5.1 Energy around you

As a roller-coaster speeds downwards, the wheels of the rolling cart heat up. As a passenger, you feel the wind rushing past you, your hair flies around and you probably scream! Energy is needed to make all these things happen. Energy exists in many different forms, from electrical energy to sound, light and heat energy. Energy can change forms, but it is never lost.

INQUIRY science 4 fun

Making spiders

Can you release energy by mixing two substances together?

SAFETY!
Do not eat food prepared in the science laboratory.

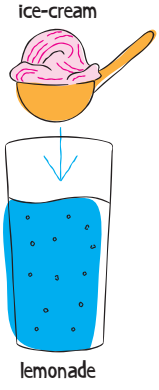
Collect this…

- lemonade
- ice-cream
- spoon

Yes

Do this…

1. Half-fill a glass with lemonade.
2. Add a scoop of ice-cream.
3. Give it a stir.



Record this…

Describe what happened.
Explain why you think this happened.

What does energy do?

On a typical day, many things happen around you. People walk and drive around in cars, birds chirp, leaves fall from trees, clothes dry on the clothesline and music comes out of an iPod®. Each of these activities needs **energy**. It is hard to explain what energy is, because you can't see it or weigh it. Instead, you can observe what energy does. Energy is needed to move or heat something, to make a noise, or to change an object's shape. Energy makes things happen.

Work is the name given to the effects of using energy. Whenever an object is shifted or forced to change shape, then work has been done.

SKILL BUILDER

Measuring energy

Energy is measured using a unit called the joule (symbol J). You use one joule of energy when you lift a 1 kg bag of potatoes 10 cm off the floor. Lifting 1 kg of potatoes isn't too hard, which shows that a joule is a small amount of energy. In fact, a joule is so small that energy is often measured in batches of 1000 joules. A batch of 1000 joules is known as a kilojoule (kJ). If you lifted 1 kg of potatoes 10 cm with 1 J of energy, then you could lift them 100 metres with 1 kJ of energy!

Food energy is commonly measured in kilojoules (kJ). Even larger amounts of energy, such as electrical energy, are measured in megajoules (MJ).

1 kJ = 1000 J

1 MJ = 1 000 000 J

SciFile

Counting calories

You may have heard of a unit of energy called the calorie. This unit is used in some countries of the world, particularly to measure food energy. One calorie (cal) is the amount of energy needed to raise the temperature of 1 gram of water by 1°C. This is about 4.2 joules.

WORKED EXAMPLE

Calculating energy

Problem 1

Calculate how many joules of energy are contained in:

a 2 kJ

b 3.5 MJ

Solution

a 2 kJ = 2 × 1000 = 2000 J

b 3.5 MJ = 3.5 × 1 000 000 = 3 500 000 J

Problem 2

Calculate how many megajoules of energy are contained in:

a 4 800 000 J

b 5 700 000 000 J

Solution

a 4 800 000 J = 4 800 000 ÷ 1 000 000 = 4.8 MJ

b 5 700 000 000 J = 5 700 000 000 ÷ 1 000 000
= 5700 MJ

Forms of energy

There are many different forms of energy, as shown in Figure 5.1.1.

- **Kinetic energy** is the energy of movement. Anything that moves has kinetic energy. The faster an object moves, the more kinetic energy it has. In a collision, kinetic energy is quickly changed into other forms.
- **Heat energy** can come from the Sun, flames, chemical reactions, electrical devices or even from a person or animal. Heat warms, burns, dries, melts, and makes hot-air balloons rise.
- **Light energy** comes from the Sun, light globes, fires and animals such as glow-worms. Without light energy, the world would be a very dark place.
- **Sound energy** is the energy that air has when it is vibrating. Your ears and brain interpret the vibrating of air as sounds. Sound comes from your voice, musical instruments, cars and power tools.
- **Electrical energy** comes from power stations, solar cells, batteries, and sparks such as lightning. Electrical energy powers your TV, computer, microwave and toaster.

1 p177

Figure 5.1.1 Here are five different and common forms of energy. All these forms of energy make things happen.

INQUIRY

science 4 fun

Creepy crawly

What happens when you twist a rubber band?

