THE SHOCKING TRUTH
Discovery Guide
Culver Company Booklet #36250

Discussion Guide for Teachers
For Grades 5-6

Introduction

This book is called *The Shocking Truth* for two reasons: "shocking" because shock is the most well-known injury that can result from carelessness around electricity; and "truth" because this is not a book of rules, it's a book about the underlying principles of electricity. So students can learn about electricity's nature and behavior and generalize that information to be able to problem-solve in any situation involving electricity.

The Shocking Truth will be most useful in science at the 5th and 6th grade level. Objectives, lesson strategies, assessment suggestions, and background information are given for each page. We have emphasized working in cooperative groups, but, of course, activities can be done by students individually.

Page 2

Subject: Science
How Long: 15 mins
Materials: Student booklet, marker

WE USE ELECTRICITY EVERY DAY WITHOUT KNOWING MUCH ABOUT IT

Objectives

Students will:

- Draw the flow of electricity from the power plant to an appliance, and back again to the distribution wires.

What You Need to Know

- Once electricity is generated, it must travel. It cannot be stored.
- Electricity travels only in a closed loop, called a circuit.
- When you turn on an electric appliance, you are closing the loop.

Getting It Across

1. Have students read the information and follow the steps on the page.
2. Have students partner and explain to each other where electricity comes from, how it travels, the work it does, and what happens to it after it has flowed through the appliances.

Did They Get It?

Are students able to:

- Identify the path that electricity travels to get to the lights in the classroom and back to the distribution grid?

Page 3

Subject: Science
How long: 45 minutes
Materials: Paper and pen
1 D battery/group
1 holiday mini light/group
(2-3" wire on each end)
Paper and pen

2 or 3 of each:
water in plastic bowl
foil
toothpicks
dry dirt
glass
paper clips
hose lengths
leather
plastic
tin can
paper
rubber band

ELECTRICITY FLOWS EASILY THROUGH CONDUCTORS

Objectives

Students will:

- Formulate operational definitions of insulators and conductors.

What You Need to Know

- Even a good insulator may conduct electricity if it is wet.
- Because the amount of electric current available from a D cell battery is small, students are able to work with these materials without injury. Remind students that connecting a circuit is only to be done under adult supervision.

Troubleshooting

Make sure that: the wire is connected firmly to both the battery and the trial material; and the trial material has good contact with the battery.

Preconceptions

Students may think that electricity can only travel through wires or metal.

Getting It Across

1. Have students read the information at the top of the page and divide into cooperative groups.
2. Students should first test their battery and light by connecting the two without any trial material in between.
3. Have groups share their predictions and results. Compare results among groups. Were the results the same? If not, why not? (Be sure the experimental set up was not at fault.) What conclusions can students draw about conductors and insulators?

Did They Get It?

Are students able to:

- List materials that are electrical conductors and insulators?
- Draw the path electricity traveled (circuit) made by their experimental set up?

What Else

Water is such a good conductor that most insulators will not work if they are wet. Have students wet their best insulator, observe what happens, and explain why it happened.

Page 4

Subject: Science
How long: 20 minutes
Materials: Student booklet, pen

ELECTRICITY ALWAYS TAKES THE EASIEST PATH TO THE GROUND

Objectives

Students will:

- Describe the path electricity travels in the illustration from the power line through the kite and the boy to the ground.
- Explain the difference between effects of low and high voltage.

What You Need to Know

- Electricity by its nature is attracted to the ground.
- If a person were in contact with electricity and the ground at the same time, he/she would be injured.
- Electricity is measured in volts, amps, and watts. Amps or amperes = the amount of electric current. Volts = the "pressure" under which that current flows. Watts = Volts x Amps. Watts measure the amount of work done by a certain amount of current at a certain pressure or voltage. (More info on watts, volts, and amps on pages 8 and 12.)

Getting It Across

1. Have students divide into groups, read the information on the page, and answer the questions.
2. Ask students to tell what the boy in the illustration might experience when his kite touched the electric lines. (These are high voltage wires, so it is unlikely that he would have muscle spasms. Other bodily effects apply.)
3. What could he have done to avoid the situation?

Did They Get It?

