The NASA "Why?" Files
The Case of the Electrical Mystery

Program 3 in the 2000–2001 Series

Educator's Guide	
Teachers & Students	Grades 3-5

EP-2000-09-20-LaRC

The NASA "Why?" Files

whyfiles.larc.nasa.gov

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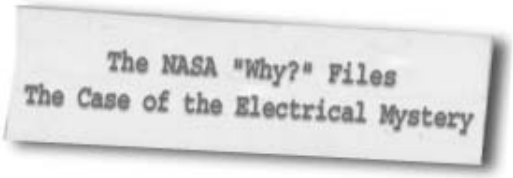
The American Institute of Aeronautics and Astronautics (AIAA) provides classroom mentors to educators who register for the NASA "Why?" Files. Every effort will be made to match a teacher with an AIAA member who will mentor the teacher either in person or by e-mail. To request a mentor, e-mail nasawhyfiles@aiaa.org

*Contact the AIAA to get a classroom mentor at **nasawhyfiles@aiaa.org**.*



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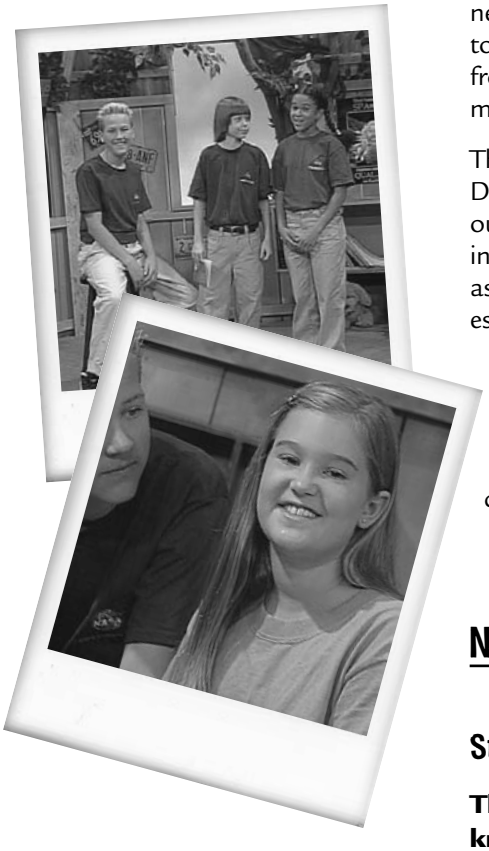
Program Overview



The tree house detective are eager to go swimming in Mr. E's pool, but a severe storm moves through the area of Wattsville. During the storm many neighborhoods lose electrical power. Once the storm ends, power is restored to most residents, but the tree house detectives notice that the houses across from the tree house are still without power, including Mr. E's house. This mystery becomes their "current" case to solve: *The Case of the Electrical Mystery.*

The tree house detectives are "charged" about this new case, and they visit Dr. D to get advice on how to solve the mystery. Dr. D directs them to various NASA researchers and offers "mini" science lessons throughout their investigation. The tree house detectives use their scientific inquiry skills, and as they gain knowledge about electricity, they periodically revise their hypothesis. With reports from I. M. Listening, KSNN (Kids Science News Network) reporter, they begin to unravel the solution to the case.

Tune in to see what is causing the houses across the street to be without power and to find out if the tree house detectives ever get to go swimming. Use your scientific investigation skills to cut through the "static" to discover the ending to the mystery.

National Geography Standards (grades 3–5)

Standard	Segment 1	2	3	4
The geographically informed person knows and understands:				
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire, process, and report information from a spatial perspective		✖		
Environment and Society				
How human actions modify the physical environment		✖		
The changes that occur in the meaning, use, distribution, and importance of resources		✖		
The Uses of Geography				
How to apply geography to interpret the present and plan for the future		✖		

National Math Standards (grades 3–5)

Standard	Segment 1	2	3	4
Numbers and Operations				
Understand numbers, ways of representing numbers, relationships among numbers, and number systems				✖
Algebra				
Represent and analyze mathematical situations and structures using algebraic symbols				✖
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement		✖	✖	✖
Apply appropriate techniques, tools, and formulas to determine measurements				✖
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them				✖
Select and use appropriate statistical methods to analyze data				✖
Problem Solving				
Solve problems that arise in mathematics and in other contexts				✖
Apply and adapt a variety of appropriate strategies to solve problems	✖		✖	✖
Communication				
Analyze and evaluate the mathematical thinking and strategies of others				✖
Connections				
Recognize and apply mathematics in contexts outside of mathematics	✖	✖	✖	✖
Representation				
Create and use representations to organize, record, and communicate mathematical ideas	✖	✖		✖
Use representations to model and interpret physical, social, and mathematical phenomena	✖	✖	✖	✖ ✖

