School-based activities

Static electricity

Background information

You may be familiar with getting zapped while getting out of a car, or zapping yourself or someone else after walking on carpet. These incidents involve static electricity. Static electricity occurs when electric charge builds up in one place. When you rub two different materials together, you can move negative charges (electrons) from one material to the other. This is often referred to as 'charging up' the materials. If the static electricity is strong enough, you can see and/or hear a spark moving from one object to another as it discharges. Discharging occurs when electrons move between a charged object and an object that is connected to the ground ('earthed').

There are two types of charge, positive charge and negative charge.

- When two materials have the same charge (positive and positive or negative and negative), they repel each other.
- When two objects have different charges (positive and negative or vice versa) they attract each other.
- Charged objects attract neutral objects (objects that have no charge).

If an object is charged, it will discharge when it is in contact with or close to the ground. This contact can be either direct or indirect. For example, a charged rod will discharge through the ground via the human body when it comes into contact with a human finger. The charge is given a pathway to the ground via the person's finger. A strong charge can jump to the finger if it is close enough. The person may feel a little shock as the rod discharges.

Lightning is a discharge of static electricity on a much larger scale. Buildings have lightning rods that reach high into the sky so that the charged clouds can discharge through them to the ground. This protects buildings by providing a safe path for the electricity to pass through.

The Triboelectric Series

Tribology is the study of friction. The triboelectric effect is the transfer of charge between materials that are rubbed together.

Materials lower on the list alongside will acquire a negative charge when rubbed against materials higher on the list.

Activities 1-4 relate to static electricity.

The Triboelectric Series

+ Positive

Air
Human skin
Asbestos
Rabbit fur
Glass
Human hair
Nylon
Wool
Silk
Aluminium, zinc
Paper
Cotton
Steel
Wood
Hard rubber
Copper, nickel, carbon
Brass, silver
Gold, platinum
Polyester
Polyurethane
Polyethylene
PVC (vinyl)
Teflon

— Negative

Activity 1: Static experiences

What to do
List your daily encounters with static electricity. For example:

- pulling clothes out of the dryer
- touching door handles in a carpeted room
- getting out of the car
- taking off certain clothes
- emptying rice out of its plastic bag.

Search the Internet for more examples of static electricity
(e.g. Science Made Simple: http://www.sciencemadesimple.com/static.html)
Compare your findings in small-group discussion.

Activity 2: Hundreds and thousands

What you need

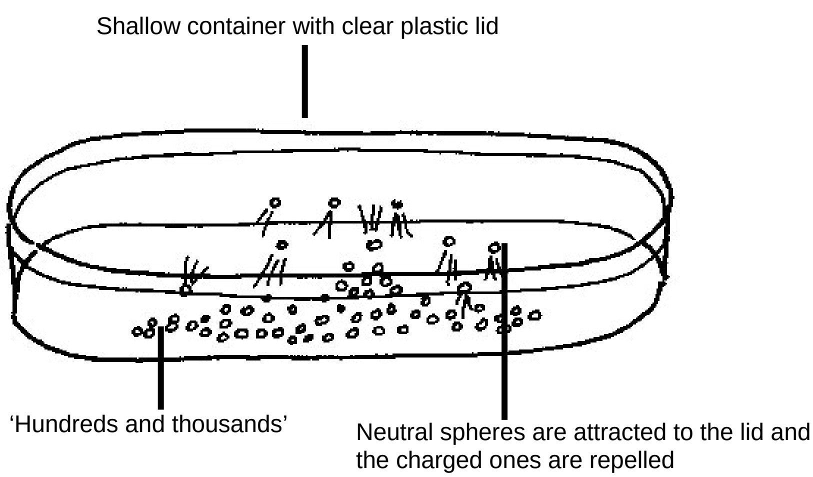
- 'hundreds and thousands'
- shallow (l or 2 cm) container with a clear plastic lid
  (e.g. a small take away food container)
- woollen clothing or cloth.

What to do

1. Put a small amount of 'hundreds and thousands' in the container.
2. Put the lid on the container and charge the lid by rubbing it with a woollen cloth. Observe what happens.
3. Gently move a finger over the top of the container and observe what happens.

Questions

1. Why do the 'hundreds and thousands' often jump back down?
2. What happens when you move your finger over the top of the container?



Activity 3: Boat races

What you need

- corks
- plastic pens
- woollen cloth or clothing
- large bowl of water.

What to do

Static electricity can be used to play a simple boat-race game.

1. Each player floats a cork 'boat' in the large bowl of water.
2. The boats are pushed under water so they come up wet.
3. Each player then charges up a plastic pen by quickly rubbing it on the woollen cloth or clothing.
4. Players then use their pens to pull the boats from one side of the bowl to the other by placing the pen close to the wet cork (being careful not to touch the cork or the water). The first cork/boat to touch the other side of the bowl wins.

If the pen touches the wet boat or the surface of the water, the pen will discharge and the boat will stop. The students may need to charge their pens more than once during the race.

Activity 4: Shocking facts about lightning

What you need

Access to encyclopedias and other reference books, or to the Internet.
(e.g. US National Weather Service: http://www.lightningsafety.noaa.gov/index.htm)

What to do

1. Find out some amazing facts about lightning. For example:
   - How long is a lightning bolt?
   - Can lightning's energy be caught and stored?
   - Big buildings get hit by lightning all the time. Why don't they burn down?
   - How many people are killed by lightning per year?
   - What can you do to prevent yourself from being struck by lightning?
   - Some people have been hit by lightning many times. Why have they survived?
   - How many bushfires are started by lightning strikes?
   - 'Lightning never strikes twice in the same place.' Is this a myth or a fact?

