Red Herring Puppets

presents

ELECTRICITY!

Study Guide for teachers and students.

THE PRODUCTION

HOW IT CAME TO BE

The idea for this STEM based multi-media performance grew out of a residency Red Herring Puppets conducted several years ago with three fourth grade classes at C.C. Bell. Elementary School in Asheville, NC. The lead teacher, Patty Long wanted to augment specific curriculum goals related to electricity and magnetism with a hands-on experience. Red Herring Puppets produced a script for a cast of ninety characters that addressed the academic standards with creative, dramatic, and humorous style. Every student researched, designed, created and performed a hand puppet character. Students also produced electric circuit boards and illustrations that were used as props in the performance. The show was well received by their classmates and the experience helped the students absorb the challenging curriculum content.

Inspired by the project's success, we set out to create a two-person touring production that entertains and engages kindergarten students while supporting and enriching curriculum content of the upper elementary grades. Through puppetry, visual detail, engaging characters, and special effects, we integrate art and curriculum, connecting with multiple learning styles and abilities. We focus on the process of scientific observation, building upon the inventions and discoveries of the past to solve future energy challenges. The show travels through history as audiences witness key moments in our scientific past that unravel the mystery of electricity in a unique and memorable way.

CURRICULUM GOALS

N.C. CORE STANDARDS IN SCIENCE & TECHNOLOGY
(The examples below are from Grade 4, but many apply to other grades as well)

3.01 Observe and investigate the pull of magnets.
3.02 Describe and demonstrate how magnetism can be used to generate electricity.
3.03 Design and test an electric circuit as a closed pathway including an energy source, energy conductor, and an energy receiver.
3.04 Explain how magnetism is related to electricity.
3.05 Describe and explain the parts of a light bulb.
3.06 Describe and identify materials that are conductors and nonconductors of electricity.
3.07 Observe and investigate that parallel and series circuits have different characteristics.
3.08 Observe and investigate the ability of electric circuits to produce light, heat, sound, and magnetic effects.
3.09 Recognize lightening as an electrical discharge and show proper safety behavior when lightening occurs.

THE PUPPETS

There are twelve large tabletop rod puppets in our production. This style is reminiscent of the Japanese Bunraku tradition in which the puppeteers appear in full view. The lead puppeteer has one hand inside the back of the figure holding up the body and controlling the head. The puppet's arms are controlled by rods attached at their elbows. We chose this style so the puppets could be full-bodied and large enough to play to an audience of three to five hundred students.

The puppet heads are sculpted in clay and then covered with a two-part plaster mold. When the plaster hardens, the clay is removed, and the mold is filled with a synthetic latex called neoprene. After a few hours the neoprene is poured out leaving a thin hollow cast of the face. We covered the face with a fleece fabric and added hair and facial features. The bodies are built with wooden boards at the shoulders and waist connected by dowels and covered with foam. The legs and arms are hollow PVC pipes inserted into measured pieces of swimming noodles and threaded with rope. The hands are shaped with foam over wire. We design and sew all our own costumes after careful reserach of the period and style of each character.

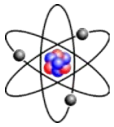
The three-dimensional pigeons appearing in the park scene with Nikola Tesla are marionettes with strings connected to a wooden control held from above. The animations projected on the screen were created using two-dimensional jointed paper cut-outs. The movements were filmed from above as the puppeteers moved the figures horizontally atop a stiff green board. We attached green tabs for manipulation and were able to use digital technology to remove the green and replace it with digitalized backgrounds illustrating the location in which the scene takes place.

THE PEOPLE

Lisa Aimee Sturz, Red Herring's Artistic Director conceived of the show, wrote the script, and headed up the puppet construction. Scientist and educator, **Laura Bochner**, served as our primary consultant and helped write several scenes. **Brett Pierce**, a professional electrical engineer and Professor **Judith Beck** from UNCA reviewed the script for accuracy and clarity. **Randy Kilgore,** built electrical effects such as sparks, Faraday's motor, and Franklin's Leyden jar. **Grayson Morris** helped create the puppet bodies and **Geneva Bierce-Wilson** helped Lisa sew the costumes. **Carolyn Raleigh** created many of the two dimensional paper puppets used in the animation. **Diane Tower-Jones** filmed the puppets while Carolyn and Lisa manipulated the figures. The scenes were edited together by **Theo Livingston Sturz**. Our technical consultant is **Mark Blessington**. **Doug Blessington** and **Theo Sturz** voiced characters on the animation. The show has thus far been performed by puppeteers **Lisa Sturz, Kathryn O'Shea, Geneva Bierce-Wilson,** and **Jon Speer.**

THE VOCABULARY

AMBER- A yellow brownish glassy material of fossilized tree sap.
The Greek word for amber, elektron is the root of our word "electricity"



ATOM- the tiny particles that makes up all things -matter.

