Insulators & Conductors

Strand		Force, Motion, and Energy
Topic		Constructing circuits
Primary SOL	4.3	The student will investigate and understand the characteristics of electricity. Key concepts include a) conductors and insulators.
Related SOL	4.1	The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) distinctions are made among observations, conclusions, inferences, and predictions; m) current applications are used to reinforce science concepts.

Background Information

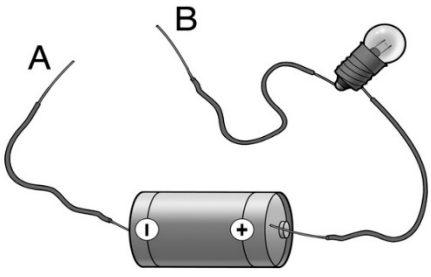
All matter is made up of tiny particles called atoms. At the heart of each atom is a group of protons which form a nucleus. Around the nucleus swirls a group of electrons which orbit much like a miniature solar system. Every atom wants to have the same number of electrons as it has protons. However, some electrons have more protons than electrons. When this happens, the atom will try to take an electron from another atom. Electricity is formed when a long string of atoms try to send electrons to each other.

As the electrons move, they carry an electrical charge with them, which we can use to power our homes and schools. Some materials, called insulators, do not give up electrons very easily. Other atoms hold their electrons very loosely, so electrons easily travel to and from them. These materials are called conductors. In order for electrons to transfer from one object to the next, they must travel through substances that do not hold on to their electrons very tightly. If they come in contact with an insulating material that will not give up its electrons, they will not be able to move further, and the electrical current will stop.

In a circuit, conductors are used to carry the electricity from the electrical source to the appliance. The motor and wires in the appliance are also conductors. The plastic or glass encasing the motor and parts of the appliance are insulators, which protect the electric charge from travelling to the outside of the appliance and creating potentially dangerous shocks.

Materials

- The same simple circuit kits from the Simple Circuit lesson. Kits should be already assembled.
  Each kit should include:
  - one D-cell battery
  - four wires, stripped on each end
  - one paper clip
  - two more paper clips or brass brads
  - two light bulb holders



- two light bulbs

Vocabulary

circuit, closed circuit, open circuit, insulator, conductor, electric current

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Ask students if they know why lightning hits trees and tall metal buildings, but not cars. Optional: Show a video of a lightning storm or a lightning strike
2. Explain that lightning travels through trees and metal because they are *conductors,* and does hit cars as often because they have rubber wheels, which are *insulators.*

Procedure

1. Review the difference between open and closed circuits, and remind students that circuits must have no gaps or break in them in order for electricity to get through. Tell students that some materials will carry electricity, and others will not.
2. Explain: Conductors are materials through which electrical charges flow easily. Metal, water, and trees are all examples of conductors.
3. Explain that insulators are materials that prevent electricity from flowing as easily. List rubber, plastic, and glass as examples of insulators.
4. Using your circuits from the previous lesson, remove the paper clip "switch." Connect other objects (listed on the "Testing Conductors and Insulators" worksheet) to the ends of the two wires to complete the circuit. Test different objects to see if they are conductors or insulators. If the light turns on, the object is a conductor. If it does not turn on, the object is an insulator. Have students record predictions and results on the table at the end of the "Testing Conductors and Insulators" worksheet. **10 minutes**
5. Explain: There are other materials besides wires that conduct electricity and can complete circuits. Think about trees during a thunderstorm. Lightning (the electrical source) wants to connect with the ground. Air resists electricity, and does not make a very good conductor. If electricity is close to a tree, it will jump to the tree instead of remaining in the air. Here, the tree completes the circuit by conducting the electricity in the lighting from the air to the ground. Conductors are materials that allow electricity to flow through them.
6. Explain: Water can often complete an open circuit if it gets inside electrical appliances. Think about the electricity that runs through an outlet or a power line. Electricity will naturally run to the ground, but since there is no wire or other conductor to carry it to the ground, it will remain in the power lines. However, if water comes in contact with electrical appliances or outlets, the water will complete the circuit. This is dangerous because it can cause fires.