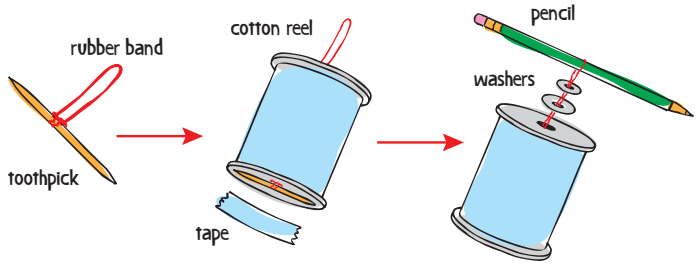
Yes

Collect this...

- rubber band
- cotton reel
- part of a toothpick or match smaller than the diameter of the cotton reel
- masking tape
- 2 metal washers
- a pencil or a piece of dowel longer than the diameter of the cotton reel

Do this...

1. Loop a rubber band around the toothpick and through the cotton reel as shown. Tape the toothpick to the cotton reel.
2. Insert the rubber band through the metal washers and loop the end around the pencil.
3. Twist the pencil to wind up your creepy crawly.
4. Place it on a smooth surface and let it go!



Record this...

Describe what happened.

Explain why you think this happened.

Stored energy

Not all forms of energy are as obvious as those discussed so far. Many of the objects around you have stored energy or **potential energy**. Petrol in a car's fuel tank and books on a shelf both have potential energy. They are not using energy at the moment but have stored energy. Stored energy gives objects the potential to make things happen: the books can fall off the shelf and the petrol can burn.

One form of potential energy is the chemical energy your body gains from eating food. This energy enables you to run, play sport, heat your body and keep your heart beating. The foods that you eat originally obtained energy from the Sun. Plants capture light from the Sun and convert it into chemical energy in the form of simple sugars. This happens in a process called **photosynthesis**. Plants such as wheat make sugars and then convert them into starch for storage. When you eat the plants, their seeds, nuts or grains (or eat animals that have eaten them), your body uses the chemical energy from these simple sugars and starch as your energy source. Figure 5.1.2 shows the energy content available from one type of breakfast cereal.

NUTRITION INFORMATION (Average)

SERVING SIZE: 30G (APPROX. 1 CUP) SERVINGS PER PACKAGE: 16

	PER SERVE	PER 100g	30g with 2/3 cup (170mL) Whole Milk	30g with 2/3 cup (170mL) So Good™
Energy (kJ)	459	1530	930	920
(Cal)	110	366	222	220
Protein (g)	2.3	7.6	7.9	8.1
Fat -Total (g)	0.1	0.4	6.6	5.9
-Saturated (g)	<0.1	0.2	4.3	0.7
Cholesterol (mg)	0.0	0.0	22.1	0.0
Carbohydrate				
-Total (g)	24.0	80.0	32.0	33.0
-Sugars (g)	2.8	9.3	10.8	6.0
Dietary Fibre (g)	0.9	3.1	0.9	0.9
Sodium (mg)	234	780	304	311
Potassium (mg)	41	136	299	327
Thiamin (mg)	0.55 (50%)*	1.83	0.58	0.65
Riboflavin (mg)	0.42 (25%)*	1.42	0.76	0.72
Niacin (mg)	2.5 (25%)*	8.3	2.5	2.5
Folate (µg)**	100 (50%)*	333	108	105
Iron (mg)	3.0 (25%)*	10.0	3.0	3.9

*=Percentage of Recommended Dietary Intake (RDI)

Figure 5.1.2

The nutritional information listed on this cereal box states that a serving contains 459 kJ of energy. For a healthy lifestyle, the energy you put into your body from food should be about the same as the energy you require for your body to function.

Figure 5.1.3 shows four different types of potential energy:

- **Gravitational potential energy** is energy stored in an object when it is above the ground. The greater the height, the more gravitational potential energy an object has. For example, the higher a water slide, the more gravitational potential energy you have at the top and the more kinetic energy you will have on the way down!
- **Chemical energy** is energy stored in substances. This energy is released by your body when you digest food, and by cars when fuel is burnt. Wood, paper, apples, petrol and batteries all contain chemical energy.
- **Elastic potential energy** is energy stored in a stretched or squashed spring. Stretched rubber bands also store elastic potential energy, which is released when they are let go.
- **Nuclear energy** is energy stored inside the small particles that make up all matter. Nuclear energy is released in a nuclear power plant, in a nuclear bomb explosion, and inside the Sun. Nuclear reactions produce heat and light.