ATTRACTION – The pull of a magnet, or the force between a north and south pole

BATTERY – a cell that stores electricity 

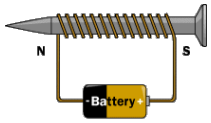
CIRCUIT – A circular loop that an electric current can flow through.

CONDUCTOR – Any material that allows electricity to move through it easily. Copper and Silver are two of the best.

CURRENT – Something that flows in one direction. When the electrons spin around inside an atom, they create an electrical current AND a magnetic field.

ELECTRICAL CHARGE A measure of the excess or deficiency of electrons in a given object.

ELECTRICITY – A form of energy produced by the flow of positively and negatively charged particles of matter.



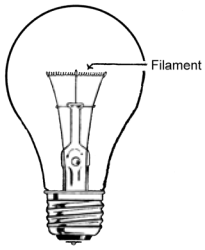
ELECTROMAGNET A coil of wire, usually wound around an iron core, which produces a strong magnetic field when an electric current is passed through it.

ELECTROMAGNETISM– Magnetism produced by electricity. When the electrons spin around inside an atom, they create an electrical current AND a magnetic field.

ELECTRON – a particle in an atom with a negative charge

ENERGY – The power to work or to act.

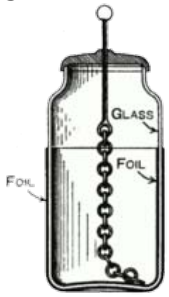
FILAMENT – a very thin thread or wire. a tungsten wire that glows when electricity flows through it inside a light bulb.



FORCE – a push or pull against resistance

FRICTION The rubbing of one thing against another

INSULATOR – A substance that does not carry a current well such as rubber, wood, air, glass, and porcelain.



LEYDEN JAR A glass jar or bottle used to accumulate electricity. Coated with foil both inside and out, it is connected to a metal conducting rod which passes through an insulating stopper and charges the jar with electricity.

LIGHTNING – The discharge of static electricity built up in a cloud.

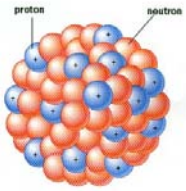
LODESTONE – A piece of magnetite that is often used as a compass.

MAGNET- A solid object with the power to attract iron or other metals.

MAGNETIC FIELD – The region within which a magnet's magnetic force acts.

MAGNETISM – The force that attracts objects to a magnet. A property possessed by certain materials, that attracts or repels similar materials. It is closely related with moving electricity.

NEUTRON – A particle in an atom's nucleus with a neutral charge.



NUCLEUS – The center of an atom.

PROTON – A particle in an atom's nucleus with a positive charge.

RENEWABLE ENERGY – An energy source that can't be used up such as wind, solar, and water power. Coal, oil, and natural gas are non-renewable because they can be depleted.

STATIC ELECTRICITY – An electrical charge that builds up due to friction between two objects that causes electrons to move from one to the other.

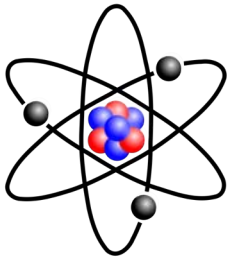
SPARK A short electrical discharge between two conductors.

TERMINAL – One of the ends of a battery

VOLT – A unit of electrical pressure which measures the force or push of electricity.

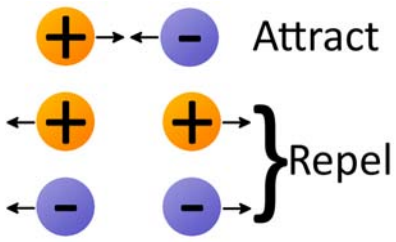
WATT - A unit of electrical power used to indicate the rate of energy produced or consumed by an electrical device.

