigate the strength of static electric charges using a stopwatch and electroscope
- Identify the strength of static electric charges between various materials
- Discover the relationship between the strength of the static electric charges and conductivity

What You Need

- *Science Investigator's Journal: Activity Sheet 2*

Experiment 1

✓ Latex balloons
✓ Black permanent marker
✓ 100% wool fabric (scarf or sweater)
✓ Dryer sheets (unscented)
✓ Stopwatch

Experiment 2

✓ Aluminum foil
✓ Clear 2-liter soda bottle, clean and dry, with label removed
✓ Large paper clip
✓ Note card
✓ Sticky tack or modeling clay
✓ Tape
✓ Scissors
✓ Materials (use materials from both lists)

List 1
- 100% wool fabric
- Silk fabric
- Cotton fabric
- Nylon pantyhose
- Plastic wrap
- Your hair

List 2
- Latex balloon
- Styrofoam plate
- 12" length of PVC pipe
- Wooden spoon

ADVENTURE TOGETHER

Explain that scientists use an electroscope – a simple instrument that detects an electric charge – to measure static electricity. Most credit the French physicist Jean Antoine Nollet for inventing the first electroscope in the 1700s. Now, it is your turn to build and test an electroscope. Record the results in your ***Science Investigator's Journal.***


Jean Antoine Nollet

2

EXPERIMENT 2: BUILDING AND TESTING AN ELECTROSCOPE

a. Cut two strips of aluminum foil 12.7 mm long by 127 mm wide (0.5 inches wide by 5 inches long).
b. Smooth each strip to be as flat as possible.
c. Bend the paper clip so there is a hook at each end.
d. Cut a strip off of the note card and a 1.5″ square.
e. Punch a hole in the center of the square scrap.
f. Make a power scale by marking the paper strip as follows: (4 3 2 1 0 1 2 3 4)
g. Slide the end of the paper clip through the hole in the square scrap.
h. Gently hang the two strips of foil on the hook. The foil should be as smooth and straight as possible.
i. Lower the strips into the bottle, bend the card around the mouth of the bottle, and tape in place.
j. Use a small wad of sticky tack to hold the paper clip in place so about half of the paper clip is sticking up above the top of the bottle.
k. Tape the power scale to the outside of the bottle, facing in so you can see the numbers as you look through the bottle. Position the power scale so the foil strips are resting at "0".
l. Use the electroscope for testing materials from each list. First, select one material from List 1 and one material from List 2. Write the materials in columns 1 and 2 of the table on Activity Sheet 2.
m. Predict the score (the number on the power scale) in the third column.
n. Rub the soft material on the rigid material.
o. Keep your eyes on the aluminum strips as you slowly move the rigid object toward the paper clip on top of your electroscope.
p. Record the actual score in the last column of the table.

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ADVENTURE TWO
Can We See Electricity At Work?

TALK ABOUT YOUR ADVENTURE

After completing the experiments, talk about your adventure into electricity:

- **What happened in each of the experiments?**

  a. *In Experiment 1*, when the balloon was rubbed against the wool, electrons moved from the wool to the surface of the balloon, leaving the "X" with a negative charge. The wall is neutral, but when the negatively charged balloon is moved towards the wall, electrons in the wall move away from the balloon. That means the negative electrons from the balloon repel negative electrons in the wall, since like charges repel. This gives the wall a positive charge. Because the surface of the balloon is negative and the surface of the wall is now positive, the balloon clings to the wall showing that opposites attract. When the electrons begin to leave the balloon's surface and enter the air, both the balloon and the wall return to a neutral charge