Are students able to:

- Describe the path electricity flows in the illustration?
- Define volts and amps?

Another Approach

Explain to students that electricity flowing through a wire is like water flowing through a garden hose. The amount of water depends on the diameter of the hose (amps). The pressure of the water depends on how far open the faucet is (volts). The amount of work that can be done (watts) depends on both volts and amps.

Have students test several drinking straws with different diameters. How hard do they have to suck to drink the same amount of water? Does the diameter affect how long it takes to drink the water?

What Else

Begin a class list of rules for safety around electricity. Post the list where students can make additions after each lesson. (From this page, students might suggest, "don't fly kites near power lines.")

Page 5

Subject: Science
How long: 15 minutes
Materials: Student booklet, pen

YOUR BODY CAN CONDUCT ELECTRICITY

Objectives

Students will:

- Predict whether or not an electrical shock is likely to occur and explain their reasoning.
- Infer that although the situation presented may not result in injury, it is still dangerous.

What You Need to Know

- Water is a good conductor of electricity. The human body conducts electricity because it is mostly water.
- Standing in a wet place and touching an electrical appliance can cause an electrical shock.
- Injury from electricity may not always occur because many variables influence any given situation. However, it is important to act as if danger were always present.

Preconceptions

The behavior of electricity is hard to predict. Students may think that because injury does not result from a dangerous situation, there is no danger present.

Getting It Across

1. Have students read the information and answer the questions in small groups. Discuss as a class.
2. Add some rules to the class list of electrical safety rules. (For example, handle with caution; remember danger is always present; don't assume it's not hot!)

Answers to Questions

- Prediction: The girls could experience electrical shock, if electricity found a way to flow from the motor or the power cord through the water on the ground and into one or both girls.
- Reason: The feet of both girls are probably wet. If there were any break in the mower's power cord, the girls could easily become part of electricity's path to ground. *However,* if there were no break in the cord, the girls might not be shocked. ***There is no way to tell if the situation is safe.*** (See story on page 15.)

Did They Get It?

Are students able to:

- Explain why there is danger of electrical shock in the situation portrayed?

What Else

Ask students to think of other situations like this one. (Answers might include washing the car and listening to a plug-in boom box or unplugging an outdoor appliance during a rainstorm.)

Page 6

Subject: Science
How long: 20 minutes
Materials: Student booklet, pen

ELECTRICITY, YOU, AND THE GROUND

Objectives

Students will:

- Describe the path that electricity could take to the ground in each example.
- Explain the danger present in the sample situations.

What You Need to Know

- In order to be injured by electricity, a person must be in contact with electricity and the ground or an object touching the ground.
- A person might not be standing directly on the ground, but electricity most likely will flow through the surface they are touching.
- Birds sit on electric lines mostly without injury because they are NOT touching the ground.

Preconceptions

Students may not understand that a tree, a ladder, or the floor is connected to the ground.

Students often think that because birds can touch electric lines without apparent harm, that human beings can, too.

Getting It Across

1. Have students read introductory information, divide into pairs, and answer the questions. Share their findings as a class.
2. Ask students how danger could be avoided in the given situations, and add their thoughts to the class list of electrical safety rules.

Answers to Questions

1. Paths to ground:
   - Picture 1: From the power line through the boy, entering through his hand and exiting through his knee or feet, whichever touches the tree first; through the tree to the ground.
   - Picture 2: Birds are not touching the ground, so the path to ground is incomplete and the birds are not injured.
   - Picture 3: From the heating element in the toaster through the metal fork, into the girl's fingers, exiting through her feet, through the floor to plumbing (wiring is often grounded to pipes), to the ground.
   - Picture 4: From the incoming power line through the hammer, into the man's hand, exiting through his legs or feet, through the metal ladder to the ground.
2. Answer given above.
3. A source of electricity and the ground.

Did They Get It?

Are students able to:

- Draw the path electricity would travel to the ground?
- Explain that they are in danger because they are always touching the ground?

Another Approach Ask students to find a way to not touch the ground. Remind them about insulators and how they might be useful in this situation. [Students might suggest standing on a fiberglass mat, wearing rubber soled shoes (not athletic shoes), or some way to hold a layer of air between them and the ground.]