2. Present the results of your research. For example:

- Download lightning images from the Internet and project them to illustrate a class presentation on 'Shocking facts about lightning'.
- Write a fictional story using one or several of the amazing facts about lightning that you have discovered.
- Write a poem or song that explains how to avoid being struck by lightning.

Cells and batteries

Background information

A cell is a single device that changes chemical energy into electrical energy. A torch battery is actually a cell (in scientific terms). A battery is a number of cells connected together in a particular way (in series). A car battery is made up of at least six cells.

When a cell or battery is connected to a conductor, one end becomes the positive terminal and the other end becomes the negative terminal. To connect one cell in series with another cell, the positive terminal of one cell should be connected to the negative terminal of the next cell. Connecting cells together in series increases the voltage available.

In 1800, Volta made the first battery using the principle that two different metals connected by certain liquids produce electricity.

A simple low-powered cell can be made using a lemon and two different metals. If you wanted to make a 'battery' using lemons, one lemon would need to be connected to another lemon with wires connecting alternate metals.

Alessandro Volta
http://www.chemistryexplained.com/

Activities 5-7 relate to cells and batteries.

Activity 5: Lemon battery

What you need

- lemons
- small pieces of zinc
- small pieces of copper
- wires
- a voltmeter or multi-meter (switched to volt)
- small light globe.

What to do

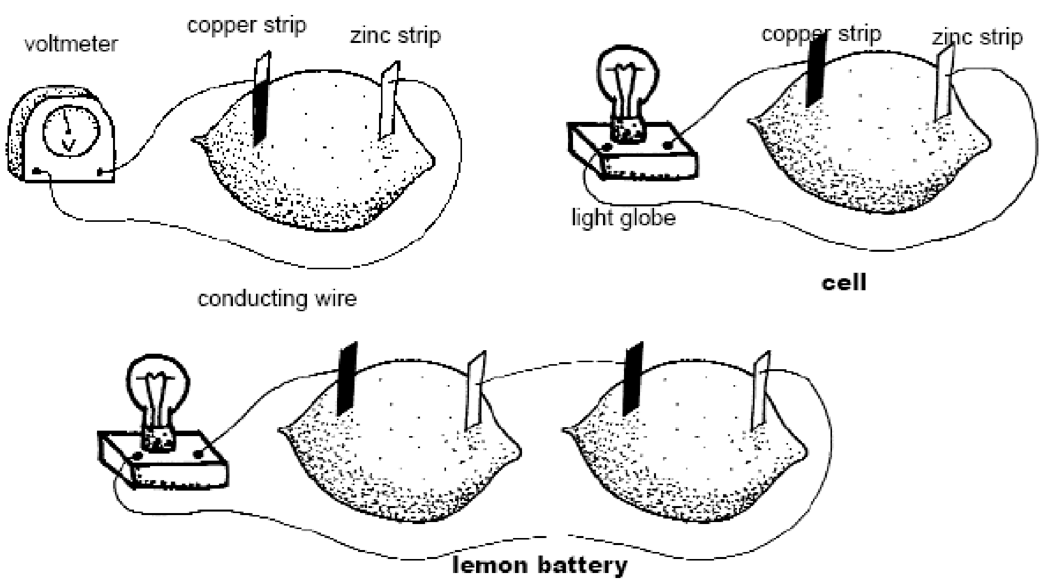
1. Give a lemon a good squeeze, but be careful not to split the skin.
2. Connect a wire to a piece of zinc and push the metal into the lemon.
3. Connect another wire to a piece of copper and push the metal into the lemon.
4. Connect the wires to the voltmeter (see diagram).
5. Record the voltage created by the lemon cell.
6. Connect a light globe into the circuit in place of the voltmeter and record what happens.
7. You may find that the current is too small to light a light globe. Connect a number of lemons together as shown in the diagram until the current is large enough to light the light globe. Record your results.

Questions

1. Is the voltage supplied by one lemon enough to light the light globe?
2. How many lemons did it take to light the light globe?
3. If you assume that each lemon supplies the same voltage, calculate the voltage that was required to make the light globe light up.
4. Describe the energy transformations taking place in this circuit.

Optional

Experiment with other substances in place of the lemons such as vinegar, potatoes, cola or a cactus.



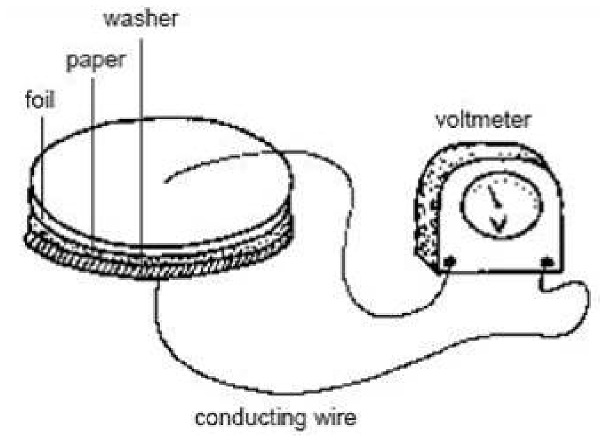
Activity 6: Voltaic piles

What you need

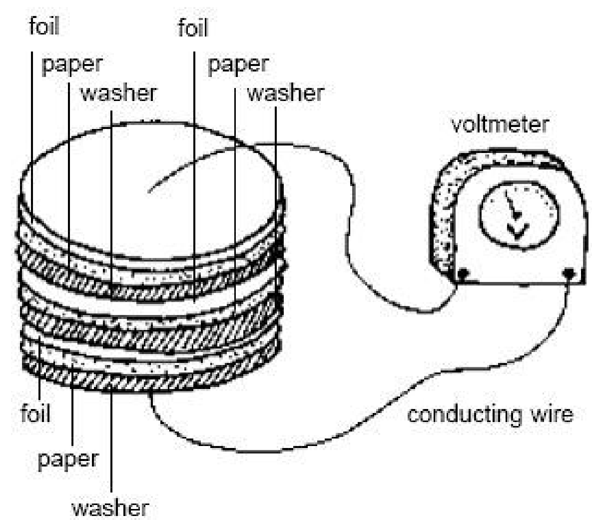
- aluminium foil
- metal washers
- paper
- salt water
- voltmeter
- wires
- 10 cent and 2 cent coins (available from coin shops, or use similar copper disks)
- other materials such as copper, zinc