2 p178

5.1

SciFile

The blade runner

Oscar Pistorius is a sprinter from South Africa who is missing the lower part of both his legs. Some people argued that his prosthetic running blades could give him an unfair advantage over able-bodied athletes. Pistorius was able to enter the qualifying races for the 2008 Beijing Olympics after a court decided that there was not enough evidence to prove that his blades gave him any advantage.

Figure 5.1.4 A prosthetic running blade stores elastic potential energy as it flexes. This energy is then released as the athlete runs.

Figure 5.1.3 Objects that have any of these forms of stored potential energy may release the energy in different forms at a later time. When stored energy is released, things happen.

5.1 Unit review

Remembering

1 **Name** the unit used to measure energy.

2 **List** five different forms of energy.

3 **Recall** what you know about energy by matching the following types with their descriptions.

- a kinetic energy
- b sound energy
- c elastic potential energy
- d gravitational potential energy
- e light energy

- i in vibrating air particles
- ii in a stretched or squashed spring
- iii in objects positioned above the ground
- iv released from glow-worms
- v in a moving object

Understanding

4 **Explain** why the energy in food is usually stated in kilojoules rather than joules.

5 **Explain** why sound energy could be considered a type of kinetic energy.

6 Petrol, kerosene and oil are all types of fuel. **Clarify** which type of energy these fuels possess.

7 **Describe** situations in which kinetic energy could cause damage.

Applying

8 **Calculate** how many joules of energy are in:

- a 3 MJ
- b 7500 kJ

9 **Calculate** how many megajoules would be in these quantities:

- a 2 500 000 J
- b 5000 kJ

10 **Identify** the types of energy that caused the changes in the:

- a 'Making spiders' activity on page 171
- b 'Creepy crawly' activity on page 173.

11 Your body needs a source of energy. **Use** Figure 5.1.5 to **list** four different ways that the chemical energy in food can be used by your body.

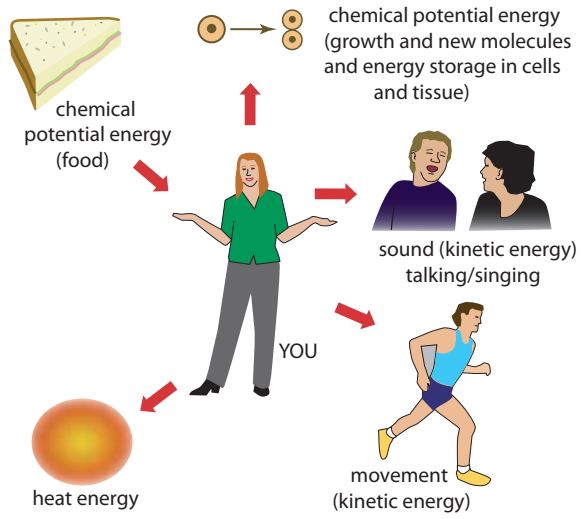


Figure 5.1.5

12 **Identify** the key type of energy possessed by a:

- a seatbelt buckle that has been in the sun all day
- b shopping trolley rolling across the floor
- c marshmallow
- d golf ball hit along the ground
- e lawnmower filled up with petrol
- f bird resting in its nest on a tree branch.

13 a Ben burns about 30 kJ per minute while he's dancing. **Calculate** the number of kilojoules he would use if he danced for an hour.

b **Calculate** how many servings of the breakfast cereal in Figure 5.1.2 on page 173 Ben would need to supply this energy.

c When Ben dances, he moves his arms and legs, he sings and he gets hot. **List** three types of energy that are present when Ben dances.

5.1 Unit review

Analysing

14 The following objects have potential energy. **Classify** each one as an example of gravitational potential energy, chemical potential energy or elastic potential energy.

- **a** A piece of chocolate cake
- **b** A stretched spring
- **c** A glass of cola
- **d** An empty coffee mug on a table
- **e** A teaspoon of sugar
- **f** A cardboard box
- **g** A 9-volt battery
- **h** A painter at the top of a ladder
- **i** A banana
- **j** A squashed tennis ball

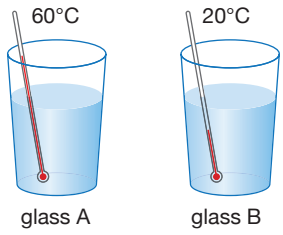
Evaluating

15 Aisha lifts a 10 kg bag of onions 10 cm off the ground. **Propose** a different task in which she would do the same amount of work.

