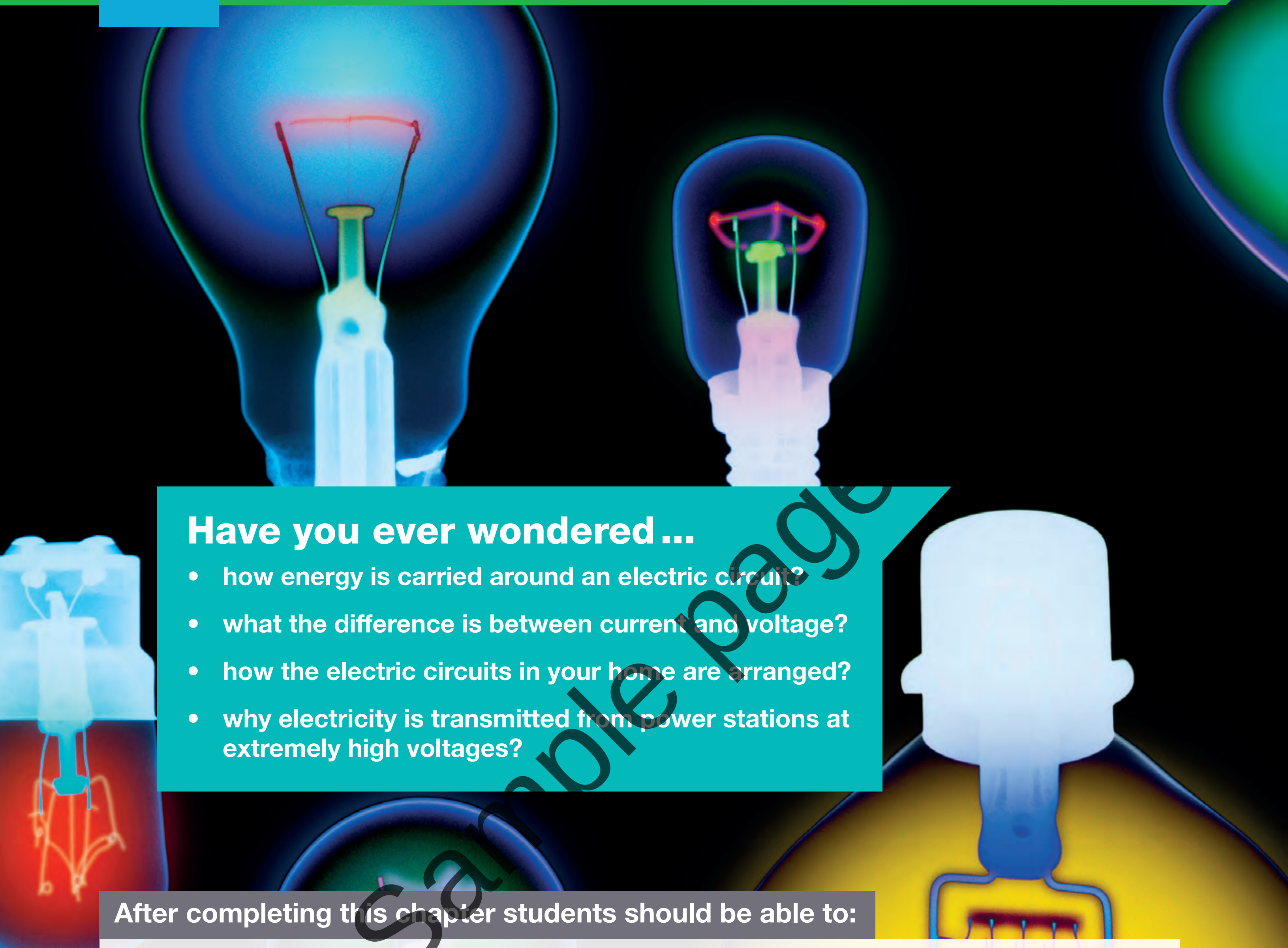
5 Electrical energy



Have you ever wondered ...

- how energy is carried around an electric circuit?
- what the difference is between current and voltage?
- how the electric circuits in your home are arranged?
- why electricity is transmitted from power stations at extremely high voltages?

Sample page

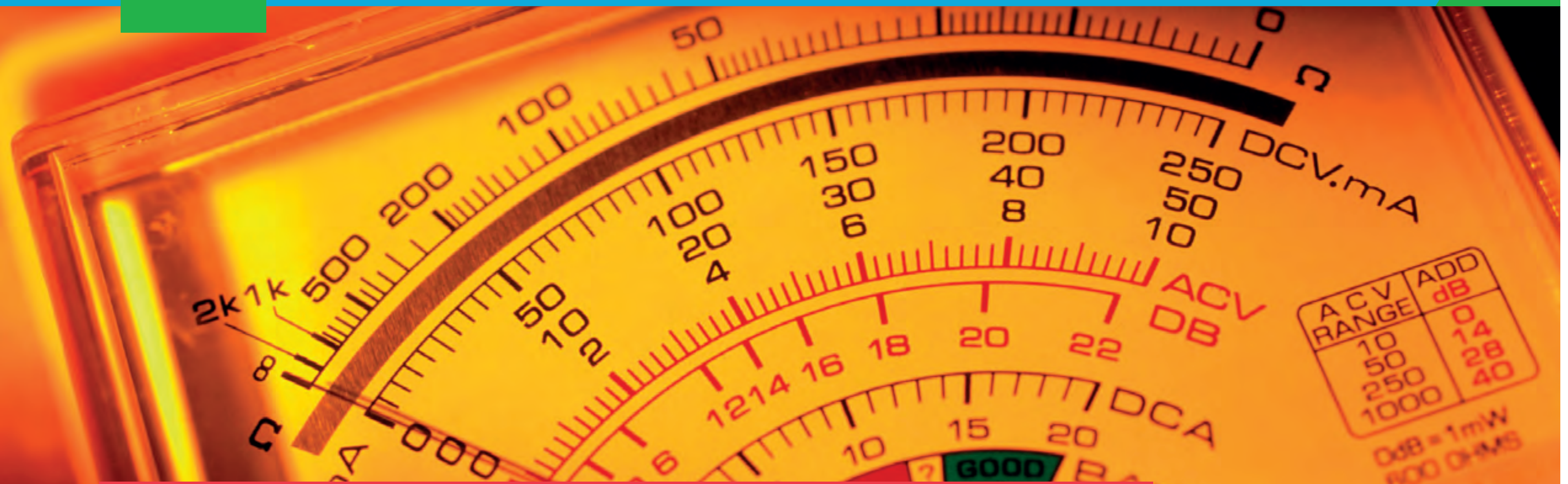
After completing this chapter students should be able to:

- describe voltage, current and resistance
- describe qualitatively the relationship between voltage, resistance and current
- compare series and parallel circuits
- outline developments in low-emission electricity generation and reduction in atmospheric pollution CCT PSC L
- apply the law of conservation of energy
- describe how usable energy is reduced, making a system less than 100% efficient
- discuss how the values and needs of contemporary society can influence scientific research into increasing efficiency of the use of electricity CCT S EU
- discuss choices that need to be considered when making decisions about the use of non-renewable energy resources S EU CC CCT

ADDITIONAL

- use Ohm's law to explain the relationship between voltage, resistance and current N
- use fruit to construct simple electrochemical cells
- research the structure of portable electrochemical cells such as mercury cells and rechargeable batteries L
- research scientific concepts that are used when designing energy-efficient devices CCT WE
- investigate the energy efficiency of appliances and relate this to a household energy account.

5.1 Measuring electricity



Electricians and electrical engineers need to ensure that the electric circuits they are installing or repairing are safe and can carry out the job they are designed for. In particular, they need to be able to measure or calculate voltage and current. You will need to measure or calculate these quantities too, for the circuits that you build in the laboratory.

Sample pages

Electric circuits

An **electric circuit** is a closed loop that provides a path for the transfer of electrical energy from a battery or power point to an electrical component. That component then converts the electrical energy into other forms of energy such as light, heat, sound or the kinetic energy of movement.

An electric circuit needs:

- a source of electrical energy, such as a battery or power point
- a component that converts electrical energy into another form of energy. A **component** is anything that is part of an electric circuit. Examples are resistors, globes, heating elements and motors
- wires to form a loop, connecting the component to the energy source.

To make the circuit easier and safer to use, it can also have:

- switches that control the flow of energy to the whole circuit or some of its branches
- fuses or safety switches that deliberately break the circuit in an emergency.

Circuit diagrams

A **circuit diagram** shows how the different components are arranged in the circuit. Figure 5.1.1 shows the circuit diagram for a simple battery-powered torch. The circuit diagram doesn't look anything like the real circuit but is a shorthand version of it. Figure 5.1.2 provides a key that allows you to determine what each component in the circuit is.

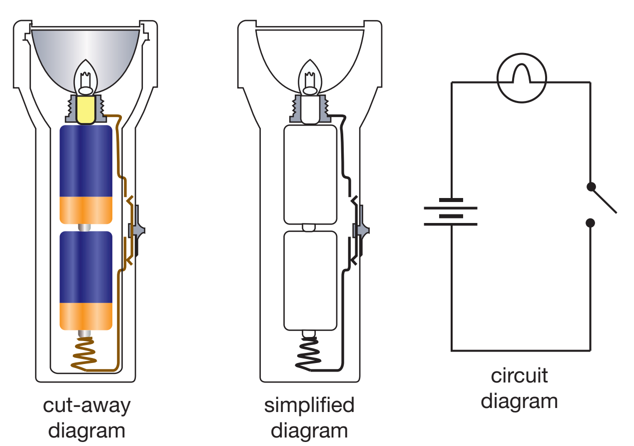


Figure 5.1.1 A torch has a battery, a globe and a switch.

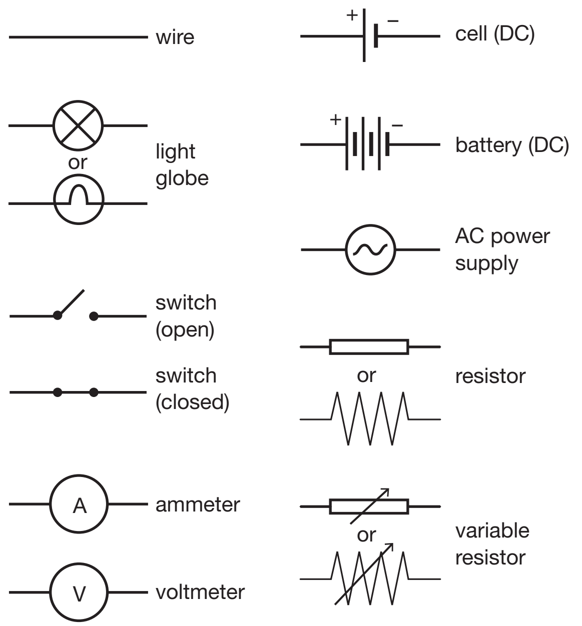


Figure 5.1.2 Symbols used for circuit components

Current

An electric current is formed whenever charge flows from one spot to another. In an electric circuit, this flow of charge is made up of electrons moving along the wires.

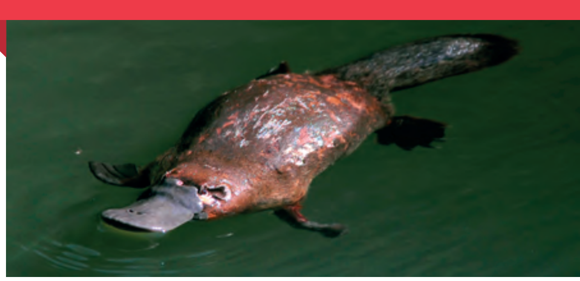
These electrons and the current they form carry energy around the circuit from the battery or power point to the different components that use it.