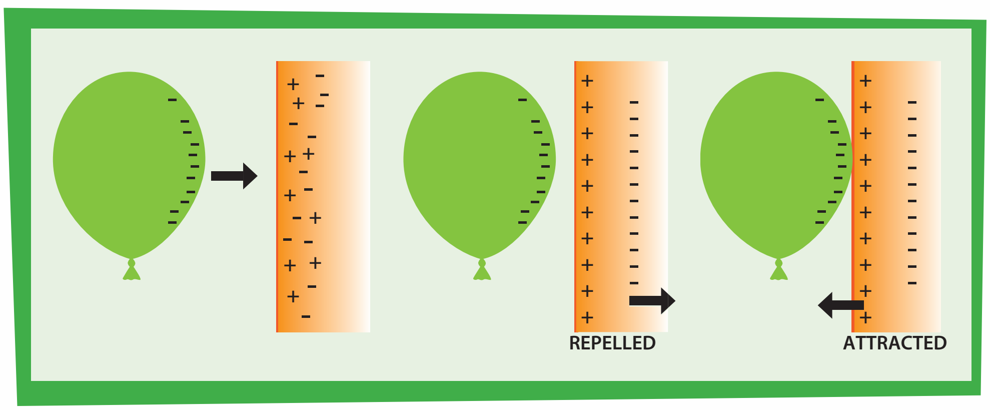
  b. *In Experiment 2*, by rubbing two objects together, one is charged with electrons from the other, making the charged object negative. When you move the charged object towards the paper clip at the top of the electroscope, the excess electrons jump to the metal and down to the aluminum strips. Both aluminum strips become negatively charged. This causes the free-hanging aluminum strips to spread apart because like charges repel. The amount they move apart depends on how much charge is transferred from the object to the aluminum. Some objects accept electrons easily (e.g., latex balloons). Other objects do not accept electrons easily

- **Based on what you now know about protons and electrons, explain the effect a dryer sheet has on your clothes when used in the dryer?**

  The dryer sheet worked to neutralize the balloon in Experiment 1. The dryer sheet has a positive charge, so when rubbed against the balloon, extra electrons were removed from the balloon's surface, giving the balloon a neutral charge. For the same reason, dryer sheets are effective at removing static from your clothes when used in the dryer. As clothes tumble together in the dryer, friction causes the electrons to jump between pieces of clothing, creating static electricity. By adding a dryer sheet, which has a positive charge, the electrons and protons attract, creating a neutral charge. This ultimately removes the static from your laundry.

- **Compare the strength of the static electric charges you measured between various materials using the Electroscope in Experiment 2.**

  Answers will vary but materials with higher conductivity will exhibit greater static electric charge.



ELECTRICITY IN NATURE

Have you ever watched a storm and been amazed as a bolt of lightning cracked across the sky? Lightning is one of the most famous examples of static electricity in nature! Lightning starts in the clouds – where millions of ice particles and water droplets collide with each other, knocking electrons loose. Eventually, the electrons in the negatively charged cloud are attracted to the positively charged surface of the earth, sending billions of electrons towards Earth's surface. The result is a bright flash of static electricity, known as lightning.

ADVENTURE TWO

Can We See Electricity At Work?

KEEP THE ADVENTURE GOING

- **SCIENCE:**
  Did you know you can hear static electricity? Go to a quiet room and bend a metal paper clip open so that one end sticks out. Tape the paper clip to the edge of a table with the straight end pointing up. Charge a latex balloon by rubbing it with a wool scarf several times. Put your ear close to the paper clip and bring the charged balloon very close to the paper clip, but do not touch it. As the excess electrons on the balloon rush to the paper clip, they make tiny crackling sounds. This is a very small version of lightning.
- **SCIENCE AND ART:**
  Although scientists have long sought to harness the power of electricity, some artists are also using the power of electricity to express themselves. One such artist, Hiroshi Sugimoto, uses static electricity to create beautiful works of art. Learn more about Hiroshi Sugimoto by visiting **www.sugimotohiroshi.com/LighteningField.html**. Next, use construction paper, spray adhesive, salt, pepper, plastic spoons and a piece of wool to create your own static electric art. Pour grains of salt and pepper onto paper. Rub the plastic spoon with wool and hold it over the salt and pepper grains. The pepper should jump towards the spoon, separating it from the salt. Repeat this to create patterns or swirls on the paper. Seal your art using the spray adhesive. Share the story of your artwork and the power of static electricity with friends, family or classmates.
- **SCIENCE, ART AND LANGUAGE ARTS:**
  FRANKENWEENIE was made using a film technique called stop-motion animation. Visit **www.disney.go.com/frankenweenie/# /video/** and click on the "Art of **FRANKENWEENIE**" clip to learn more about stop-motion animation and the role electricity played in the film. Use the iMotion HD app or write a storyboard and create your own stop-motion film about electricity. Share your finished film with friends and family.

