Solid Conductors

Part of the IEEE Teacher In-Service Program - www.ieee.org/organizations/eab/precollege
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Lesson Focus

Demonstrating the concept of conducting or insulating electricity, while identifying how different materials serve as conductors. Note: This lesson plan is designed for classroom use only, with supervision by a teacher familiar with electrical and electronic concepts.

Lesson Synopsis

The Solid Conductors activity encourages students to test different classroom materials to determine if they are conductors or insulators of electricity. Students work in teams testing their hypotheses about each material, then groups compare results and discuss findings.

Age Levels

8-11.

Objectives

- Learn that different materials have different electrical properties.
- Learn the roles of insulators and conductors.
- Learn to predict outcomes and draw conclusions.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- electrical properties of different materials
- conductors and insulators
- circuits and current
- making predictions and testing a hypothesis

Lesson Activities

Students test materials a variety of easy to find solid materials in a circuit to determine whether they serve as an electrical conductor. Students make hypotheses about each item and discuss the results in teams and as a class. Student teams also construct their own circuit tester using wires, batteries, cardboard, metal paper fasteners, and a bulb.

Resources/Materials

- Teacher Resource Document (attached)
- Student Resource Sheets (attached)
- Student Worksheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- IEEE Teacher In-Service Program
  (www.ieee.org/organizations/eab/precollege/tispt)
- IEEE Virtual Museum (www.ieee-virtual-museum.org)
- ITEA Standards for Technological Literacy: Content for the Study of Technology
  (www.iteawww.org/TAA/Publications/STL/STLMainPage.htm)
- McREL Compendium of Standards and Benchmarks
  (www.mcrel.org/standards-benchmarks)
  A compilation of content standards for K-12 curriculum in both searchable and browsable formats.
- National Institute of Standards and Technology (NIST) (www.nist.gov)
  Information about measurements and measurement uncertainty.
- National Science Education Standards (www.nsta.org/standards)

Recommended Reading

- DK Eyewitness Series: Electricity (ISBN: 0751361321)
- My World of Science: Conductors and Insulators by Angela Royston
  (Heinemann Educational Books, ISBN: 0431137269)

Optional Writing Activity

- Write an essay (or paragraph depending on age) about the history of electricity.

References

IEEE Teacher In-Service Program
www.ieee.org/organizations/eab/precollege/tispt

Solid Conductors

For Teachers:
Alignment to Curriculum Frameworks

Note: All Lesson Plans in this series are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principals and Standards for School Mathematics.

◆National Science Education Standards Grades K-4 (ages 4 - 9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- Light, heat, electricity, and magnetism

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Understanding about science and technology

◆National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- Properties and changes of properties in matter
- Transfer of energy

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Understandings about science and technology

◆Standards for Technological Literacy - All Ages

Design

- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Solid Conductors

For Teachers:
Teacher Resources

◆ Materials

- Student Reference Sheets
- Student Worksheet
- One set of circuit materials for each group of students:
  - 3 pieces of 6" bell wire (6" each) (strip the ends)
  - 1 Side D batteries and holder
  - Socket and 1.5 volt bulb
  - small piece of cardboard
  - two metal paper fasteners
  - Solid materials for testing (coin, paperclip, nail, pencil, metal spoon, plastic spoon, bobby pin, hair clip, etc.)

◆ Procedure

1. Provide Student Reference sheets to students as advance reading material.
2. Have one set-up already prepared as an example.
3. Divide students into groups of 4-5 students.
4. Ask the groups to create a solid conductor testing set up, with wires, batteries, bulb (as shown in Student Worksheet).
5. Provide student teams with a variety of solid materials and ask them to predict whether each will serve as a conductor of electricity. In the set up, electricity must flow through the object being tested in order to light the bulb. Students record their predictions for each material on the Student Worksheet.
6. Student groups should then test each material using their solid conductor testing set up and describe the results on the Student Worksheet.
7. Student groups report their individual predictions, findings, and surprises to the class.

◆ Time Needed

1-2 class periods

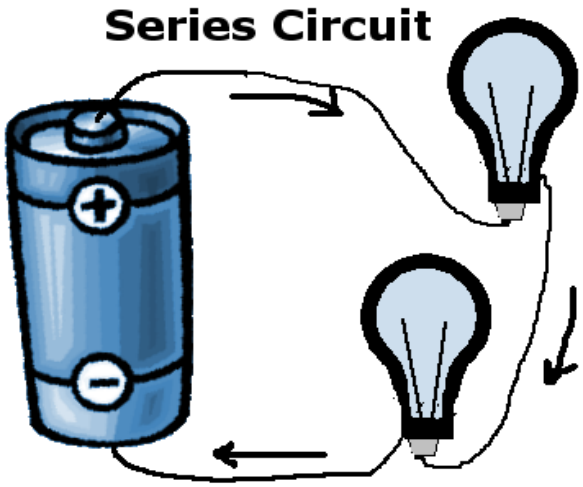
◆ Tips

- Teachers may want to encourage students to bring items in from home to test.
- Teacher may want to assign the Student Reference Sheet as advance reading homework.

Student Resource:
What is a Simple Circuit?

