Unit 7.1 Static electricity

context You can be easily 'shocked' after touching someone who has just slid down a plastic slide. Likewise, a crackling sensation often can be felt when you remove your jumper over your head or when you remove clothes from the tumble dryer. These phenomena are caused by a form of electricity known as **static electricity**.

Fig 7.1.1 Static electricity is all about charge. It often appears as sparks, sometimes as lightning.

PP Quick Quiz

Positive, negative or neutral?

Most objects are **neutral**—that is, they have no overall electric charge. Objects can become charged, however, if they rub against other objects or materials. To understand how this happens, it is necessary to look at what is happening to the atoms that make up the objects and materials.

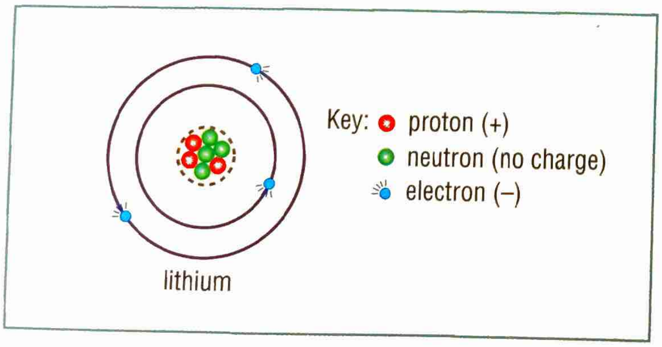

Fig 7.1.2 Atoms are neutral because they contain the same number of electrons and protons.

Everything is made of atoms—atoms make up water, bricks, clothes, pens, trees, humans and the gases of the air.

Atoms contain three types of particles:

- **protons**—are positively charged (+). They are located in the nucleus, which is the core of the atom.
- **electrons**—are negatively charged (–). The size of the negative charge on an electron is exactly the same as the size of the positive charge on a proton. Electrons travel around the nucleus in the atom's outer regions.
- **neutrons**—the nuclei of most atoms contain neutrons. As their name implies, neutrons are neutral, having no charge. As electricity is all about charge, neutrons can be ignored.

Atoms are neutral—they have the same number of positive protons and negative electrons, so their total charge is zero.

Go to Science Focus 2, Unit 2.3

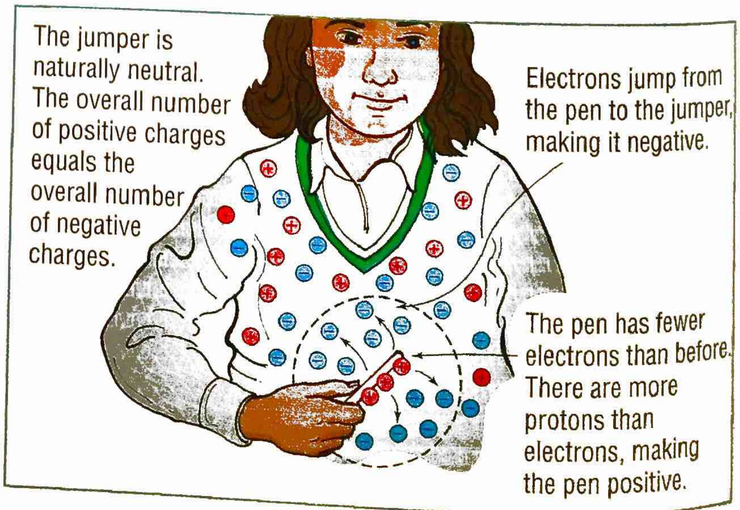

Fig 7.1.3 Negative charges (electrons) can be rubbed off a plastic pen and onto a woollen jumper. This leaves the pen positively charged and the jumper negatively charged.

Becoming charged

Rubbing often causes electrons to jump from one material or object to another. One object ends up with more electrons than protons, and the other ends up with more protons than electrons. Both objects are now said to be **charged**. Only electrons can move onto other materials because they are on the very outside of the atoms. Protons (and neutrons) are buried far too deep inside the atom's nucleus to be affected by rubbing. The charge on an object can be predicted by looking at the number of protons and electrons it has. Hence:

- If an object loses electrons to another material, then it will have more protons than electrons. The object is said to be **positively charged** (+).
- If an object gains electrons from the other material, then it will be **negatively charged** (–) because it has more electrons than protons.

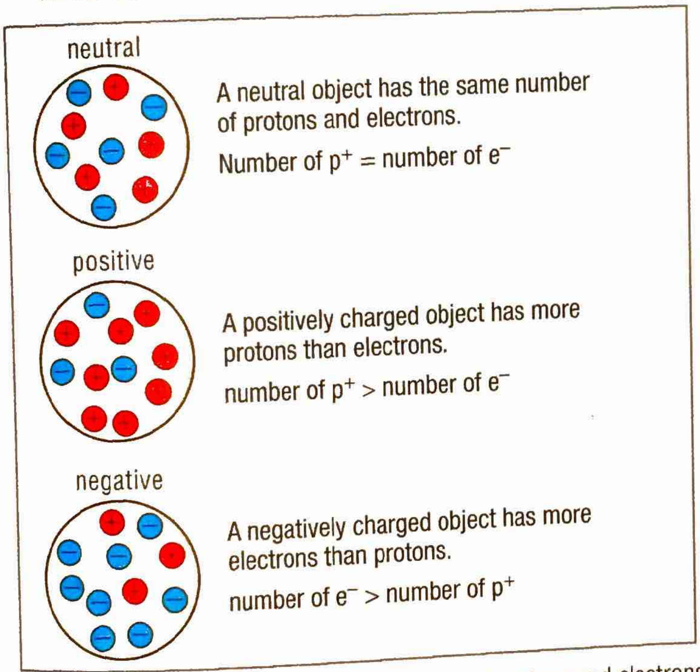

Fig 7.1.4 Objects are charged if the number of protons and electrons is not equal. The term *charge* can refer to a single proton or electron or a group of protons or electrons.

Attraction and repulsion

Prac 1 p. 216

Charges exert force on any other charges that happen to be nearby. This force is referred to as **electrostatic force**. The type of electrostatic force exerted depends on the charges that are interacting with each other. Note that:

- Charges that have the same sign (i.e. + and + or – and –) are referred to as like charges. **Like charges repel**, pushing away one another.
- Unlike charges have the opposite signs (i.e. + and –). **Unlike charges attract** one another, pulling them closer together.