ADVENTURE TWO: RESOURCE GUIDE

Everyday Mysteries: Fun Science Facts from the Library of Congress. How does static electricity work? The Library of Congress. 31 October 2012. **www.loc.gov/rr/scitech/mysteries/static.html**

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ADVENTURE THREE

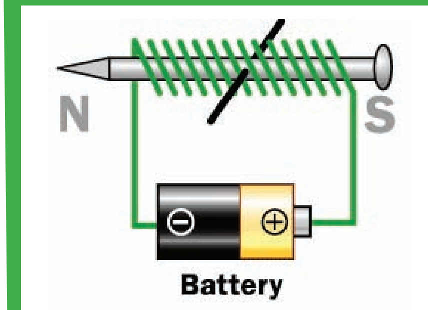
A Tale Of Two Poles: How Can Magnets Be Used To Harness Energy?

GRADE LEVEL: 5 - 8
TOPICS: Science, Language Arts, Art, Music

ADVENTURE TOGETHER

1. Introduce the concept of magnetism. Explain that magnetic fields are created by moving or spinning particles such as protons or electrons in a current-carrying wire. The current creates a magnetic field around the wire.
2. An object with an exceptionally large magnetic field is called a magnet. Magnets always have a North-seeking and South-seeking pole. Just as opposite charges attract and like charges repel, opposite poles attract and like poles repel.
3. Create a list of ways magnets can be used. How are magnets used at home? At school? Throughout your city or state? How might magnets be useful to metalworkers, doctors, office workers, scientists and even astronauts? Many simple machines and appliances, such as junkyard cranes and television sets, generate magnetic fields. Together, research magnets and discuss at least one new example of how they are used in the world today.
4. Discuss the difference between a permanent and temporary magnet. Permanent magnets are metals (usually metal alloys made of iron, nickel and cobalt) that never lose their magnetic properties. Temporary magnets lose their charge when removed from a magnetic field. Temporary magnets can be made of soft metals or created from the flow of electricity.
5. An electromagnet is a temporary magnet created when an electrical current flows through a metal wire, creating a magnetic field and magnetizing the wire. When the electrical current stops, the magnetic properties are lost. For example, a large crane will pick up scrap metal with a huge electromagnet. When the current is flowing, the electromagnet lifts pieces of metallic scrap and the crane moves them. When the current is not flowing (the switch is off), the scrap metal will fall. Electromagnets are found in door bells, electronic locks, TVs, speakers and computers. They are also the essential component to electric motors.

A simple electromagnet



6. Build a simple electromagnet and conduct four mini-experiments to explore how different variables affect the strength of the electromagnet.

SAFETY SMART!®

Only use insulated copper wire for this experiment. Bare wire can cause a harmful shock.

Words to Know

electromagnet, electrons, magnet, magnetic field, motor, molecules, protons, resistance, voltage, windmill, wind turbine

Children will be able to:

- Explain the difference between a temporary and permanent magnet
- Describe how electricity and magnetism are related
- Predict, test and summarize how the strength of an electromagnet is affected by four variables
- Describe how electromagnets can be used to harness the power of electricity

What You Need

✓ *Science Investigator's Journal: Activity Sheet 3*
✓ 1.5 Volt battery
✓ 9 Volt battery
✓ 6-inch iron nail
✓ Box of paper clips
✓ Wire stripper to remove plastic coating from the ends of the wire
✓ 10 feet of insulated 15-gauge copper wire

Note:
Copper wiring is coated with different colors based on its thickness or gauge. This makes it easy for children to distinguish between the 20-gauge wire and the 15-gauge wire.

