12 Energy in our lives

Planning page

Getting started

12.1 What is energy? page 254
- Investigate 30 Energy from food

12.2 Forms of energy page 257
- Activity page 258
- Investigate 31 Observing energy changes
- Animation Roller-coaster
- Assessment task 12 Energy changes

12.3 Energy comes—energy goes page 266
- Investigate 32 Where does the energy go?

Main ideas
- Chapter 12 crossword

Review
- Chapter 12 test

Essential Learnings for Chapter 12

Essential Learnings	*References*		
	Student book (page number)	***Workbook (page number)***	***Teacher Edition CD (Assessment task)***
Knowledge and understanding *Energy and change* Energy can be transferred from one medium to another	pages 260–262 pages 266–268	page 97 page 99	Assessment task 12 Energy changes
Energy is converted when it is transferred or transformed	pages 260–262 pages 266–268	page 97 page 99	Assessment task 12 Energy changes
Science as a human endeavour Immediate and long-term consequences of human activity can be predicted by considering past and present events	pages 269–270	page 98	
Ways of working Conduct and apply safety audits and identify and manage risks	Investigate 31 pages 261–262		
Evaluate data, information and evidence to identify connections, construct arguments and link results to theory	Investigate 32 pages 267–268		

QSA *Science Essential Learnings by the end of Year 9*

Vocabulary

conservation
conversion
efficiency
elastic
energy
gravitational
joules
kinetic
multimeter
non-renewable
nuclear
potential
renewable
thermometer
transferred
transformed

Focus for learning

Brainstorm and discuss what energy is (page 253).

Equipment and chemicals (per group)

Investigate 30 page 255 small piece of food (eg Nutri-Grain or Tiny Teddy), Bunsen burner, wire to make holder, small test tube, thermometer, measuring cylinder, stand and clamp

Activity page 258 large cotton reel, rubber band, tape, match, metal washer, pencil

Investigate 31 page 261 **Part A:** piece of magnesium ribbon 1–2 cm long, pair of metal tongs, Bunsen burner, heatproof mat

Part B: 6 V battery, 3 connecting wires with alligator clips, heatproof mat, few strands of steel wool, switch

Part C: piece of nichrome wire or iron wire about 50 cm long, 2 pieces of copper wire about 50 cm long, multimeter, Bunsen burner, crushed ice

Part D: solar cell kit (consisting of several solar cells connected to an electric motor, preferably fitted with a propeller)

Part E: beaker of water, tuning fork

Investigate 32 page 267 2 L ice-cream container or similar, 250 mL beaker or similar, 2 thermometers, boiling water, graph paper, stopwatch

Special preparations

Investigate 30 page 255 To avoid the possibility of damage to the thermometers, slide a small piece of plastic tubing over the bulbs.

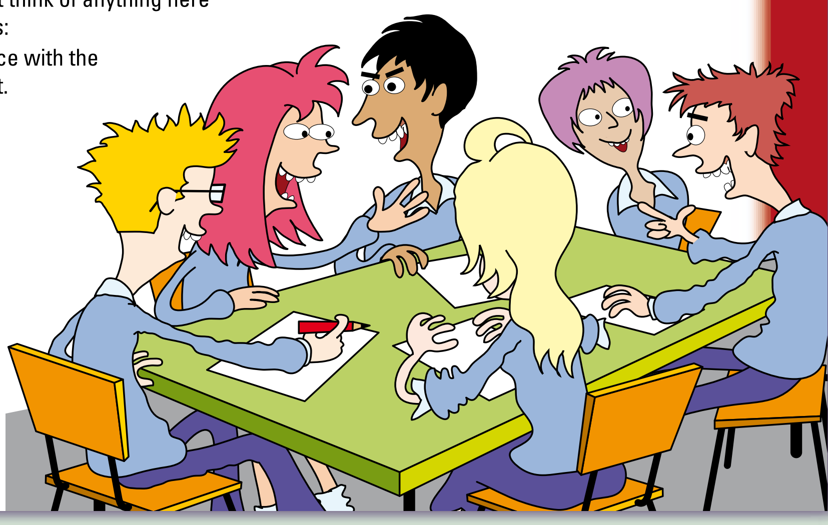
A chimney made out of a metal food can (fruit, soup or drink) directs the heat from the burning food to the test tube. Cut the top and bottom off a metal drink or food can, and cut a ‘door’ at the bottom for the burning food.

12 Energy in our lives

Getting Started

You have probably used the word 'energy' many times, but what is energy? And are your ideas about energy the same as other people's ideas? A good way to sort out your ideas is by *brainstorming*. To do this follow these six steps.

1 Sit in a group of about six people, facing each other.
2 Select someone to write down all the ideas.
3 Everyone should try to give at least one idea about energy—the more ideas the better at this stage. If you can't think of anything here are some suggestions:
   - Think of a sentence with the word 'energy' in it.
   - Draw something with a lot of energy.
   - What do we use energy for? List the different types of energy and give examples.
4 Don't discuss the ideas yet, and don't criticise anyone else's idea.
5 After 2 or 3 minutes of brainstorming, discuss the group's ideas about energy. You might like to select some of these ideas, write or draw them on a large sheet of paper and present them to the class.



Starting point

The Getting Started brainstorming activity will give you an indication of the students' level of understanding of this concept and allow you to identify those students who need extra help. Some students may have a good understanding of what energy is and the various sources of energy. This is an opportunity to arrange your class into groups to use peer tutoring strategies.

Issues

Section 12.3 lends itself to some discussion about concerns for our energy consumption and energy alternatives we need to consider. Invite guest speakers to the school who are involved with alternative energy or reducing energy usage in our homes, schools and industries. (Essential Learnings: responsible, ethical and informed decisions about social priorities often require the application of scientific understanding.

Learning experience: word wall

Create a word wall:

- Divide students into small groups, and give each group a marker pen and a packet of Post-it notes.
- Ask students to write words that relate to the word *energy*.
- Each group then brings their words and sticks them to the feature wall in the classroom. Discuss how you will group the words, eg types of energy, uses for energy, verbs, nouns etc.
- Develop the lists of words on the wall as you work through the chapter. You may even choose some to add to the spelling or vocabulary list.
- Students could write sentences using words from the wall list.

Hints and tips

- Ask students to write a list of items, foods or activities that provide or require large amounts of energy. Ask students to explain how this energy is supplied or acquired.
- Energy is the ability to do work. If something is not moving it does not mean it has no energy but that it has the *potential* to do work (potential energy). An unlit match has potential energy, as does a battery not connected in an electrical circuit.

12.1 What is energy?

If you use a torch for a long time, the light gradually gets dimmer and dimmer until it no longer shines. We say the batteries are 'flat'—they have run out of energy. In a similar way you can't pedal a bicycle or dig in the garden for too long because your body runs low on energy. If you don't eat food, your body becomes weaker and weaker. This is why we say that food gives us energy.

Everything around us depends on energy. Plants need energy from the sun to make food. Cars depend on the energy stored in petrol. Energy is used in homes, offices and industry to run all sorts of machines. It is used for lighting and heating our homes, and for cooking and storing food.

Obviously energy is very important to us, but you probably found in Getting Started that it is difficult to say exactly what it is. It is easier to say what energy can do. If you have a lot of energy, then you can do a lot of work. You do **work** when you use a force to move something. **Energy** is the ability to do work.

The more energy something has, the more work it can do. A gale-force 100 km/h wind has more energy than a gentle 10 km/h breeze. It can therefore do more work, for example turning windmills or ripping off roofs. Also, a raised sledgehammer has more energy and can do more work than an ordinary hammer, because it is heavier (has more mass).

Anything that does work must have a supply of energy. A motorbike will not keep running unless it is supplied with petrol. Petrol provides energy that the engine uses to do work. When you pedal a bicycle, the energy comes from the muscles in your body, and your muscles get their energy from the food you eat. If you have a higher intake of energy than you need, then the extra energy is stored in your body as fat. On the other hand, an inadequate energy diet will lead to a thin and unhealthy body.

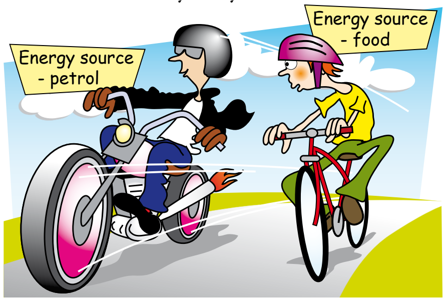


Fig 3 The bicycle and the motorbike both need energy to move them.

Measuring energy

In talking about how much energy something has, it is important to have a unit for measuring energy. In the same way that the litre is the unit for measuring volume, energy has a unit called the **joule** (J). This unit was named after a British scientist called James Joule. You use one joule of energy to lift a 100 gram mass one metre. Because a joule is only a small amount of energy, it is common to use **kilojoules** (kJ) and megajoules (MJ).

The table on page 256 shows you how much energy is involved in various everyday activities.

1 kilojoule	=	1000 joules
1 megajoule	=	1 000 000 joules

To find how much energy is stored in food, you can turn it into heat and measure what that heat can do. In Investigate 30 you will burn some food to do that. Of course there are no fires burning inside you. The food combines with oxygen in your cells in the chemical reaction called respiration, and heat energy is released.

Learning experience

Ask students to bring in food nutrition or energy information tables from food packets. As a group, identify and discuss which types of food seem to provide most energy, and ask students to suggest reasons for this.

Ask students to tabulate some of this information in their notebooks.

Investigate

30 ENERGY FROM FOOD

Aim

To find out how much energy is released when a small piece of food burns.

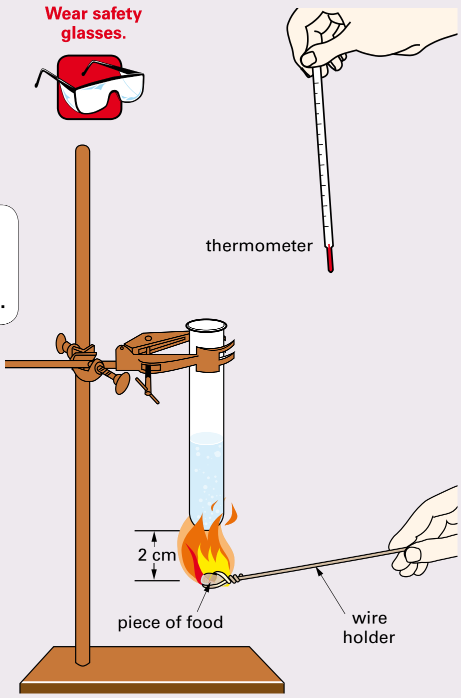
Materials

- small piece of food, eg Nutri-Grain or Tiny Teddy
- Bunsen burner
- wire to make holder
- small test tube
- thermometer
- measuring cylinder
- stand and clamp

Teacher note: When selecting foods remember some students may be allergic to burning peanuts.