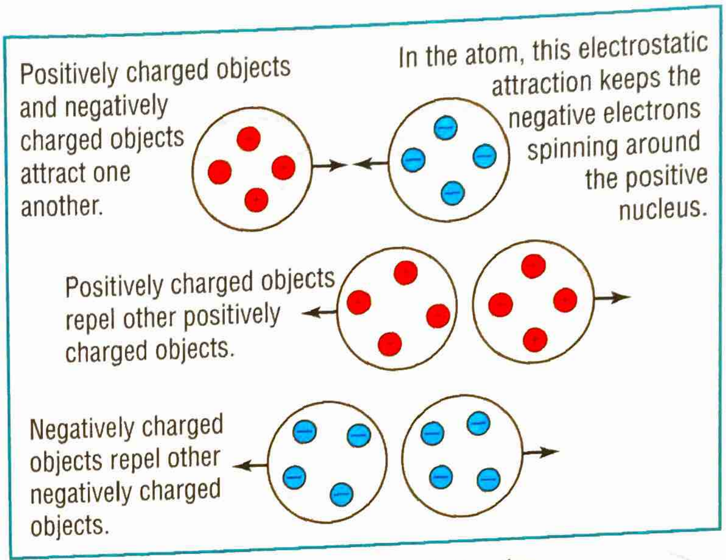

Fig 7.1.5 Electric charges exert a force of attraction or repulsion on each other. These forces are known as electrostatic forces.

PP Interactive

Induced charge

Prac 2 p. 216

Briskly rub a plastic pen on a woollen jumper and you will probably find it can attract small pieces of paper. The pen is charged and so is the jumper on which you rubbed it. The pieces of paper, however, are neutral—they have an equal number of protons and electrons and no *overall* charge. Therefore, you would not expect the paper to be attracted to the pen. **Induced charges** have formed (or induced) within the pieces of paper, and it is these charges that cause it to be attracted to the pen. The process happens via a number of steps.

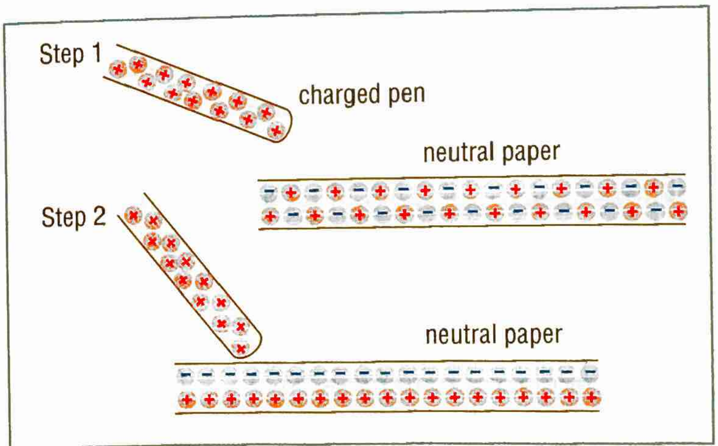

Fig 7.1.6 Induced charges are created when charges in a neutral object shift and separate.

Step 1: A negatively charged pen approaches neutral paper and repels the negative charges in the paper, forcing them to retreat as far away as they can. In this case, they move to the bottom side of the paper.

Step 2: The positive charges cannot move because they are tightly held in the nucleus of the atoms, and so are left at the top of the paper.

Step 3: These positive charges are attracted to the negatively charged pen, and so the paper sticks.

Step 4: After the pen and paper have been in contact for a short time, the charges spread out over both, leaving both with the same (negative) charge.

Step 5: The like (negative) charges repel each other and the paper falls off.

Electric fields

Prac 3 p. 217

The electrostatic forces that charges exert on one another arise because of invisible force-fields around each charge. These fields are called **electric fields**. Larger charges have stronger electric fields and the further the distance from the charge, then the weaker the electric field becomes. Scientists use electric field lines to represent an electric field—they show which direction a positive charge would move if it was placed in the field.

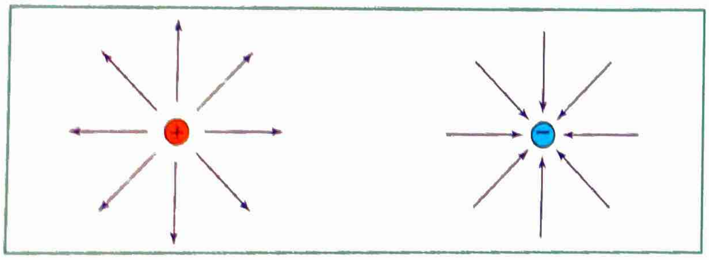

Fig 7.1.7 The field lines in an electric field points away from positive charges and towards negative charges. Electric field lines don't really exist but provide a convenient way of visualising what is happening around a charge.

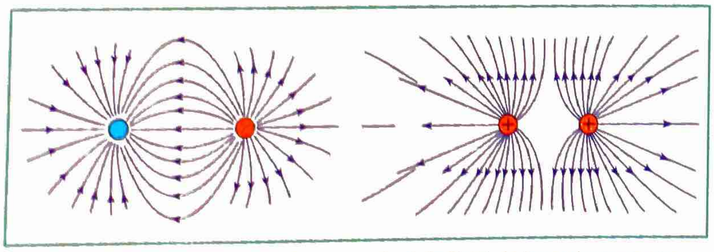

Fig 7.1.8 Each charge has its own electric field. If two charges are close to each other then their fields will interact, pulling the charges together or pushing them apart.

Electric fields are similar to gravitational fields in many ways. **Gravitational fields** are the invisible force-fields found around planets that make objects fall 'downwards', towards their centres. They also keep the planets in orbit around the Sun, and the Moon in orbit around Earth. Heavier planets have stronger gravitational fields than lighter planets. All gravitational fields weaken as the distance from the planet increases.

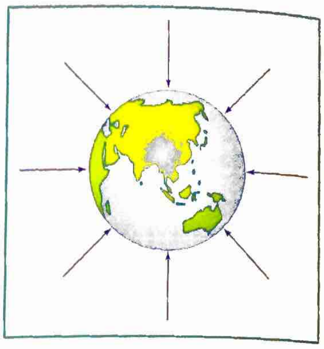

Fig 7.1.9 Earth's gravitational field exerts a force on all objects, towards its centre. Gravitational field lines are used to show the direction an object would fall.

What is static electricity?

Electricity is really just a collection of charges. **Static electricity** is a collection of charges. Sometimes there is so much charge that electrons will jump through the air, causing a spark. When someone touches a charged object, they may receive a severe shock as the charge jumps onto them and then passes through them to the earth. Most of the time, however, static electricity simply leaks, or **dissipates**, into the air, making the object neutral once again.

Good and bad static electricity

The sparks from static electricity can range from annoying to deadly, especially if the spark arrives in the form of lightning. Static electricity can also be used productively to make photocopies and to demonstrate some really hair-raising effects on the Van de Graaff generator.

The Van de Graaff generator

A Van de Graaff generator produces a large build-up of charge on its metal dome.

Carpet static

Static electricity often 'zaps' you after you have walked on certain types of carpet. Walking rubs your shoes against the carpet, causing a build-up of charge on your body. Usually, this charge would leak back out of your shoes, but sometimes rubber soles may insulate them enough to block this leakage. Gradually, you get more and more charged up as you walk across the carpet. All that excess charge is released when you touch an object, such as a doorknob, the charge jumping into that object and you become neutral once more. This causes a spark, which is felt as a small electric shock.

Charge tends to concentrate on sharp corners and spreads out more over flatter surfaces. One way of avoiding a shock is to touch any object that may be charged with an open palm instead of a finger. This spreads the charge and avoids a spark.