What to do

1. Make a voltaic pile, (see diagram), with paper dipped in salt water sandwiched between aluminium foil and a washer.
2. Measure the voltage between the two metals with a voltmeter and record this value.



3. Try multiple layers, (see diagram). Set up a suitable table on your computer and record the voltage each time.
4. Try other combinations of metals, each time measuring the voltage with the voltmeter. Record the results in your table.



Questions

1. Did you construct a single cell or a battery in each trial? Explain your answer.
2. Which combination gave the greatest voltage reading?
3. Describe the energy transformations taking place in this circuit.

Activity 7: Battery (cell) life

What you need

- voltmeter
- wires
- light globe
- clock/watch
- several types of cells (for example, cheap and expensive carbon cells, rechargeable Nicad cells, alkaline cells). They all need to be the same size, for example, D cells. Note the purchase price of each.

What to do

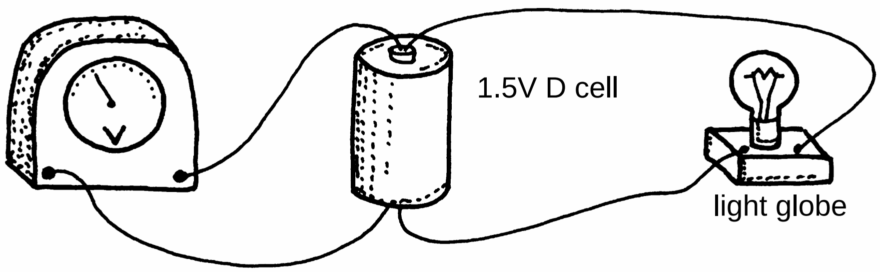
1. Set up the circuit shown in the diagram.
2. Take the voltage reading across the cell every two minutes and record the results in a table that you set up on your computer.
3. As the cell goes flat and the light grows dimmer, note the voltage at which you would consider the cell to be of little further use.
4. Mark this point on a voltage versus time graph for this cell.
5. Repeat for the other cells. If you want to conduct a shorter experiment, choose smaller cells such as AA.

Questions

1. Which cell lasted longest?
2. Which cell(s) died with very little warning?
3. For each cell, work out:

$$\frac{\text{time lasted (minutes)}}{\text{cost (cents)}}$$

4. Which gave the best value for money?



Electric circuits

Background information

Moving charge is called current. Conductors are materials that allow current to flow easily through them. Metals, for example, are good conductors of electricity. Insulators are materials that don't allow current to flow through them easily. Examples of insulators are wood, glass and plastic.

When an ammeter (an instrument that measures current) is connected in a circuit with a cell or battery, a light globe and a good conductor, the light globe will light up and the ammeter needle will move. Poor conductors will allow electricity to pass through them and will make the ammeter needle move but will not light the light globe. Insulators will not allow electricity to pass through them so the light globe will not light up, nor will the ammeter needle move.

When a battery or cell is connected in a circuit, it produces a current that travels in one direction only. A current that flows in one direction only is called direct current or DC current. The current that comes to your home is called alternating current or AC current. This type of current is produced by generators. AC current changes direction many times in one second. The current that comes to your home alternates back and forth 50 times in one second (50Hz). Some appliances have special electronic devices in them to convert the AC current to DC current.

Electrical appliances convert electrical energy into other forms of energy such as movement and sound (kinetic energy), heat (thermal energy) light and stored energy (potential energy). The energy in food and batteries is called chemical potential energy. There are other types of potential energy.The energy of compressed springs and drawn archery bows is mechanical potential energy. Examples of objects that have gained gravitational potential energy are lifts that have moved up and boxes raised by forklift trucks.

Ammeter
http://www.ngfl-cymru.org.uk/vtc/ngfl/science/107/PP-electricity.html

Activities 8-10 relate to electric circuits.

Activity 8: Conductors and insulators

What you need

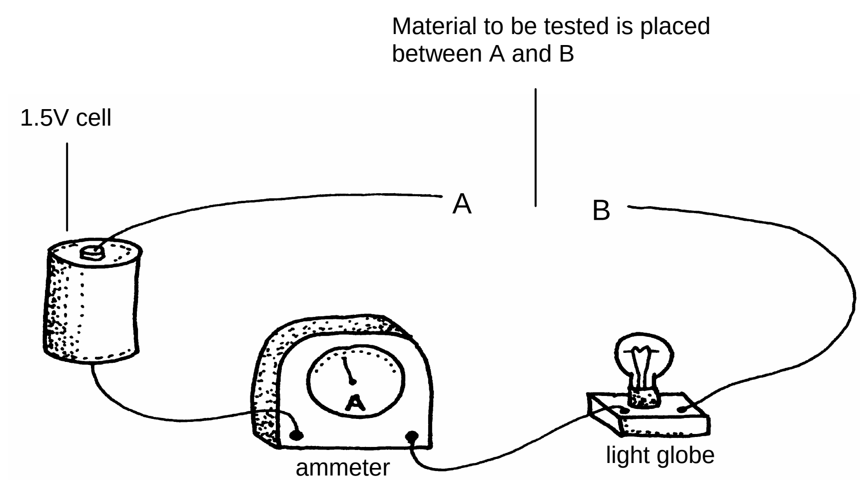
- *Conductor worksheet* (one copy per group or individual, see next page)
- 1.5 V cell ('battery')
- small light globe
- four lengths of insulated wire
- a collection of objects such as a fork, copper wire, aluminium foil, plastic object, dish of water, dish of salty water, graphite pencil (with both ends sharpened), piece of wood, chalk, keys, silver rings, gold rings
- an ammeter (if available)
  Primary teachers: Your neighbours may have a multi-meter which can act as an ammeter. Alternatively, your local secondary school is likely to have an ammeter that you can borrow.