ELECTRONS & ELECTRICITY?



ATOMS: Atoms are the most basic particles of matter - anything that has mass and takes up space. You can think of them as the "building blocks of matter." They are very small, but they make up everything in the universe. They are like tiny Legos that you can use to make all sorts of things. Castles! Cars! Towers! Animals! From small building blocks, you can make larger, complicated things. But you can always break those things down to atoms.

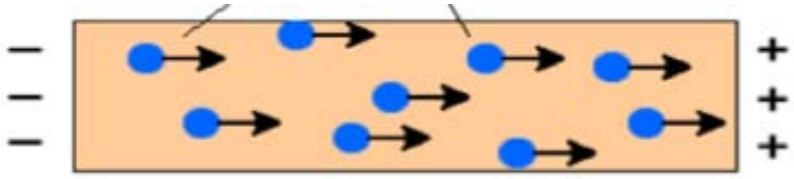
PARTICLES: Atoms are composed of three even smaller parts called particles. Protons are positively charged particles, neutrons have no charge, and electrons carry a negative charge. The protons and neutrons are packed together in the center of an atom in a tight huddle called a nucleus. The electrons are in constant motion around the nucleus. Electrons are very small compared to protons and neutrons. You can think of electrons like bumble bees buzzing around a huddle of penguins (the protons and neutrons).



OPPOSITES ATTRACT: Positive and negative charges are attracted to each other and want to come together. Similar charges don't want to come together; they want to stay apart or repel each other. The negative electrons are attracted to the positive nucleus and so they usually stay near their protons.

ELECTRONS MOVE AND FLOW: When electrons get really excited, they can leave their atoms and flow off in search of a positive charge to connect with. Electrons flow really well through metal. That's why metal things are good conductors of electricity. Salt water is also a good conductor. Electrons don't flow well through things like rubber, wood, and plastic. Those are insulators.

MOVING ELECTRONS=ELECTRICITY: Electrons in motion have energy. In order to use this energy to power electrical appliances, we need to set up circuits with an electric current. Electrical currents are similar to the flowing water in a river current which travels in one direction. We can create an electric circuit with a constant flow of electrons.



HISTORICAL TIMELINE

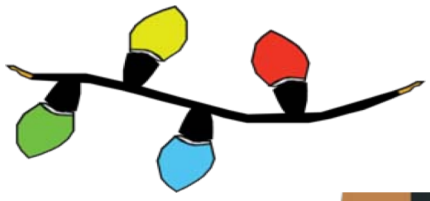
WHEN	WHO	WHERE	WHAT
????	Sioux Indians Norse people Aztecs	Canada U.S.A Scandinavia Iceland Mexico Cen. America	People believed that rain and thunder were caused by Wakinyan Tanka, the Great Thunderbird Thor, God of Thunder Worship of the rain god, Tlaloc, He Who Makes Things Sprout
~2700 BC		Egypt	Referred to electric fish as the "Thunderer of the Nile"
~2500 BC	Greeks	Greece	Greek mythology attributes lightening to the god Zeus, head of the Greek pantheon.
~2000 BC	Magnus	Northern Greece	A shepherd discovered the magnetic attraction of magnetite.
~600 BC	Thales of Miletus	Greece	Thales is considered the father of scientific inquiry because he recorded his observations of static electricity.
300 BC	Huang-ti	China	Huang-ti, a Chinese general supposedly made the first compass using lodestone.
~1200	Chinese	China	Chinese sailors used lodestone as compasses for their ships.
~1350	Arabs	Middle East	Arabic word for lightning (*raad*) applied to the electric ray.
~1600	Dr. William Gilbert	England	Dr. Gilbert published "De Magnete" which distinguished between electrical and magnetic attraction and suggested that Earth is a giant magnet.
~1670	Otto von Guericke	Germany	He invented the first electrostatic generator using friction to make a spark and created the first vacuum.
1705	Francis Hauksbee	England	Modified the electrostatic generator by putting mercury inside. It created a blue spark that had never been seen before.
~1720	Stephen Gray	England	He discovered that electricity could flow like a current. He also identified substances as conductors and insulators.
1733	Charles du Fay	France	Discovered that electricity has a positive and negative charge and that opposites attract.
1745	Masschenbroek von Kleist	Holland Germany	Invented the Leyden jar to store an electric charge.
1752	Benjamin Franklin	Philadelphia U.S.A.	Kite experiment to show that lightening is a form of static electricity. He also invented the lightening rod.
1791	Luigi Galvoni	Italy	He experimented with a frog to develop his ideas on bioelectricity.