Photocopiers

Photocopiers use static electricity to produce images. A cylindrical drum is positively charged, and an image of the original page is projected onto it. Light areas of the image destroy the charge, whereas black regions leave the charge intact. A fine, negatively charged powder (called toner) drops onto the drum and sticks to the positive areas. The drum then rolls its powder image onto paper, which is then heated to melt the toner permanently onto it.

Thunder and lightning

Movement of water droplets and air molecules can cause charges to build up within storm clouds. If the build-up is great enough, then charges may flow suddenly from one part of a cloud to another, or to a separate cloud, or even to the ground. The sudden movement of charges causes the surrounding air to become super-heated and to expand rapidly. The temperatures can be as high as 30 000°C. This expansion causes shock waves to travel through the air, which we hear as thunder.

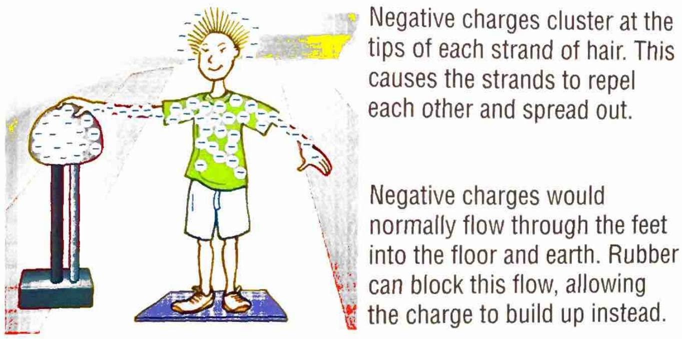

Fig 7.1.10 A Van de Graaff generator uses a belt to transfer negative charges to its metal dome.

Aircraft refuelling

An aircraft needs to be protected from the effects of static electricity during refuelling. Friction between the air and the aircraft creates a large charge on the outside of the aircraft. This charge stays on the aircraft after it has landed, and might jump as a spark from the aircraft to the fuel hose, causing a disastrous explosion. To prevent this, a wire is first connected between the aircraft and the ground, allowing any excess charge to safely leave the aircraft.

Worksheet 7.1 Static electricity

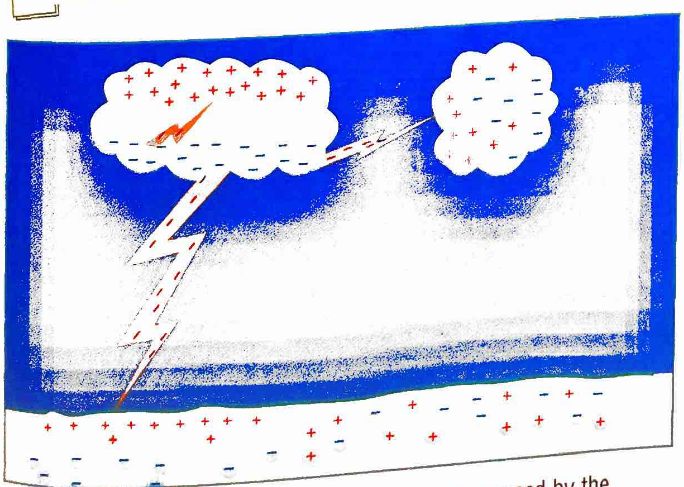

Fig 7.1.11 Lightning is just an enormous spark, caused by the separation of charge in clouds.

Science Clip

Unusual strikes!

In 1987, a lightning strike killed eleven soccer players and injured more than 30 players and spectators in Congo, Africa.

In 1970, ten European tourists sheltering under a tree were hit by a shock wave caused by the air surrounding a strike becoming super-heated and rapidly expanding. They emerged naked, but otherwise unhurt, their clothes having been blasted from them!

Science Fact File

Lightning

The Earth is hit by about one hundred lightning strikes every second. You should follow these safety tips if lightning is striking nearby.

- Shelter in a building or a car—electricity tends to flow around the outside of them, so you should be safe inside.
- Keep clear of anything tall, such as trees, umbrellas, fishing rods or even golf clubs—lightning tends to strike the tallest or pointiest object nearby.
- Keep clear of wire fences, railway tracks and cars (unless you are in one!)—lightning tends to strike metal objects.
- Drop to the ground immediately if you are outside and your hair stands on end or your skin tingles—these indicate that you are in a lightning strike zone and are in immediate danger.
- Crouch down if you are caught outside. Keep your feet close together with your hands on your knees. Keeping your feet together reduces the chances of the lightning travelling from foot to foot.
- Stay wet if you are outside—if you are hit, electricity will tend to flow through your wet clothes, rather than through your body.
- Keep away from water, such as the surf or lakes, and get to shore as soon as possible if you are on or in water.
- Do not to use a landline telephone (i.e. one with a cord)—electricity from lightning strikes can travel through phone cables to the telephone ear piece. Mobile and cordless phones are safe during a thunderstorm.

Unit 7.2 Current electricity

context

Electrical appliances such as iPods, hairdryers, electric toothbrushes, computer laptops and games consoles, like Wii, Xbox 360 and PS3, cannot work using static electricity because they need a constant flow of charges moving through them. This flow is called electric current or current electricity. Moving charges need an unbroken path to flow along. This path is called an electric circuit.

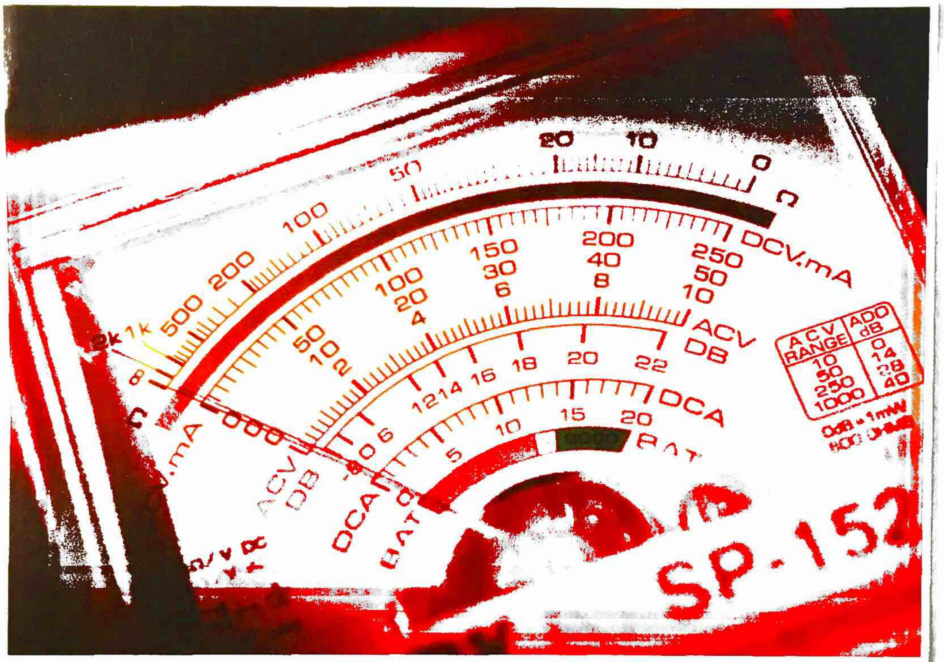

Fig 7.2.1 Current electricity is moving electricity. An ammeter measures how much current is flowing through it, whereas a voltmeter measures the energy used as the charges move through a component in the circuit.