Planning and Safety Check

- Read through the investigation, then describe to your partners what you have to do, measure and record.
- What data will you need to record?
- What safety precautions will be necessary?



Method

1 Use the measuring cylinder to measure *exactly* 10 mL of water into a small test tube.

2 Clamp the test tube as shown.

3 Use a thermometer to measure the initial temperature of the water.

4 Use the wire to make a holder for the piece of food.

5 Light the Bunsen burner. Then put the food in the flame. As soon as it catches fire, hold it about 2 cm under the test tube.

6 When the food stops burning, stir the water *gently* with the thermometer, and measure the final temperature.

7 If you have time, repeat the experiment with other foods, eg potato crisps, nuts, bread, rice, spaghetti.

Discussion

1 By how many degrees did the temperature of the water increase?

2 It takes 4.2 joules to raise the temperature of 1 mL of water by 1°C. So, to calculate the heat energy gained by 10 mL of water, multiply the temperature rise by 42. Your answer will then be in joules.

3 Do you think all the energy from the burning food went into heating up the water in the test tube? Explain.

4 Were there any problems with the investigation? If so, suggest how these problems could be fixed.

Lab notes

- The results of this investigation can be improved by using food or drink cans with both ends removed and a ‘door’ for the burning food. The can acts as a chimney or heat shield to reduce the effect of air movement and direct the heat upwards to the test tube.
- If the flame from the food goes out it will need to be re-ignited with the burner. Remind students to keep the burner alight on the safety flame.
- Try to avoid using peanuts as some students may be allergic to them.
- Students need to be aware of the potential hazard in stirring the water in the test tube with the thermometer. It may be advisable to attach a small piece of plastic tubing to the bulb of the thermometer to avoid breakage.
- Remind students of the need to conduct a ‘fair test’ by making sure all test tubes are the same etc.
- Class data could be collected for a particular type of food. The range of results could lead to a discussion about the design of a fair test.
- Provide a can or other container as a rubbish bin for burnt food for each group.
- As an extension, it is possible to determine the mass of the foods and then calculate the joules per gram so that comparisons can be made between foods.
- Ensure students work with their group and minimise movement once the investigation has started, as some foods burn for quite a while.

Check!

1 For each of the following words, write a sentence to show that you understand its scientific meaning.

force   work   energy

2 How do you know if something has energy?

3 Why can a cricket ball do more work than a golf ball moving at the same speed?

4 How many joules are there in:
- a a kilojoule?
- b a megajoule?

5 Use the table below to answer these questions.
- a How much energy does the average person get from the food they eat in a day?
- b How many kilojoules of energy does a burning match produce?
- c Which has more energy stored in it—a car battery or one litre of petrol?
- d Is there enough energy stored in a battery to boil a kettle of water?

6 a Where does the energy needed to start a car come from?
- b If you leave the lights on while your car is parked for a few hours, you may have trouble starting it. Why?

7 In a science lab, Alex and Holly are doing an experiment on the chemical energy stored in foods. Look carefully at the illustration. List at least five things they are doing that are unsafe.

Energy involved in everyday activities (in kilojoules)

Energy produced by a burning match	10
Energy you gain by eating a chocolate biscuit	300
Energy needed to boil a kettle of water	700
Energy you use in walking 5 km	1000
Electrical energy stored in a car battery	2000
One day's hard work	7000
Average energy gained from the food you eat in a day	11 000
Electrical energy used by a family home each day	80 000
Energy stored in five litres of petrol	160 000
Energy made by a power station every second	2 000 000

8 Why do you puff and pant after running quickly or exercising?

9 In Getting Started on page 253 a student said that whenever a change occurs, energy is involved. For example, a kettle boils when you supply heat energy. Give as many examples as you can to illustrate this idea.

Check! solutions

1 The meanings should be something like these:

Force is the strength of a push or pull.

Work is when energy is used to move something or change its shape.

Energy is the ability to do work.

2 If something has energy, it can do work by changing the shape or position of another object.

3 A cricket ball can do more work (or more damage) at the same speed because it has a greater mass and therefore more energy.

4 a There are 1000 joules in a kilojoule.
- b There are 1 000 000 joules in a megajoule.

5 Using the table:
- a The energy you get from the food you eat in a day is approximately 11 000 kJ.
- b The energy produced by a burning match is approximately 10 kJ.
- c A battery has about 2000 kJ, whereas one litre of petrol has about 32 000 kJ.
- d Yes, there is enough energy in a battery to boil a kettle of water, several times in fact.

6 a The energy to start a car comes from the battery. To go back a step further, the battery is charged by the motor, which gets its energy from the fuel that is burned.
- b If the lights are left on, most of the energy in the battery may be used up and there may not be enough left to start the car.

7 Holly is eating in the lab and does not have her hair tied back. Alex is not wearing his safety glasses and is pointing the test tube at his face. The paper on the bench is a fire hazard, there should be no food in the laboratory and there is no bench mat beneath the Bunsen burner. It is also reasonable to infer that they are thinking and talking about something else.

8 During an aerobics session your body will use up oxygen and produce carbon dioxide. The energy which is used during the session is replaced by energy which is produced by respiration when food reacts with this oxygen. Puffing and panting will get rid of the carbon dioxide and replace the oxygen.

9 Students can probably think of dozens of examples. Here are a few:

A car goes when you burn fuel which is chemical energy.

Your mobile phone goes when you supply electrical energy from the battery.

A plant grows when it receives energy from the Sun.

12.2 Forms of energy

There are many different forms (types) of energy.

Kinetic energy

Any moving object has **kinetic** (kin-ET-ic) **energy**. When you run you have kinetic energy. A moving train has a large amount of kinetic energy. The kinetic energy of the strong winds in a cyclone or tornado can cause a lot of damage. As a moving object slows down, it loses kinetic energy. When it stops it has no kinetic energy.

Fig 6 The winds in cyclones and tornadoes have a huge amount of kinetic energy.

The amount of kinetic energy an object has depends on its speed. The faster the object moves, the more kinetic energy it has. For example, a cricket ball bowled by a fast bowler has more kinetic energy than one bowled by a spin bowler.

Kinetic energy also depends on the mass of the moving object. The larger the mass, the greater its kinetic energy. A cyclist and a bus may be travelling at the same speed, but the bus has much more kinetic energy because it has greater mass.

Gravitational potential energy

Much of the energy around us is *stored energy*. We notice it only when it changes to other forms. It has the *potential* to do work, so stored energy is called **potential energy**. For example, the stored energy that something has when it is high up is called **gravitational potential energy**. This energy is there ready to be used because of the pull of gravity. When you are at the top of a slide you have gravitational potential energy—you have the *potential* to slide to the bottom. The heavier you are, and the higher the slide, the more potential energy you have. As you slide down, this gravitational energy is changed to kinetic energy. Energy can easily change back and forth between potential and kinetic.

Fig 7 At the top of the slide you have gravitational potential energy.

To see how energy changes back and forth between potential and kinetic, open the **Roller-coaster** animation on the CD. Working with technology

Hints and tips

As an extension activity or for the more mathematically interested students you may like to show them the formulas for kinetic and gravitational potential energy. Give the students a worksheet where they are to perform some simple calculations using the formulas, as it helps to link together the studies of science and mathematics.

(Note: kinetic energy = $\frac{1}{2}mv^2$ and potential energy = mgh.)

Animation

Students should view the animation **Roller-coaster** on the CD.

Learning experience

Bring a basketball or soccer ball to class. Bounce or throw the ball up and down in front of you. Ask the students to explain what is happening in terms of energy. Explain to the class that the moving ball has kinetic energy; the ball has gravitational potential energy when it rests in the palms of your hands just prior to being dropped.

Hints and tips

Develop your own list of elastic situations where energy is stored, such as a trampoline or a bent plastic ruler, and inelastic situations where energy is not stored, such as a piece of concrete, a brick or a desk top. Ask the students to categorise the situations and put them into two groups: elastic and inelastic. At this point it may be worth explaining elastic potential energy in reference to collisions of objects.

Ask the students if they can think of types of materials which lend themselves to being more elastic than others and why; what properties do they have?

Elastic potential energy

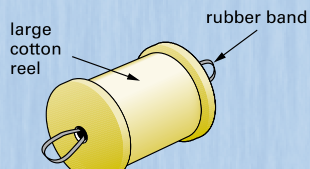
When you jump on a trampoline, what pushes you into the air? Try to visualise what happens in slow motion. The trampoline consists of a frame with a flexible mat attached by springs. When you land on the mat, it moves down, stretching the springs and storing energy called **elastic potential energy** in them. As the stretched springs return to their original size and shape, they release their stored energy. The mat is pulled back up, and you are thrown into the air.

A wind-up toy stores elastic potential energy. So does a stretched elastic band. The more it is stretched, the more elastic energy it has, and the more work it can do.

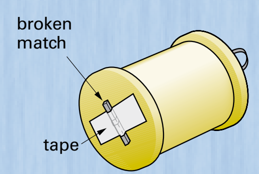
Fig 8 The elastic energy stored in the stretched trampoline springs throws you into the air.

Activity

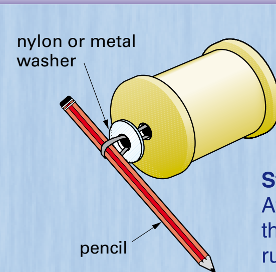
Make a motormouse as shown.



Step 1
Thread a rubber band through the cotton reel.



Step 2
Put a piece of broken match through one end of the rubber band. Tape the match to the reel so it will not move.



Step 3
At the other end, put the washer over the rubber band, then put a pencil through the rubber band.

To make it go, simply wind up the pencil until the rubber band is tightly twisted. Then put the motormouse on the floor and let it go.