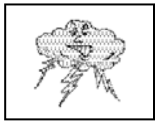
What to do

1. Construct an electrical circuit as shown in the diagram below.
2. Test the circuit by connecting a piece of wire between A and B. The light globe should light up.
3. Explore a range of objects and materials to see which act as good conductors between A and B and light the light globe.
4. Complete the *Conductor worksheet* that can be found on the next page.

Questions

1. Which objects or materials caused the light globe to light up?
2. Are these materials good conductors or poor conductors?
3. Which objects or materials caused the needle on the ammeter to move but did not cause the light globe to light up?
4. Are these materials good conductors or poor conductors?
5. Which objects or substances didn't affect the needle on the ammeter or light up the light globe?
6. What are these materials called?





Conductor Worksheet

Object tested	Made of?	Ammeter reading (Amps)	Light globe			Conclusion
			Not lit	Dimly lit	Brightly lit	
Example: Conducting wire	Copper	1.4			Yes	Conducting wire is a good conductor.

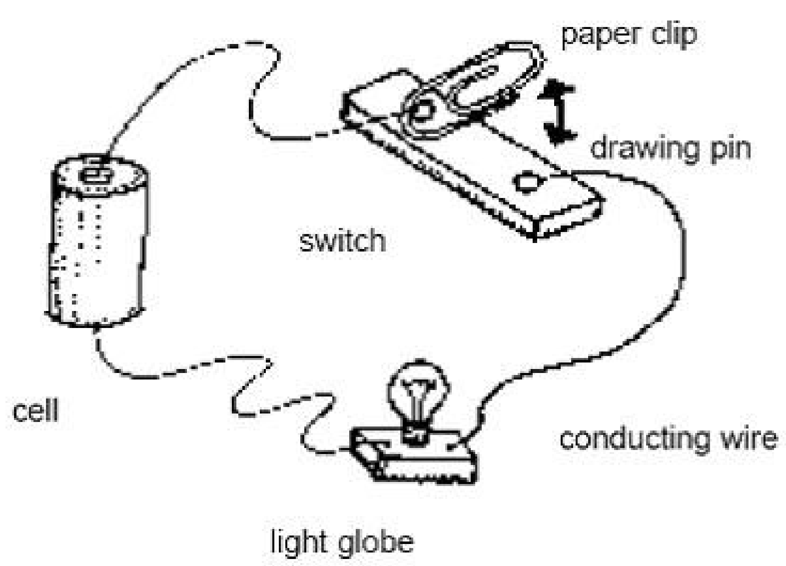
Activity 9: Switches and circuits

What you need

- cell (battery)
- tape
- three pieces of insulated wire
- light globe
- two drawing pins
- small piece of cork
- paper clip.

What to do

1. Try to use one cell and one wire to make the light globe light up. Is this possible?
2. Use one light globe, one cell and two wires to make the light globe light up.
3. Make a switch as shown in the diagram below. By pressing the paper clip down, the circuit will be complete and the light globe will light up.



Questions

1. Were you able to light up the light globe using only one cell and one wire? Try to explain why/why not.
2. Describe the energy transformations that took place in the circuit you constructed in Step 2.
3. Why do you think switches are useful in electric circuits?

Further research

Search the Internet for websites describing ‘electrical circuits’, e.g. http://science.howstuffworks.com/circuit.htm.
Summarise the additional information about circuits that you find.
Present your summary to your class as a short report.

Activity 10: Electrical safety

What you need

- Internet access or other research facilities
- poster paper
- graph paper
- volunteers
- multiple copies of the *Electrical safety worksheet* (see next page).

What to do

1. Answer the questions on the *Electrical safety worksheet* to find out how much you know about electrical safety.
2. Do some research on electrical safety and investigate common misconceptions about electrical safety.
3. Make a poster demonstrating what to do and what not to do when using electrical appliances. Alternatively, use computer software such as PowerPoint to make a short presentation on electrical safety.

Optional

4. Survey ten people you know using the *Electrical safety worksheet* and graph the findings.
5. Survey classmates or other year levels using the *Electrical safety worksheet* to compare different age groups.

Answers to the *Electrical safety worksheet*

1F	6T	11F
2T	7F	12T
3T	8T	13F
4T	9T	14T
5F	10F	15F

http://www.labelsourceonline.co.uk

Electrical safety worksheet

Are you switched on to electrical safety?

Read each statement carefully and decide if it is true or false.

Write **T** or **F** in the box.

1. Any tradesperson listed in the telephone book is qualified to do electrical work in your home.
2. If you are outside playing in a thunderstorm the best thing to do is to go indoors.
3. Using double adaptors increases the risk of overheating and fire.
4. You should not use the telephone during a thunderstorm.
5. All houses in Victoria have a safety switch in their switchboard.
6. You should always wear shoes when you use the washing machine.
7. It is safe to fly a kite near power lines.
8. The human body can conduct electricity.
9. If a power line is broken and has fallen down you should stay at least six metres away.
10. When working outside with electrical appliances you should wear thongs.
11. If an electric cord is frayed, the best thing to do is to wrap electrical tape around it.
12. All electrical appliances should be switched off and unplugged when not in use.
13. If someone gets an electric shock you should move them to a safe position.
14. If an appliance is faulty you should have it fixed or destroy it.
15. Babies are too small to get hurt if they poke things into a power point.