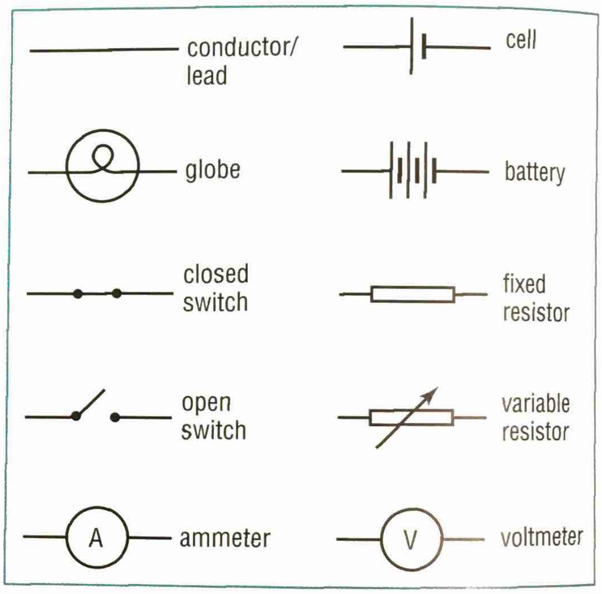

Fig 7.2.2 Symbols show which components are connected in a circuit.

Electric circuits

Whereas static electricity is made of charges that do not move, **current electricity** is made up of charges that move around an electric circuit. The path along which these charges flow must be complete. Any breaks in it will be enough to stop the current flowing.

The three basic parts of a simple circuit are:

- an energy source, such as a battery, power point or power pack
- something to use up the electrical energy, such as a globe, motor or heating element (resistance)
- wires (conductors) for the electric current to flow through.

Usually circuits also include a switch to turn the circuit on and off. The parts that make up a circuit are called its **components**.

Circuit diagrams

A **circuit diagram** is a shorthand way of showing the components that are connected in a circuit, how they are connected and in which order. Each component has its own easy-to-draw symbol and lines are used to represent the wires that connect them.

Current

Electric **current** measures the amount of charge flowing around the circuit every second. A large current involves more charge passing through a circuit each second than does a small current.

Most of the components in an electric circuit are made from metals, such as copper and tungsten. Like all materials, metals contain both positive protons and

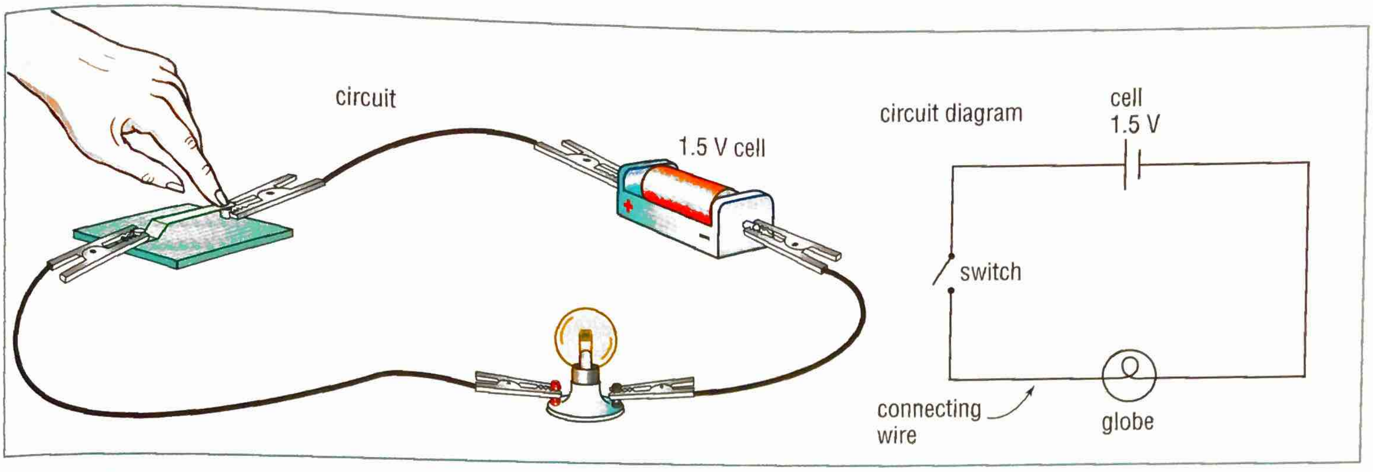

Fig 7.2.3 Two different versions of the same simple electric circuit. This circuit is similar to that found in a torch.

negative electrons. Although their protons and most of their electrons are not able to move far, a few electrons on each metal atom are free to move about. These free electrons form a negatively charged 'sea' that is able to flow from atom to atom and around the circuit. The more electrons that flow every second, the higher the current.

Current is measured in **amperes** (unit symbol A), which is sometimes shortened to 'amps'. Milliamps (mA) are used to measure extremely small currents and one milliamp is equal to one-thousandth of an ampere. An instrument called an **ammeter** measures current by being placed directly in its path. This involves 'breaking' the circuit and inserting the ammeter.

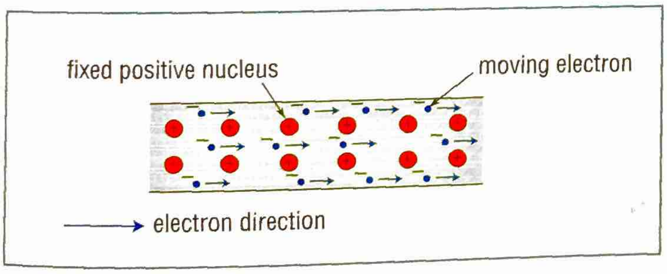

Fig 7.2.4 A current in a wire is made up of moving electrons, moving from the negative terminal of a battery or power pack to its positive terminal.

Voltage

Voltage is a measure of the amount of energy available to push charges around a circuit and is supplied by batteries, power points and power packs. Voltage is also used to measure the amount of energy released by an energy user, such as a globe, heating element or motor.

Voltage is measured in **volts** (unit symbol V) and is measured with an instrument called a **voltmeter**. Probes from the voltmeter are connected to each end of the component to be measured, 'piggybacking' it. In this way, the voltmeter measures the energy used by charges as they pass through the component.