Electric current is measured using an **ammeter**. An ammeter measures the amount of charge that flows through it every second. The current is high if a lot of charge flows through it in one second, and low if only a small amount of charge flows through it.

Current is measured in **amperes** (unit symbol A), which is often shortened to 'amps'.

SciFile: Nervous about electricity?

Your muscles are activated by electrical impulses sent along your nerves. The same happens in other animals too. A platypus uses sensors within its bill to detect electric currents from the muscle movements of yabbies, fish and frogs.



SKILL BUILDER: Connecting up an ammeter

Electrons must pass through an ammeter for the charge to be detected. Therefore, the ammeter needs to be in line with the rest of the circuit's components. This arrangement is known as being in series and is shown in Figure 5.1.3.

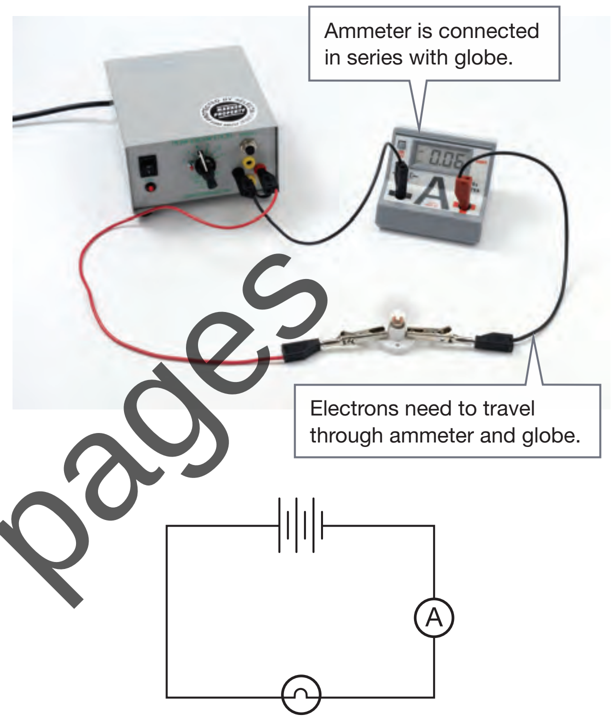


Figure 5.1.3 Ammeters measure the current that passes through them. An ammeter needs to be in line (in series) with the rest of the circuit.

Voltage

Voltage is a measure of the amount of energy:

- supplied to the charges by the voltage source (the supply voltage)
- used by the charges as they pass through a component such as a light globe (voltage drop).

Voltage is measured using a **voltmeter**. The voltage is high if the electrons are supplied with a lot of energy or are losing lots of energy. The voltage is low if the electrons lack energy or lose very little. If the voltage is zero, it means the battery is dead, the power point is turned off or the electrons are losing no energy in that part of the circuit.

Voltage is measured in **volts** (unit symbol V).

Sample pages

Connecting up a voltmeter

SKILL BUILDER

A voltmeter compares the energy of electrons before and after they pass through a component such as a light globe. For this reason, voltmeters are connected in parallel. This means they are not part of the circuit itself, but instead attach across the component being measured, piggy-backing it. This arrangement is shown in Figure 5.1.4.

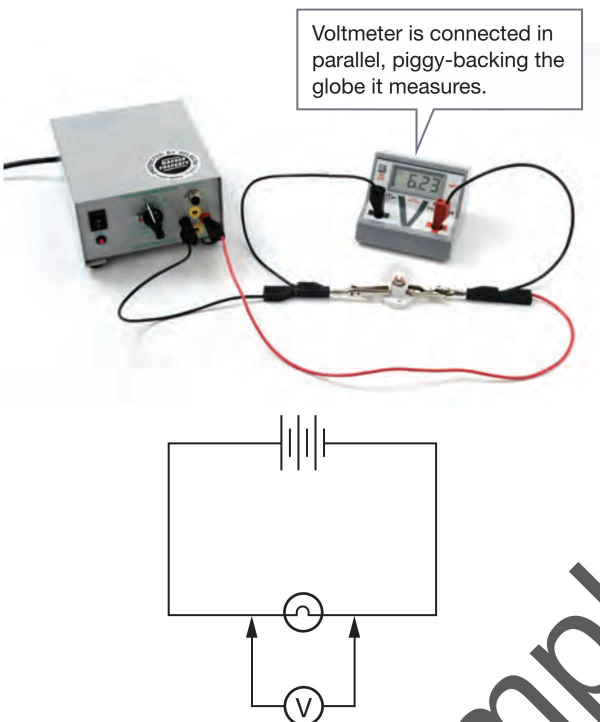


Figure 5.1.4 Voltmeters measure how much energy is used by charges as they pass through an energy converter such as a light globe. The voltmeter is connected in parallel with the component whose voltage it is measuring.

Sample pages

Supply voltage

Electrons get the energy they carry around the circuit from the circuit's energy source. Each energy source has its own voltage. Higher supply voltages give the electrons a bigger 'push' than low supply voltages.

Mains power

In Australia, power points supply 240 V to the electrons in any circuit plugged into them. Sometimes a **transformer** (like the one in Figure 5.1.5) is used to reduce the voltage from a power point to a more manageable voltage. For example, laptops typically only need a supply of 19 V, mobile phones need 6 V to recharge and digital cameras 6.5 V.

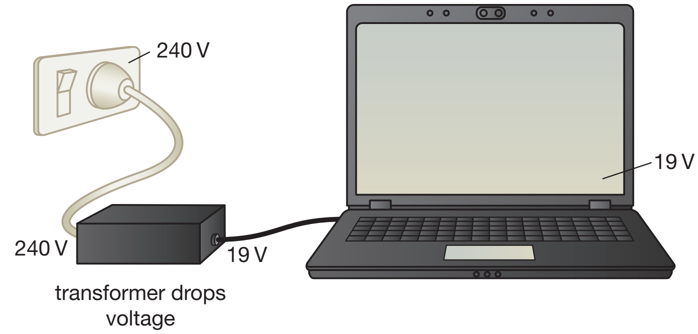


Figure 5.1.5 A step-down transformer reduces the 240 V provided by a power point to the 19 V that a laptop needs.

