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Electrical Connections

Table of Contents

Topic
Electrical conductors and insulators

Key Question
What materials will conduct electricity?

Learning Goal
Students will test a variety of materials to determine if they are conductors or insulators.

Guiding Documents
Project 2061 Benchmarks
- *Make safe electrical connections with various plugs, sockets, and terminals.*
- *Keep records of their investigations and observations.*

NRC Standards
- *Electricity in circuits can produce light, heat, sound, and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.*
- *Plan and conduct a simple investigation.*
- *Employ simple equipment and tools to gather data and extend the senses.*

Science
Physical science
- electricity
  - conductors
  - insulators

Integrated Processes
Observing
Predicting
Comparing and contrasting
Drawing conclusions

Materials
For each group:
- wire with ends stripped, 15-25 cm
- D cell
- bulb
- tape
- materials to be tested (see student page)

For each student:
- student pages

Background Information
A direct electrical current is a steady flow of electrical charges through a medium called a *conductor*. In solid conductors (which include all metals), it is the negatively charged electrons that flow and make up the electrical current. Metals have some electrons that are not tightly bound to any single atom; they are free to move about from atom to atom. These electrons are called *conducting electrons*.

Positive charges do not flow in a solid conductor, since the positively-charged protons are bound within the nuclei of atoms. These atoms are locked in the grid-like structure of the solid material and are not free to move. Therefore, the current in a solid conductor is caused by the movement of negative electric charges (electrons).

In liquids that conduct electricity, the electrical charges that flow can be positive, negative, or both. The negative charges are provided by either free electrons or *negative ions* (atoms or molecules with extra electrons). The positive charges are provided by *positive ions* (atoms or molecules that are missing electrons).

Materials that do not normally conduct electricity are called *insulators*. Other materials that conduct electricity to a lesser degree than conductors, but more than insulators, are called *semiconductors*; these are of great importance in electronics. *It is important to note that at certain voltages and temperatures, all materials will conduct electricity to some degree.* Even air, which is normally an excellent insulator, will conduct electrical charges when the voltage is high enough; lightning illustrates this. The only perfect insulator is a vacuum.

Management
1. Students should work in groups of two to four.
2. Beforehand, make a sample circuit to test the conductivity of materials and show students.
3. Bulbs (item number 1962), wire (item number 1968), and wire strippers (item number 1970) are available from AIMS.

Procedure
Part One
1. Distribute materials to each group.
2. Show students how to build a circuit to test the conductivity of materials using the D cell, wire, and light bulb.

3. For the first five objects listed, have students predict whether or not the object will conduct electricity. Instruct them to place the object in the circuit and record the results.
4. Have students pick five additional objects to test, and repeat the process.
5. Discuss the results and have students write conclusions in the space provided. Make sure that students note that some objects, like the pencil, are both conductors and insulators, depending on what part of the object is placed in the test circuit.

Part Two

1. Using the first page for reference, have students list the conductors and insulators in the appropriate boxes on the second page.
2. Discuss common characteristics of the conductors. Have the students record these characteristics in the space provided.
3. Discuss common characteristics of the insulators. Have the students record these characteristics in the space provided.
4. Distribute the third page. In the appropriate areas of the Venn diagram, have the students write the names of the objects tested. Discuss the results.

Connecting Learning

1. How are all the conductors alike?
2. How are all the insulators alike?
3. What distinguishes a conductor from an insulator?
4. Are there any objects that are both conductors and insulators? [pencil] How is this possible?
5. What other things do you think might be conductors?
6. What other things might be insulators?
7. Why are many wires coated with plastic or some other material?
8. What are you wondering now?

Extensions

1. Test other objects to see if they are insulators or conductors.
2. Build a different circuit to test the conductivity of materials.
3. Build a circuit to test the conductivity of various liquids.

Curriculum Correlation

Health

Discuss the importance of insulators to health and safety. Identify some of the places insulators are used in the classroom.

Conductor or Insulator?

Key Question

What materials will conduct electricity?

Learning Goal

Students will:

test a variety of materials to determine if they are conductors or insulators.

Conductor or Insulator?

A *conductor* is any item that allows electrons to flow freely through it. The light bulb should light.

An *insulator* is any item that does not allow electrons to flow easily through it. The bulb will not light.

Tape one end of the wire to the bottom of the cell. Wrap the other end of wire around the metal side of the light bulb. Tape it securely in place.

Test each item. Record your findings in the table below.

Item	Prediction	Conductor	Insulator
paper clip			
tape			
pencil			
string			
ruler			

Conductor or Insulator?

