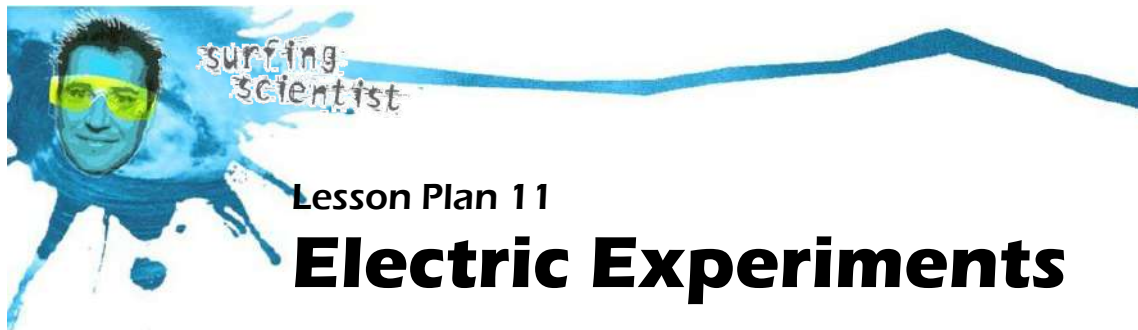




Lesson Plan 11

Electric Experiments

Brief description

Students experiment with aluminium foil, batteries and cheap, readily available low voltage light bulbs* to construct a simple conductivity tester. They use their conductivity testers to classify a range of materials as conductors or insulators.

** Available from most electronics or hobby supplies retailers*

Duration:	70 - 100 minutes
Year level:	Middle to upper primary
Topics:	Energy & Change, Electricity, Circuits, Conductors and Insulators, Classifying
Preparation:	10 to 20 minutes
Extensions:	SOSE: Research the: history of light bulbs / impact of the discovery of electricity on civilisation / uses of electricity Art / Science / Technology: Design, build and decorate a diorama with electric light bulbs



Overview

Whole class	Introduce Activity 1 Use a standard torch to lead discussion	(10 – 15 min)
Small groups	Activity 1: Make a simple circuit with light bulbs, batteries and aluminium foil	(15 – 20 min)
Whole Class	Discuss the simple circuits activity Introduce Activity 2	(5 – 10 min)
Small groups	Activity 2: Make a Conductivity Tester Test and classify materials	(30 – 45 min)
Whole class	Discuss Activity 2	(10 – 15 min)

Planning for safety:

The low voltage light bulbs and batteries used in this lesson are safe to touch and cannot draw large currents or reach hazardous temperatures. The glass bulbs are relatively strong but should be handled with care to avoid breakage. The risks associated with this lesson are easily managed by implementing a few simple safety precautions and behaviour rules. You should always consider the individual circumstances of your classroom and discuss concerns with your Principal or science coordinator.



Materials and equipment

Quantities are sufficient for every student to make their own Conductivity Tester

Qty per circuit	Description
1 ¹	1.5 Volt Light Bulbs
1 ²	Battery (AA, C, or D Cell)
1	Aluminium foil (30 × 30 cm)
4	Paper clips
1	Clothes pegs
1	Paper / cardboard
1	Sticky tape
1	Scissors
	Materials for conductivity testing Wood (eg stirrers / toothpicks / match sticks) Plastic (eg straws / plastic cutlery) Rubber (eg balloons / rubber bands) Metal (eg cutlery / nails / screws) Paper and/or cardboard Composite materials to test: Pencils (sharpened both ends) Gardening wire or twist ties Electrical wire Water and salty water

¹ Readily available from retail electronic or hobby stores for approximately 50 cents each - both bayonet or screw varieties are suitable

² Ask students to bring batteries from home if cost is a prohibitive factor



Preparation

Contact electronics store or hobby supplier in advance to ensure sufficient quantities are available. Check that each bulb is marked 1.5 Volt – they are easily mixed up with higher voltage bulbs which will glow very faintly, if at all, when connected to a 1.5V battery (the voltage is stamped on the metal case).