7. Divide students into two teams. One team will represent the conductors and the other team the insulators. Allow teammates to work together to create a fun name for themselves. Have your conductor team create labels that say, "Conductor" and the team name out of sticky-notes, tape, or small shipping labels. Have the other team create labels with its team name and the word "insulator" on them. After each team has created at least two labels for each player, have the teams race to see who can use all of their labels to identify objects in their classroom as conductors or insulators. When the first team places its last label, the game pauses and students and teacher may check to make sure objects are labelled correctly. If the finished team has labeled any objects incorrectly, return the incorrect labels to the team, and continue to play until one of the teams runs out of labels again. Repeat this process until one team has correctly placed all of their labels. **10 minutes**

Conclusion

1. Explain to students that even though electricity is a valuable tool, it is very dangerous. Students must never touch or play near electrical equipment or bare wires.
2. Explain: Because trees are conductors, it is important to stay away from trees that have electrical wires passing near their branches. It is also important to stay away from trees and go inside during thunderstorms, when lightning could send an electrical current through the trees.
3. Note that water is also a conductor. This means that students should stay away from lakes, rivers, and even puddles when there is electrical equipment nearby or when they see signs of a thunderstorm.
4. Explain: In addition, water can conduct electricity inside the house. When electrical appliances get wet, the water serves as a conductor from the electrical supply, and can cause a fire or ruin the appliance. Thus, it is important to keep appliances away from bathtubs, sinks, and hoses, and to avoid spilling liquids around them.
5. Explain to students that, because people are primarily composed of water, they are also conductors.

    The human body is 60% water. Because humans are mostly composed of water, students are conductors, just like wires and trees! Tell students to watch out for safety hazards and stay away from electrical equipment and power lines. Only professional line technicians, with their special insulating uniforms, are qualified to touch these electrically charged lines and equipment. Stay safe and leave it to a line technician!

Assessment

- **Questions**
    - What are some examples of conductors and insulators in your home?
    - Why do you think electrical cords are covered in a rubber coating?

        The rubber provides insulation from the electricity running through the metal wires.
    - Seventy years ago, almost all electrical appliances were completely made out of metal. Now, most appliances are plastic on the outside. Why do you think this is?

The plastic casing insulates against electricity so the surfaces of electrical appliances do not carry dangerous electric shocks.

- **Other**
  - Have students complete the Conductors and Insulators identification sheet.
  - Have students choose one of the three prompts attached and finish the story. For differentiation, allow students to complete the story in the form of a picture book or a comic strip, if they like.

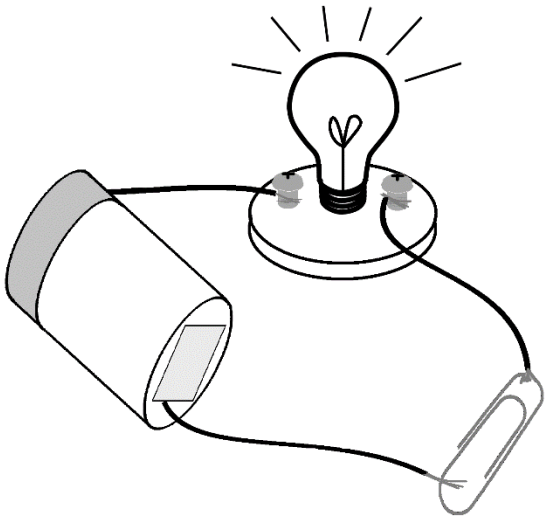
Extensions and Connections (for all students)

- Have students research Thomas Edison's invention of the light bulb. Study how he experimented with insulators and conductors in order to find a good substance to produce light.
- Have students take apart an unwanted appliance and look for conductors and insulators inside.

Strategies for Differentiation

- Allow students to use an audio recorder or a video recorder.
- Give clues to struggling students that point them in the right direction when selecting insulators and conductors.
- Work with struggling students in small groups to provide extra guidance as they assemble circuits and test conductors and insulators.
- Place struggling students in groups with gifted or excelling students, and have them work together.

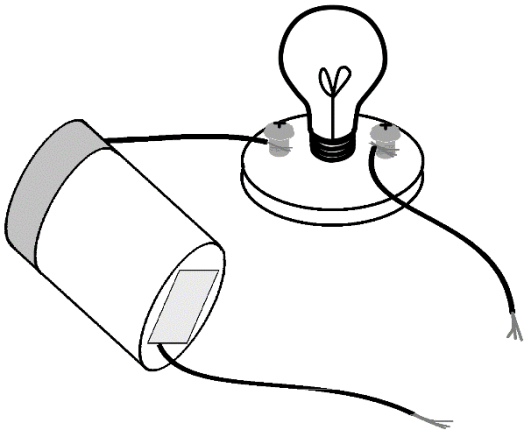
Testing Conductors and Insulators



1. Collect your materials.
    - 1 battery
    - 1 light bulb and bulb holder
    - 3 plastic-coated wires
    - Tape
    - All items listed in the Conductor Identification Table.