National Science Standards (grades k–4)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, orders, and organization		✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖			
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understanding about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties of objects and materials	✖	✖	✖	
Light, heat, electricity, and magnetism	✖	✖	✖	✖
Earth and Space Science (D)				
Properties of earth materials	✖	✖		
Science and Technology (E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology	✖	✖	✖	✖
Science in Personal and Social Perspective (F)				
Types of resources		✖		
Science and technology in local challenges	✖	✖	✖	✖
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖

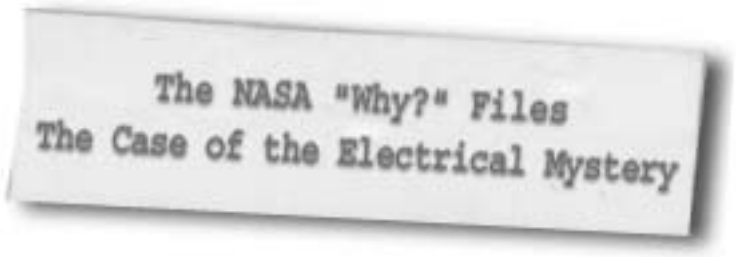
National Science Standards (grades 5–8)

Standard	Segment 1	2	3	4
Unifying Concepts and Processes				
Systems, order, and organization		✖	✖	✖
Evidence, models, and explanations	✖	✖	✖	✖
Change, constancy, and measurement	✖			
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	✖	✖	✖	✖
Understandings about scientific inquiry	✖	✖	✖	✖
Physical Science (B)				
Properties and changes of properties in matter	✖			
Transfer of energy	✖	✖	✖	✖
Earth and Space Science (D)				
Structure of the earth system	✖			
Science and Technology (E)				
Abilities of technological design	✖	✖	✖	✖
Understanding about science and technology	✖	✖	✖	✖
Science in Personal and Social Perspectives (F)				
Populations, resources, and environments		✖		
Natural hazards	✖			
Risks and benefits		✖		
Science and technology in society	✖	✖	✖	✖
History and Nature of Science (G)				
Science as a human endeavor	✖	✖	✖	✖
Nature of science	✖	✖	✖	✖
History of Science			✖	

National Educational Technology Standards (grades 3–5)

Performance Indicators for Technology-Literate Students

Standard	Segment 1	2	3	4
Basic Operations and Concepts				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	✖	✖	✖	✖
Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.	✖	✖		✖
Technology Productivity Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖		✖	
Technology Communication Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	✖		✖	
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.		✖	✖	
Use telecommunication and on-line resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.		✖	✖	
Technology Research Tools				
Use telecommunication and on-line resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.		✖	✖	
Use technology resources for problem solving, self-directed learning, and extended learning activities.		✖	✖	✖
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.				✖
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.		✖	✖	
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.		✖		✖



Segment 1

Once again the NASA "Why?" Files tree house detectives are involved in trying to solve a case. As a powerful thunderstorm approaches Big City, the tree house detectives decide that it would be best to cancel their plans to go swimming and leave the tree house to head for the safety of their homes. The storm knocks out power to many local residents, but it is quickly restored to all the residences except the houses located across from the tree house. The tree house detectives are puzzled by this occurrence, and they decide to make this their next case, *The Case of the Electrical Mystery*. With Dr. D's help, the tree house detectives learn about static electricity. Dr. D reviews how to conduct a scientific investigation and recommends they visit a NASA Langley researcher to gather information about lightning to help them solve the mystery.

Objectives

Students will
- experiment with static electricity.
- learn that charged objects attract neutral and other charged objects.
- learn that objects have a negative, positive, or neutral charge.
- discover that opposite charges attract and like charges repel.
- learn that an atom has a proton, an electron, and a neutron.
- learn that protons are positively charged and that electrons are negatively charged.
- discover that the fast movement of electrons through the air causes the air to heat and then to glow.
- learn how cloud-to-ground and cloud-to-cloud lightning forms.
- learn how lightning research helps to create safer commercial, fighter, and shuttle flights.