- What type of energy does the motormouse have when you let it go?
- What type of energy did it have before you let it go?
- Energy is needed to wind up the motormouse. Where did this energy come from?
- Investigate the relationship between the number of turns of the pencil and the distance the motormouse travels.

Learning experience

A fun activity is to test the elasticity of different brands of jelly snakes. The students could design their own test and do the activity either at school or at home. Make sure you ask them to draw a data table to record results. Revise what makes a fair test and types of data (quantitative and qualitative).

Learning experience

Design an experiment to predict and investigate the potential energy of rubber bands. Divide the class into small groups. Give each group 4–5 rubber bands of varying widths and lengths. Ask students to predict which rubber band has the greatest potential energy and design a fair test to prove or disprove their prediction. Collect, tabulate and discuss the results.

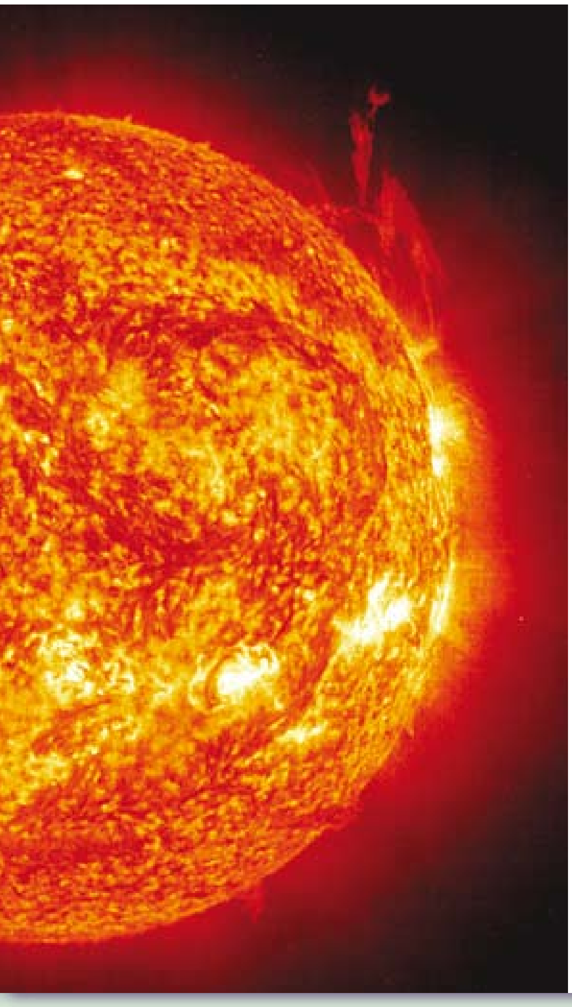
Chemical energy

Energy is stored in chemicals as **chemical energy**. When fuels such as wood and petrol are burned, this stored energy is released as heat and light. Foods also contain chemical energy which can be used by our bodies.

Nuclear energy

Energy is also stored inside atoms as **nuclear energy**. It can be released from some atoms, eg uranium atoms, in nuclear power stations.

Fig 10 Nuclear energy stored in hydrogen atoms is the source of the Sun's energy.



Sound energy

Sound is a form of kinetic energy caused by vibrating objects. It travels from place to place as sound waves. The louder the sound is, the more energy it has, and the more work it can do by vibrating things such as your eardrums.

Heat energy

Heat is a form of energy that hot objects have. If heat energy is taken away from an object, it becomes cooler. This is what happens in refrigerators and in air-conditioned rooms.

Light energy

Burning chemicals, very hot objects and stars all release light energy. It travels through space in waves (as do radio and TV waves, microwaves and ultraviolet waves). Light energy from the sun, called *solar energy*, is used by plants to make their food.

Electrical energy

Electrical energy is widely used because it is easily transmitted by wires to the place where it is needed. It can be changed into other forms of energy by the many electrical devices that have been invented. It can also be stored in batteries.

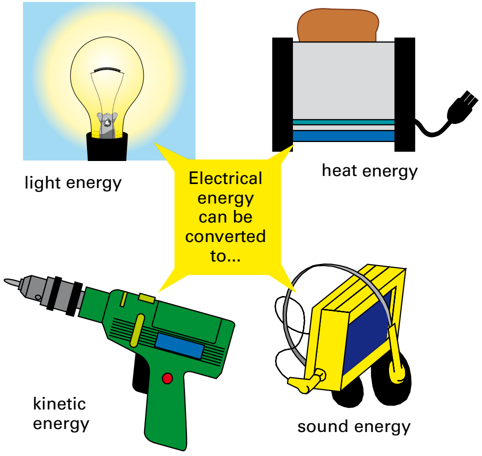


Fig 11 Electrical energy is very useful because you can easily convert it into other forms of energy. Four different energy converters are shown here.

Hints and tips

Check that students can make the connection between this chapter on energy and Chapter 7 Organisms in ecosystems. Reinforce the concept that energy cannot be created or destroyed (page 267).

With nuclear energy, revisit what an atom is, its subatomic particles and the nucleus. Nuclear energy is energy to do with the nucleus of the atom (radioactivity, fission and fusion). It is different from chemical energy, which has to do with the electrons of the atom.

Homework

Ask students to work in small groups or pairs to research a form of energy. Ask the groups to make a poster or model for their energy form. Students should then give a 5-minute presentation to the class.

Students should make notes about each form of energy and how it is used in everyday life.

Learning experience

Cut out pictures from magazines that illustrate energy being used, and hand them out to groups in the class. Ask each group to explain the energy that is involved in each picture and to justify their answer. For example, a car uses chemical energy from the fuel; a falling tree has kinetic energy.

Hints and tips

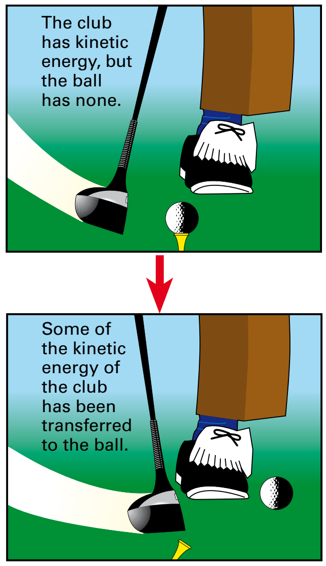
Get the students to do a concept map about energy. This map can be added to throughout the unit and used as a revision tool. As a challenge, they could broaden their map to link together concepts from other topics in the textbook. By doing this the students will see how energy is intrinsically linked throughout science.

Assessment task

This would be a good time to set Assessment task 12: Energy changes, found on the CD.

Energy changes

Energy can be *transferred* from one object to another. In golf, a ball at rest is made to move by a moving golf club. Some of the kinetic energy of the club is transferred to the ball.



Another everyday energy transfer occurs when you heat water on a stove. Heat is transferred from the gas flame or the electrical heating element to the water, causing it to boil.

Energy can also be *converted* or *transformed* from one form into another. For example, if you rub your hands together they become warm. You have converted the kinetic energy of your moving hands into heat energy. You can describe this change with an arrow, as shown top right.

Sometimes more than one form of energy is produced when an energy change occurs. A candle is designed to convert stored chemical energy into light, but some of the stored energy becomes heat. When you use an electric drill, not all of the electrical energy is converted to the kinetic energy of the drill. Some is lost as sound energy and some as heat energy (the drill becomes hot).

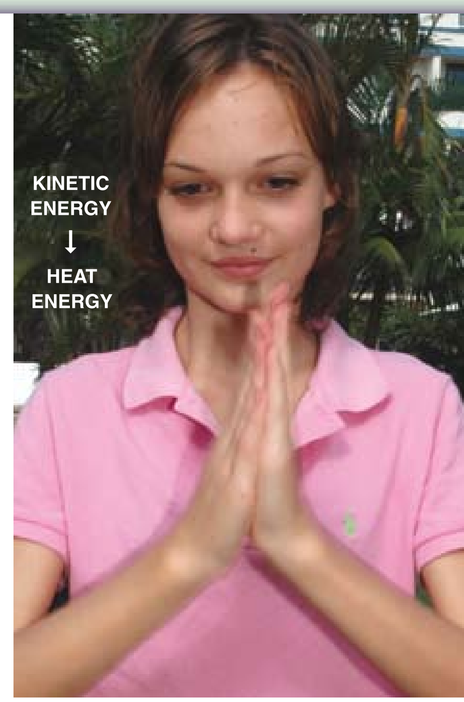
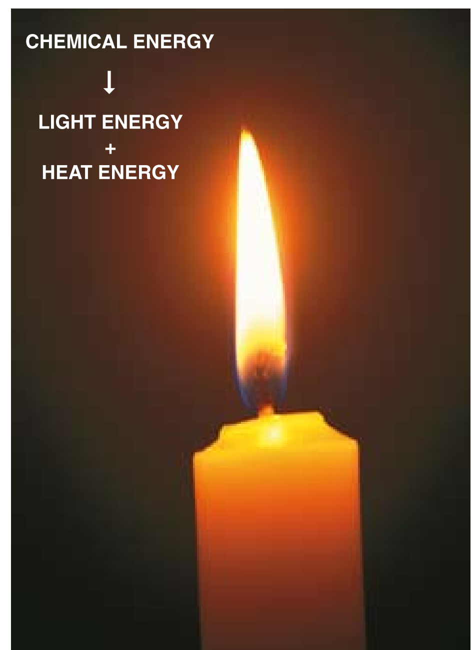


Fig 13 Rubbing your hands together converts kinetic energy into heat energy.

Fig 14 The energy conversions that occur when a candle burns.



Learning experience

Make a mouse trap

Part 1: Ask students to work in pairs to design and draw plans of a simple machine or device that undergoes at least five energy changes and can ultimately catch a mouse. Give each pair of students a large sheet of butcher's paper or A3 paper to sketch their plans. Students should include measurements and materials and outline the energy conversions for their device.

Part 2: Students can construct their mouse trap using recycled materials (with teacher or parental guidance). Some may decide to roll a ball through a series of small rollercoaster-type paths to set off a mouse trap; some may be more creative and elaborate. However, make sure students work within the time allocated. Each pair of students can 'show and tell' their mouse trap.

This activity will give those students who enjoy designing and building models an opportunity to express their knowledge of energy.