In the laboratory, power packs reduce the 240 V from a power point to the voltages required in experiments. Most power packs can be adjusted to supply a range of voltages from 1.5 V to 6 V or 12 V.

Batteries

As you can see in Figure 5.1.6, batteries come in different sizes and shapes and different batteries provide different voltages. The voltage of batteries can be further increased by placing a number of them end to end. For example, eight 1.5 V AA batteries arranged head to tail give the same 12 V as supplied by a car battery.

Prac 1 p178

Figure 5.1.6 Dry cell batteries come in different shapes and voltages. Higher voltages can be obtained by arranging the batteries end to end in series.

INQUIRY science 4 fun

Investigating batteries

What voltages do batteries supply?

Collect this ...

- range of battery-operated appliances, such as wristwatches, cameras, toys and torches

SAFETY

Do not use a car battery in this activity.

Do this ...

1. Open up the back of the battery-powered appliances.
2. Take note of the voltage of the battery or batteries and how many batteries are being used.

Record this ...

Describe the different batteries, their voltages and combinations you found in each appliance.

Explain why you think batteries come in different sizes, shapes and voltages.

Voltage drop

Electrons lose energy as they pass through a component such as a light globe, a heating element or a motor. This results in a voltage drop across the component. This voltage drop depends on the resistance of the component.

5.1

Resistance

As electrons pass along the wires of an electric circuit, their path is restricted a little by the atoms that make up the wires. This restriction is known as **resistance**. Resistance measures how difficult it is for an electric current to flow through a material or a component. A high resistance means it is difficult for electrons to pass through the material. A low resistance means that it is easy for the electrons to pass through the material.

The energy and voltage lost by electrons as they pass through a component depends on the resistance of the material in the component. Electrons don't bump into much as they pass through low-resistance materials, and so they lose almost no energy and almost no voltage. In contrast, in high-resistance materials there are obstacles in the way of the electrons. A little energy is lost every time the electrons are bumped off-course. Overall, a lot of electrical energy and voltage is lost as all the electrons pass through.

Resistance also affects the current flowing through a circuit. As the resistance of a component increases, fewer electrons get through it every second. This reduces the current flowing through it.

The resistance of a wire depends on the:

- type of material the wire is made from. For example, metals generally have low resistance, whereas rubber has an incredibly high resistance
- length of the wire. Doubling the length of a wire doubles the number of obstacles that the electrons must pass through. This doubles its resistance
- thickness of the wire. It is more difficult for electrons to pass along thin wires than to pass along thick wires.

Resistance is measured in **ohms**. The unit symbol for ohms is the Greek letter omega, Ω. Resistance can be measured by a multimeter, like the one in Figure 5.1.7.

Sample pages

Figure 5.1.7 A multimeter combines an ammeter and a voltmeter, and can also measure resistance.

Conductors

Metals are **conductors**. This means that an electric current will pass through them. However, some metals are better conductors than others. It all depends on their resistance.

Copper is an excellent conductor. It has a very low resistance and almost no energy is lost from it. It is also relatively cheap. For these reasons, copper wires are used in most electric circuits around the home, in factories and in cars. Another excellent, low-resistance conductor is aluminium. Aluminium is much lighter than copper. This is why aluminium is used for high-voltage transmission lines strung between distant pylons (poles), like those in Figure 5.1.8.

Figure 5.1.8 Transmission lines need to be made of a low-resistance, light metal. Copper would be far too heavy, so aluminium is used instead.

Tungsten and nichrome alloy are metals and so they conduct electricity too, but not as well as copper or aluminium do. Tungsten and nichrome have relatively high resistances and so electrons passing through them lose much of their energy and voltage. This energy is converted into heat and sometimes light. This makes them ideal to use as heating elements in electric kettles, hair dryers, electric blankets and the filaments of old-fashioned incandescent light globes like the one in Figure 5.1.9.

Figure 5.1.9 Tungsten and nichrome wires conduct electricity but have a high resistance. This old-fashioned light globe uses a tungsten filament. Its resistance converts electrical energy into light and heat.

Insulators

Some materials have such a high resistance that they can block electric current completely. These materials are said to be **insulators**. Examples are rubber, plastics, wood, glass and ceramics. Figure 5.1.10 shows how plastic is used to wrap electric wires and cables to insulate them from their surroundings. Glass and ceramics are used to insulate high-voltage power lines so that current doesn't pass into the poles that are holding them up.

Prac 2 p178

Figure 5.1.10 Plastic coating is used to insulate each of the three wires in an electric cable. More plastic coating wraps all the three wires together, insulating them even further.

Sample pages

Relating current, voltage and resistance

Current, voltage and resistance are all related to one another. Change one of them and at least one of the others will change too. For example, if the:

- current remains the same, then the voltage drop (and energy lost) will increase as the resistance of a component increases. This is similar to what happens in a car. The rougher and steeper the road, the more petrol (chemical energy) the car will use
- supply voltage remains the same but the resistance of a component is increased, then less current will flow through the component. This is because it is harder for the electrons to get through. This is similar to what happens to the traffic on a road. If there is roadwork or an accident restricting traffic, then fewer cars will get through
- supply voltage is increased, then the current flowing around the same circuit will increase. Similarly, the number of cars that can pass every hour over a bridge increases if the cars travel faster, with more kinetic energy.

5.2

ADDITIONAL

Ohm's law

The relationship between current, voltage and resistance can be summarised by Ohm's law, which states:

voltage = current × resistance

or

$$V = IR$$

where V = voltage (measured in volts V)

I = current (measured in amperes A)

R = resistance (measured in ohms Ω).