1800	Alexandra Volta	Italy	Made the first battery to store electricity using alternating layers of zinc and copper.
1809	Humphry Davy	England	Invented the first electric arc lamp using charcoal.
1820	Hans Christian Oersted	Denmark	Demonstrated that magnetism and electricity are related by using an electric current to create a magnetic field.
1825	William Sturgeon	England	Invented the electro-magnet
1827	André-Marie Ampère	France	He built on the work of Oersted and came up with mathematical equations to understand electricity and magnetism.
1831	Michael Faraday	England	He discovered electricomagnetic induction and later invented the electric motor
1832	Pavel Schilling	Germany	Electric telegraph
1847	Hermann von Helmholtz	Germany	Energy cannot be created or destroyed, only transformed.
1856	Robert Houdin	France Algeria	A magnet that can be turned ON and OFF by electricity
1875	Herman Sprengel	Germany	He invented the mercury vacuum pump.
1875	Henry Woodward Mathew Evans	Canada	Patented the first light bulb.
1876	Alexander Graham Bell	Scotland Canada USA	Bell was awarded the US patent for the telephone
1878	Joseph Swan	England	He created the first working light bulb using carbonized paper filaments.
1879	Thomas Edison	New Jersey U.S.A.	Invention of the incandescent light bulb.
1888	George Westinghouse	USA	Established the "Westinghouse Electric & Manufacturing Company" to distribute AC current using several of Tesla's inventions.
1897	Sir Joseph John Thompson	England	He discovered the electron and proposed a model for the structure of an atom.
1905	Albert Einstein	Germany U.S.A	Published a paper on the "photoelectric" effect. He won the Nobel Prize for this in 1921
1918	Ernest Rutherford	New Zealand England	Discovered the proton
1885-1943	Nikola Tesla	Czechoslovakia USA	Tesla was a talented electrical engineer. His most notable inventions include alternating current and the radio.
1931	Ernst Ruska	Russia	Is credited with developing the electron microscope, which allows scientists to magnify objects up to one million times.
1932	James Chadwick	England	Discovered the neutron and measured its mass.
1944	Otto Hahn	Germany	Nobel prize for chemistry. He uncovered the process of nuclear fission.

AN ELECTRICAL EXPERIMENT:
CIRCUITS, CONDUCTORS & INSULATORS

The ELECTRICITY! show mentions the scientist Stephen Gray who realized that some things are better conductors of electricity than others. In this fun experiment, you can build a simple **circuit** and discover which materials are **conductors** and which materials are **insulators**. Conductors allow electrons to flow through them, but insulators resist electron flow.

Materials you will need:



- Short string of Christmas lights, or segment of Christmas lights cut from a longer strand (ask an adult to cut the Christmas lights with wire cutters or a sharp knife)

- One 9 volt battery

- Two wires with alligator clip on either end.