Worksheet 7.2 Circuit symbols

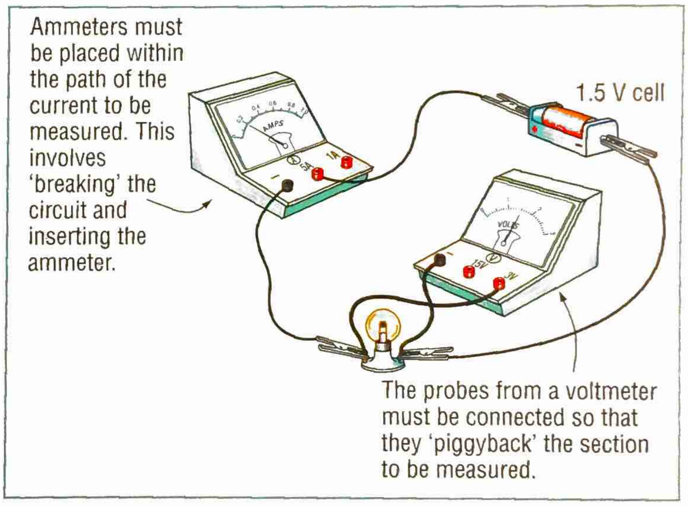

Fig 7.2.5 How to connect an ammeter and a voltmeter. The broken ammeter becomes part of the circuit and the voltmeter piggybacks part of it.

PP Interactive

Energy sources

Charge would never move around a circuit if it was not provided with the electrical energy and voltage to do so. At home, electrical energy and voltage usually come from a power point or from some type of cell or battery. Each energy supplier can be thought of as a charge 'pump'.

Science Clip

Living batteries

The electric eel is able to generate up to 600 volts, which it uses to stun small fish! The human body is full of small voltage generators, which are used to send messages via nerve cells.

Power points and power packs

Power points supply most of the electricity in the home. The 240 volts they supply can be deadly, so always make sure that the switch is off before connecting or disconnecting appliances.

Power packs are often used in school laboratories instead of batteries. Usually, their voltage can be altered from 1.5 volts up to 6 or 12 volts.

Cells and batteries

Batteries are used when a portable source of electricity is needed. Some are rechargeable, whereas others must be replaced when 'dead'. A typical small cell, such as an AA battery, provides 1.5 volts, whereas a car battery supplies 12 volts. A battery is made from a group of single cells, each of which uses chemical reactions to get electrons moving.

Wet cells

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Prac 2 p. 225

A **wet cell** consists of two different metal plates (known as **electrodes**) placed in a bath of acid.

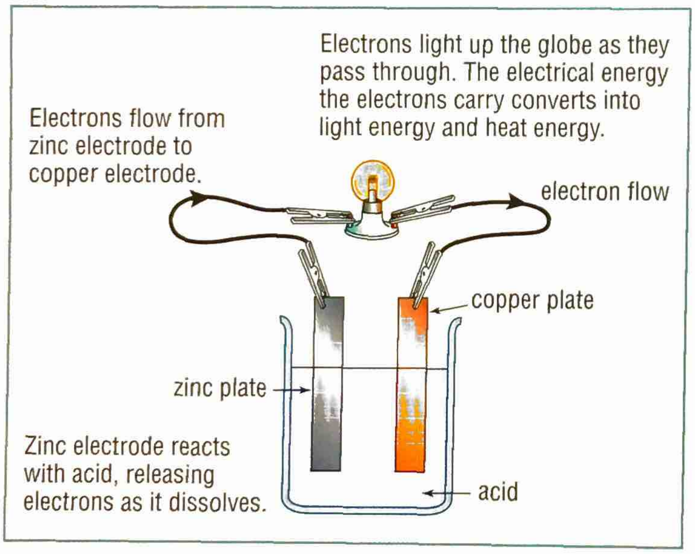

Fig 7.2.6 A typical wet cell. The acid slowly reacts with and dissolves the zinc plate, releasing electrons into the circuit. The electrons flow to the copper plate, lighting the globe as they pass through it.

A car battery is a collection of wet cells. The wet substance is sulfuric acid and the plates or electrodes are made of lead and lead oxide. When a car is running, chemical reactions in the battery are reversed, and help recharge the battery. Eventually, build-up of chemicals on the electrodes prevents recharging and the battery 'dies'.

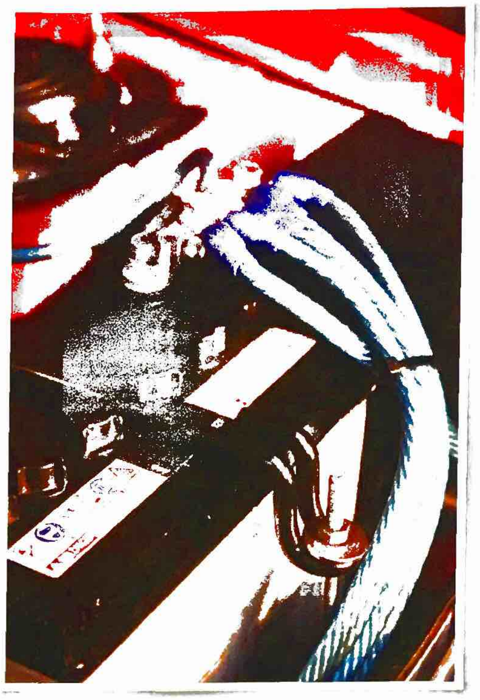

Fig 7.2.7 A car battery uses a series of wet cells to generate its 12 volts.

Dry cells

Wet cells are usually large, heavy and can leak acid if tipped over. This makes them useless for torches, laptop computers or TV remote controls. These appliances need small, light and portable batteries that don't leak. They use a **dry cell** that contains a chemical paste instead of a liquid and their electrodes are shaped to make them compact.

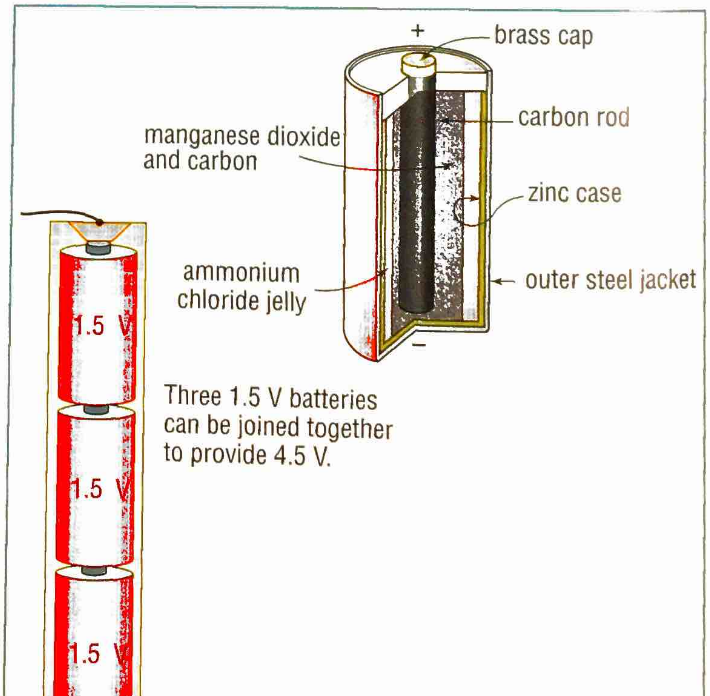

Fig 7.2.8 Dry cells are small, light and portable. If more voltage is needed then several cells can be connected together.