Bring a working torch from home to introduce the lesson.



Objectives

Students' prior knowledge

No prior knowledge is required or assumed for this lesson plan.

Science skills

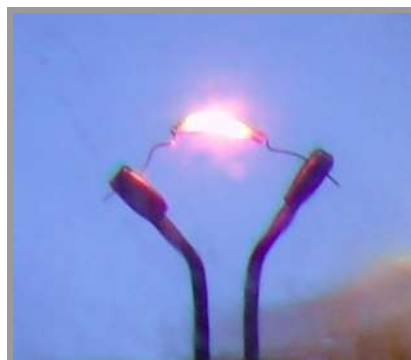
- Students will:
- experiment with light bulbs, batteries, aluminium foil and other materials to construct an electric circuit
 - construct an electric conductivity tester
 - classify materials as electrical conductors or electrical insulators
 - record their results in a table

Science concepts

- electric currents only flow when a circuit is complete
- conductors are materials that conduct electric currents
- insulators are materials that do not conduct electric currents
- electricity is a form of energy
- electric energy can be converted to other forms of energy such as light energy, sound energy or kinetic energy
- electric energy can be stored in batteries

Positive attitudes

- Students will
- work cooperatively with partners/group members and ensure everyone has sufficient opportunities to see and understand the activities
 - handle equipment responsibly
 - handle and dispose of waste responsibly (eg pour excess water into garden beds, not down the sink)
 - report breakages or safety issues to the teacher immediately



A light bulb filament up close



Procedure

Introduction – Whole Class (10 – 15 min)

- Use a torch to introduce the lesson – ask leading questions such as:
 - “how do you think a torch works?”
 - “do you know what is inside the torch”
 - “how does the on/off button work?”
 - “what happens if you leave the torch on?”
- Discuss Activity 1 during which students will attempt to complete a circuit so that a current flows through a light bulb
- Allocate groups, discuss safety issues and distribute worksheets and materials

Activity 1: Simple Circuits – Individual / Groups (15 – 20min)

- Distribute or collect materials
- Students experiment through trial and error with materials provided to make the light bulb glow
- Monitor progress and use questions and hints to assist students/groups in achieving a working circuit – see teacher notes for common difficulties encountered by students

Discussion – Whole Class (5 – 10 min)

- Discuss Activity 1 and the students discoveries during the experimentation by using leading questions such as:
 - “how did you make the current flow through the light bulb?”
 - “what things prevented your circuit from working?”
 - “once your circuit was working, how did you stop the light bulb glowing?”
- Introduce Activity 2 during which students will modify their circuits to construct Conductivity Tester

Activity 2: Conductivity Tester – Individual / Groups (30 – 45 min)

- Students build a conductivity tester
- Students use their conductivity tester to classify a range of materials as conductors or insulators
- Students answer worksheet questions in science journals

Conclusion – Whole Class (10 – 15 min)

- Use a working conductivity tester to demonstrate the correct results for each material you supplied
- Discuss possible reasons for getting a wrong result
- Discuss the results and ask whether students predicted them correctly, or if they were surprised by the results
- Discuss the importance of insulators in terms of electrical safety