Vocabulary

amber - crystallized fossil form of the sticky resin product produced by some trees. It is capable of gaining a negative charge by friction.

discharge - the release of stored energy

electrical charge - amount of electricity in or on an object

electricity - a form of energy produced by the flow or accumulation of electrons

electron - a subatomic particle with a negative electrical charge

lightning - visible bright flash created from the discharge of the current between areas of opposite charges and between clouds or cloud-to-ground

neutron - a subatomic particle with a neutral (no) electrical charge

power outage - a loss of electrical power

power source - point from which the power flows, such as a battery

proton - a subatomic particle with a positive electrical charge

repel - to drive or to force back

severe thunderstorm warning - severe weather conditions exist and immediate action should be taken

static electricity - the buildup of electrical charges on a surface produced by contact and separation of dissimilar materials. In this type of electricity, the electrical charge is on something, and it does not move through a circuit.

thunder - sound heard from the rapid heating and expansion of the air around a lightning bolt which forms a sound wave

turbulence - a disturbance in the atmosphere caused by uplift of winds

Van de Graff generator - a machine that is used to produce very high voltoages; invented by physicist Robert Jemison Van de Graff in 1930

Video Component (15 min)

Before Viewing the Video

Introduce the video to the students by having them discuss what happened when the storm knocked out power in their homes. What were the effects?

1. Create a K-W-L chart as a class, which includes "What do we **know**?" (K),"What do we **want** to find out?" (W), and "What have we **learned**?" (L) The first two columns should be completed now, with the third completed later. Subjects might include electricity use in our daily lives, how batteries work, how lightning is made, and/or how electricity flows through wire. Reinforce with the students the rules of brainstorming:

   Accept all ideas from others, even if you don't agree with them.
   Don't criticize other people's ideas.
   Listen to other people's good ideas.

What do we **know**?	What do we **want** to find out?	What have we **learned**?

2. From the NASA "Why?" Files web site (see p. 24), download a copy of the Problem Board for the students to use while viewing the video. Have the students complete the chart as the tree house detectives complete their problem board. You may wish to pause the video, as appropriate, for students to record the information.

3. As a class project, collect information from the news media and the Internet about static electricity, lightning, and current electricity. You might explain that static electricity is what shocks you when you walk in bedroom slippers across a carpet and touch the doorknob. Current electricity is what we use with flashlights or electric appliances.

3. Review important safety rules when investigating electricity.

   Keep fingers and objects away from electrical outlets.
   Never fly kites near power lines.
   Never climb trees near power lines .
   Keep ladders and TV antennas away from power lines.
   Never overload outlets with too many plugs.
   Never pull a plug out by the cord.
   Never use radios or hair dryers around bathtubs or showers.
   Stay away from downed power lines and electric company substations.
   Keep a boat's mast away from power lines.
   Never work on an appliance or take it apart while it is plugged into the socket.

4. Have the students try out the simple static electricity experiments from the guide and the NASA "Why?" Files web site, http://whyfiles.larc.nasa.gov

After Viewing the Video

Discuss the questions that are asked at the end of the first segment.

- What are some reasons that Dr. D's train set doesn't work?
- What caused the power outage to happen on one side of the street and not the other?
- Did the lightning storm cause the power outage?
- How should the tree house detectives use what they have learned to investigate more?

2. Make a display board of the processes used in conducting a scientific investigation. You may wish to go to the NASA "Why?" Files web site, **http://whyfiles.larc.nasa.gov** to review and print information on scientific investigation from the previous programs. Include the following words on the display board: problem statement, research, materials, hypothesis, procedure, data, conclusion, variables, information, experiments, and questions. Some of these words may be used several times during an investigation. (For example, the detectives change their hypothesis several times as they discover new information.) Have the students write down the steps that the tree house detectives use to solve the problem during the four video segments.
3. Research the types of precautions that should be taken during thunderstorms and have the students use the resources below to prepare informational posters about the safety rules.
4. Investigate more activities in this guide and on the web site.