ADVENTURE THREE

A Tale Of Two Poles: How Can We Use Magnets To Harness Electricity?

EXPERIMENT 1: TEST THE NUMBER OF COILS

a. Use the wire stripper to remove 1.5 cm (about 0.5 inches) of the plastic coating at each end of the 15 and 20-gauge wires.

b. Using the 20-gauge wire, wrap the wire around the length of a 3-inch nail 20 times, leaving about 30 centimeters (12 inches) of loose wire at each end.

c. Connect one end of the wire to the positive terminal and the other end of the wire to the negative terminal of a 1.5V battery.

d. Place a pile of paper clips on the table in front of you. Predict and record the number of paper clips you will be able to pick up with the electromagnet on Activity Sheet 3.

e. Test your prediction. Hold your electromagnet over the paper clips and record the number of paper clips picked up by the electromagnet.

f. Now, test how the number of coils affects the strength of the electromagnet. First, disconnect the wire from the battery. Then, uncoil and recoil the 20-gauge copper wire around the 3-inch nail 40 times instead of 20 times. Predict and record how many paper clips the electromagnet will pick up when it is made with more coils. Test your prediction and record your results.

Note

Be careful not to leave the circuit closed too long. This could actually magnetize the nail, causing it to pick up paper clips even when the current is turned off.

EXPERIMENT 2: TEST THE VOLTAGE

a. Now, test how **voltage** affects the strength of your electromagnet. Wrap the 20-gauge copper wire around the length of a 3-inch nail 20 times and connect the battery terminals to a 1.5V battery. Predict how many paper clips the electromagnet will pick up. Test and record your findings.

b. Predict and record how many paper clips you will pick up using a 9V battery. Then, connect the wire to the battery terminals of a 9V battery and test your electromagnet. Document your results using Activity Sheet 3.

EXPERIMENT 3: TEST THE THICKNESS OF THE WIRE

a. Next, test how wire thickness affects electromagnetic strength. Wrap the 20-gauge copper wire around the length of a 3-inch nail 20 times. Connect the ends of the wire to the 1.5V battery and record the number of paper clips you are able to pick up with the electromagnet.

b. Then, wrap the 15-gauge copper around the 3-inch nail 20 times. Predict how many paper clips the electromagnet will pick up using a thinner wire. Test your prediction by connecting the ends of the wire to the 1.5V battery. Record the number of paper clips picked up by the electromagnet.

EXPERIMENT 4: TEST THE NAIL LENGTH

a. Finally, test the affect of nail length on electromagnetic strength. Wrap the 20-gauge copper wire around the length of a 3-inch nail 20 times. Record the number of paper clips the electromagnet was able to pick up.

b. Then, wrap the 20-gauge copper wire around the length of a 6-inch nail 20 times. Predict how many paper clips will be picked up using a longer nail. Test your prediction and record your results on Activity Sheet 3.

FOR ADDITIONAL EXPERIMENTS, try the steps above using one of the following combinations: 15-gauge wire and a 3 inch nail; 15-gauge wire and 6 inch nail; 20-gauge wire and 6 inch nail. Also try testing the electromagnet in the experiment using other metallic items such as straight pins or thumb tacks to compare the magnetic properties of various objects.

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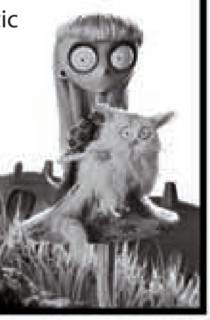

ADVENTURE THREE

A Tale Of Two Poles: How Can We Use Magnets To Harness Electricity?