Teacher's notes

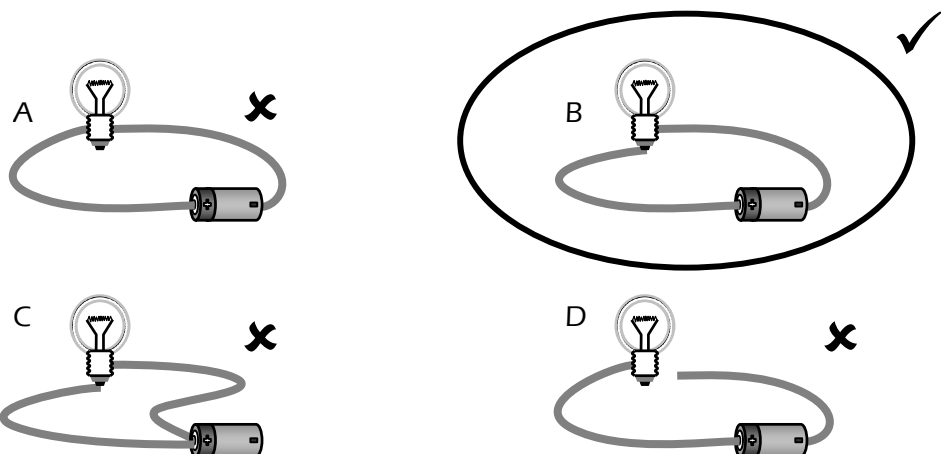
Early finishers and prior knowledge

Some students will have mastered the art of making a complete circuit before this lesson and it is important to plan ahead for these students. Grouping these students together would ensure others have sufficient time to make their own discoveries through trial and error. Students with a particularly advanced knowledge of circuits may enjoy designing more complicated circuits which they could demonstrate at the end of the lesson.

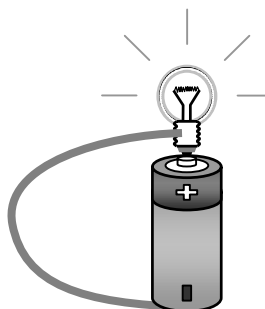
Activity 1: Simple Circuits

For an electric current to flow through the light bulb, the battery must be connected to the bulb to form a complete circuit as illustrated below. No current will flow through the light bulb in the other configurations for the following reasons:

- A both wires are touching the metal casing which is connected to one side of the filament – this configuration is an example of a short circuit because current will flow unimpeded through the casing and back to the battery
- C both wires are connected to the positive terminal of the battery
- D one of the wires is not connected to the light bulb

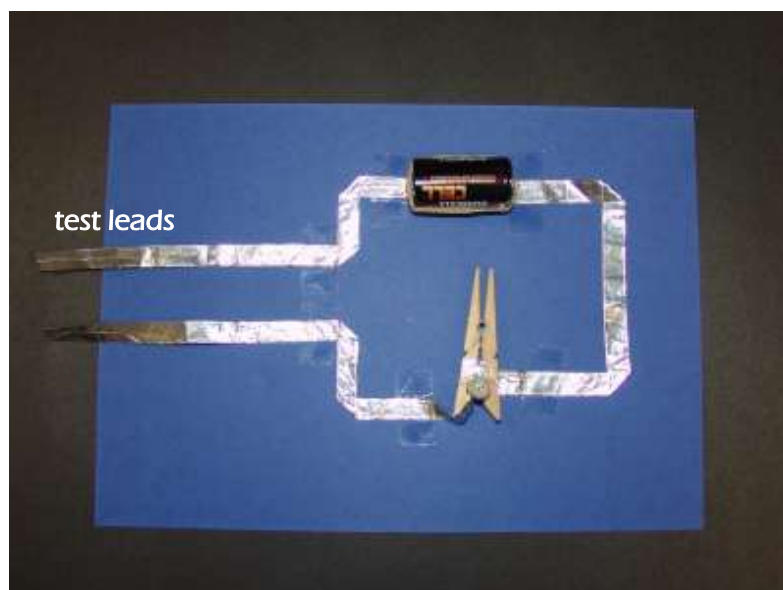


The one wire method:



Activity 2: Conductivity Tester

The design below is a suggestion only – your students may use or modify it or come up with something entirely different. To test a material, touch it with the ends of the test leads.



The battery wires are attached with sticky tape and extra pressure is applied by an elastic band.

The wire connected to the bulb's case is clamped by a clothes-peg and the base connected is wound with sticky tape



Troubleshooting circuits and Conductivity Testers

For correctly wired circuits, check the contact between the wires, battery and bulb – a reasonable amount of pressure is required to make sufficient contact. If you cannot find a fault in the circuit but it still does not work:

- check batteries with a spare light bulb and wire
- check light bulb with a spare battery and wire

Links to background information about electricity:

How Stuff Works - Electricity

<http://www.howstuffworks.com/electricity.htm>

Energy Quest

<http://www.energyquest.ca.gov/story/chapter02.html>

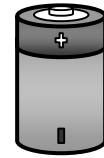
Dr Karl article about the Electric Chair

<http://www.abc.net.au/science/k2/moments/s1401056.htm>



Simple Circuits

Can you make the light bulb glow?