Page 7

Subject: Science
How long: 15 minutes
Materials: Student booklet, pen

ELECTRICITY, YOU, AND WATER

Objectives Students will:

- Distinguish between safe and dangerous situations involving electricity and water.

Getting It Across

1. Divide the class into four groups and assign a picture to each one. Ask groups to act out the safe behavior in each situation. (For the telephone picture, ask students to make a list of *unsafe* situations involving the telephone and water.)
2. Add students' ideas to the class list of electrical safety rules.

Answers to Questions The top picture is safe. All the others are unsafe.

Did They Get It? Are students able to:

- Distinguish correctly between safe and unsafe situations concerning electricity and water?
- Describe safe alternatives to the ones given?

What Else Ask students to locate GFCIs in your classroom or school. What conclusions can they draw about where GFCIs are placed? (GFCIs are used outdoors and inside near water because those are the areas of greatest risk of contact.) Have they seen GFCIs embedded in appliance cords? Why are they placed there? (To perform the same function as a GFCI in the wall.) What kind of appliances are most likely to have a GFCI in the power cord? (Those to be used around water.)

Page 8

Subject: Science
How Long: One hour
Materials: Student booklet, pen

ELECTRICITY CAN SHOCK, BURN OR KILL YOU!

Objectives Students will:

〈 Practice converting from one unit of measure to another.
〈 Recognize the relationship of amperage, length of exposure, and bodily effects of contact with electricity.

Preconceptions

Students will probably think that lower amperages are less dangerous than high amperages. However, at the 5-10 mA level, the muscles become paralyzed and a person can't let go which lengthens their exposure and increases the level of injury.

Getting It Across

1. Ask students to look at the question in the lower righthand corner and study the page to find the answer. Is the amount higher or lower than they expected?
2. Have students work in pairs to answer the questions on the chart.

Answers to Questions

1. If 1 milliamp (mA) equals 1/1000 of an amp, then 1 amp would equal 1000 milliamps.
2. 1000 W x 10 mA/W = 10,000 mA.
3. 1 amp = 1000 mA. Therefore, the effect would be Probably Fatal.

Did They Get It?

Are students able to:
〈 Explain why low amperage can be just as dangerous as high amperage?
〈 Accurately convert units of amperage?

What Else

1. Watts = Volts x Amps. Assume you have a 1000 W hairdryer plugged into a 120 V circuit. How much amperage is available? (1000/120 = 8.33 amps) What would happen if you accidentally came into contact with that much amperage? (8 A x 1000 mA/A = 8000 mA. Effect is Probably Fatal.)

Page 9

Subject: Science
How Long: 15 minutes
Materials: Student booklet, pen

SOMETIMES THE DANGERS OF ELECTRICITY ARE NOT OBVIOUS

Objectives

Students will:
〈 Apply what they know to new situations involving electrical equipment and installations.

What You Need to Know

An electrical arc is a sudden flash of electricity between two points that are not touching. Arcs are very hot, and they can shock a person and start fires.

Preconceptions

Students may think that because electrical equipment is all around them, electricity is not dangerous.

Getting It Across

1. Have students read the information and do the matching exercise.
2. Ask students to discuss with a partner if there is any way a person can tell there is danger from electricity in each picture. Go over each picture as a class, identifying possible points of contact and the path electricity would travel to the ground.
3. Add to the class list of electrical safety rules.

Answers

Reading from left to right, top to bottom:

F: When wires overheat, they can cause fires from the heat itself, or from sparks generated when insulation melts and the exposed wires touch.

B: In substations, equipment is located close together, so the danger of even light casual contact is high. Because of the amount of voltage in substations, a person does not have to contact equipment for electricity to arc to the person and shock him/her.

E: Padmounted transformers must be locked, because contact with the equipment inside would cause electrocution. If there is an equipment failure, the box might become energized, posing another risk of contact with electricity.

D: Overhead transformers do not pose as great a threat as padmounted transformers because they are much less accessible. However, the risk of shock and/or death is the same.

C: Most electric lines that appear to be insulated are only weather-proofed, which will not protect you from shock. Even if the line is insulated, the tiniest pinhole or break in the insulation puts you at risk.