TALK ABOUT YOUR ADVENTURE

After completing all four experiments, talk about your adventure into electricity:

- **Explain the difference between a temporary and a permanent magnet.**
  Permanent magnets are metals (usually metal alloys made of iron, nickel and cobalt) that never lose their magnetic properties. Temporary magnets lose their charge when removed from a magnetic field. Temporary magnets can be made of soft metals or created from the flow of electricity.
- **Describe how electricity and magnetic fields are related to an electromagnet**
  An electromagnet is a temporary magnet created when an electrical current flows through a metal wire, creating a magnetic field and magnetizing the wire. When the electrical current stops, the magnetic properties are lost.
- **How did each variable affect the strength of your electromagnet?**
  When an electric current flows through a wire, it produces a magnetic field. If the wire is wrapped around an iron nail, the magnetic field magnetizes the iron by lining up the molecules in the same direction. The more the copper wire is coiled around the nail, the greater the magnetic field and strength of the electromagnet. A higher voltage will result in more current flowing through the copper coils, increasing the strength of the magnetic field and the electromagnet. A thicker copper wire will have less resistance to flow than a thin wire, increasing the strength of the magnetic field and conductivity of the electromagnet. The longer the nail, the farther the copper wire is coiled and the farther the current has to flow, decreasing the strength of the electromagnet. In summary, wires with smaller gauges increase the resistance, reduce the electric current and weaken the magnetic field. The strength of the magnetic field will decrease as the copper wire is coiled across a greater distance.
- **Describe how electromagnets can be used to harness the power of electricity.**
  Unlike normal magnets, electromagnets lose their magnetic properties when the electric current is not flowing – meaning they can be turned on and off. That makes them an essential component to electric motors! Electromagnets allow us to use electricity to power a motor which can in turn power many other things. Another impressive use of electromagnets is the creation of Maglev Trains. These gliding trains do not require an engine and replace steel tracks with magnets! Learn more about electromagnets and Maglev Trains here: **www.science.howstuffworks.com/transport/engines-equipment/maglev-train.htm.**

ELECTRICITY IN NATURE

Have you ever used a compass while hiking? Compasses have accurately guided centuries of adventurers as they traveled around the world. But how? Well, the answer has to do with electromagnets of course! Like the iron nail used in this experiment, Earth has an iron core. As liquid iron is moved across the core, massive electrical currents are created. And just like the electricity flowing across the iron nail, the electricity moving through Earth's core creates a magnetic field. This makes Earth one of the largest electromagnets ever and is what gives the North and South Poles an actual magnetic charge! Because the needle of a compass is attracted to the magnetic pull of the North Pole, it will always point to magnetic north. Spend some time outdoors with a compass appreciating the beauty of nature as you ponder the power of electromagnetism: **www.ehow.com/list_6577390_orienteering-games-kids.html**.

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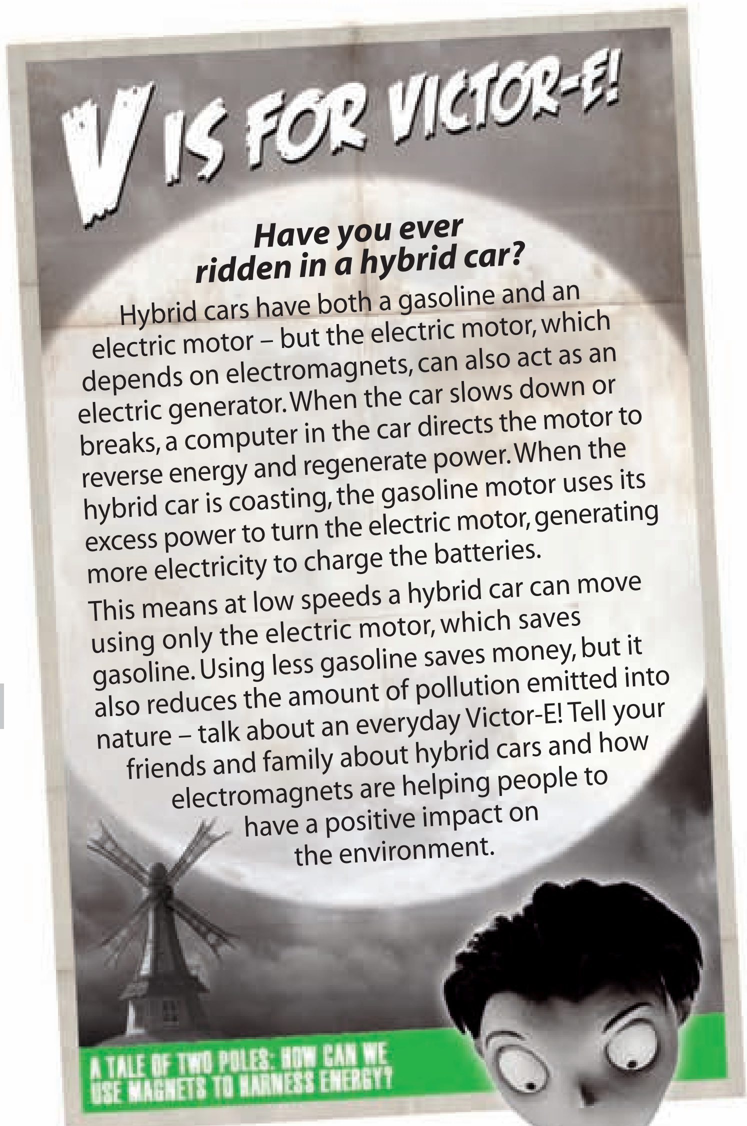
Disney
FRANKENWEENIE