- For a constant current, voltage varies directly with resistance. This means that if the resistance of a component doubles, then the voltage drop (and energy lost) will double too.
- For a constant supply voltage, current varies inversely with resistance. This means that if the resistance of a component doubles, then only half the current will flow through it.
- For a constant resistance, voltage varies directly with current. This means that if the current through a component doubles, then the voltage drop (and energy lost) will double too.

SKILL BUILDER

Using Ohm's law

Figure 5.1.11 shows one easy way of using Ohm's law. Cover the quantity you need to calculate. You then do the calculation that is left exposed.

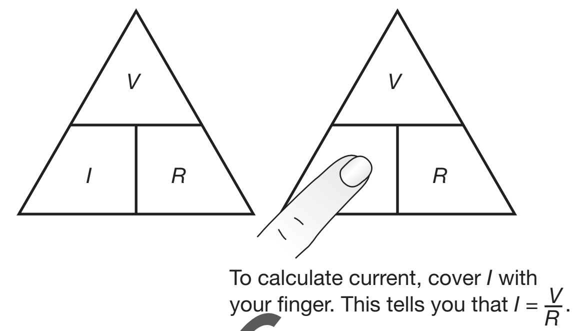


Figure 5.1.11 An easy way to use Ohm's law

WORKED EXAMPLE
Using Ohm's law

Problem

An unknown resistor carries a current of 5 A. A voltmeter connected across it shows 10 V. Calculate the resistance of the resistor.

Solution

To find the resistance, cover the symbol R. This gives you the formula $R = \frac{V}{I}$.

$$\text{Hence } R = \frac{V}{I} = \frac{10}{5} = 2\ \Omega$$

Practice N

1 A 3 Ω resistor has a current of 2 A passing through it. **Calculate** the voltage lost over it.

2 A 4 Ω resistor has 12 V applied to it. **Calculate** the current passing through it.

3 A current of 2 A passes through a resistor. The voltage drop is 12 V. **Calculate** its resistance.

Prac 3 p179
5.3
5.4

ADDITIONAL

Sample pages

5.1 Unit review

Remembering

1 **Recall** the following terms by matching each term (a–c) with its correct description (i–iii).

a	current	i	Measures how difficult it is for charges to pass through a material
b	voltage	ii	Measures the flow of charge passing through the circuit
c	resistance	iii	Measures the energy provided to or used by charges

2 **Recall** units and unit symbols by copying and completing the table.

Quantity	Unit	Unit symbol
Current		
Voltage		
Resistance		

3 **List** three things that resistance depends on.

4 **List** two examples of an electrical:
- a conductor
- b insulator.

5 **Name** two metals that have:
- a low resistance
- b high resistance.

Understanding

6 **Explain** what a transformer is used for.

7 **Explain** why copper is used for the wiring around a house but aluminium is used for high-voltage transmission lines.

Applying

8 **Calculate** the total supply voltage of the battery arrangement shown in Figure 5.1.12. N

The following key applies to questions 9 and 10.

Key
- **A** 0 A (current is blocked)
- **B** 1 A
- **C** 2 A
- **D** 4 A

9 The circuit in Figure 5.1.13 was set up. The ammeter shows the current flowing through the globe. The supply voltage was then increased to 12 V. **Use** the above key to **predict** the new ammeter reading. N

10 The globe in Figure 5.1.13 was swapped with one of greater resistance. **Use** the above key to **predict** the new ammeter reading. N

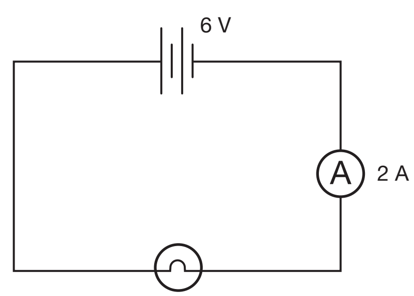


Figure 5.1.13

Analysing

11 **Contrast** a conductor with an insulator.

12 **Contrast** the ways in which an ammeter and a voltmeter are connected into a circuit.

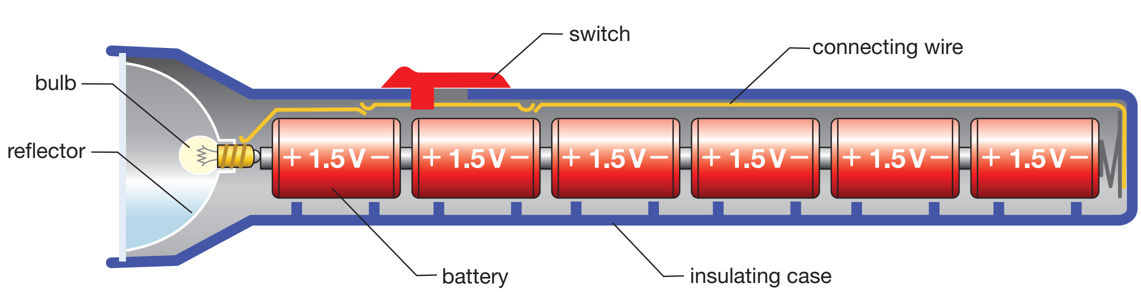


Figure 5.1.12

Sample pages

Evaluating CCT

13 An analogy is a model that compares something that is difficult to understand with something that is easier to understand. For example, electrons moving along a wire are impossible to see and difficult to imagine. For this reason they are often compared to something easier to understand, such as cars driving along a road.

- a In this analogy, **state** what would represent:
  - i electric current
  - ii resistance.
- b **Analyse** the flow of cars along a busy single-lane road that:
  - i widens with extra lanes
  - ii is blocked by a broken-down car.
- c **Use** this analogy to **predict** what would happen to current if a light globe were replaced by:
  - i a copper wire
  - ii an insulator.

14 An electric current can flow when different metals touch each other.

- a If you place aluminium against an amalgam filling in your tooth, you will feel pain in the tooth. **Propose** reasons why.
- b Builders often work with different metals. For example, they use steel nails and screws, aluminium foil and copper wires. **Propose** ways in which they can keep themselves safe when working with different metals.