Careers

nuclear physicist
aerospace engineer
electrical engineer
meteorologist
storm chaser
physical science teacher

Resources

Books

Parker, Steve: *Eyewitness Science: Electricity.* DK Publishing, Incorporated, 1992, ISBN 1879431823

Birch, Beverly with Robin Bell Corfield: *Benjamin Franklin's Adventures with Electricity.* Barron's Educational Series, Incorporated, 1996, ISBN 0812097904

Granowsky, Alvin, Craig, and Joy Tweedt: *Zak and Ben.* Modern Curriculum Press, 1985, ISBN 0813651611

Leon, George de Lucenay: *The Story of Electricity: With 20 Easy-to-Perform Experiments*. Dover Publications, 1991, ISBN 0486255816

Web Sites

What is Energy?
The site introduces students to what energy is and provides further information on ten sources of energy including electricity.
http://www.eia.doe.gov/kids/

The Atoms Family
The web site has many fun pages to explore! The featured web page incorporates facts about electrical safety in a "What's Wrong with this Picture" format. It also includes experiments that put your knowledge of static and electrical to the test.
http://www.miamisci.org/af/sln/frankenstein/

Energy Quest's "The Energy Story"
This student friendly site provides a clear overview of electricity and highlights a balloon experiment that applies the concepts reviewed in the story.
http://www.energy.ca.gov/education/story/story-html/chapter02.html

Theatre of Electricity
This site features the electricity generator known as the Van de Graaff.
http://www.mos.org/sln/toe/construction.html

Lightning: The Shocking Story
The National Geographic web site features the science of lightning, striking lightning photos, stories of survivors of lightning strikes, and a static electricity experiment.
http://www.nationalgeographic.com/lightning/

NASA "Why?" Files Web Site
Official web site of the NASA "Why?" Files. Student, teacher, and parent friendly.
http://whyfiles.larc.nasa.gov

ALFY - The Kids Portal Playground: Electricity and Magnetism
ALFY's Picks has a number of web sites that are fun and educational. Magnets, magnetic forces, conductors, static electricity, and electricity are some of the topics you can explore on this colorful and fun-filled site.
http://www.alfy.com/Teachers/Teach/Thematic_Units/Electricity_Magnetism/EM_1.asp

NASA Research and Missions
Lightning Detection from Space: A Lightning Primer
The Lightning Primer provides information about Lightning and the history of the scientific research conducted to learn more about this natural wonder. NASA's Marshall Space Flight Center has played an important role in the collection and interpretation of lightning data gathered from space and on the ground. Review this site to see how this data is making a difference in future scientific ventures and studies.
http://thunder.msfc.nasa.gov/primer/primer2.html

Activities and Worksheets

In the Guide

On the Web

You can find the following activities on the Web at http://whyfiles.larc.nasa.gov.

Static Glow
Activity that lights a fluorescent bulb to demonstrate static electricity flow.

Parts of an Atom
A student assessment activity on the parts of an atom.

Dr. D's Lab Experiments

Try some of the experiments that Dr. D did in his lab.

Experiment 1

Tear a piece of paper into tiny pieces. Stroke a comb through your hair several times. Place the comb near the paper pieces.

What happened? _____

Why? _____

Experiment 2

Blow up a balloon and rub the balloon on your head. Place the balloon near the paper pieces and observe what happens. Repeat with salt or puffed rice.

Why are the paper and other objects attracted to the balloon? _____

_____

Do the objects stay attracted to the balloon? _____

Why or why not? _____

Rub the balloon on your head and try sticking the balloon to the wall.

Why does it stick? _____

Time how long the balloon stays up on the wall.

Why does the balloon eventually fall? _____

_____

What would make the balloon stay up longer? _____

_____

Rub the balloon on your head and hold the balloon near a small stream of water coming from your faucet.

What happened? _____

_____

Why? _____

Explanation

Static electricity exists whenever there are unequal amounts of positively and negatively charged particles present. Rubbing the balloon or comb on your hair makes the balloon or comb have more of one type of charge. The rubbing transfers the electrons from you to the balloon surface and gives the balloon a negative charge. As you bring the balloon near the objects, the balloon induces a positive charge on the objects and opposite charges attract. When the objects and the balloon touch, electrons flow from the balloon to the objects, giving the objects a negative charge. Now that the balloon and the objects both have the same charge, they repel each other; hence, they fall off the balloon.

Misconceptions

Static electricity is not caused by friction. It appears when two unlike materials make contact and then are separated. All that is required is the actual touching of the two materials. Rubbing will increase the total contact area between the materials and this will, in turn, make the materials more electrically dissimilar. Rubbing enhances static electricity, but it is not the cause.

Cling On

Purpose

To provide students with the opportunity to discover static cling and to observe how some objects attract and some repel.