Electricity and magnetism

Background information

Hans Christian Oersted discovered that electric currents produce magnetic fields. He noticed that a magnetic compass needle moved when it was placed near a wire carrying current. This suggested that when the wire carried a current, it had a magnetic field just like ordinary magnets. When the current was switched off, the wire stopped being a magnet.

Magnets that you are familiar with are generally magnetic all the time. By winding wire around particular metals and passing a current through the wire, we can make a stronger electromagnet. Big electromagnets are used to move scrap iron in junk yards – the electromagnet is switched on to pick up the metal scrap and switched off to drop it.

The power supply in Australia brings AC current to every household. The frequency of the household power supply in Australia is 50 Hertz. This means that the current goes forwards and backwards 50 times each second. If you brought a magnet close to a light globe that was switched on, the filament would vibrate. This is because the magnetic field around the magnet and the magnetic field produced by the current-carrying wire interact, causing a force to be exerted on the filament. The direction of the force will depend on the direction of the current. Since the current is moving back and forth many times a second, the filament is seen to vibrate.

The discovery of electromagnetism led Michael Faraday to discover the principle behind the electric motor – when a coil of current-carrying wire is placed between magnets, the coil turns. The motor can be made to rotate faster by increasing the number of coils between the magnets, increasing the current in the wire or using stronger magnets.

Michael Faraday
http://commons.wikimedia.org/

Activities 11 & 12 relate to electromagnets and electric motors.

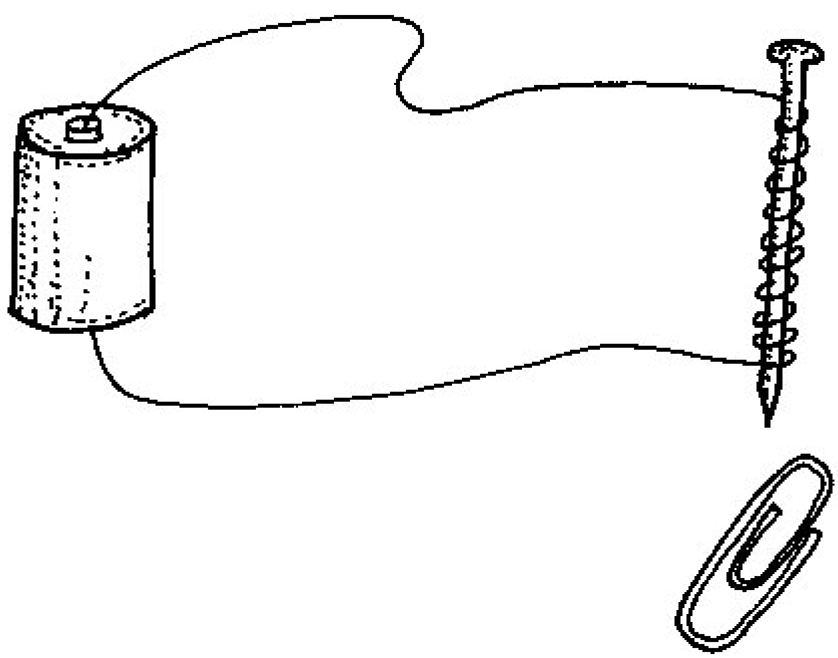
Activity 11: A simple electromagnet

What you need

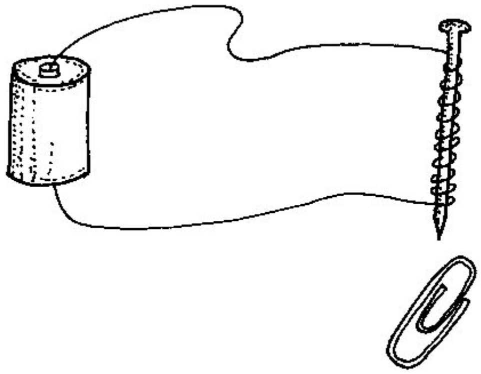
- *Electromagnet worksheet* (one per student or group, see next page)
- large nail or bolt
- long piece of insulated wire
- 1.5V cells (batteries)
- a packet of paper clips.

What to do

1. Strip the insulation from each end of the wire and twist the strands together.
2. Wind the wire around the nail about 15 times.
3. Connect the two ends of the wire to opposite ends of the cell.
4. Hold the nail close to a small pile of paper clips.
5. Count how many paper clips were picked up and record the number in the table on the *Electromagnet worksheet*.
6. Repeat steps 2-5, changing the number of coils of wire wrapped around the nail. Use the worksheet to record the number of paper clips picked up by the electromagnet each time.
7. Try connecting two cells in the circuit and repeat steps 2-6. Record your results on the worksheet.
8. Answer the questions on the worksheet.



Electromagnet worksheet



Record the number of paper clips lifted in each column.

Number of winds of wire

		15	**20**	**25**	**30**
Number of cells	**1**				
	2				

Questions

1. How many paper clips can be picked up using 15 coils and one cell?
2. How many paper clips were picked up using 25 coils and two cells?
3. Did connecting more cells in the circuit affect the number of paper clips that were picked up?
4. What affects the number of paper clips that can be picked up?

Optional
Experiment with additional combinations of the number of cells and the number of coils. Use a spreadsheet to record and graph the results of your research.