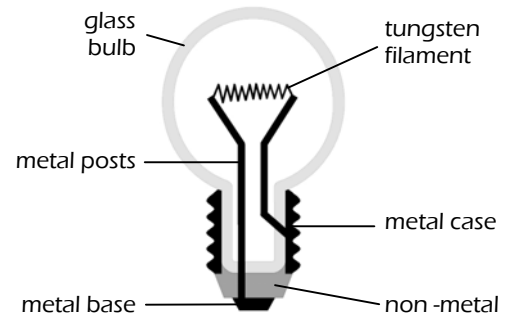
Objective

In this activity, you will try to make an electric current flow through a circuit. You will know the instant you are successful because the light bulb will glow! When you have mastered your simple circuit, experiment with other ways to make the circuit, or devise a simple switch.

Inside a light bulb

For such a successful invention, light bulbs are pretty simple things. Take a closer look inside your light bulb (use a magnifying glass if you have one). Inside is a filament that looks like a tiny spring. The filament is made from a type of metal called *tungsten*. It is attached to two tiny metal posts. One of these posts is connected to the outer metal case. The other post is connected to the metal part of the bulb's base.

When electricity flows through it, the tiny filament heats up to more than 2000 degrees Celsius! At these temperatures, tungsten usually reacts with the oxygen and burns out very quickly. To protect the filament from oxygen in the air, light bulbs are filled with a special gas called argon. Argon doesn't react with tungsten so the bulb can glow for hundreds of hours.



⚠ Safety note: You are using very safe low voltage light bulbs and batteries which are safe to touch. *Never touch household light bulbs – they can become very hot!*

Procedure

1. How does a torch work?

Before you begin experimenting try drawing the inner workings of how you think a torch works in your science journal. Include the battery (or batteries), light bulb and switch.

2. Make aluminium foil wires

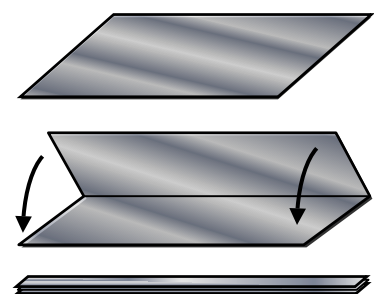
To make a simple, strong wire for your experiments, take a rectangular piece of aluminium foil about 30 × 15 cm and fold it in half. Keep folding the foil this way until you have a long flat 'wire' about 1.5cm wide.

3. Making current flow

Using your aluminium wires, battery, light bulb and any other items you have at your disposal, try to make a complete circuit. When you are successful, electric current will flow through the wires and the light bulb so that it glows bright.

4. Make improvements

When you have mastered making a current flow, experiment with ways to make your circuit more sturdy. Use whatever items or materials you have at your disposal to improve your design. You might even design an on/off switch. If something doesn't work after a few attempts, just stop and look for another way to make your idea work.



Making foil 'wires'

What have you discovered?

When you have finished experimenting, use what you have learnt to draw another picture of how you think a torch works. Does your new drawing match the one you made earlier? Can you describe what you have learnt about how electric currents flow?



Make your own electric Conductivity Tester



As you probably discovered during earlier experiments, some materials allow an electric current to flow while others do not. Materials that conduct electric currents are called conductors. Materials that do not conduct electric currents are called insulators.