KEEP THE ADVENTURE GOING

- **SCIENCE, LANGUAGE ARTS, ART AND MUSIC:**
  In the experiment above you saw how an electric current produces a magnetic field. The reverse is also true – a change in a magnetic field can produce an electric current. This is the principle behind the operation of windmills and wind turbines. Wind turbines use the power of the wind to rotate a shaft which then rotates a set of magnets around a coiled wire. As the magnets rotate, they create a changing electrical field which produces electricity.

Complete one or more of the following activities to teach children about wind energy:

- Read the true story *The Boy Who Harnessed the Wind* by William Kamkwamba and Bryan Mealer (2010) to find out how a young boy used wind energy to produce electricity for his village. Then, discuss William's story. How have windmills and wind turbines contributed to both culture and technology? How have windmills and wind turbines changed? What are some advantages to windmills? What are some disadvantages?
- Visit **www.strandbeest.com** to learn more about Theo Jansen, an artist and kinetic sculptor that captures the power of the wind in his artwork. Discuss his sculptures together. Then, use a variety of lightweight materials to create your own wind sculpture. Invite friends, family or classmates to view this artwork; have children explain their design and how it relates to or celebrates the power of the wind.
- Musicians are using wind energy to compose beautiful and unusual songs. Visit **www.ecochunk.com/2127/2012/09/03/harmonic-fields-art-festival-features-500-wind-powered-musical-instruments/**. See how 500 musical instruments have been arranged to play music entirely generated by the wind. Then, watch a great video featuring a wind powered chime: **www.youtube.com/watch?v=sFlirUB-D7Q**. Try making various sizes and types of wind chimes or even your own sound sculpture and write a song powered by the wind.



ADVENTURE THREE: RESOURCE GUIDE

Brain, Marshall. *How Electric Motors Work*. How Stuff Works, Inc. 30 October 2012. **www.electronics.howstuffworks.com/motor4.htm**

Brain, Marshall and Lance Looper. *How Electromagnets Work*. How Stuff Works, Inc. 30 October 2012. **www.howstuffworks.com/electromagnet.htm**

Jefferson Lab. *What is an electromagnet?* 30 October 2012. **www.education.jlab.org/qa/electromagnet_is.html**

NASA. *Introduction to the Electromagnetic Spectrum*. 30 October 2012. **www.missionscience.nasa.gov/ems/01_intro.html**

ACTIVITY SHEET 1

from Adventure One

Top secret!!

Name____

Date____________________

EXPERIMENT 1: Build a simple circuit.

FIRST, check your work space for the following materials:

- ✓ 2 D batteries
- ✓ Masking tape
- ✓ Flashlight that you can unscrew and take apart
- ✓ 12" strip of heavy-duty aluminum foil

SECOND, set up and conduct the experiment.