As in a wet cell, a chemical reaction generates charge that will flow when the cell is connected to a circuit. There are several types of dry cell:

- zinc–carbon cells are cheap
- alkaline–manganese cells are longer lasting, but more expensive
- lithium cells are compact, light and long-lasting
- nickel–cadmium cells (otherwise known as nicad) can be recharged using a recharger connected to a power point. The current it supplies reverses the chemical reactions within the cell, sending the electrons back to the electrode they originally came from.

Solar cells

A **photovoltaic cell** or **solar cell** is made of two layers of a substance called a **semiconductor**. When sunlight strikes the top layer, electrons are given energy to move from one layer to the other, creating an electric current. Several cells are used to make a solar panel.

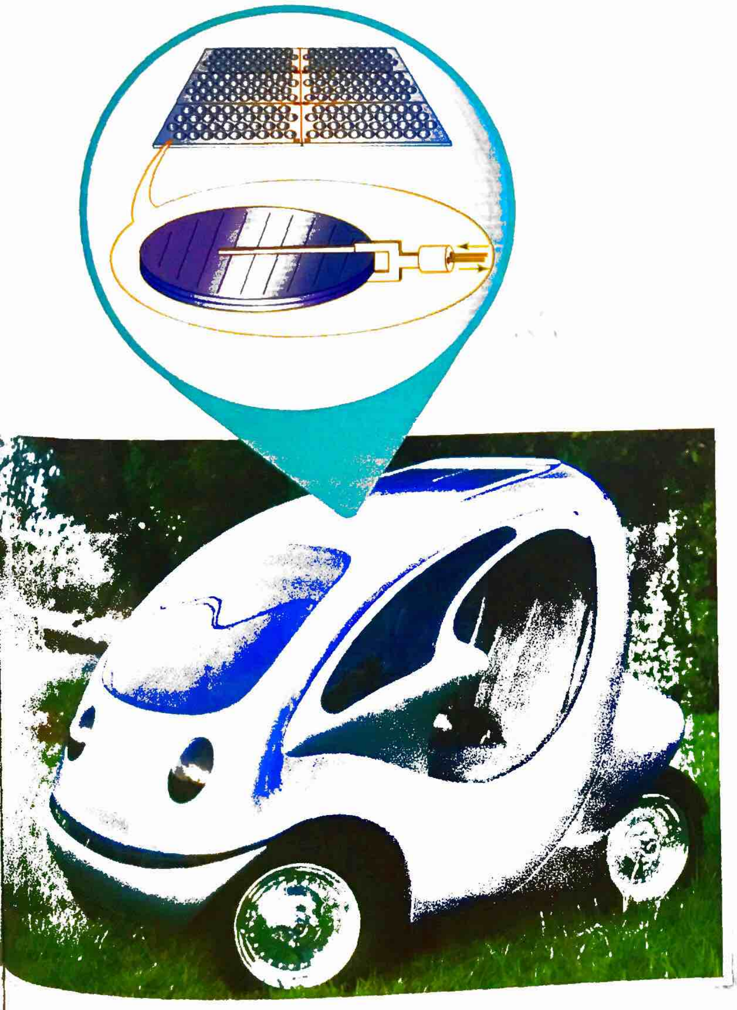

Fig 7.2.9 Sunlight falling on a photovoltaic cell forces electrons from one layer to the other, causing an electric current. This solar-powered car has a solar panel made from photovoltaic cells on its roof.

Conductors and insulators

Prac 3 p. 226

A **conductor** is a material that allows current to flow through it easily. Metals are good conductors of electricity. Copper wire is a low-cost and widely available conductor that is commonly used to connect the components in electric circuits around the house, in factories, in cars and in the ones you will build in the laboratory. Aluminium is more expensive but is used when copper would be too heavy, such as for high-voltage transmission lines that need to be strung between distant pylons.

Materials that do not normally allow current to pass through them are known as **insulators**. Plastic and rubber are two very effective insulators.

Fig 7.2.10 Household wires are made from three cables. Each cable contains a cluster of conducting copper wires wrapped in a sleeve of insulating plastic. They are then wrapped in another sleeve of insulating plastic.

Resistance

An old-fashioned incandescent light globe has a fine strand of tungsten called a **filament**. Electrons moving through the circuit have much more difficulty getting through this filament than they do getting through the much thicker and highly conductive copper wire. The energy the electrons give up trying to get through the filament is turned into heat and light.

A light globe is an example of **resistance**—something that restricts the flow of charge and 'robs' moving charges of energy. Resistance converts electrical energy into heat and light energy. Good conductors have very low resistance, whereas insulators have extremely high resistance.

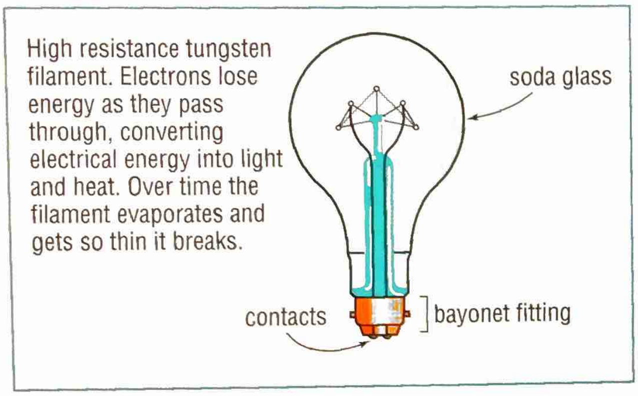

Fig 7.2.11 The resistance is obvious in an old-fashioned, energy-wasting incandescent light globe.

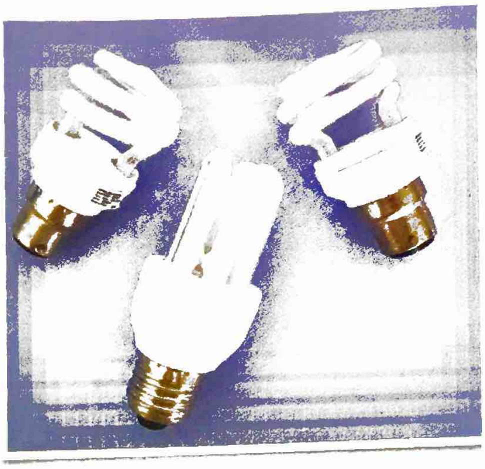

Fig 7.2.12 After 2010, only energy-saving, compact fluorescent light globes will be able to be purchased in Australia.

Science Clip

Saving the globe

Old-style, incandescent light globes are not very efficient as much of the energy they use is emitted as heat and not light. In an effort to increase efficiency and to reduce CO_2 emissions from electricity generation, in 2007 Australia began to phase out incandescent light globes. It was the first country to do so.

Thin nichrome wire is used as the heater in electric kettles, hairdryers, toasters, irons and electric hotplates. Nichrome has much greater resistance than the copper wire used in the rest of the circuit, and so it heats up when a current passes through it. Nichrome is ideal as it doesn't react with oxygen or water and does not become brittle when heated.