Materials

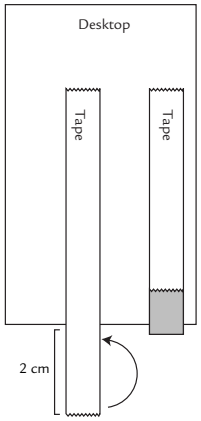
transparent tape in dispenser

science journal notebook

Procedure

1. Working with a partner, tear two strips of tape, each about 10 cm long from the tape dispenser.
2. Stick them to your desktop, leaving about 2 cm hanging over the edge.
3. Fold the edge back so that there's a nonstick part to hold onto. See diagram 1.
4. Hold onto the nonstick parts and slowly peel the strips off the desk, so that the tape doesn't curl.
5. Hold the two strips by their ends and bring them close together (nonstick sides). What happens? Record your observations in your science journal.
6. Now, have your partner gently rub a finger over both strips several times.
7. Bring the strips together again. What happened? Record your observations in your science journal.
8. Stick one of the strips back on your desk and stick the other one right on top of it.
9. Peel both strips off your desk and then gently peel both strips apart. Predict what will happen when you bring the two strips together. Have your partner record your prediction in your science journal.
10. Test your prediction and record your observations in your science journal.
11. Have your partner rub the strips several times again and predict what will happen when you bring the strips together after they have been stroked.
12. Test your prediction and record your observations in your science journal.

Diagram 1



Conclusion

What happened when you brought the strips of tape near each other the first time?____

_____

The second time?_____

_____

Why?_____

What happened after the tape was rubbed by your partner's finger?_____

_____

Why?_____

What other things have you seen that behave as the tape does?_____

_____

How were these other things like the tape?_____

How were they different?_____

Extension

1. Place some plastic drinking straws on a table. Charge a plastic pen with static by rubbing it with a wool cloth. Place the pen close to the straws.