Activity 12: Vibrating light globes

What you need

- strong magnet
- clear 240V incandescent household light globe connected to the mains power supply (for example, a table lamp with the shade removed). Use a low wattage light globe to avoid eye damage.

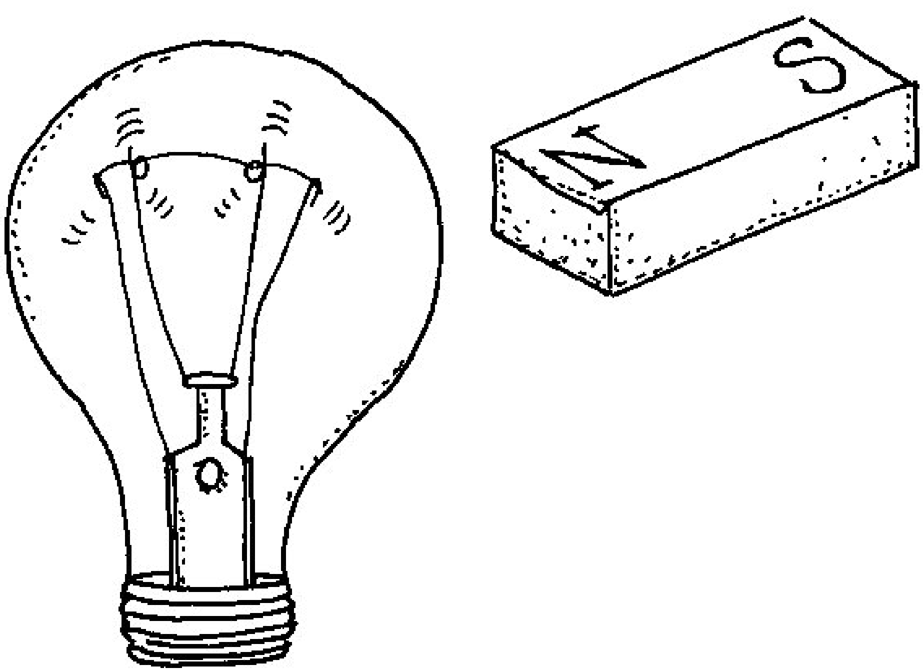
What to do

1. Bring the magnet near a light globe that is not switched on and record observations.
2. Now bring the magnet near the light globe when it is switched on and record observations.

Questions

1. Is the filament a magnetic material? Explain.
2. Why do you think the filament vibrated?
3. Your observations are based on what happens when you put a magnet near a filament using AC current. What do you think the filament would do if the current through it only moved in one direction (using DC current)?

It is very important that magnets not be brought close to computer screens or televisions as this can permanently affect the screen image.



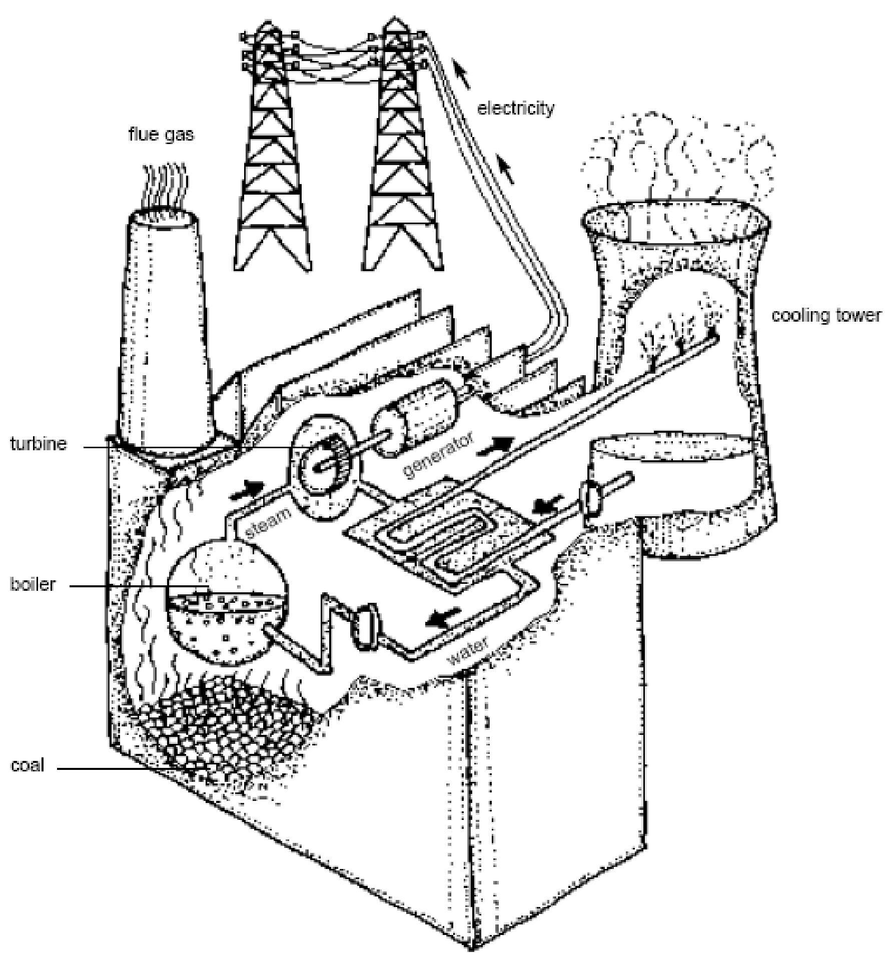
Generators

Background information

Michael Faraday was the first person to make an electric generator. He understood that many electrical effects are reversible. A simple electric generator is just a simple electric motor in reverse. Generators convert movement into electricity when turbines turn coils of wire between magnets, while electric motors convert electricity into movement by using electricity to turn coils of wire between magnets.