A: Transmission towers may look fun to climb, but the danger of arcing is high. In addition, if there is an equipment failure, the tower itself could be energized.

Did They Get It?

Are students able to:

〈 Trace the path to ground from point of contact in each example?

Another Approach

Take students outside the school building and locate lines, transformers, and where the electrical lines enter the school and other nearby buildings. What other equipment can they see? (The electric meter.) What is it used for? (To measure how much electricity is used in the school.)

Page 10

Subject: Science
How Long: 15 - 50 minutes
Materials: Student booklet, pen

STAY AWAY FROM ELECTRIC LINES AND UTILITY EQUIPMENT!

Objectives

Students will:

〈 Demonstrate their knowledge of safe behaviors around electricity.

What You Need to Know

If you choose to use the extended activity suggested below, students may need a chance to observe electrical equipment found on their way to school before they can draw a map.

Getting It Across

1. Have students read the information and work the maze.
2. Discuss the printed directions in the maze as a class. What makes the dead-end choices wrong? (Danger of contact with electricity is present in each one.)

Did They Get It?

Are students able to:

〈 Distinguish correctly between dangerous and safe situations in the maze?

What Else

Ask students to draw a map of their route to school. Mark the places where electrical equipment is placed (including overhead lines). Indicate places where there is danger of electrical contact.

Page 11

Subject: Science
How Long: 15 min
Materials: Student booklet, pen

PEOPLE WHO WORK WITH ELECTRICITY USE SPECIAL PROTECTIVE GEAR

Objectives

Students will:

〈 Distinguish between safety gear and every day wear.
〈 Explain why special precaution is needed to work around electricity.

Preconceptions

Students may think that, if rubber is an insulator, then the rubber soles on their athletic shoes or latex kitchen gloves will protect them from electricity.

Getting It Across

1. Have students work in groups to select the correct choice and explain their choices.
2. Add students' conclusions to the class list of electrical safety rules.

Answers

Hard Hat: The hard shell protects the head from bumps and falling objects. A baseball cap would not.

Safety Glasses: The plastic lenses will not break, and the edges are sealed so nothing can enter the eye from outside.

Safety Gloves: Heavy duty rubber protects the lineworker's hands. The gloves are rated to be safe at different voltage levels. Lineworkers test the gloves every day for holes. The rubber gloves are covered by leather outer gloves which protect the rubber gloves from harm.

Did They Get It?

Are students able to:

〈 Describe the difference between safety gear and ordinary wear?

What Else

Ask your local electric company to send someone to your school to demonstrate safety equipment used by lineworkers.

Page 12

Subject: Science
How Long: 30 minutes
Materials: Student booklet, pen

BROKEN OR DOWNED POWER LINES ARE ALWAYS DANGEROUS

Objectives

Students will:

- Apply their understanding of the principles of electrical safety to a new situation.
- Communicate their hypotheses about appropriate behavior in a specific situation.

What You Need to Know

- This page is the first introduction to the idea that other people may not be able to help someone trapped in a car with a power line on it. The best help onlookers can be is to call the utility company for help.
- It is essential that a person leaving an energized car does not step out of it because he/she would become a path to ground.

Getting It Across

1. Before students read any information on this page, ask them to think about how to avoid becoming a path to ground, if they were in a car that had a power line on it. (Their first answer should be to just stay inside the car until help arrives. If they had to leave, they would jump, not step, from the vehicle. Students probably will not know that they should shuffle or roll away.)
2. Have students work in groups to read the information in each white block and discuss the outcomes as a class. (See answers below.)
3. Ask a volunteer to put a chair in front of the class and demonstrate how to jump from a car to the ground, then roll or shuffle away.
4. Add to the class list of electrical safety rules.

Answers

1. When you are in the car, you are not part of the path to ground. Why? (Like birds on a wire, the person is not touching the ground.)
2. Don't touch the car and the ground at the same time. Why not? (The person would become a conductor for the electricity in the car to go to ground.)
3. Don't try to help someone else from the car while you are standing on the ground. Why not? (As soon as you touch that person, the electricity in the car would flow through him/her and through you to the ground. You could both be killed.)
4. *Bottom of page:* If by accident a person touched Point A and Point B at the same time, what amount of voltage would flow through the person's body? (3500 V - 1000 V = 2500 V) The person would be killed.