15 AA and AAA batteries are different sizes but both supply voltage of 1.5 V. **Propose** a reason why batteries come in different shapes and sizes, even when some of them supply the same voltage.

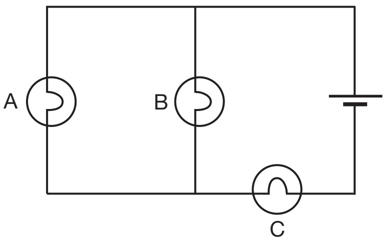
Creating CCT

16 **Construct** a circuit diagram that has a battery, a resistor, a switch and connecting wires. Include an ammeter that measures the current flowing through the resistor and a voltmeter that measures the voltage drop across it.

17 **Construct** a circuit diagram like that shown in Figure 5.1.14 but add:

- a a switch that would turn all three globes on and off
- b a switch that will only turn globe B on and off
- c an ammeter that would measure the total current through the circuit
- d an ammeter that would measure the current that flows only through globe A
- e a voltmeter that would measure the voltage lost by charges as they pass through globe B.

Figure 5.1.14



Inquiring

1 Figure 5.1.15 shows a superconductor. Research what a superconductor is and what it can be used for. Present your research as a digital document that includes images. ICT

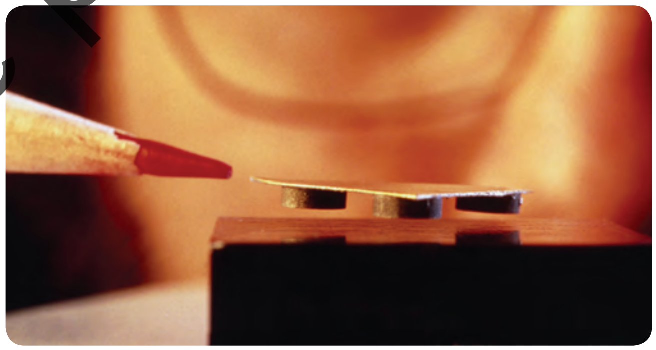


Figure 5.1.15 Superconductors have the ability to levitate or float in the air.

2 Research Georg Ohm, the physicist after whom the unit of resistance is named. Find:

- biographical details such as his date and places of birth and death
- information regarding his life
- information regarding his scientific achievements
- whether he developed Ohm's law or whether it was named after him
- another of his laws that has been since disproven.

Present your findings as short biography.

Sample pages

5.1 Practical investigations

1 Dry cell voltages

Purpose

To measure the supply voltages of different batteries.

SAFETY
Do not use a car battery in this activity.

Materials

- selection of batteries with some charge left in them
- voltmeter or multimeter

Procedure

1 In your workbook, construct a table like the one shown in the Results section.

2 Set the voltmeter or multimeter to its least-sensitive scale.

3 Attach or touch the voltmeter or multimeter terminals or probes to the terminals of each battery. For most batteries, their terminals will be their ends. Record your measurement in the results table.

4 Record the voltage printed on the battery.

Results

Record your measurements in a table like this one.

Battery type	Voltage printed on battery (V)	Measured voltage (V)

Practical review

1 **Use** your results to **assess** the accuracy of this statement. *The supply voltage of batteries is always a little lower than the voltage printed on them.*

2 Batteries have a resistance (their internal resistance) and so they use up some of the supply voltage. **Use** this fact to **explain** your results.

Sample pages

2 Graphite light globe

Purpose

To construct a light bulb using a pencil refill.

SAFETY
The pencil refill will get very hot, so do not touch it once it is connected into the circuit.

Materials

- refill for a mechanical pencil
- cardboard tube
- 9 V battery
- 2 wires with alligator clips
- large beaker, glass jar or drinking glass
- electrical insulation tape
- scissors
- digital camera or mobile phone (optional)

Procedure

1 Set up the apparatus shown in Figure 5.1.16. The pencil refill will break easily so take care when handling it.

2 Connect the wires to the terminals of the battery.

Results

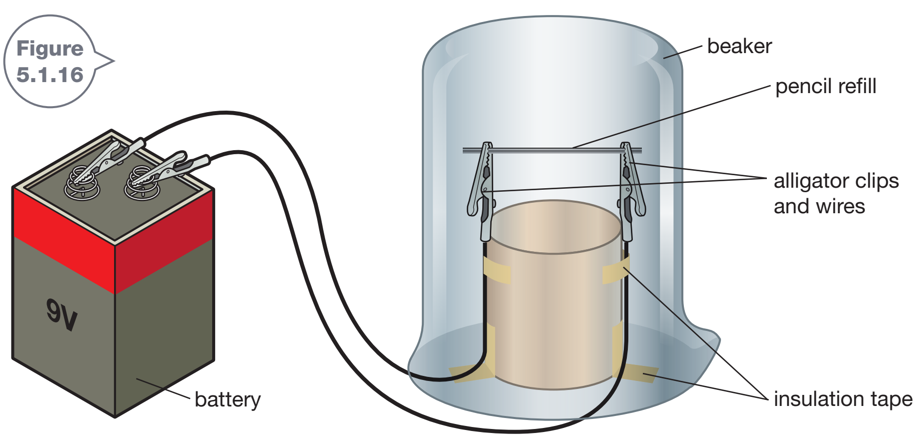
Record what happens.

Practical review

1 Pencil refills are made from graphite mixed with clay. **Deduce** whether the graphite–clay mix is a conductor or insulator.

2 **Deduce** whether the graphite–clay mix has a higher or lower resistance than the copper wires.

Figure 5.1.16



3 Ohm's law

Purpose

To determine whether a light globe obeys Ohm's law.

Materials

- adjustable power pack (up to 12 V)
- connecting wires
- 12 V light globe and holder
- ammeter
- voltmeter

SAFETY

The globe will get hot so do not touch it.

Ensure that the ammeter and voltmeter are connected as shown.