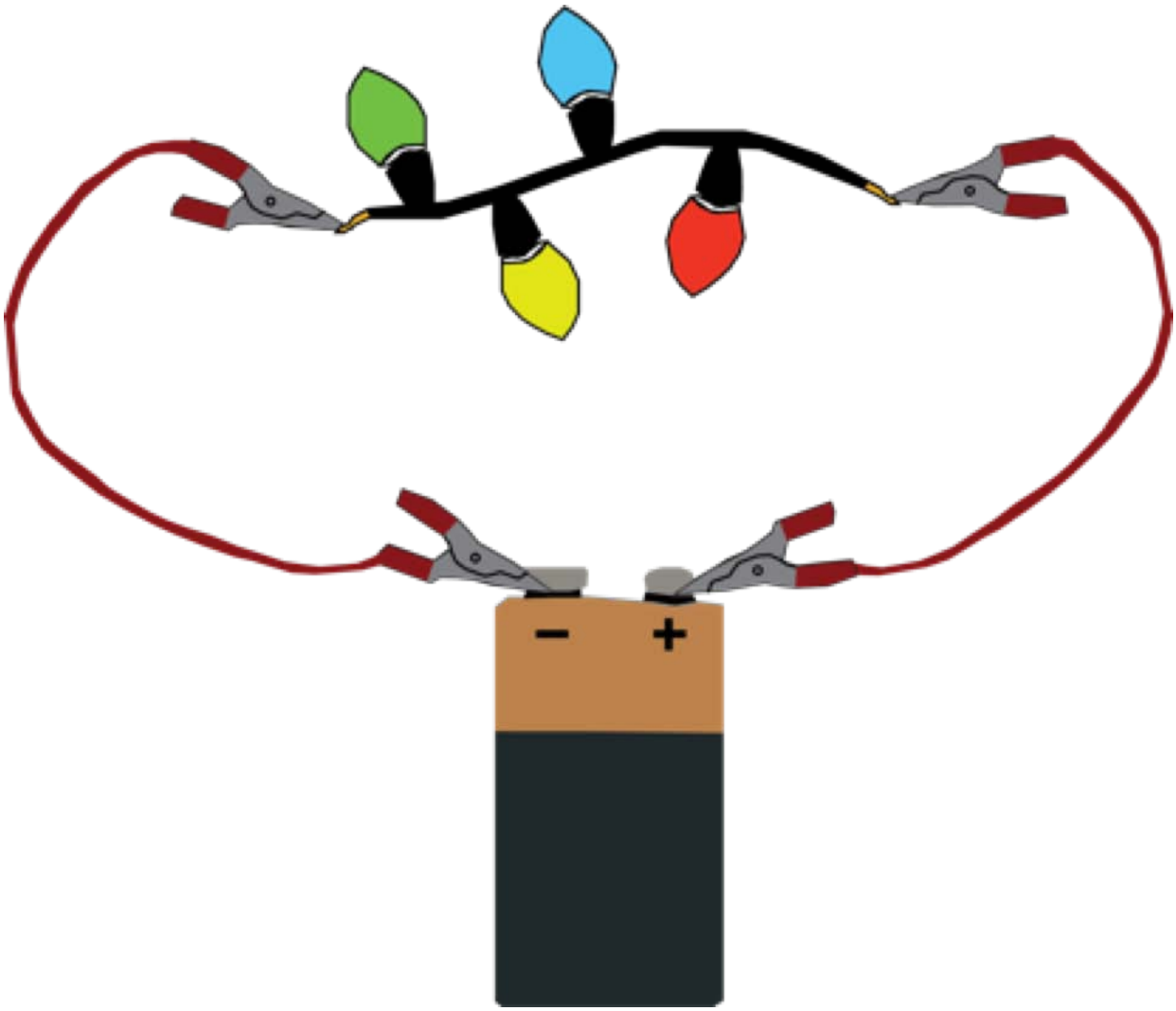
- Wirestrippers

- Materials to test in your circuit :

    - Penny
    - Nickel
    - Dollar bill
    - Button
    - Popsicle stick
    - Pipe cleaner
    - Paper clip
    - Small nail
    - Metal key
    - Piece of yarn or string
    - Twig
    - Pencil
    - Piece of aluminum foil
    - And any other small things around your house or classroom that you want to test!

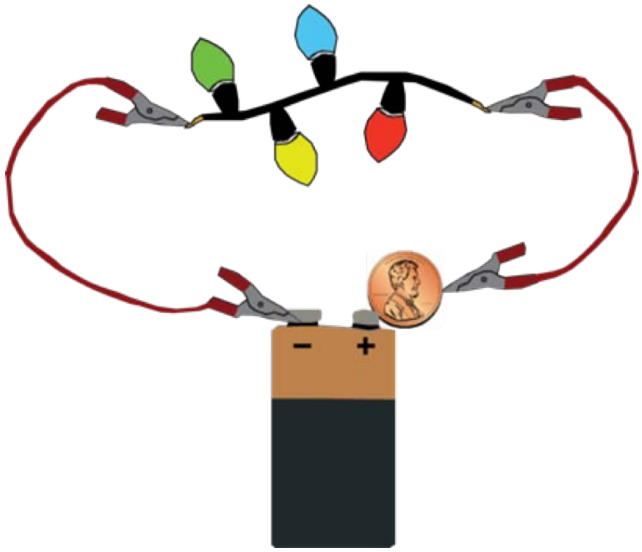
Setting up your experiment:

1) Hook the battery and the lights together in a simple circuit with the alligator clips. Everything in the circuit should make a circle. (Did you know, the word circuit comes from the word circle!) Clamp one end of the string of lights to the positive (+) terminal of the battery, and clamp the other end of the string of lights to the negative (-) terminal of the battery. Ask an adult to strip some of the insulation off the ends of the Christmas lights if no wire is exposed. Make sure the alligator clamps touching the Christmas lights are clamped to the copper wire inside the plastic insulation.



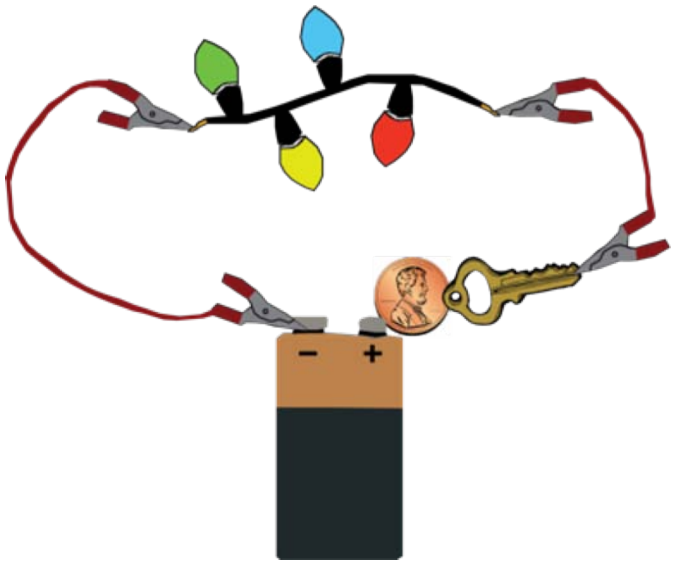
2) If your circuit is hooked up properly, and if your battery and lights are working, your Christmas lights will light up! But as soon as you break the circuit somewhere, electrons stop flowing and the lights go out. In how many places can you break the circuit?

3) Time to test your conductors and insulators! First, you'll test each item by itself. A good item to start with is the penny. Unclamp your lights from the positive (+) terminal. Clamp onto the penny, then touch the penny to the positive (+) terminal of the battery. Do the Christmas lights light up? If so, the penny is a conductor! A conductor allows electrons to flow through it to complete the circuit. If not, it is an insulator. Insulators do not let electrons flow freely.



4) Test each of your other items. As you test them, sort them into two piles: a conductor pile and an insulator pile.

5) When you're done experimenting on the items individually, see if you can make a complete working circuit with two or more (or try three or more!) of the items



6) What things make good electrical conductors? What are bad conductors of electricity? You should start to notice a pattern as you conduct your experiment.

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USEFUL WEBSITES

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http://kids.discovery.com

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http://www.eia.gov/kids/energy.cfm?page=electricity_home-basics-k.cfm

Electricity
http://en.wikipedia.org/wiki/Electricity

History of Electricity
http://inventors.about.com/cs/inventorsalphabet/a/electricity.htm

The History of Electricity
http://library.thinkquest.org/6064/history.html

Magnet Lab
http://www.magnet.fsu.edu/education/tutorials/pioneers/

University of Manchester How Do We Make Electricity Interactive:
http://www.childrensuniversity.manchester.ac.uk/interactives/science/energy/electricity/

Zoom on Static Electricity from PBS:
http://www.pbslearningmedia.org/resource/phy03.sci.phys.mfe.zsnap/static-electricity-snap-crackle-jump/

There have been vast improvements in the design of the battery. We now have small high powered rechargeable batteries. The invention of the microchip has revolutionized the variety and quality of the personal electronic devises available today. Many of today's scientists are working to develop and improve sustainable sources of energy that don't deplete our natural resources. Perhaps one day **you** will discover how to harness the power of lightening to fuel our modern energy needs.