Investigate
31 OBSERVING ENERGY CHANGES

Aim

To observe the energy changes that occur in a variety of situations.

Planning and Safety Check

Discuss the safety issues for each part of the investigation.

Draw up a data table like the one shown below. For each part, you will record the energy conversion(s) that occur, and any energy transfer(s) from one place to another without an energy conversion. (You may need to discuss this with others.)

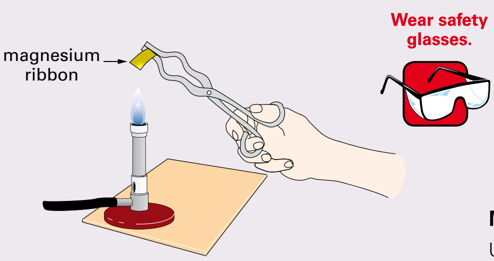
Part	Observations	Energy conversion(s) that occurred	Energy transfer(s) that occurred
A			
B			

PART A

Materials

- piece of magnesium ribbon 1–2 cm long
- pair of metal tongs
- Bunsen burner
- heatproof mat

Warning: Do not look directly at the burning magnesium. Look to one side. The light is very bright and could damage your eyes.



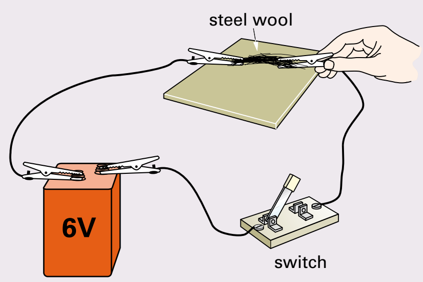
Method

Light the burner. Use the tongs to hold the magnesium in the flame until it starts to burn. Then take it out of the flame and hold it over the heatproof mat.

PART B

Materials

- 6 volt battery
- 3 connecting wires with alligator clips
- heatproof mat
- few strands of steel wool
- switch



Method

Use the wires to connect the battery and switch as shown. Put the steel wool on the heatproof mat. Connect the wires to it. Press down the switch for a few seconds. Observe what happens.

Do not leave the switch on.

Lab notes

Set up each part of this Investigate at a different work station around the room. Ask groups to work their way around each work station and allow 5–10 minutes at each.

Part A

- Pre-cut the magnesium ribbon to 1–2 cm lengths.
- Make sure students are aware of the safety issues with burning magnesium. Ask students not to look directly at the bright flame.
- Students should burn the magnesium over a heatproof mat to avoid the white ash falling on the desk or clothes.

Part B

- The steel wool can crackle a bit and can have an unpleasant smell when it burns.
- You can use a power pack set on 6 V instead of a battery. However, make sure students turn the switch on for 2 or 3 seconds only.

Lab notes

Part C

- You will also need some fine sandpaper to clean the ends of the wires to make sure good contact is made between the two metals.
- If you use multimeters it is good practice to pre-set them. Do not allow students to fiddle with the settings.

Part D

- Light intensity is critical here so use the north windows or do this part outside.

Part E

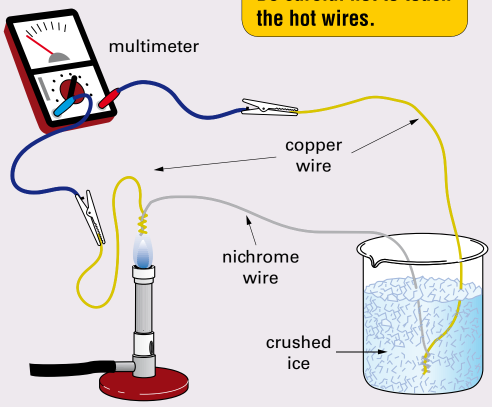
- This is fun but will make a mess, so set up this work station near the sink and have plenty of cloths available for cleaning up.

PART C

Materials

- piece of nichrome wire or iron wire about 50 cm long
- 2 pieces of copper wire about 50 cm long
- multimeter
- Bunsen burner

Be careful not to touch the hot wires.



Method

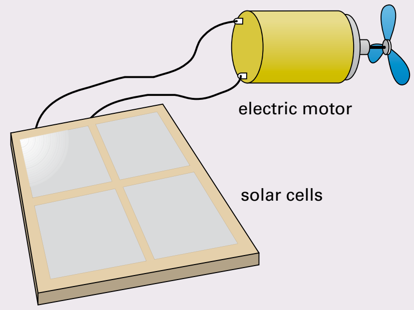
Sandpaper the ends of the copper wire, then twist the ends of the three wires together tightly as shown. Connect the ends of the copper wires to the terminals of the multimeter. (The multimeter detects small electric currents.) Put one junction in the crushed ice and heat the other junction until it gets red hot. Observe the multimeter carefully.

What you have made here is called a *thermocouple.* It is used to measure temperatures in ovens and furnaces.

PART D

Materials

- solar cell kit (consisting of several solar cells connected to an electric motor, preferably fitted with a propeller)



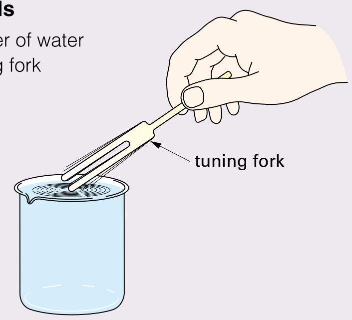
Method

Place the solar cell kit in bright sunshine. What happens if you cover all or some of the solar cells?

PART E

Materials

- beaker of water
- tuning fork



Method

Strike the forked end of the tuning fork gently on the heel of your shoe (not on the bench). Hold the fork near your ear. Strike the fork again, but this time look closely at the prongs.

Strike the fork a third time, and touch the surface of the water in the beaker with the vibrating prongs.

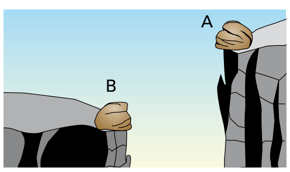
Check!

1 Copy and complete each of these sentences.
- a A moving object has ______ energy.
- b Energy that is stored is called ______ energy.
- c A boulder rolling downhill is losing ______ ______ energy, but gaining ______ energy.
- d Burning a piece of coal changes ______ potential energy into ______ and ______ energy.
- e Springs can ______ energy which can be released later.

2 Make two columns, one headed 'kinetic energy', and the other 'potential energy'. Place each of the following in the correct column.
- a an archery bow ready to shoot an arrow
- b a running high-jumper just before leaving the ground
- c a jet plane at the point of take-off
- d at the top of your bounce on a trampoline
- e a spring-loaded popgun
- f a child's swing at its highest point
- g a child's swing at its lowest point

3 What are the two types of potential energy?

4 The two rocks below have the same mass. Which one has more potential energy? Why?



5 What is the difference between an energy transfer and an energy conversion? Give examples.

6 What form(s) of energy do the following have?
- a a diver standing at the top of a tower
- b a bent ruler
- c a block of chocolate
- d a burning log
- e a glowing firefly
- f a lightning flash
- g ocean waves
- h a slice of bread
- i a TV set (turned on)
- j a warm pizza
- k the water in a waterfall
- l a wound-up toy

7 Pair up these lists correctly in your notebook.

Object	Main energy conversions
battery	electrical to sound
electric motor	electrical to light & sound
lift going up	chemical to kinetic
solar cell	chemical to heat & light
radio	nuclear to electrical
TV	chemical to electrical to light
torch	light to electrical
car	chemical to electrical
campfire	electrical to kinetic
nuclear power station	electrical to kinetic to gravitational

8 Maria connected a coil of wire to a milli-ammeter, as shown. When she pushed a magnet quickly into the coil, the ammeter showed that there was an electric current flowing. When she stopped moving the magnet, no current flowed. Write a sentence describing what happened in terms of energy changes.

9 Go back to Getting Started on page 253. How have your ideas about energy changed after working through this chapter?

Check! solutions

1
- a A moving object has **kinetic** energy.
- b Energy that is stored is called **potential** energy.
- c A boulder rolling downhill is losing **gravitational potential** energy, but gaining **kinetic** energy.
- d Burning a piece of coal changes **chemical** potential energy into **heat** and **light** energy.
- e Springs can **store** energy which can be released later.

2

Kinetic energy	*Potential energy*
b	a
c	d
g	e and f

3 Two types of potential (stored) energy can be chosen from gravitational, elastic, chemical and nuclear.

4 Rock A has greater potential energy because it is higher and therefore stores more energy than rock B.

5 An energy transfer is when a particular form of energy is transferred from one object to another object, eg hitting a ball with a bat. An energy conversion occurs when energy is changed from one form to another, eg jumping on a trampoline.

6 These are the main types of energy:
- a Gravitational potential
- b Elastic potential
- c Chemical potential
- d Heat and light
- e Light
- f Light and heat
- g Kinetic and sound
- h Chemical potential
- i Light, sound and heat
- j Chemical potential and heat
- k Gravitational potential and kinetic elastic potential
- l Elastic potential

7

Object	*Main energy conversions*
battery	chemical to electrical
electric motor	electrical to kinetic
lift going up	electrical to kinetic to gravitational
solar cell	light to electrical
radio	electrical to sound
TV	electrical to light and sound
torch	chemical to electrical to light
car	chemical to kinetic
campfire	chemical to heat and light
nuclear power station	nuclear to electrical

8 As Maria moved the magnet in the coil, the kinetic energy was changed to electrical energy and then kinetic energy to move the needle in the ammeter.

9 Students' answers here will depend on what they knew at the start of this chapter and what they have learned as they worked through it.

challenge

1 Copy and complete the table below.

Energy used	Energy converter	Energy produced
______	light globe	______
______	electric fan	______
______	petrol engine	______
kinetic	______	electric
______	torch cell	______
______	steam engine	______
______	atomic bomb	______
electrical	______	heat
______	slingshot or catapult	kinetic
______	waterwheel	______
kinetic	______	sound

2 What energy changes are being described in each of the following? Use arrows as in Fig 13 and Fig 14 on page 260.

a The wind blew hard, turning the windmill noisily as it pumped the water from deep underground into the trough.

b At the flick of a switch the washing machine started turning and churning the clothes.

c '… two, one, zero.' The rocket belched fire and smoke, the ground shook and, with a deafening roar, the rocket left the launch pad.

d The lightning flashed, and the thunder crashed. The gum tree was split right down the middle.