Procedure

1. Copy the table from the Results section into your workbook.
2. Construct the circuit shown in Figure 5.1.17.
3. Set the power pack on the lowest possible voltage.
4. Record the ammeter and voltmeter readings in the table.
5. Set the power pack on a different supply voltage and repeat your measurements.
6. Repeat until you have tested all possible voltage settings on your power pack or have five different sets of current/voltage measurements.

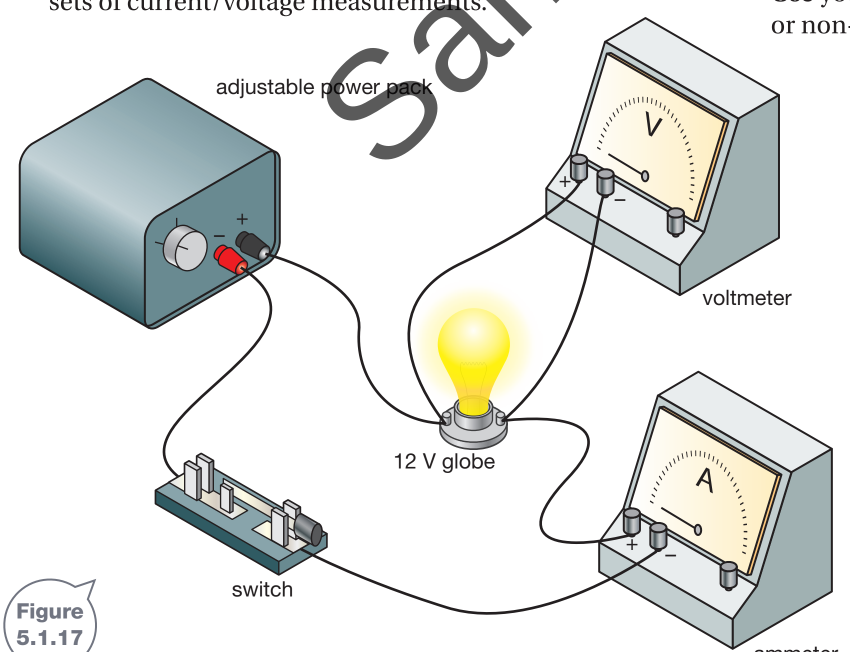


Figure 5.1.17

Results

1. Record your results in a table like this one.

Supply voltage (V)					
Current (A)					
Voltage (V)					
Calculated resistance of globe (Ω)					

2. Ohm's law can be used to calculate resistance of the globe.

   Use $R = \frac{V}{I}$.

   Calculate the resistance of the light globe for each set of measurements and add to your table.
3. Plot a graph of voltage versus current (place voltage on the vertical axis and current on the horizontal). Draw a line of best fit or a smooth curve through the middle of your results.

Practical review

1. **Construct** a circuit diagram for Figure 5.1.17.
2. A component is ohmic if its resistance is approximately the same for all voltages and currents and its voltage/current graph is a straight line.

   Use your results to **classify** the light globe as ohmic or non-ohmic.

Sample pages

5 Chapter review

Remembering

1 **State** whether the following statements are true or false.
- **a** Energy converters have resistance.
- **b** A current is flowing when a spark jumps from one object to another.
- **c** Radiation spins the turbine in a nuclear reactor.
- **d** Australia has no geothermal power plants.

2 **Name** the components shown in Figure 5.5.1.

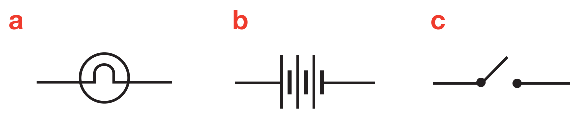


Figure 5.5.1

3 **State** what the following do if an abnormally high current passes through them.
- **a** fuse
- **b** circuit breaker

4 **State** the unit and unit symbol used to measure resistance. N

5 Coal is Australia's main source of electrical energy. **List** its advantages and disadvantages.

Understanding

6 **Define** the following terms. L
- **a** electrolyte
- **b** resistance
- **c** solenoid

7 **Predict** the expected current and voltage of each of the globes in Figure 5.5.2. N

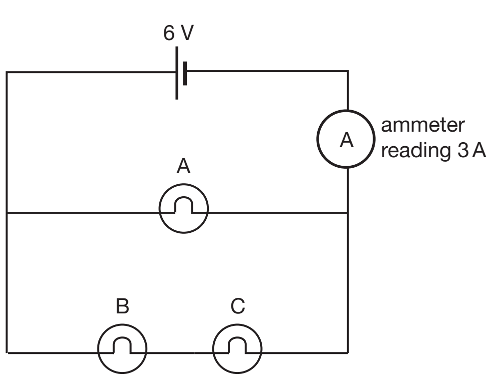


Figure 5.5.2

8 **Explain** why a wet cell is suitable for a car but not for a tablet computer.

9 **Explain** the advantages of having all your home appliances connected in parallel rather than in series.

10 Voltage is boosted before electrical power is transmitted long distances. **Explain** why.

11 **Explain** why laptops need a transformer when plugged in.

Applying

12 **Identify** three appliances around your home that use an electric motor.

13 **Identify** three energy sources used to generate electricity that are:
- **a** renewable
- **b** non-renewable.

Analysing

14 **Contrast** the electron flow and voltage of AC electricity and DC electricity.

15 **Compare** a dynamo with a turbine.

Evaluating CCT

16 **a** **Identify** which renewable way of generating electricity would be best for your area in New South Wales.
- **b** **Justify** your choice.

17 **a** **Determine** whether you can or cannot answer the questions on page 169 at the start of this chapter.
- **b** **Assess** how well you understand the material presented in this chapter.

Creating CCT

18 **Use** the following ten key words to **construct** a visual summary of the information presented in this chapter.