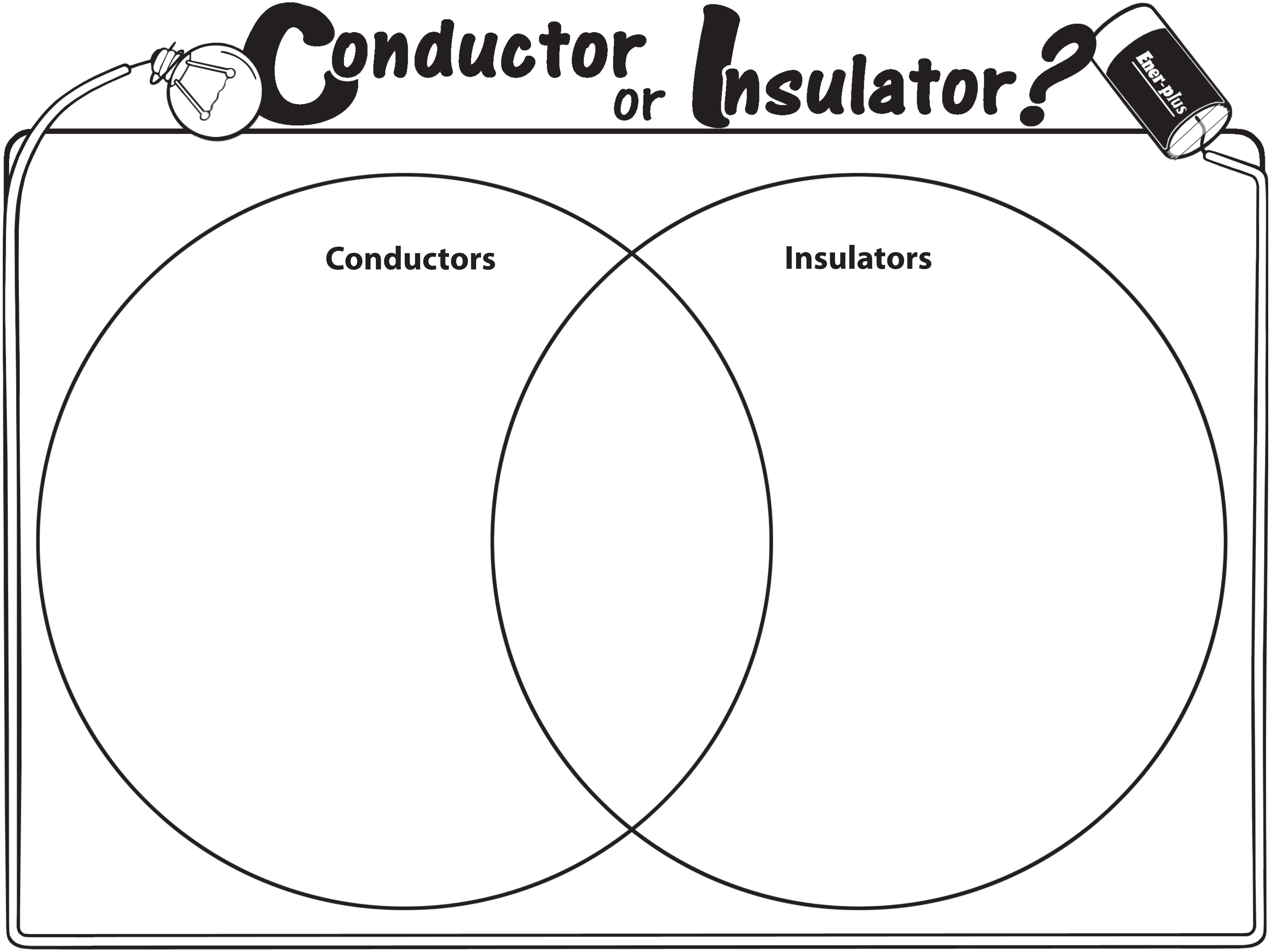
Conductors	Insulators

How are the conductors alike?

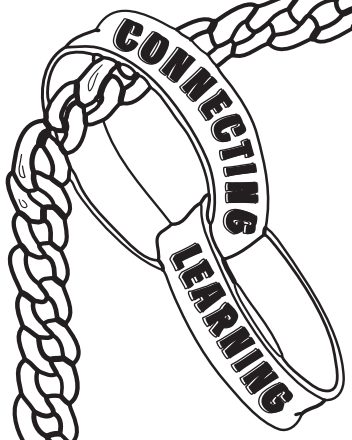
How are the insulators alike?

Conclusions:

Conductor or Insulator?

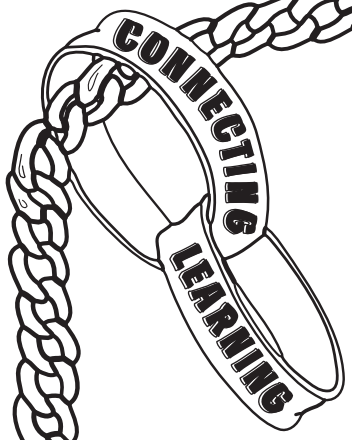


Conductor or Insulator?



Connecting Learning

1. How are all the conductors alike?
2. How are all the insulators alike?
3. What distinguishes a conductor from an insulator?
4. Are there any objects that are both conductors and insulators? How is this possible?
5. What other things do you think might be conductors?



Connecting Learning

6. What other things might be insulators?

7. Why are many wires coated with plastic or some other material?

8. What are you wondering now?