3 List at least three different things in which chemical energy is stored.

4 Into what forms of energy does the human body convert the chemical energy in food?

5 If a neon street light converts 300 J of electrical energy into 200 J of heat energy and 90 J of light energy, how much sound energy is produced? (Assume these are the only energy conversions that occur.)

6 Give an example of something that has:

a gravitational energy due to its high position

b elastic energy because it has been stretched

c chemical energy

In each case explain how the energy can be used to produce movement.

7 How could you demonstrate that sound is a form of kinetic energy?

8 Draw a cartoon of a jack-in-the-box. Discuss with another student how potential energy is involved, and how this energy changes when the lid is opened. Write a caption to describe your cartoon in energy terms.

9 What is the source of energy for a solar-powered car? What energy conversion occurs when the car is moving? How would such cars operate at night or on cloudy days?

Challenge solutions

1

Energy used	*Energy converter*	*Energy produced*
electrical	light globe	**light and heat**
electrical	electric fan	**kinetic**
chemical	petrol engine	**kinetic, sound and heat**
kinetic	**generator**	electric
chemical	torch cell	**electric**
heat	steam engine	**kinetic**
nuclear	atomic bomb	**heat, light and sound**
electrical	**radiator**	heat
elastic	slingshot or catapult	kinetic
gravitational	water wheel	**kinetic**
kinetic	**loudspeaker**	sound

2 These are the energy changes:

a kinetic → sound
→ gravitational potential

b electrical → kinetic → sound
→ heat

c chemical → gravitational potential
→ sound
→ heat

d electrical → sound
→ kinetic
→ light

3 Chemical energy is stored in food, petrol and natural gas.

4 In our bodies, chemical energy is converted mainly to heat and kinetic energy.

5 There will be 10 J of sound energy produced. This answer is obtained by subtraction.

6 Good examples are:

a An aeroplane at high altitude can sometimes glide to a safe landing if the engines fail.

b The stretched string in an archer's bow will cause the movement of an arrow when released.

c LPG gas will enable a car to move when it is burned in the engine.

7 Very close observation of objects which are producing sound will show that they are vibrating. For example, you can feel your larynx as you speak or the speaker in a hi-fi system that is operating.

8 
This 'jack-in-the-box' is stored in the box on top of a powerful spring which stores elastic potential energy. When the lid is opened this stored energy is changed into kinetic energy and 'Jack' pops out of his box.

9 The source of energy for a solar-powered car is the Sun. When the car is moving, electrical energy is being converted to kinetic energy. At night or on cloudy days the cars could operate on chemical potential energy which is stored in batteries.

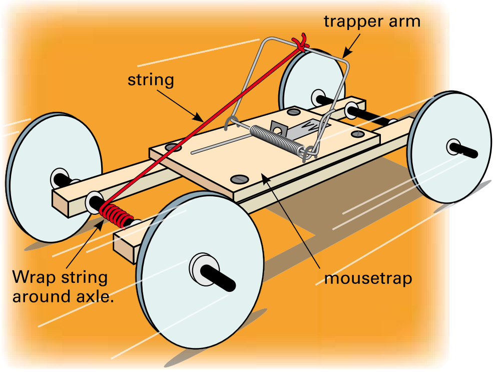
Learning experience

Photocopy and enlarge this page of the textbook. Glue each question or groups of questions on sheets of cardboard and laminate. Separate the class into groups and give each of them one of the question sheets. Each group should discuss the question and complete the answer. Once this is done, students should exchange their question sheet for another one.

This allows students to talk through questions and actively support each others' learning.

try this

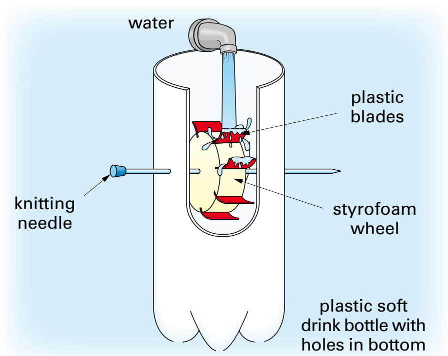
1 Build a mousetrap racer as shown. To make it go, simply wind the string around the axle by turning the rear wheels. Then put it on the floor and release it. What energy changes occur?



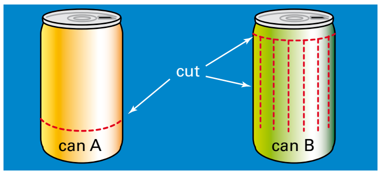
WEBwatch

You could do a project on mousetrap racers. Go to www.scienceworld.net.au and follow the links to **Mousetrap racers**.

2 Make a working model of a waterwheel as shown below. In this device, the gravitational energy of the water is changed to kinetic energy which is then transferred to the spinning wheel.



3 To make a windmill you will need 2 empty soft drink cans, a wire coathanger, scissors and pliers. Carefully cut the bottom 4 cm off a soft drink can (A). Cut the top rim off a second can (B). Cut strips 2 cm wide to within 2 cm of the bottom of can B.



Put the base of can B into can A, then fold back the strips to form vanes, as shown in the photo. Make holes in the middle of the base of each can. Put the coathanger wire through these holes and bend it as shown.

Find some moving air and watch it spin. Can you modify it to make it work better?

Learning experience

Allow the students to come up with their own 'energy toy' to construct and explain. They may like to present their information in the form of a step-by-step instructional booklet incorporating energy explanations of their toy.

Hints and tips

Research and prepare some data tables on the efficiency of different energy sources. Students may be surprised to discover solar energy is not all that efficient.

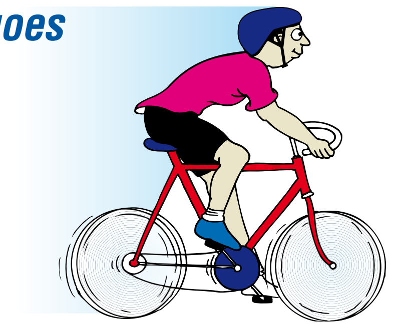
12.3 Energy comes—energy goes

Wasted energy

When we use energy it often changes from one form to another. For example, the cyclist is using the chemical energy stored in her muscles to pedal her bike. So chemical energy is converted into useful kinetic energy. But as she pedals she gets hot. So some of her energy is wasted as heat energy. These energy changes can be shown by an energy arrow. The thickness of the arrow shows roughly how much energy is converted into the different types.

Sometimes one energy change follows another. The series of steps is called an **energy chain**. For example, the energy chain for a moving car has three steps.

1. The stored chemical energy of the petrol is converted into heat energy when the petrol is burnt in the car's engine.
2. Some of this heat energy is converted into kinetic energy of the moving engine parts.
3. This kinetic energy is then transferred through the gears to the wheels.



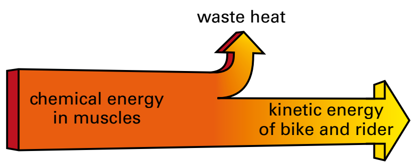
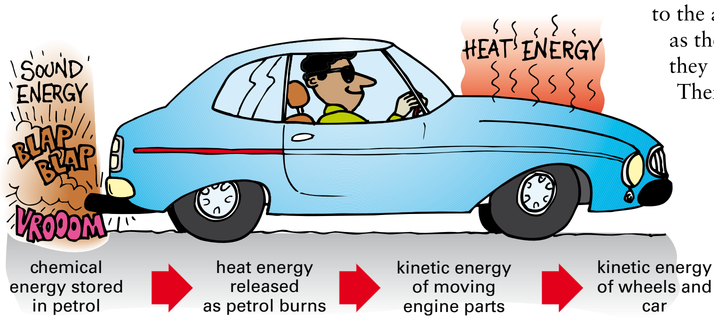


Fig 27 An energy arrow for riding a bike

The energy chain is not 100% efficient, since each step in the chain involves some loss of energy. Friction between the moving parts of the engine produces heat. This heat is transferred to the air around the car. Also, as the engine parts move they produce sound energy. Therefore, not all the stored energy in the petrol is used to make the car's wheels turn. In fact, engineers have calculated that if you start with 100 joules of chemical energy, you end up with only 25 joules of kinetic energy. The other 75 joules is wasted as heat and sound.

Note that the *total* amount of energy you end up with is the same as the amount you started with. The 75 joules of waste heat and sound from the car is not useful, because it cannot be used again. All energy converters waste energy like this—usually as heat. The longer the energy chain, the more energy that is wasted.



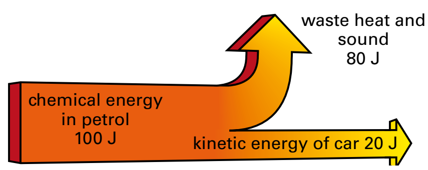


Fig 28 Energy chain and energy arrow for a car

Learning experience

We are increasingly made aware of the importance of being energy efficient, especially in our homes. Ask the students to design an energy-efficient house. You may like them to design a set of plans and/or a scaled model. They need to explain their choice of house materials used, orientation, energy efficient devices etc.

Learning experience

Ask students to draw or collect pictures and label an energy chain for devices and machines we use in our everyday activities. For example, for a toaster:

electrical energy → heat energy
electrical energy → light energy

Learning experience

Bring a small toy car to class. Gently roll the car across a bench and ask students to suggest why the toy car eventually stops. What happens to the energy the car had when it started? Again roll the car across the bench but this time place a mat on the bench. Ask students to explain in terms of energy why the car didn't go as far on the mat. Ask students to describe what would happen if you were to roll the car on a frictionless surface. Would it continue to move and never stop?

The efficiency of an energy converter is the percentage of the input energy which is turned into useful energy.

$$\text{Efficiency} = \frac{\text{useful energy}}{\text{input energy}} \times 100$$

For example, the efficiency of a car is about 25%. Because there is always some waste energy, the efficiency of an energy converter is always less than 100%.

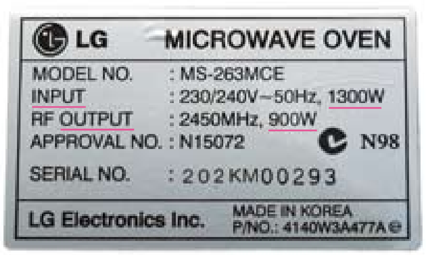


Fig 29 This label from a microwave oven shows that for every 1400 watts of electricity (1400 joules per second) the oven produces only 900 watts of heat. It is therefore 64% efficient.