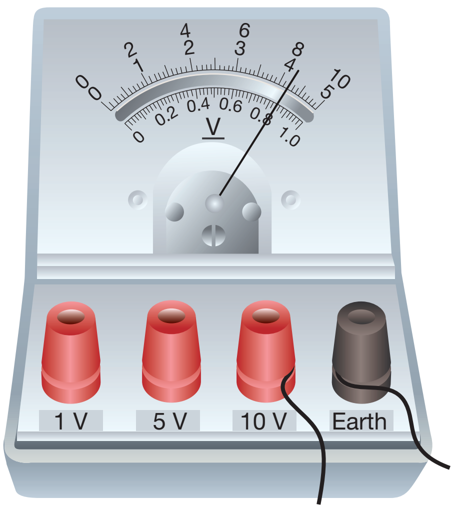
current	voltage	resistance
ammeter	voltmeter	magnet
coil	motion	
motor	generator	

5.8

Sample pages

Thinking scientifically

Q1 Analogue voltmeters have a needle and a dial. Many have different terminals along their base, with each terminal measuring a different maximum voltage. CCT



The voltmeter shown here was used to measure the voltage over a light globe. Its measurement is shown. State which of the following voltage readings is most likely to be correct.

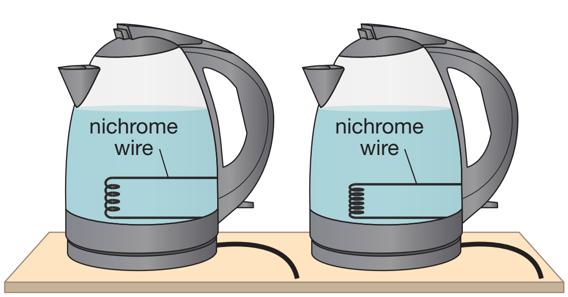
A 0.84 V
B 4.2 V
C 8.2 V
D 8.4 V

Q2 The actual supply voltage of a 3 V battery is to be measured using the voltmeter above. CCT

Assess which set of terminals would give the most accurate reading of this battery's voltage.

A 1 V and earth
B 5 V and earth
C 10 V and earth
D earth only

Q3 Marge tested how long each of these electric kettles took to boil water. CCT



The kettles were almost identical. Identify what is different between them.

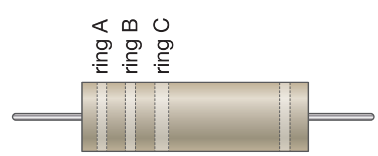
A the amount of water each held
B the voltage of the heating element
C the type of wire used as a resistance
D the resistance of each heating element

Q4 To run a fair test on the kettles in question 3, identify which of the following Marge would have to keep constant. CCT

A the position of the lid (up or down)
B the amount of water each held
C the temperature of the water at the start
D all of the above

Q5 Resistors are electronic components. Their resistance is marked on them as a series of coloured bands. What each colour band means is shown in the table below. CCT

Colour	Ring A	Ring B	Ring C
Black	0	0	× 1
Red	2	2	× 100
Yellow	4	4	× 10 000
Blue	6	6	× 1 000 000



State the most likely resistance of this resistor.

A 40 Ω
B 400 Ω
C 20 Ω
D 2 000 000 Ω

Sample pages

Glossary

Unit 5.1

Ammeter: an instrument that measures current

Ampere: the unit of current; symbol A

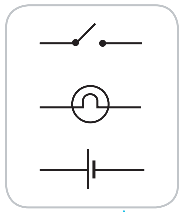
Circuit diagram: shows how all components in the circuit are connected

Components: the parts of a circuit

Conductor: a material that allows a current to pass

Current: the flow of charge

Electric circuit: the path down which charge flows



Components

Insulator: a material that blocks current

Ohm: the unit of resistance; symbol Ω

Resistance: a measure of how difficult it is for current to pass; measured in ohms (Ω)

Transformer: a device that increases or reduces voltage

Voltage: a measure of the amount of energy provided to charges or used by them; measured in volts (V)

Voltmeter: an instrument that measures voltage

Volts: the unit of voltage; symbol V

Unit 5.2

Active wire: a wire that carries current to a component; it is coated in brown plastic

Circuit breaker: a switch that turns off a circuit if too much current flows through it

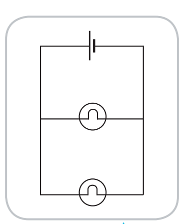
Earth wire: a wire through which current only flows when there is a leak of current in an appliance; it is coated in yellow and green plastic

Electrocution: death by electricity

Fuse: a wire of high resistance; it will melt if too much current flows in the circuit

Neutral wire: a wire that carries current away from the component; it is coated in blue plastic

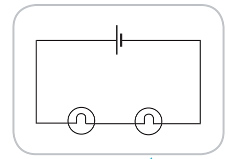
Parallel circuit: a circuit that has a number of branches, each with its own components



Parallel circuit

Safety switch: a device that turns all household circuits off if it detects a leak in current; it is also known as a residual current device (RCD)

Series circuit: a circuit with all its components arranged in a line, forming a single loop



Series circuit

Unit 5.3

Dynamo: a small generator that spins its magnet instead of its coils

Electromagnet: a solenoid with an iron rod in its centre

Electromagnetism: the relationship between electricity and magnetism

Electromagnet

Field lines: lines that show the direction of the force on iron filings and compass needles

Generator: uses electromagnetism to produce electricity; it needs a spinning coil and a magnet

Magnetic field: an invisible force field around a magnet

Motor: a machine that uses electromagnetism to spin; it needs a current-carrying coil and a magnet

Solenoid: a current-carrying loop of wire

Unit 5.4

Alternating current (AC): the current generated by electrons changing the direction in which they move

Direct current (DC): the current generated by electrons always moving in one direction

Efficiency: the percentage of energy that is converted into useful forms

Electrochemical cell: a 'mini-battery' that uses chemicals and redox reactions to generate electrical current

Electrolyte: a solution or wet paste containing dissolved chemicals that conducts electricity and completes the circuit in an electrochemical cell

Law of conservation of energy: the amount of energy before and after a change is the same; no energy is created and none is destroyed

Photovoltaic cell: a solar cell; directly converts solar energy into electrical energy

Turbine: a large-scale electricity generator

Sample pages