1. Unscrew the flashlight and carefully remove the light bulb.
2. Tape the 2 batteries together, putting positive and negative ends together.
3. Use the strip of aluminum foil. Wrap one end around the metal screw threads of the light bulb. Secure with a little tape. Do not cover the tip of the light bulb.
4. Tape the other end of the foil to the flat (negative) end of the stacked batteries.
5. What do you think will happen when you touch the metal tip of the light bulb to the post end of the battery stack?

THIRD, write your prediction here:

____

____

____

____

____

____

conductor

6. Touch the metal tip of the light bulb to the post (positive) end of the battery stack.

FOURTH, record your observation here: (What happened)

____

____

____

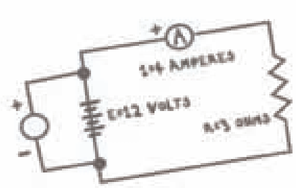
____

____

____

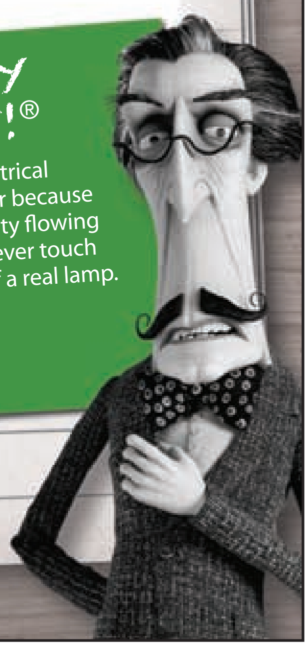
____

Was your prediction correct? ☐ **Yes** ☐ **No**



SAFETY SMART!®

You can touch this electrical current without danger because the amount of electricity flowing is so small. But never, ever touch the electrical socket of a real lamp.



Find an old flashlight

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D Battery

Name____

Date____________________

Science Investigator's Journal

ACTIVITY SHEET 1

from Adventure One

EXPERIMENT 2: Test a simple circuit for good and poor conductors.

FIRST, write your observations on this page of your scientific journal.

1. What happened when you reversed the conductor?

____

____

2. What happened when you taped the batteries flat end to flat end?

____

____

3. What happened when you used only one D battery?

____

____

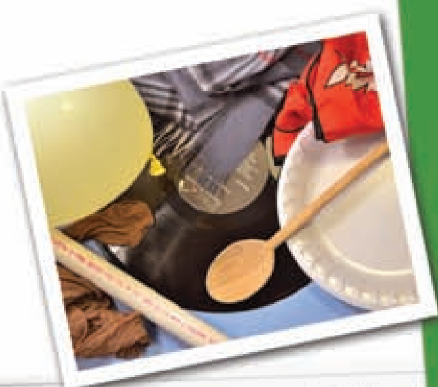
SECOND, Get ready for the next phase of your experiment, "Try other conductors".

On the table below, list the materials you will test in the first column labeled "Materials". Write Good or Poor Conductor in the second column labeled "Prediction". After you have completed this phase of the experiment, place a check for each correct prediction under the third column labeled "Observation".

Materials	Prediction	Observation

Sponsored by and in cooperation with UL

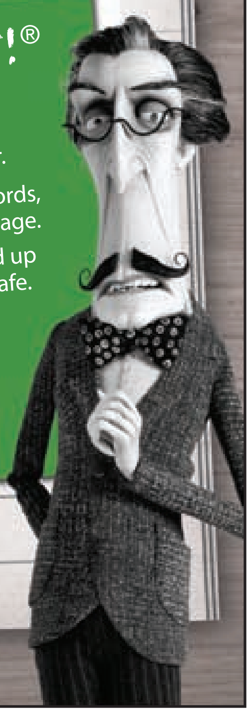
PRESENTED BY: PTO TODAY School Family Nights



SAFETY SMART!®

Keep in mind that water is a good conductor of electricity, so keep electrical appliances away from water.

- Inspect electrical cords, extension cords, power strip, and appliances for damage.
- Don't overload extension cords; add up the watts to ensure you are being safe.
- Don't hide electrical cords under carpets or behind drapes.