Power stations have large turbines that are used to turn a magnet inside a big coil of wire to produce electricity that eventually reaches your home. There are different types of power stations. Many turn turbines using steam produced by burning coal, while others use steam produced by nuclear energy. Some are more environmentally friendly and use wind or water to turn their turbines.

Activities 13 & 14 relate to generators.



Activity 13: Do-it-yourself generator

What you need

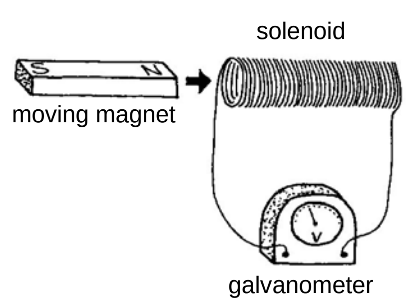
- solenoid (wire coil)
- iron bars to place in the solenoid
  (e.g. uprights can be unscrewed from retort stands)
- bar magnets
- wires
- galvanometer.

What to do

1. Connect the solenoid to the galvanometer.
2. Set up a table on your computer to record your observations.
   The table should have two columns:
   Column 1 should be headed 'Experiment' and used to record what you did in steps 3-8 below,
   Column 2 should be headed 'Observations'.
3. Move the north end of the magnet in and out of the solenoid (more than once) and record your observations.
4. Move the south end of the magnet in and out of the solenoid (more than once) and record your observations.
5. Move the magnet back and forth around the solenoid and record your observations.
6. Insert an iron bar inside the solenoid and see what effect this has on the current reading. Record your observations.
7. If you can alter the number of coils in the solenoid, increase the number of coils. Repeat steps 1 to 5 and record the differences observed.

Questions

1. Was a current registered on the galvanometer when the magnet was not moving?
2. Did the direction or reading of the current change when the magnet was inserted and then removed? Explain.
3. Did the speed of the magnet's movement affect the current?
4. Was there a difference in the current reading or direction when the magnet was inserted the other way around (with the south end entering the solenoid first)?
5. Does placing an iron bar in the coil have any effect?
6. Does increasing the number of coils affect the direction of the current or the current reading on the galvanometer?



Activity 14: Power to the people

What you need

- recording materials.

What to do

Brainstorm where mains electricity comes from. This will give an indication of students' level of understanding.

Class discussion points

- In coal-powered power stations the generators convert the energy of coal into electrical energy.
- It is easier to transport electricity rather than coal, thus the power station is close to the coal supply.
- Is electricity a clean source of power? Consider living next to the power station.
- In Victoria, about half of the energy from brown coal is lost as heat. One quarter is used to dry the brown coal itself. One quarter is turned into electrical energy.
- The energy from coal produces pressurised steam, which turns a generator. What other sources of energy can be used to produce steam to turn a generator?
- What sources of energy can be used to turn a generator, without needing to first burn a fuel to produce steam?
- Which source of power can produce electricity without burning a fossil fuel, and without the use of an electrical generator?

Further research

Most power stations currently use the following four steps to produce electricity:

1. Fuel is used to heat water and produce pressurised steam.
2. Steam or other energy source turns turbines.
3. Turbines power the generators.
4. Electricity is produced and transmitted to consumers.

Some power stations use all four steps above, some can avoid step 1, and some can avoid steps 1-3.
Search the Internet ('power stations' and 'alternative energy sources') to find out how each of the power stations listed below works, and to find out which steps (1-4) are needed for them to produce electricity.

- Coal-fired
- Gas-fired
- Nuclear power
- Hydro power
- Geothermal power
- Wind-powered
- Wave-powered
- Tidal
- Solar power.

Why is it important to avoid step 1 if possible? What by-products and problems does this step create?

Activity 15: Developments in electricity

What you need

- brief biographies of famous people associated with electricity (following pages)
- research facilities.

What to do

1. Construct a 'developments in electricity' time-line using the biographies in the following pages.
2. Use the Internet to research one of the following people in detail and prepare a report on them:
    - Thomas Edison
    - Nikola Tesla
    - Alessandro Volta
    - Michael Faraday
    - Benjamin Franklin
    - Hertha Ayrton.

    Include the following information:
    When did the person live?
    What were their main contributions to our knowledge of electricity?
    Were any units of measurement named after them?
    What was life like in their day and what effect did their discovery have on people's daily lives?

    Search the Internet for relevant images and include these in your report. Use Powerpoint or a poster format to produce a short class presentation on the person you have researched.

Benjamin Franklin's experiment proving the identity of lightning and electricity
http://original.britannica.com

Biographies

Namarrkon
The Aborigines of northern Australia have a number of stories that explain thunder, lightning and the wet-season clouds and rain. Namarrkon (spelling varies as the consonant sounds have no exact equivalents in English) is the Lightning Spirit of the Kunwinjku people of Western Arnhem Land in the Northern Territory. He/she has a circle of flashing lightning leading from his/her head to the lower parts of his/her body. Namarrkon creates electrical storms and destroys trees by throwing the stone axes that protrude from his/her knees and elbows. It is widely believed that the marrkidjbu or 'clever men' have the power to call on Namarrkon to strike a particular person whom they wish to have killed.

Thor
Thor was the god of thunder in Norse (Northern European) mythology. He had a magic hammer which he threw with the aid of iron gloves. It always returned to him. Lightning strikes occurred when his hammer hit something hard. Thunder was the sound of his rolling chariot. Thor was the eldest son of Odin, the ruler of all gods. Thursday is named after Thor.

Thales (about 580 B.C.)
Thales was born in Miletus in Asia Minor. He is considered to be the founder of Greek philosophy and was one of the so called Seven Sages (Wise Men) of Greece. He explained many natural phenomena.