Did They Get It? Are students able to:

- Correctly hypothesize the appropriate behavior in the situation given?
- Describe the precautions taken to avoid becoming a path to ground in this situation.

What Else? Ask students to go home and practice appropriate safety behaviors for this situation with their families. Ask them to report the results of their practice.

Page 13

Subject: Science
How Long: 15 minutes
Materials: Student booklet, pen

WHAT TO DO IN AN ELECTRICAL FIRE

Objectives Students will:

- Recognize that electrical fires cannot be put out with water.
- Identify several causes of electrical fires and describe what to do.

Getting It Across

1. Ask students to read the information on the page, to name two causes of electrical fires, and to identify the steps to take in event of an electrical fire.
2. Ask the class to answer the question at the bottom of the page. (Putting water on an electrical fire would increase the risk of electrical shock by giving electricity a conductor through which to travel away from the point of contact both on the ground and back through the stream of water to the rescuer.)

Did They Get It? Are students able to:

- Describe accurately the risks of putting out an electrical fire with water?
- Identify causes of electrical fires and steps to take in case of fire?

What Else? Ask students to plan an emergency escape route with their families. Ask them to draw a map of the route and share it in class with a small group. What features do different plans have in common?

Page 14

Subject: Science
How Long: 15 minutes
Materials: Student booklet, pen

WHAT TO DO IF SOMEONE HAS BEEN SHOCKED OR BURNED BY ELECTRICITY

Objectives Students will:

- Recognize that in an electrical emergency, the best help may be to stay away.
- Identify three steps to take in an electrical emergency.

Preconceptions

Students may think that if a person is already shocked or burned, the danger is over. But if the source of electricity is still live and near or touching the victim, the situation could be deadly for someone who approaches too closely.

Getting It Across

1. Ask students to read the information on the page. Ask them, why might the best help be to stay away from someone who has been shocked or burned? (Because the helper could become part of the path to ground and also get hurt.)
2. Ask students to answer the THINK question in a small group. Then have each group share their answer.
3. Ask the class to name the steps to take in event of an electrical emergency. (1: Tell an adult to pull the plug from the outlet or turn off the power at the fuse box. 2: Call for help. 3: when you are sure there is no danger, tell an adult to give first aid. Proper steps are listed on page 14.)

Did They Get It?

Are students able to:

- Describe the dangers to the rescuer in an electrical emergency?
- List appropriate steps to take?

What Else?

Ask students to review the class list of electrical safety rules and make any necessary additions.

Page 15

Subject: Science
How Long: 15 mins + 45 mins (to share stories)
Materials: Student booklet, pen

ELECTRICITY CAN BE DANGEROUS!

Objectives

Students will:

- Analyze information in a story to find the cause of an electrical emergency.
- Organize information from an interview to show the cause and effect of an electrical accident.

Getting It Across

1. Ask students to read the information on the page. Ask them what actually caused Ellen's electrical accident. (Water in the grass conducted electricity from the mower's power cord to Ellen.) What saved her life? (That her friend pulled the power cord out of the socket.)

2. Ask students to find someone to interview about an electrical accident they experienced. Have students schedule an interview and write a story or summary of what happened, using the questions listed on page 15. Students may share their stories with a partner or as a class.

Did They Get It?

Are students able to:

- Name the causes of electrical accidents in the example given and in their own interview?

What Else?

Students might be able to invite someone to class who survived an electrical accident. Have students prepare questions to ask the speaker similar to those given.

Page 16

Subject: Science, Language
How Long: 15 minutes
Materials: Student booklet, pen

STAY SAFE AROUND ELECTRICITY!

Objectives

Students will:

- Review principles of electrical safety.

What You Need to Know

The puzzle summarizes the information in the booklet. Have students do the puzzle as a class and discuss each word.

Did They Get It?

Are students able to:

- Recognize appropriate vocabulary and concepts?

What Else?

Ask students to review the class list of electrical safety rules and make any necessary additions. Put the list in a form that students can take home to their families.