2. Build a simple circuit with a switch.

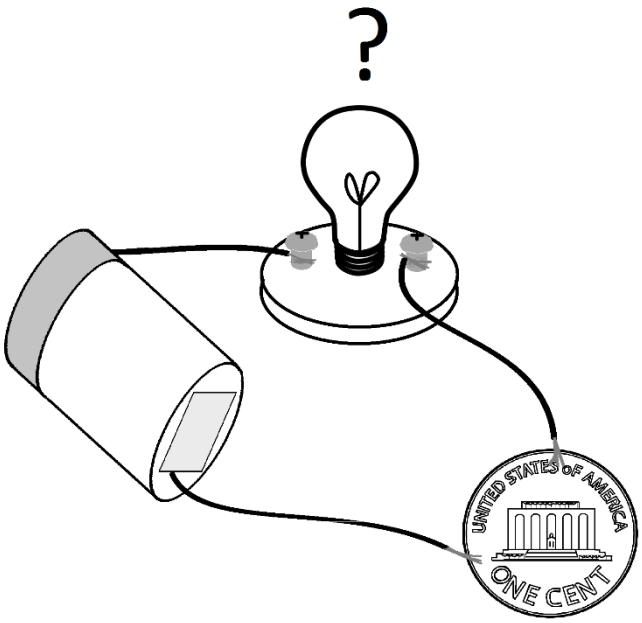
3. Remove the paper clip from the circuit



4. Look at the table below, and predict whether the objects will conduct electricity or insulate against it. Record your predictions.

5. Place the bare ends of the two loose wires on a penny, and see if the bulb lights up. Record the result in the "Results" column of the table.

6. Repeat step 5 for the other objects in the table below.



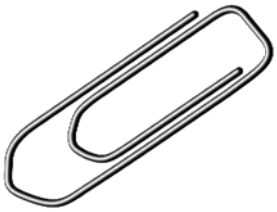
Material	Prediction	Result
Penny		
Nickel		
Grass		
Staple		
Pen		
Pencil Lead		
Eraser		
Tooth Pick		
Green Twig		
Water in a plastic/foam cup		
Soda in a plastic/foam cup		
Keys		
Notebook Paper		
Choose your own material:		
Choose your own material:		
Choose your own material:		

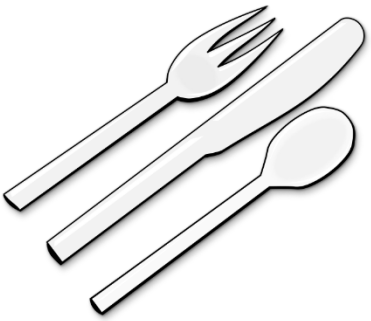
Stay Safe and Leave it to a Line Technician

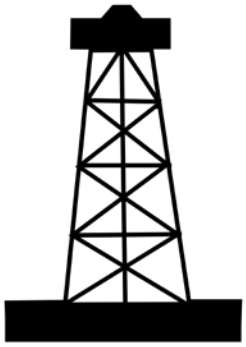
1. Keep fingers and other objects away from electrical outlets.
2. Never yank an electrical plug out by the cord.
3. If you see a broken outlet or a frayed electrical cord, don't touch it, and tell an adult.
4. Keep electrical appliances away from bathtubs or other liquids like drinks or cleaning solutions.
5. Always fly kites in open areas—never near power lines.
6. Never climb trees near power lines.
7. Stay away from downed power lines, transformers, and areas where line technicians are working.
8. Respect DANGER and WARNING signs.