Conservation of energy

You have looked at examples of how energy is converted from one form to another. After thousands of such observations, scientists decided that there is a special rule or *law* that describes energy changes. The law of **conservation of energy** says that energy cannot be made or destroyed—it can only be converted from one form to another. This means that the universe always has the same amount of energy, even though this energy is constantly being converted from one form to another and being transferred from one place to another.

To help you understand the law of conservation of energy, think about a board game such as Monopoly, where money can be used for buying and selling. The money is transferred between players and the bank, but the total amount is always the same. At the end of the game, if all the players add up their cash, the total should be the same as at the beginning, although it will be distributed differently. The same applies to energy. It moves around and changes its form, but the total amount is always the same.

Investigate

32 WHERE DOES THE ENERGY GO?

Aim

To find out what happens to the heat energy as a container of hot water cools down.

Materials

- 2 L ice-cream container or similar
- 250 mL beaker or similar
- 2 thermometers
- boiling water
- graph paper
- stopwatch

Working with technology

You could use a datalogger with temperature probes. Open the ICT skillsheet on using dataloggers on the CD.

Method

1 Use one of the thermometers to measure the temperature of the air (room temperature).

Planning and Safety Check

Read through Steps 1–6 so that you know exactly what you have to do.

You will need to do Steps 2, 3 and 4 quickly.

Design and draw up a suitable data table to record your results. You will be measuring the temperature inside and outside a beaker of hot water every minute for at least 15 minutes.

2 Put the beaker in the ice-cream container as shown on the next page. Add 200 mL of hot water to the beaker—being careful not to burn yourself.

3 Pour 1500 mL of cold water into the ice-cream container.

Hints and tips

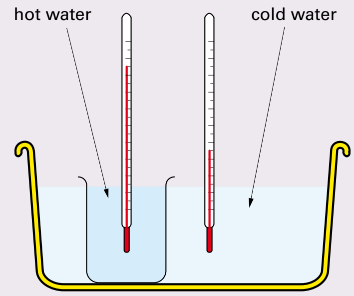
- When energy is referred to as being lost, it is not destroyed but simply converted into another form of energy which is generally not useful.
- Some students have problems with mathematical calculations. Make up values for useful energy and input energy and ask students to calculate the efficiency values.
- Monitor students when they attempt Check! 7 and 9 on page 271.

Lab notes

- Students need to be well organised to do this investigation. They should spend at least 15 minutes reading through the investigation then deciding how to allocate jobs. For example, one member of the group can read the thermometer in the hot water, another can read the one in the cold water, another can record the data and another can control the stop watch. It is essential that the data tables are drawn before the investigation starts.
- Give the students the usual warnings about using thermometers. To avoid thermometer breakage it may be advisable to use a small piece of plastic tubing to cover the bulb.
- It is important that students measure the volumes of the hot and cold water accurately as they will use this to calculate the heat energy gained and lost.

Lab notes

- Students may need help graphing the data, particularly with drawing a smooth curve of best fit. Plotting a straight line of best fit is shown on page 85. Graphing a smooth line of best fit is in *Science World 2* page 9 (with an animation).
- To show the variation in results, draw up a data table for the class results. Discuss the need to repeat measurements and average results to improve accuracy.
- As an extension, students can calculate the efficiency of heat transfer in this situation.



4 Place one thermometer in the beaker and the other in the ice-cream container. Start the stopwatch and measure the temperature inside and outside the beaker.

Record these temperatures in your data table (for time = 0).

5 Measure the inside and outside temperatures every minute, using the thermometers to stir the water gently. (Don't take the thermometers out of the water.)

Keep taking temperatures for 15–20 minutes.

6 Plot both sets of results on a graph of temperature (vertical axis) versus time (horizontal axis). Draw a smooth curve for each set of points. (The curve doesn't have to go through each point—so long as it shows the general trend of the results.)

Label the two curves and draw a third line on your graph to represent room temperature during the experiment.

Discussion

1 Copy and complete the following summary.

As the temperature of the water in the beaker decreased, the temperature in the ice-cream container ______. The water in the beaker ______ energy, while the water in the ice-cream container ______ ______.

2 Which is the independent variable, and which is the dependent variable?

3 Calculate how much heat energy the water in the beaker lost (volume of water in mL x rise in temperature).

4 Calculate how much heat energy the water in the ice-cream container gained.

5 Are the two amounts of heat energy the same? If not, explain why they are different.

6 Describe the transfer of heat energy in this experiment. Do you think that the total amount of energy changed? Explain.

7 On your graph, look at the curve for the water inside the beaker. The curve is steep to start with, then levels out. Suggest a reason for this.

8 Predict what would happen to the temperatures inside and outside the beaker if you continued this experiment for an hour or more.

Where does energy come from?

We use a lot of stored energy without really thinking about where it comes from. We get food from the supermarket, petrol from the service station, and electricity through power lines. But where does the energy in these things come from in the first place?

Green plants store the energy of sunlight as chemical energy (food), using the process of photosynthesis. Animals that eat these plants use most of the energy for their body activities and store the rest. So animals that eat plants and other animals are using stored energy that came originally from the sun.

Most of our electricity comes from power stations that burn coal to produce steam. This steam is then used to turn turbo-generators that produce the electricity. The petrol we use in our cars is produced by the distillation of crude oil. We also use natural gas for heating. Coal, oil and natural gas are called **fossil fuels** because they were formed from plant and animal remains.

Hints and tips

Pose these questions:

- Might we ever run out of useable energy?
- Why is the government investigating renewable energies?

Ask the class to explain what they think the terms 'useable energy' and 'renewable energy' (page 270) mean.

Learning experience

Revisit the energy word wall (page 253). Add words that were not previously there. Ask students to use the words correctly.

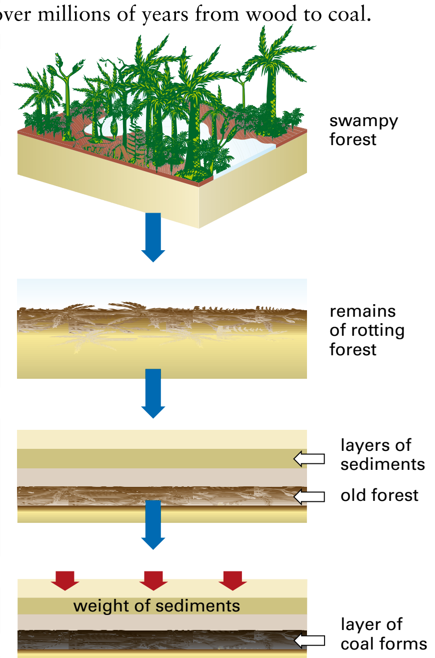
science bits

How coal was formed

When geologists examine the fossil plants in coal, they find that these remains come from plants that no longer exist on Earth. They infer that these plants probably grew in moist warm swampy forests about the time dinosaurs roamed the Earth. This suggests that present coal deposits probably formed from ancient plants that existed millions of years ago.

Over a period of time the climate changed and the plants in these forests died, leaving layers of decaying wood and other plant material. Sediments such as sand and mud were then deposited on top of the old forest, trapping the plant material.

As more and more sediments were deposited, the weight of these layers forced out much of the water and gases from the plant material, making it richer in carbon. Thus began the slow change over millions of years from wood to coal.

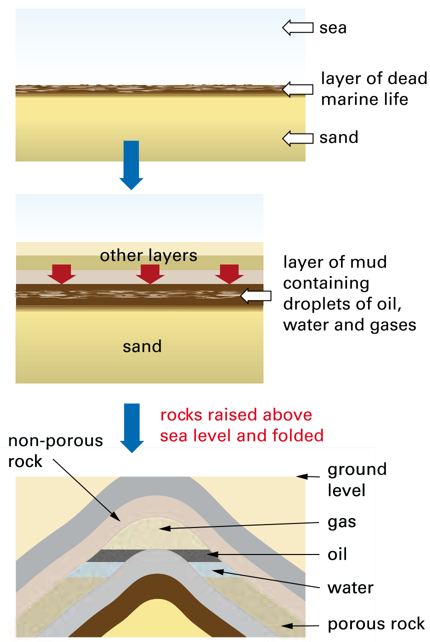


How oil was formed

Geologists infer that oil was formed from microscopic plants and animals which died and then settled to the bottom of shallow seas and lakes.

The remains of these marine organisms were covered quickly by sand and mud. After being buried by thick sediments and subjected to heat and pressure over millions of years, biochemical processes formed crude oil, various gases and water. At the same time the sediments hardened to form rock.

Once formed, the oil and natural gas slowly seeped towards the Earth's surface through porous rocks like sandstone which soak up the oil like a sponge. Sometimes the oil and gas were trapped (often under pressure) beneath a layer of non-porous rock like shale, through which they could not escape. To extract the oil and gas a pipe has to be drilled down through the rocks above.



Hints and tips

Investigate how many more years the world's and Australia's reserves of oil and coal are estimated to last.

Homework

Students could gather some more information about coal, oil and gas formation and the Earth's environmental conditions when this occurred. Make sure students write a bibliography of their sources of information, including web addresses.

Learning experience

Have students investigate the efficiency of some renewable energies and find out why they are not 100% efficient. They can then present the information to the class.

Issues

Round off this section by looking at the alternative energy sources to fossil fuels and their feasibility for supplying the energy needs of our country. Ask students to suggest changes to our current practices or ways of thinking that might help to reduce our energy consumption.

The class could follow up the discussion with a debate about renewable and non-renewable resources. Divide the class into two groups. One group should research renewable resources and the other non-renewable resources. Research topics could be framed around the following questions:

- Are non-renewable resources such as oil too important to be wasted as a fuel for cars, trucks and aircraft?
- Nuclear energy is a non-renewable resource. Does it have a part to play in our energy needs?
- Should the price of non-renewable fuels be put up to encourage people to use public transport instead of cars? What other implications would there be for people if the price of non-renewable fuel was increased?