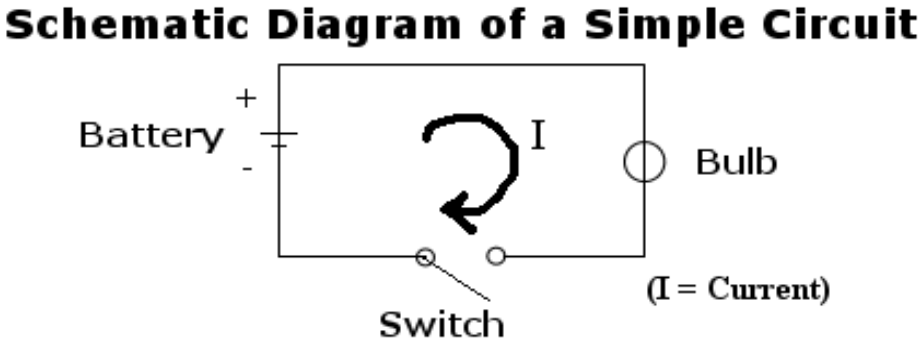
◆ Simple Circuit

A simple circuit consists of three minimum elements that are required to complete a functioning electric circuit: a source of electricity (battery), a path or conductor on which electricity flows (wire) and an electrical resistor (lamp) which is any device that requires electricity to operate. The illustration below shows a simple circuit containing, one battery, two wires, and a bulb. The flow of electricity is from the high potential (+) terminal of the battery through the bulb (lighting it up), and back to the negative (-) terminal, in a continual flow.



◆ Schematic Diagram of a Simple Circuit

The following is a schematic diagram of the simple circuit showing the electronic symbols for the battery, switch, and bulb.



Solid Conductors

Student Resource:
What Are Conductors and Insulators?

◆ Conductors/Conductivity

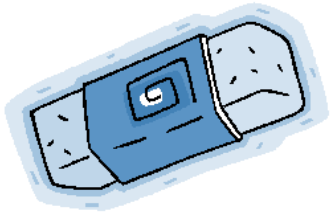
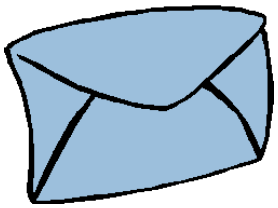
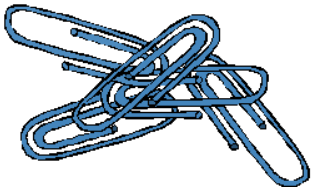
Conductivity is the ability or power to conduct or transmit heat, electricity, or sound. Conductors are materials that electricity easily passes through, that do not resist the flow of electricity. Examples are copper, aluminum, steel, silver, gold, electrolytes. Not all materials conduct electricity equally well.

◆ Insulators

Insulators are materials that resist the flow of electricity, so electricity does not easily pass through. Examples are plastic, wood, rubber, cloth, air, glass. Some materials are better electricity insulators than others.

◆ Challenge

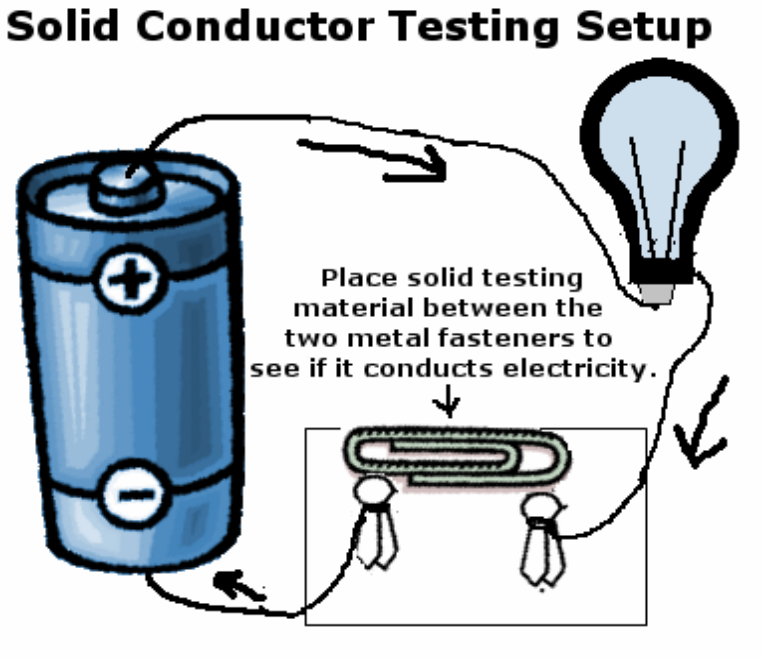
Do you think the following items are more likely conductors or insulators?

 **Eraser** ☐ Conductor ☐ Insulator	 **Metal Pen** ☐ Conductor ☐ Insulator	 **Paper Envelope** ☐ Conductor ☐ Insulator
 **Pencil** ☐ Conductor ☐ Insulator	 **Paper Clip** ☐ Conductor ☐ Insulator	 **Chalk** ☐ Conductor ☐ Insulator
 **Coin** ☐ Conductor ☐ Insulator	 **Spoon** ☐ Conductor ☐ Insulator	 **Nail** ☐ Conductor ☐ Insulator

Student Worksheet:
Testing Solid Conductors

◆ Solid Conductor Testing Set Up

You can make a solid conductor testing set up with a battery, three wires, and a bulb as seen below. If a material is placed between the two metal fasteners that does conduct electricity, the bulb will light up. If the material placed between the fasteners does not conduct electricity, the bulb with not light up. In a way, by introducing a solid conductor into the circuit, and then removing it, you are creating a switch.



Next, make your own solid conductor testing device and then complete the questions on the next page. You'll first predict whether you think certain materials will perform as conductors or insulators, then test your hypotheses.

Solid Conductors

Student Worksheet (continued): Testing Solid Conductors

Instructions:
In the table below, list the items your team will test. Then, discuss as a group whether you think the object will be a conductor or insulator of electricity. Once you've make your predictions, test each item with your "solid conductor testing device" and indicate your findings in the right column.

Solid Objects To Be Tested	Prediction: Will the Object Conduct?		Testing Result: Was it a Conductor?	
	Yes	No	Yes	No

◆ What objects did not have the results you expected? Why do you think those items did (or did not) conduct electricity?

◆ What would be a good material for an electrician's glove to be made of? Why?