Prac 4 p. 226
Prac 5 p. 227

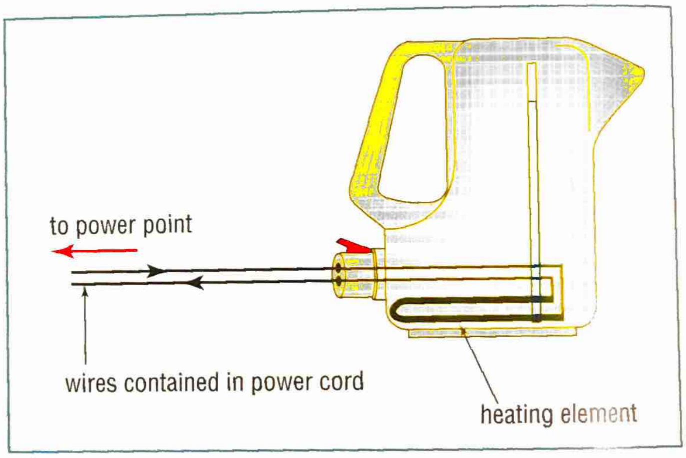

Fig 7.2.13 The heating element in an electric jug has a much higher resistance than the rest of the circuit it is part of. The element converts electrical energy into heat.

7.2 QUESTIONS

Remembering

1 **Recall** the basic parts of a simple circuit by matching the word with its best description.

a energy source	i wires
b conductors	ii heating element
c resistance	iii battery

2 **Recall** basic electrical components by drawing the symbol for:
   a a cell
   b a globe
   c a switch.

3 **Name** the device used to measure:
   a current
   b voltage.

4 **State** the units that are used to measure:
   a current
   b voltage.

5 **Specify** the voltage supplied by each of the following:
   a a AA torch battery
   b a household power point
   c a car battery.

>>

Unit 7.3 Using current electricity

context

Electric circuits are connected up in different ways, depending on how lights and other appliances are to operate. Imagine if you had to turn on the dishwasher, washing machine and all the other appliances around the house just to get the TV working! Or if you switched the bedroom light on and all the other lights in the house got dimmer! Some circuits will do exactly this—you need to pick the right type of circuit to do what you want it to do.

Fig 7.3.1 Many parallel circuits are working here.

Series circuits

If two globes are arranged one after the other, in a line with the battery, then the globes are said to be in **series**. Although the same current passes through each globe, the voltage supplied is shared between the globes. This makes each globe glow more dimly than if there was just one globe in the circuit.

The circuit is broken if any of the globes in a series circuit is removed or 'blows'. The current cannot jump over the break and so it cannot reach any of the other globes. They will not light up either.

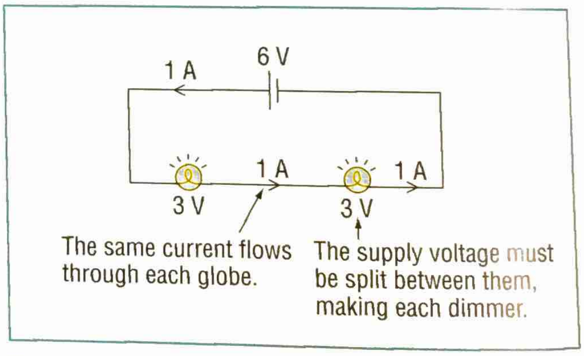

Fig 7.3.2 Globes that are in series are in a single line.

Circuits

Prac 1 p. 233

Two basic types of electric circuits are series and parallel circuits. Although series circuits are relatively simple, they have one big disadvantage—if the lights in a house were connected as a series circuit, then they would need to be all on or all off at the same time. Likewise, the air conditioner and dishwasher would turn on when you turned on the TV. Parallel circuits are a little more complex but allow a lot more flexibility. Each branch can be controlled separately. This makes them a far more practical way of wiring a house.

Parallel circuits

If two globes are arranged in separate branches, then they are said to be **parallel**. The voltage is the same for each globe in a parallel circuit and each will glow with equal brightness. At the branch point, the current splits. One globe will take half the total current and the other globe will take the other half.

If either globe in this circuit is removed or 'blows' then only that branch is broken. The other globe will stay alight because its branch is still intact.

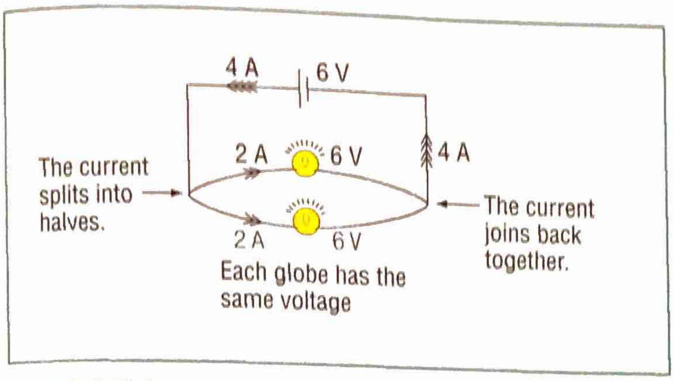

Fig 7.3.3 Globes that are in parallel are in different branches.

Worksheet 7.3 Electrical current

Fairy lights

Fairy lights and Christmas-tree lights can be wired in series or in parallel or sometimes a combination of both.

A series arrangement of 20 lights would share the 240 volts from the power point, giving each globe 12 volts. Globes come in different sizes (often 6 and 12 volts). For this circuit 12 volt globes would be ideal.

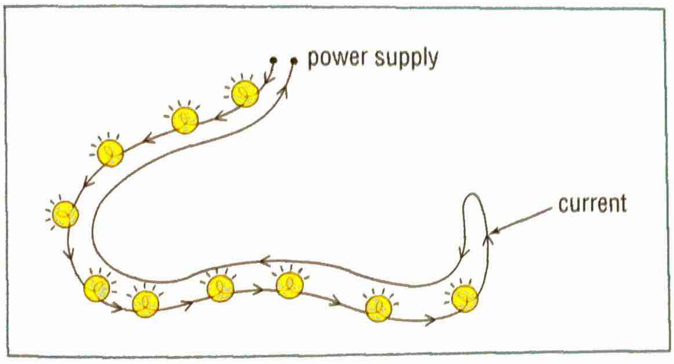

Fig 7.3.4 Fairy lights in series—they all carry the same current but share the supply voltage. If one globe blows, they all go out.

One disadvantage of a series circuit is that if one globe 'blows', they all go out. This makes it very difficult to find the failed globe.

The same 12 volt globes could also be arranged in parallel. All would have the same voltage (i.e. 12 volts). The advantage of a parallel circuit is that if one globe blows then all the others would continue to glow, making it easy to find the bad one. This circuit would need a power supply of only 12 volts and would 'blow' if it was connected directly into a 240 volt power point. A **transformer** is used to reduce the 240 volt supply to the 12 volts needed by the circuit.