Renewable or non-renewable

There is a major problem in using fossil fuels as a source of energy. They are **non-renewable**. They have taken millions of years to form from energy that came originally from the sun. Yet once they have been burnt in our cars or in power stations they are gone forever. This is why we say they are non-renewable. The process of obtaining energy from fossil fuels is also very inefficient, as shown below. In fact, there is more energy reaching the Earth in 10 days of sunlight than in all the fossil fuels on Earth!

It makes much better sense to use **renewable** energy sources that can be replaced as they are used. We now have the technology to capture the sun's energy directly for our use. For example, solar cells are used to provide power supply systems for remote and rural areas. Hydro-electricity and wind power are other renewable energy sources. You will find out more about renewable and non-renewable energy in later studies.

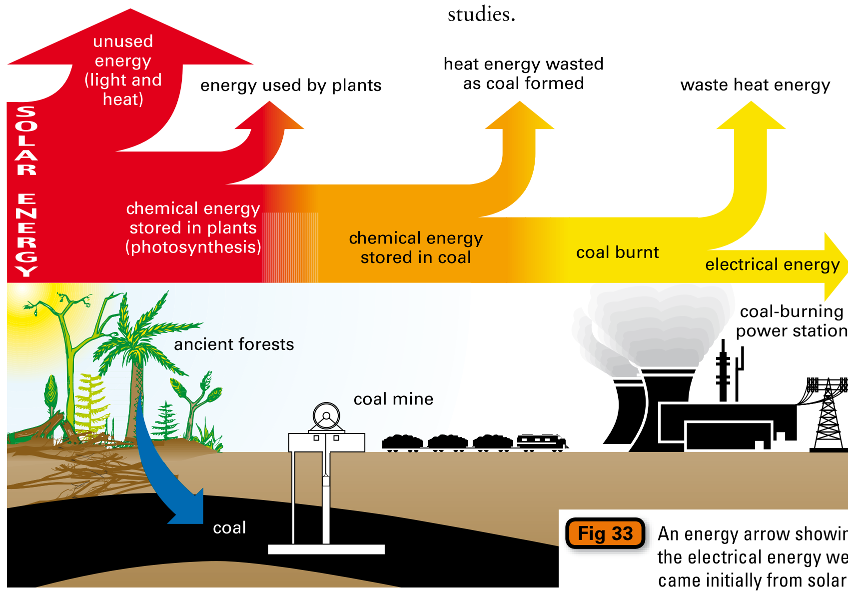


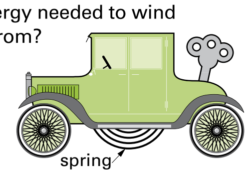
Fig 33 An energy arrow showing how the electrical energy we use came initially from solar energy. Notice how much energy is wasted at each step.

Check!

1 Suppose you wind up a toy car and let it go.

a Where did the energy needed to wind up the toy come from?

b Where has this energy gone when the toy stops moving?



2 When using a hacksaw to cut a piece of metal, the blade and the metal both become hot. Explain in energy terms why this happens.

3 Classify the following energy sources as renewable or non-renewable: coal, diesel fuel, LPG gas, ocean waves, the sun, uranium, wind, wood.

Check! solutions

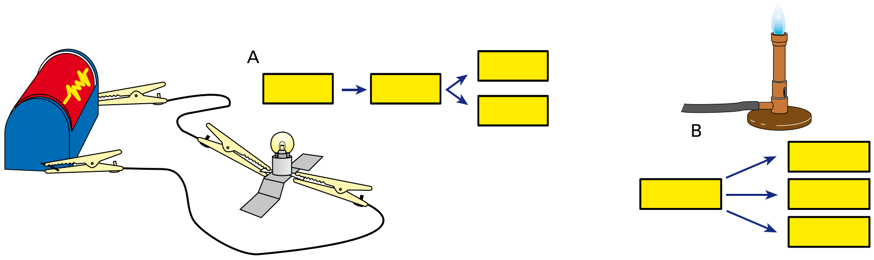
1 a The energy came from the kinetic energy in the muscles of your fingers which, in turn, came from the chemical potential energy in the food you ate.

b The energy has gone into kinetic and sound energy which, in turn, are changed into heat energy.

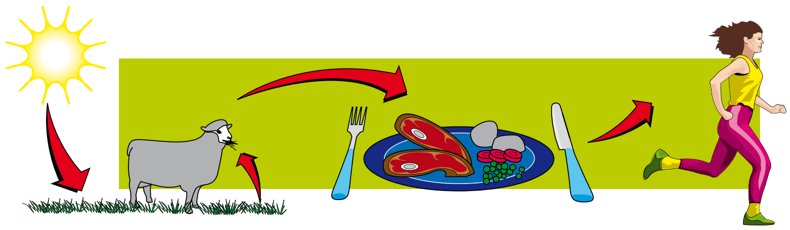
2 As the hacksaw blade cuts through the metal, the kinetic energy is changed to heat and sound energy. The metal and the blade become hot because the particles in the metal and the blade are caused to vibrate more quickly.

3 The renewable sources of energy are ocean waves, the Sun, wind and wood. The non-renewable sources are coal, diesel, LPG and uranium.

4 Copy the boxes and complete the two energy chains below.



5 Draw an energy chain that shows the energy changes from the Sun to the woman.

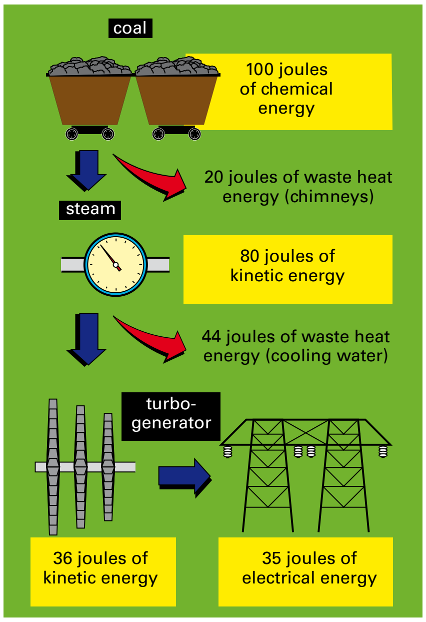


6 Explain in your own words how the petrol used in cars came originally from energy from the Sun.

7 A hot water system is 65% efficient. If it is supplied with 3000 joules of electrical energy, how much heat energy does it produce?

8 To charge a battery you have to supply energy. But you never get as much energy from the battery as you use to charge it. Why is this?

9 The diagram on the right shows the energy changes in a coal-burning power station.
   a Draw an energy arrow to describe what happens in the power station.
   b How many joules of heat are lost to the environment for each 100 joules of chemical energy stored in the coal?
   c A small amount of energy is lost when the kinetic energy of the turbo-generator is converted to electrical energy. Infer how this energy is lost.
   d What is the efficiency of the turbo-generator?
   e What is the overall efficiency of the power station?



Hints and tips

Remember to monitor students when they attempt Check! 7 and 9.

4 A

chemical → electrical → light, heat

B

chemical potential → heat, light, sound

5 An energy chain would be:

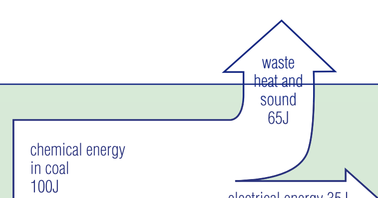
solar → chemical → kinetic

6 The reason is that petrol is produced from crude oil or petroleum which is formed below the earth when tiny plants and animals decompose. These plants originally use sunlight to grow.

7 Only 65%, or 1950 J, will be converted to useable heat.

8 Whenever energy is changed from one form to another, some of it is changed to heat and 'dissipated'. This happens with a battery; just feel it after use to check.

9 a



b 65 J of heat energy are lost to the environment for every 100 J in the coal.

c 1 J of energy is lost as heat in overcoming friction during rotation.

d Efficiency = output/input × 100 = 35/36 × 100 = 97%

e The overall efficiency of the power station is only 35/100 or 35%.

Learning experience

Separate students into small groups and ask them to complete the challenge questions together. When placing students in groups ensure that there is a good balance of abilities within groups, so that all students are given the opportunity to provide and contribute answers and knowledge.

challenge

1 Here are the efficiencies of five energy converters.

torch battery	90%
solar cell	10%
electric motor	60%
filament light bulb	5%
fluorescent light	20%

a Draw a bar graph to display this data.

b Draw a table that shows for each of the energy converters:
- the type of input energy
- the type of output energy
- the type of wasted energy.

c Why is it cheaper to light schools with fluorescent lights rather than filament light bulbs?

2 What form of energy does a frictional force usually produce?

3 Peter burnt his finger on a frypan. He immediately put his burnt finger in some crushed ice. Explain in energy terms what happened when:

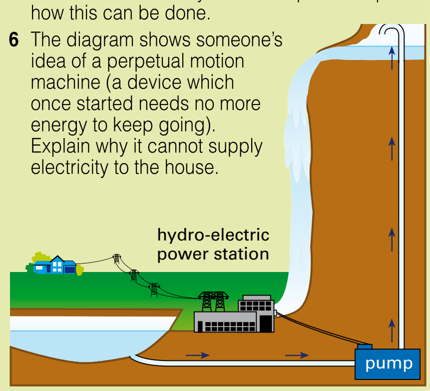
a he burnt his finger

b he put his finger in the ice.

4 Two cars collide head-on. What happens to the kinetic energy that each car had before the crash?

5 Machines that have moving parts can be made to run more efficiently. Use examples to explain how this can be done.

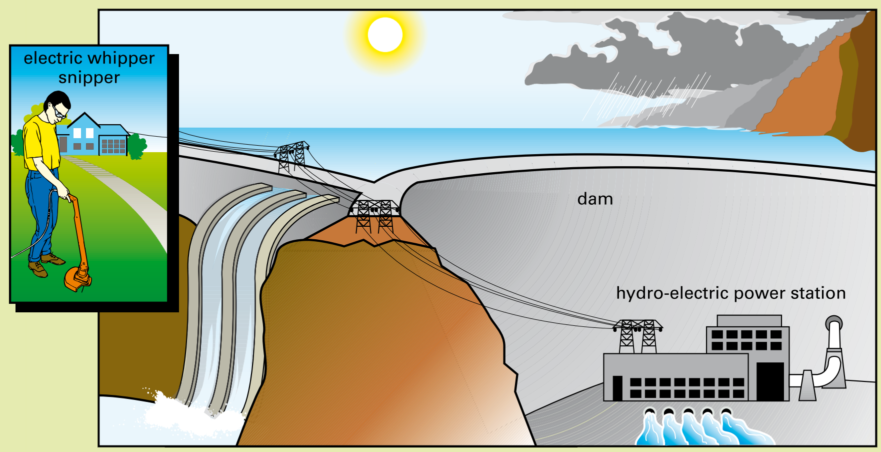
6 The diagram shows someone's idea of a perpetual motion machine (a device which once started needs no more energy to keep going). Explain why it cannot supply electricity to the house.