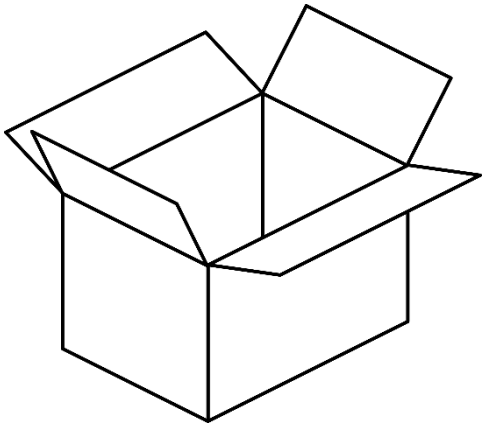
Conductors and Insulators Identification Sheet

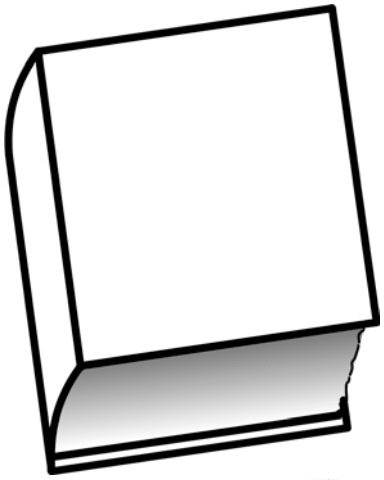
Circle the conductors and cross out the insulators on this page.

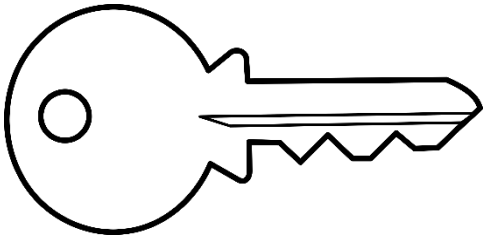


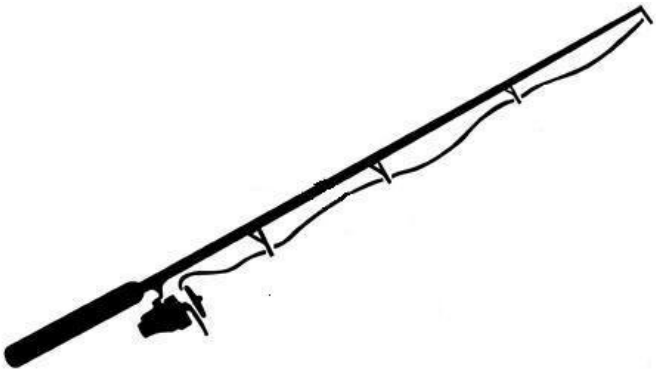












"Don't Complete the Circuit"

Writing Prompt

Lightning Liz looked up just in time to see a giant storm cloud roll over her head and block the sun. Before she had time to pack up her bag and grab her bike, huge pellets of rain began shooting towards the playground, hitting the metal slide, and bouncing off the light poles. Thankfully, Lightning Liz had remembered to bring her rain boots with her. She grabbed her shiny new umbrella. "Hurry, Liz!" Neon Leon yelled from under a tree, "It's safe and dry under here." As Liz ran to grab her bicycle, the sky lit up with a huge flash of lightning.

Finish the story by helping Neon Leon and Lightning Liz to stay away from conductors. Don't let them complete any circuits for the lightning. Remember to give your story a title.

"Electrical Safety Outside"

Writing Prompt

Neon Leon and Lightning Liz unrolled their kites and watched them soar into the air. When the wind began picking up, the kites danced toward the trees. "Let's move over to the clearing!" Neon Leon said. "There aren't any trees there because they had to make room for the power lines." "Alright," said Lightning Liz. On the way, Lightning Liz saw a transformer box. She was tired, and she thought the transformer would make a nice seat. Just as she was about to sit down on the box, Neon Leon saw a sign. "Lightning Liz, that sign says DANGER!"

Finish the story by helping Neon Leon and Lightning Liz to stay away from electrical hazards. Don't let them complete any circuits for the electricity. Remember to give your story a title.

"Electrical Safety Inside"

Writing Prompt

Lightning Liz measured out her ingredients and switched on the electric beater to mix up the batter. The eggs made her hands slippery, and she dropped the mixer into the bowl, getting it very messy. She put the mixer in the sink while Neon Leon grabbed a towel to wipe the mess off the counter. When she turned around, their dog was busy chewing on the mixer's electrical cord which dangled down from the sink. He had peeled a small section of the rubber coating off the cord. "Is it still safe to plug the mixer back in?" Lightning Liz asked Neon Leon. "There is still batter all over the motor and handle. Maybe we should put the whole thing in the sink first and get it clean."

Finish the story by helping Neon Leon and Lightning Liz to stay away from conductors. Don't let them complete any circuits in the kitchen. Remember to give your story a title.