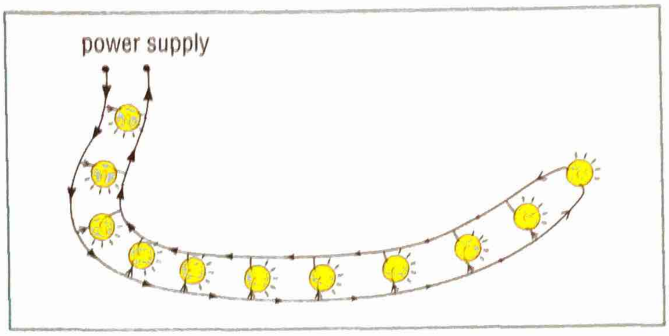

Fig 7.3.5 Fairy lights in parallel—they all have the same voltage and brightness, but the total current is split among them.

More complex circuits

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A circuit can combine series and parallel sections. Switches can then control current flow in each section, giving you some flexibility on what is 'on' and what is 'off'.

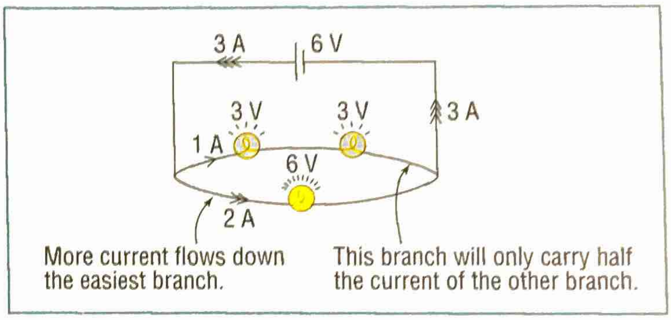

Fig 7.3.6 This circuit has two globes in series in one branch of a parallel circuit. The total current splits so that most current goes through the section with the lowest resistance.

Household circuits

The mains electricity wiring in your house is just one big parallel circuit. The big advantage of this arrangement is that each parallel branch can be controlled independently with a switch. Power points within the home allow extra parallel branches to be connected, where each branch gets the same 240 volts.

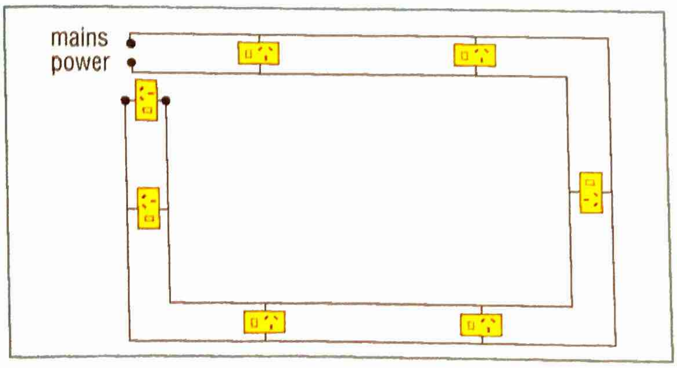

Fig 7.3.7 A house has a series of parallel circuits, each connected to the mains power at the switchboard. Each circuit and each power point receives 240 volts.

AC/DC

A battery pushes current in only one direction. Current that flows in only one direction around the circuit is known as **direct current** (DC). The current that comes from power points is **alternating current** (AC). This current is pulled back and forth 50 times every second, at a rate of 50 hertz (50 Hz). Household electricity is supplied as AC because it is easier to generate and transmit than DC.

Worksheet 7.4 Electricity costs

Worksheet 7.5 Saving power

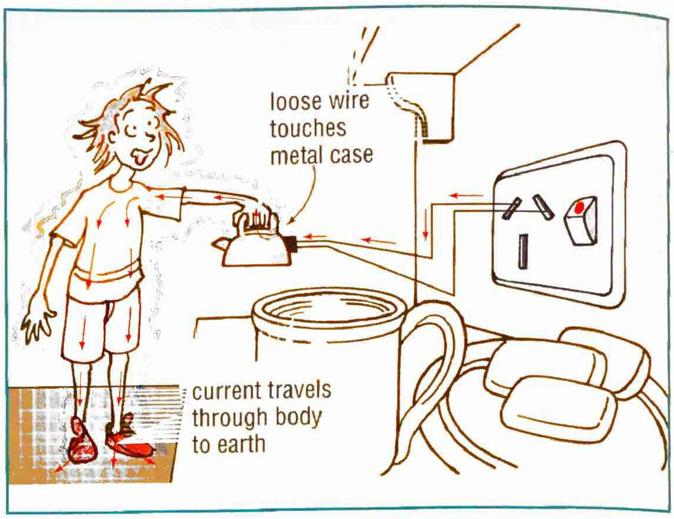

Fig 7.3.8 Electric shock occurs when current finds a path through the body.

When things go wrong

A **short circuit** occurs when an easier path for current is created accidentally. This might happen if a wire becomes loose, say when a hairdryer is dropped, or if someone accidentally becomes part of the circuit themselves, say by sticking a knife into a toaster. A massive current then flows, causing the circuit to overheat, melt the surrounding insulation and possibly catch fire. Anyone who is part of the circuit will receive a nasty shock or will be electrocuted. To avoid this happening, home circuits have a **fuse** or **circuit breaker** that melts or 'trips' if too much current is flowing. A fuse is a short section of thin metal or a loop of thin wire. If the current in a circuit becomes too large the fuse will burn out, breaking the circuit and stopping the dangerous current from flowing.

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A device called a safety switch or **residual current detector** (RCD) may also be connected to the household power supply to reduce the risk of electric shock. An RCD compares the current entering a home with that leaving via the correct circuit. If there is a difference caused by some current 'leaking out' (e.g. through a person's body), it switches off the main power switch within a few thousandths of a second. Serious electric shock is prevented.

Science Clip

That's shocking!

The electric chair was invented to provide a quick and painless alternative to hanging, which often decapitated or strangled prisoners slowly. In 1860, William Kemmler was the first to die by electric chair. The first jolt of 1000 volts burnt his hair and skin and burst blood vessels, but he still lived! He eventually died after another 70 seconds of 1300 volts. Other prisoners convulsed so violently that they broke their own legs or broke the leather straps holding down their arms.

The electric chair gives short jolts of electrical current until the prisoner dies of a heart attack. A total of 4300 prisoners were executed by electric chair in the United States. Lethal injection has now replaced the electric chair as a method of execution.

Fig 7.3.9 The electric chair was designed to deliberately cause a heart attack.

Science Fact File

Safety

Electric shock or even electrocution (i.e. death by electricity) may occur if current finds a path through your body to the earth beneath you. A tiny current can cause death by damaging tissues and interfering with electrical signals driving the heart. For this reason, electricians wear rubber-soled shoes and use tools with insulated handles. Always follow these safety instructions when dealing with electricity.

- Never handle a plug without turning off the power point, and never interfere with circuits connected to mains power.
- If you do come across someone who has had an electric shock, first turn off the power, using the main switch at the fuse box if necessary.
- If this is not possible, do not touch the person directly, as you will be given a shock too. Sometimes, insulators such as a plastic rope or garden hose can be used to move them away from the source of electrocution.
- Then assistance and appropriate first aid can be given. Whatever happens, ring 000 (or 112 on a mobile if 000 doesn't connect).