7 State the law of conservation of energy. Illustrate your answer by describing the energy changes that occur when a fireworks rocket takes off and explodes high in the air, emitting coloured balls of light as the remaining pieces fall to the ground.

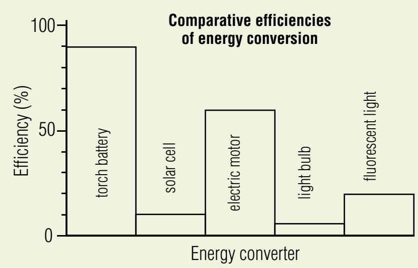
8 Write a story (approximately a page) about 'The year the Sun stopped shining'.

9 Look at the diagram below. Draw an energy chain tracing the energy changes from the Sun to the energy user on the left.



Challenge solutions

1 a



b In every case energy is wasted as heat.

Energy converter	*Input*	*Output*	*Waste*
battery	chemical	electrical	heat
solar cell	solar	electrical	heat
electric motor	electrical	kinetic	heat
light bulb	electrical	light	heat
fluoro tube	electrical	light	heat

c It is cheaper to use fluorescent tubes rather than bulbs because they are more efficient and less heat is wasted. Generally, a 40 W tube will produce about as much light as a 100 W bulb.

2 Frictional force usually produces heat energy.

3 Here are the explanations:

a When Peter touched the hot frypan, heat energy was transferred to his finger causing pain and some damage to the cells.

b When he put his finger on ice some of the heat was transferred to it, reducing the pain and damage.

4 When cars collide, their combined energy is used to change the shape of the car bodies, which is elastic potential energy. In the process, heat and sound energy are also produced.

5 Machines can be made to run more efficiently by reducing friction, which wastes energy as heat. For example, a bicycle will be more efficient and easier to pedal if:
- the tyres are correctly inflated to reduce the contact area with the road
- the chain and axles are oiled to reduce friction
- the rider is not carrying excess weight, which increases friction with the road
- the rider is wearing smooth, close-fitting clothes, which reduce friction with the air.

6 This and other perpetual motion devices cannot work because all machines are less than 100% efficient and output is always less than input. In this example the electricity produced from the power station would not be enough to pump the water back up to the top and therefore could not be supplied to the house.

7 The law of conservation of energy states that energy cannot be made or destroyed; only changed from one form to another. This can be illustrated by a skyrocket. Before ignition, the energy is in the form of chemical potential energy. Once it is lit, the fuel burns to produce a gas which expands and is pushed out. The rocket produces kinetic energy, light energy and heat energy. As the rocket rises, some of the kinetic energy is converted to gravitational potential energy.

8 Of course everyone's story will be different, but there are some important things that students should mention. These are:
- the slow cooling of the Earth and atmosphere, the freezing of lakes and

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

1 ______ is the ability to do work. It is measured in ______ (J).
2 ______ energy is the energy an object has because of its movement. Potential energy is ______ energy.
3 There are many different ______ of energy; for example, light, heat, ______ and sound.
4 Energy can be ______ from one object to another, and it can be ______ from one form to another.
5 When an energy change occurs some energy is always wasted as ______.
6 The law of ______ of energy says that energy cannot be made or destroyed.
7 Most forms of energy (including fossil fuels) can be traced back to the sun using energy ______.
8 ______ energy sources such as solar energy can be replaced as they are used. Non-renewable sources such as ______ cannot be replaced when they are used.

chains
coal and oil
conservation
converted
electricity
energy
forms
heat
joules
kinetic
renewable
stored
transferred

Try doing the Chapter 12 crossword on the CD. Working with technology

REVIEW

1 The electricity you use in your home is a form of energy that came originally from:
A electricity in thunderstorms
B coal
C the potential energy of water stored in dams
D the Sun

2 Which one of the following is false?
A If an object has energy it can do work.
B A raised object has potential energy.
C Energy can appear from nowhere and also disappear.
D When you hit something you are transferring energy.

3 Which would require most energy?
A riding a bicycle on level ground
B riding a bicycle up a hill
C walking
D doing your homework

4 Which of the following involves a transfer of energy from one object to another, rather than a change in the form of the energy?
A Hot tea poured into a cup makes the cup hot.
B A hydro-electric power station uses running water to generate electricity.
C The tyres of a moving car become hot.
D Oil is burnt to heat a room.

Main ideas

1 energy, joules
2 kinetic, stored
3 forms, electricity
4 transferred, converted
5 heat
6 conservation
7 chains
8 renewable, coal and oil

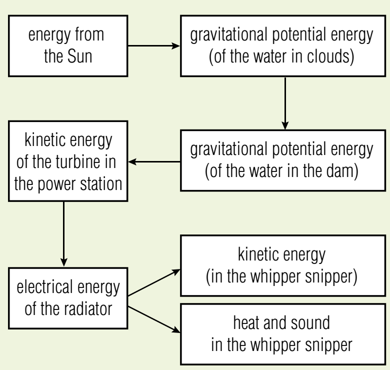
Review solutions

1 **D**
2 **C**—This is against the law of conservation of energy (page 267).
3 **B**
4 **A**—Heat energy is transferred from the hot tea to the cup.

rivers and domestic water supplies. It would also mean extra fuel and clothes to keep warm.

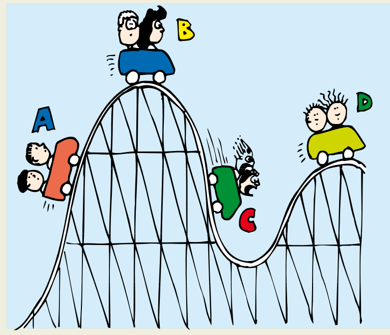
- the lack of light which would mean that plants could not make their food by photosynthesis and would eventually die. This, in turn, would mean that animals including humans would be very hungry and start dying also.
- continual darkness would make it very difficult to travel and do things like go to school and transport goods. It would also make it very difficult to maintain essential services like electricity and water supplies.

In short, life would become more and more difficult and estimates are that few people in the world would last more than a few months.

9


REVIEW

5 **a** In which position does the roller-coaster car have the most gravitational potential energy?
b In which position does it have the most kinetic energy?



6 For every 100 joules of energy used by an electric light bulb, you get only about 5 joules of light energy.
a What happens to the other 95 joules of energy?
b What is the efficiency of the light bulb?

7 A rock is held above a concrete path and dropped. Copy and complete the energy chain below, by putting the correct energy forms in the two empty boxes.

[ ] → KINETIC → HEAT, [ ]

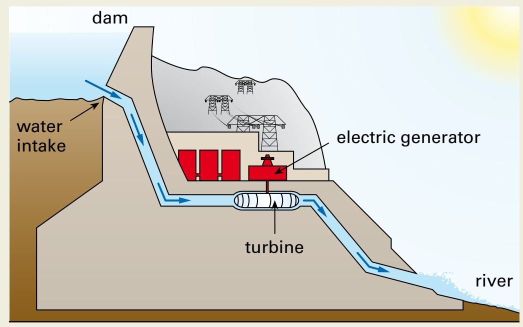
8 David said that electrical energy is made in power stations. Is he correct? Explain using the law of conservation of energy.

9 Bree found this data for Australia's energy use in 2003–04.

Substance	Percentage of total
coal	41.8
oil	33.8
natural gas	19.6
hydro-electricity	1.1
wood, bagasse and other renewables	3.7

a Draw a pie chart to display this data.
b Which fossil fuels are used in Australia?
c What percentage of Australia's energy use is from renewable sources?
d Use a dictionary to find out what bagasse is.

10 Write an energy chain to describe the energy changes that occur in a hydro-electric power station (shown below).



11 A ball bounces because the kinetic energy it has when it hits a surface changes to elastic potential energy as the ball is pushed slightly out of shape. This elastic energy then changes back to kinetic energy as the ball leaves the surface. Design an experiment to compare the efficiency with which different types of balls change their kinetic energy into elastic potential energy when they bounce.

Check your answers on page 306.

5 **a** B
b C

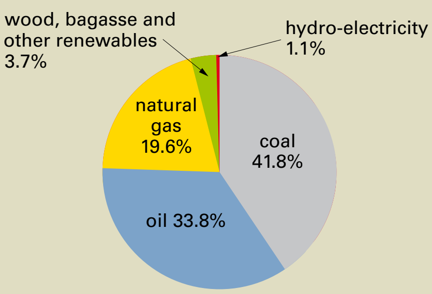
6 **a** The other 95 joules of energy are wasted as heat energy. This is why the bulb becomes so hot.

b
$$\text{efficiency} = \frac{\text{energy}}{\text{input energy}} \times 100 = \frac{5\text{ joules}}{100\text{ joules}} \times 100 = 5\%$$

7 gravitational potential → KINETIC → HEAT, sound

8 People often say that electrical energy is made in power stations, but this is not scientifically correct. According to the law of conservation of energy, energy cannot be made—you can only change it from one form to another. In a power station you are converting the chemical energy in coal or the kinetic energy of falling water into electrical energy.

9 **a**



b Coal, oil and natural gas
c 4.8% (hydro-electricity + wood, bagasse and other renewables)
d Bagasse is the crushed, juiceless remains of sugar cane left after extracting the sugar. It is used as a fuel and for making wallboard etc.

10 gravitational potential energy of water in dam
↓
kinetic energy of water in pipe
↓
kinetic energy of spinning turbine
↓
electrical energy in electrical generator

11 The more efficiently a ball changes its kinetic energy into elastic potential energy (then back to kinetic energy), the higher it bounces. To compare different balls, you could drop them from the same height onto the same surface and measure how high they bounce. To make the test completely fair, the balls would need to be the same mass and size.