Try other conductors

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Borrow Stopwatch

Name____________________________

Date______________

Science Investigator's Journal
ACTIVITY SHEET 2
from Adventure Two

EXPERIMENT 1: Static electricity at work.

FIRST, check your work space for the following materials:

- ✓ Latex balloons
- ✓ 100% wool fabric (scarf or sweater)
- ✓ Black permanent marker
- ✓ Dryer sheets (unscented)
- ✓ Stopwatch

SECOND, set up and conduct the experiment. Record your responses:

HOW STRONG IS THE CHARGE?		
Number of strokes with wool	Cling time prediction	Actual time (seconds)
1		
3		
6		
12		

EXPERIMENTING FURTHER. Now investigate and record what happens when:

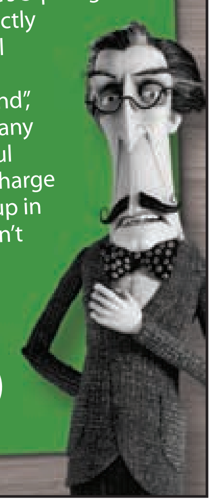
- You put the opposite side of the balloon to the wall: ____________________
- You move the dryer sheet very close to the clinging balloon: ____________________
- You change the size of the balloon: ____________________
- You test the charged balloon against other vertical surfaces (filing cabinet, desk leg, window, etc.): ____________________
- When the balloon falls, which side does it land on? Is it random? Explain why or why not? ____________________
- After several trials, do you notice fuzz or pieces of fabric collecting on the balloon? Explain why this is happening. ____________________

EXPERIMENT 2: Building and testing an electroscope.

MEASURING STATIC ELECTRICITY			
Material #1	Material #2	Predicted Score	Actual Score

SAFETY SMART!®

- Lightning is a form of static electricity, but on a much larger scale! Lightning will always travel the shortest distance possible from storm cloud to ground. Therefore, never, ever stand under a tall tree during a thunderstorm.
- Insert an appliance's 3-prong electrical plug directly into a 3-prong wall outlet. The third prong is the "ground", which discharges any potentially harmful excess electrical charge that might build up in the appliance. Don't use an adapter to bypass the third prong.



Voltage

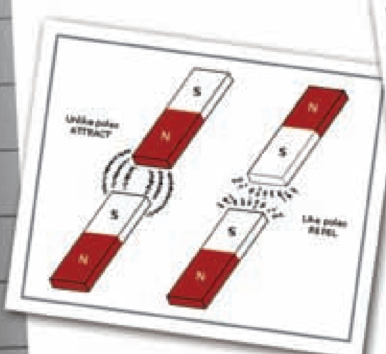
Name________________________________

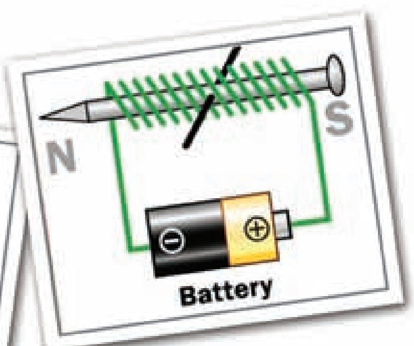
Date______________

Science Investigator's Journal
ACTIVITY SHEET 3
from Adventure Three

EXPERIMENT 1: Testing the strength of an electromagnet.

Variables	Number of paper clips: Predicted	Number of paper clips: Actual
VARIABLE 1: # OF COILS		
20 coils		
40 coils		
VARIABLE 2: VOLTAGE		
1.5V battery		
9V battery		
VARIABLE 3: THICKNESS OF WIRE		
20-gauge wire		
15-gauge wire		
VARIABLE 4: DISTANCE WIRE IS COILED ACROSS		
Coiled across length of a 3 inch nail		
Coiled across length of a 6 inch nail		





SAFETY SMART!®

Only conduct this experiment using coated (insulated) wire. Bare wire can produce a harmful shock. Never touch bare or exposed wires!

Get some 15 and 20-gauge wire

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