   What happens?_____

   Why?_____

2. Try a variety of hairbrushes and combs made out of different materials like plastic, wood, or metal.

   Does your hair behave differently with each?_____

   Which one would give you a "bad" hair day?_____

3. Brainstorm for ideas about how static electricity is produced in nature.

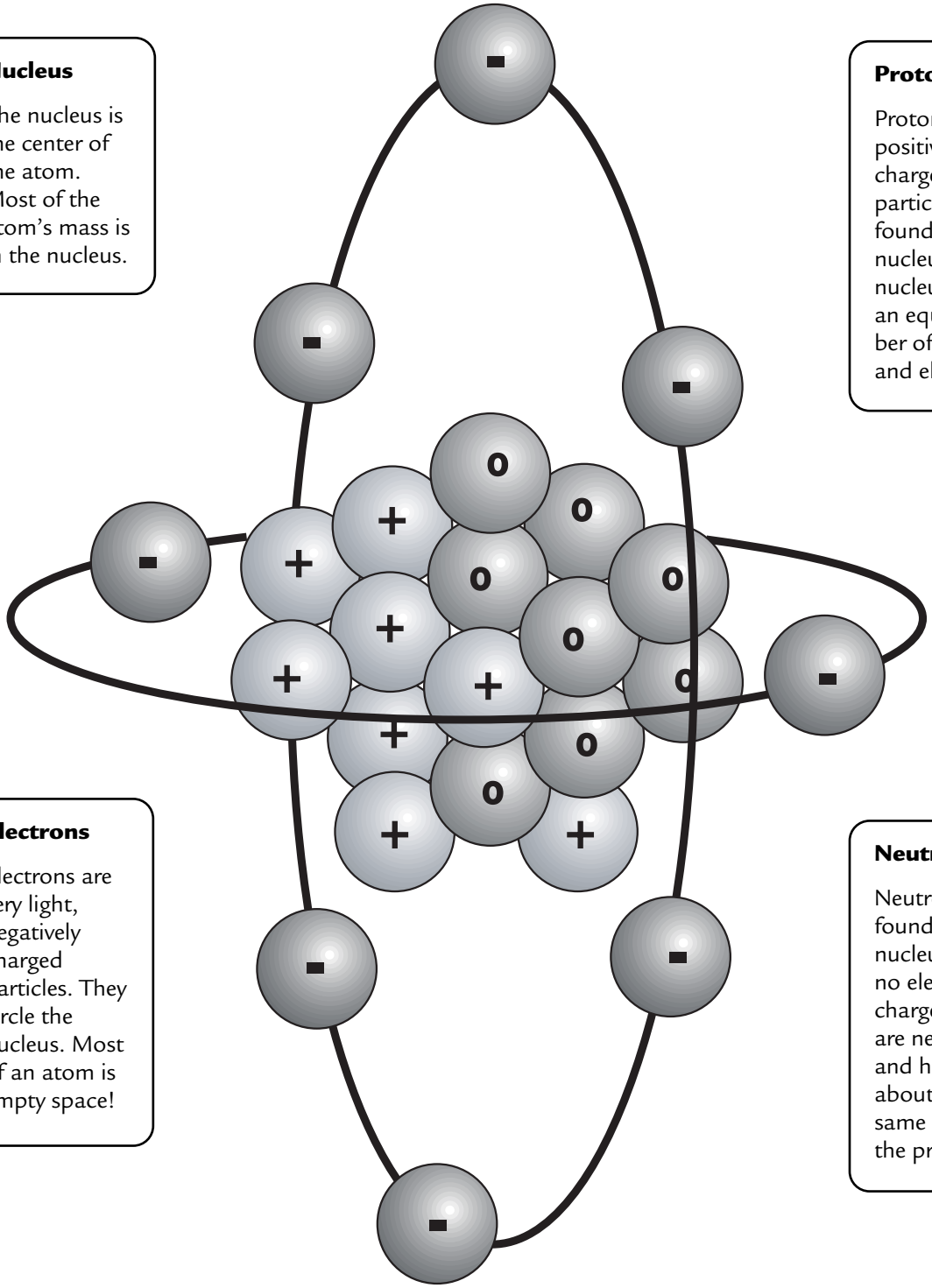
   Does weather make a difference?_____

Atoms & Atoms Everywhere

Read the clues and draw a line from the clue to the part of the atom that it describes.

Nucleus

The nucleus is the center of the atom. Most of the atom's mass is in the nucleus.



Protons

Protons are positively charged of particles found in the nucleus. The nucleus has an equal number of protons and electrons.

Electrons

Electrons are very light, negatively charged particles. They circle the nucleus. Most of an atom is empty space!

Neutrons

Neutrons, also found in the nucleus, have no electrical charge. They are neutral and have about the same mass as the proton.

Lightning – Folklore and Mythology

Many cultures have passed down stories about lightning over the centuries. The Greeks, Romans, and Norsemen all told stories of gods who ruled with lightning rods. Zeus was the king of the Greek gods who ruled from Mount Olympus. Zeus is the equivalent to the Roman god Jupiter, who protected the universe and Rome with his lightning bolt. Thor, a fierce warrior, was the Norse god who rode through the heavens during thunderstorms in his goat-pulled chariot. When Thor threw his hammer, lightning flashed throughout the skies.

1. Choose one of these three mythological gods or another of your own choosing and research the myth which surrounds him. You may use the Internet, books, encyclopedias, or other sources to conduct your research. Write a report on the mythical god that you chose and be sure to include several interesting facts!

2. Once you have researched your mythical god, create a story that depicts a day in his life. Be sure to include how he used lightning to control his world. Illustrate your story.

3. Investigate other cultures to determine whether they had mythical gods known for using lightning. Investigate folklore to see how other cultures explained lightning.

Benjamin, Oh, Benjamin

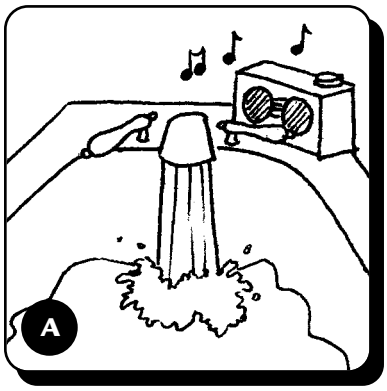
Was Benjamin Franklin's kite really struck by lightning? Why did Benjamin Franklin want to fly a kite in a storm? What did it prove? Was he the first one to perform this experiment? Was he doing research?

Investigate the true story of Benjamin Franklin and his flying electrifying kite experiment. Write a story for your local newspaper giving the who, what, where, when, and why of Benjamin Franklin and his famous experiment.

EXTRA! EXTRA!
READ ALL ABOUT IT!