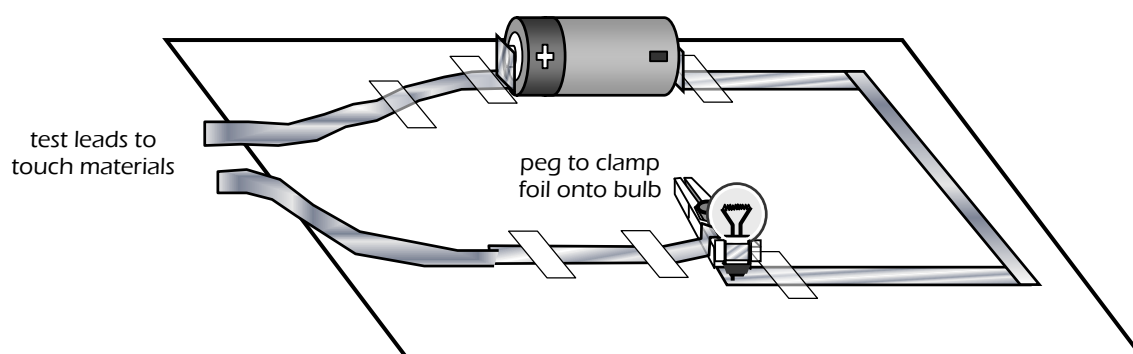
Objective

In this activity, you will build a simple electric device called a conductivity tester. You will use it to test whether a range of materials are electrical conductors or insulators.

Procedure

1. Make a Conductivity Tester

Build your conductivity tester on a piece of stiff cardboard. You will need two long *test leads* with which to test various materials. If you touch the test leads together, the bulb should glow. The diagram below is an example of how you might make your conductivity tester, but you can use any design that works.

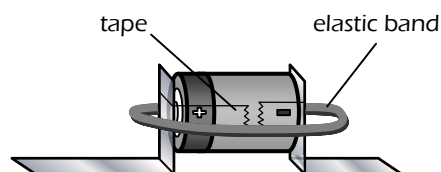


Example design for a Conductivity Tester

Suggestions

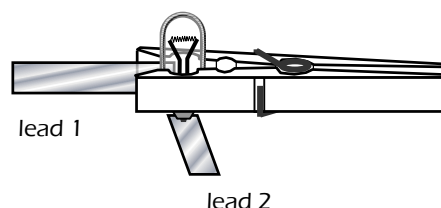
Attaching leads to the battery

To keep the aluminium leads firmly connected to the battery, attach them with sticky tape. Then wrap an elastic band tight around the battery.



Attaching leads to the light bulb

Wrap one lead around the bulb's metal case and secure with a clothes peg. Attach the second lead other to the metal contact at the bulb's base and wrap it tightly with sticky tape.



2. Test materials

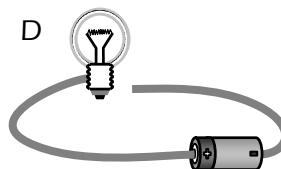
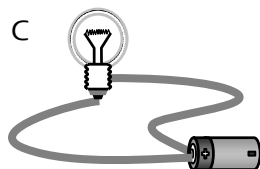
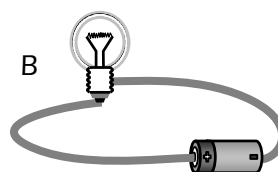
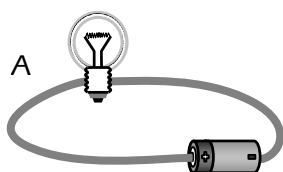
Test as many materials as time permits. Use a table like the one shown here to record your results in your science journal. Write "yes" or use a tick mark in the correct column to indicate if each material is a conductor or insulator.

To test whether a material is a conductor or insulator of electricity, touch it firmly with the test leads. If the light bulb glows the material is a conductor. If the light bulb does not glow the material is an insulator. Try testing some objects that are made from more than one type of material, such as a pencil or plastic coated paperclip, and record your results.

Material	Conductor	Insulator

Circuit diagrams

- For each of the four drawings below, explain why the light bulb will light up or not:



- To make circuit diagrams easier to draw, electricians and engineers use standard symbols.

— Wire conductor

 On/Off Switch

 Battery

 Light bulb

Using these symbols, draw:

- a diagram of the conductivity tester you made with a label for the test leads
- a circuit diagram of a torch