Thales found that a piece of amber (fossilised plant sap), when rubbed with a cloth, attracted feathers and the dried pith of plants. (The Greek word for amber is *hlektron*).

William Gilbert (1544–1603)
William Gilbert was an English physicist and physician who was educated at the University of Cambridge. He was appointed physician to Queen Elizabeth I.

William Gilbert determined that a compass needle points north because the Earth behaves as a giant magnet. In 1600 he published a book, *De Magnete*, which gave a full account of all his experiments on magnets and electrical attractions. His book was used as the main reference on electricity and magnetism for over 150 years.

Benjamin Franklin (1706–1790)
Benjamin Franklin was an American printer, author, diplomat and philosopher as well as a scientist. In 1752 Franklin performed his famous experiment, which involved flying a kit in a thinderstorm. The kite was used to 'capture' lightning, using a special storage device called a Leyden Jar. The jar was connected to the kite by a string. His experiments were the first to show that lightning is electricity. He was very lucky not to have been killed! Franklin also explained how objects become charged and discharged using his theory of 'positive' and 'negative' charge.

Petrus van Musschenbroek (1692–1761)
The Dutch physicist, Petrus van Musschenbroek is one of two people credited with the invention of the Leyden Jar in about 1745. The German scientist, Ewald George von Kleist, who was working independently, is also accorded this honour.

Leyden Jars were used to store static electricity. Van Musschenbroek's jar was a water-filled glass jar with an iron rod in it. It was named in honour of the city of Leyden, where its inventor was born.

Ewald George von Kleist (1700–1748)
Ewald George von Kleist was the Dean of Kamin Cathedral in Pomerania (now a part of Poland). Von Kleist discovered the Leyden Jar independently of van Musschenbroek. His model used a chain in a glass jar, while van Musschenbroek's used an iron rod.

Otto von Guericke (1602–1686)
Otto von Guericke was a German physicist who studied law and mathematics. Von Guericke developed the first machine for producing an electrical charge. It consisted of a sulphur ball which could be spun on an axle. The turning ball would be brushed with a hand, a soft leather pad or a woollen cloth. Its operation was accompanied by showers of sparks. Von Guericke also did many experiments on air pressure, including the famous Magdeburg hemispheres demonstration, and invented the first air pump.

Luigi Galvani (1737–1798)
Luigi Galvani was an Italian professor of anatomy. Galvani accidentally discovered that he could make a frog's leg twitch violently when it was touched in different places by iron and copper rods. He (wrongly) thought that the frogs leg contained 'animal electricity' that was released when it was touched by these metals. It was Volta who proved that the frog's leg and the two different metals were behaving like a battery. The electrical terms, GALVANISM and GALVANISATION, were named in Galvani's honour.

Allesandro Volta (1745–1827)
Alessandro Volta was an Italian physicist who performed many experiments with electricity, and developed the first battery, called a Voltaic Pile. It consisted of stacked copper and zinc plates, separated by paper or cloth that had been soaked in salt water. Voltaic piles were the first steady source of electric current. In honour of his work, Napoleon made Volta a count, and the electrical unit the VOLT was named after him.

Hans Christian Oersted (1777–1851)
Hans Christian Oersted was a Danish physicist who was educated at the University of Copenhagen. In 1818, Oersted discovered that a magnetic compass needle will move when it is placed near a wire carrying a current. He also discovered the first electromagnet. This discovery began the study of electromagnetism, an important step on the path to the first electric motor. Oersted was the first person to extract the metal aluminium, and the magnetic unit, the OERSTED, is named in his honour.

André Ampère (1775–1836)
André Ampère was a child prodigy who mastered every aspect of mathematics by the time he was twelve. He went on to become a professor of physics, chemistry and mathematics at various universities in France. Ampère built the first meter for measuring electricity, and was the first person to work out the mathematical relationship between electricity and magnetism. The unit of measurement of electric current, the AMPERE, is named in his honour.

Michael Faraday (1791–1867)
Michael Faraday was the son of an English blacksmith and received little formal education. He became a physicist and chemist, and is best known for his discoveries of electromagnetic induction and electrolysis. In 1821, Faraday discovered the principle behind electric motors, which convert electricity into movement. He understood that many electrical effects are reversible – he was the first person to make an electrical generator, which converts movement into electricity. The electrical unit, the FARAD, was named in his honour.

Thomas Edison (1847–1931)
Thomas Edison developed the electric light bulb, the electric generator, the phonograph and the motion picture. Altogether, Edison patented more than 1000 inventions. In 1882, he developed and installed the world's first large central electric power station in New York City. This generator supplied direct current, while later generators produced alternating current, as proposed by Nikola Tesla and George Westinghouse.

Nikola Tesla (1856–1943)
Nikola Tesla, an electrical engineer and inventor, was born in Smiljan (in the former Yugoslavia). He emigrated to the United States in 1884 and later became an American citizen. In 1888, Tesla developed the first system for generating alternating current. George Westinghouse installed this system in the Niagara Falls power station, which opened in 1895. In 1891, Tesla developed a high voltage transformer – the Tesla coil – which has important applications in the field of radio communications.
The magnetic unit, the TESLA, is named in his honour.

Hertha Ayrton (1854–1923)
Hertha Ayrton was born in England. She was trained as a mathematics teacher, but went on to become an electrical engineer. Ayrton worked on the development of electric arc lamps. Her inventions were used as searchlights during World War I and in the cinema. Ayrton published many papers on electric lighting, and was the first woman to become a full member of the Institute of Electrical Engineers. She was refused membership of the Royal Society on the grounds that she was a married woman.

Hertha Ayrton
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