CAPTION: _____

Staying Electrically Safe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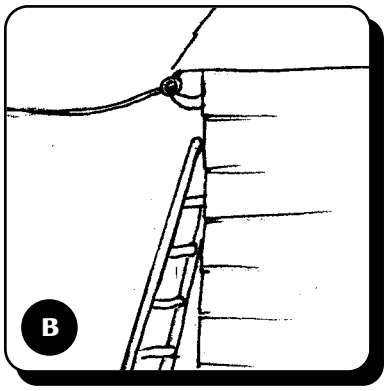
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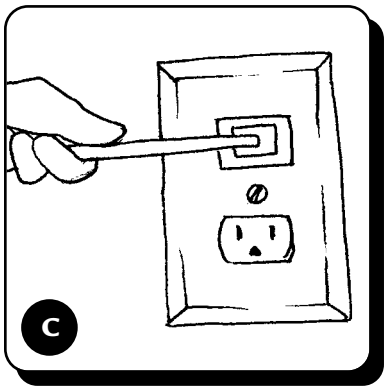
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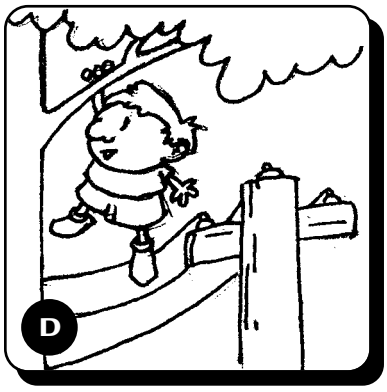
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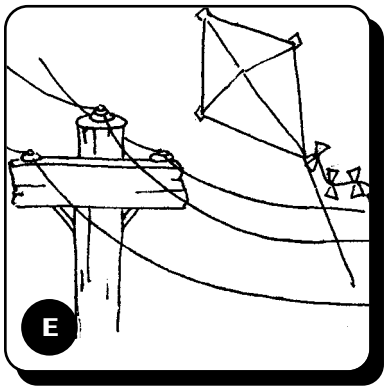
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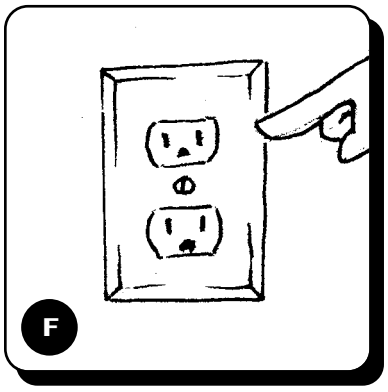
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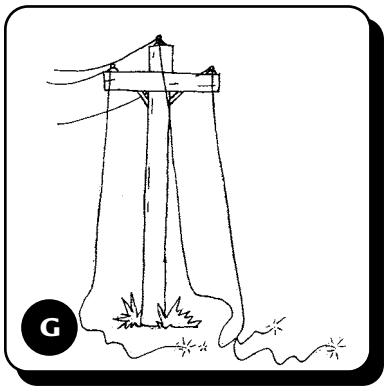
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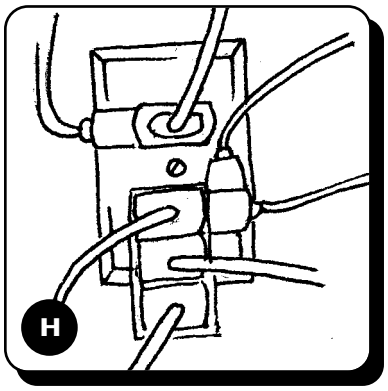
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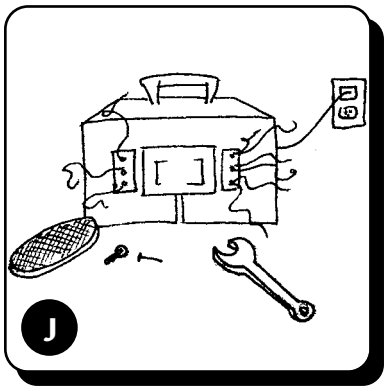
J

Match the safety rule to the appropriate picture.

_____1. Keep fingers and objects away from electrical outlets.
_____2. Never fly kites near power lines.
_____3. Never climb trees near power lines.
_____4. Keep ladders and TV antennas away from power lines.
_____5. Never overload electrical outlets with too many plugs.
_____6. Never pull a plug out by the cord.
_____7. Never use radios or hair dryers around bathtubs or showers.
_____8. Stay away from downed power lines and electric company substations.
_____9. Never work on an appliance or take it apart while it is plugged into the socket.