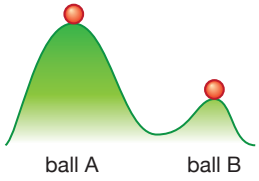
16 For each pair of objects shown in Figure 5.1.6:

- **i** **identify** which (A or B) has more energy
- **ii** **justify** your response.

a



b



c

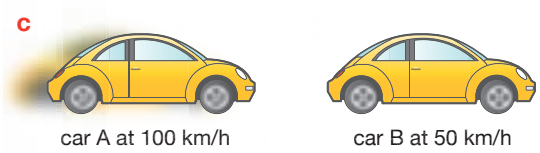


Figure 5.1.6

Inquiring

1 **a** Research the approximate number of joules of energy contained in a:

- **i** litre of full-cream milk
- **ii** litre of petrol
- **iii** litre of oil
- **iv** kilogram of coal
- **v** kilogram of wood.

b Construct a column graph to show the energy content of these substances.

2 Investigate the energy content of a range of fast foods. Link a typical meal from one fast food restaurant with activities required to use up an equivalent amount of energy.

3 Research Oscar Pistorius on the internet. Outline his life story.

4 Some animals can produce their own light. This process is called bioluminescence. Research five animals that can produce their own light.

5.1 Practical activities

1 Making a spinning snake

Purpose

To observe how heat can cause a change.

Materials

- square of aluminium foil
- 15 cm length of string
- retort stand and clamp
- Bunsen burner and bench mat
- matches

SAFETY

Be careful not to touch the spiral just after it has been heated.

Procedure

1. If your aluminium foil is thin, then fold over a piece to double its thickness.
2. Cut a spiral shape from your piece of foil about 8 cm in diameter, as shown in Figure 5.1.7.

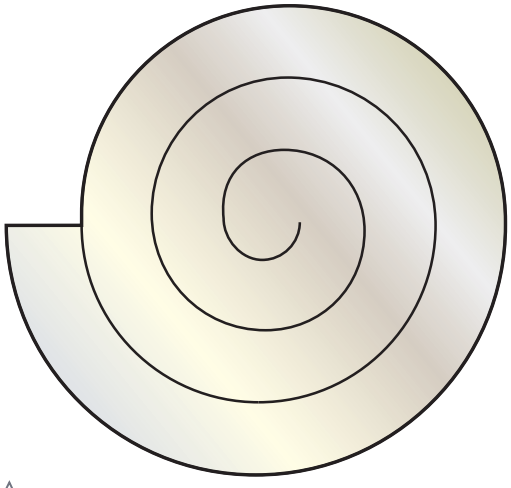


Figure 5.1.7

3. Make a small hole in the tip of your spiral and tie a piece of string from the tip to a clamp as shown in Figure 5.1.8.

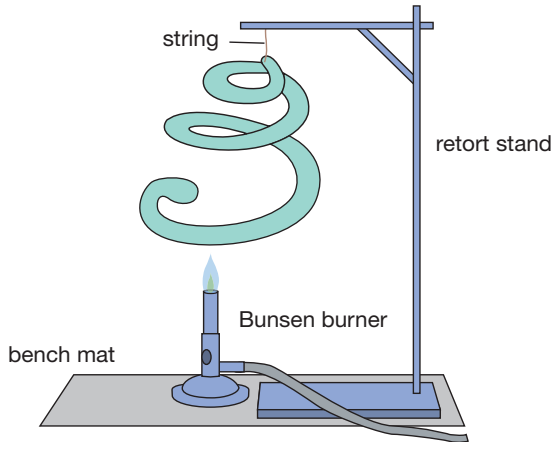


Figure 5.1.8

4. Position a Bunsen burner underneath the spiral. Make sure that the flame will not touch the spiral.
5. Light the Bunsen burner and adjust it to produce the blue flame.
6. Observe the spiral.

Results

List changes that happened to your foil spiral.

Discussion

1. **Identify** which source of energy caused these changes to occur.
2. **Propose** how you think this energy might have caused the change you observed.
3. **Propose** why the spiral was made from aluminium foil instead of paper.
4. The circulating air that caused this change is called a convection current. **Propose** situations in which convection currents might occur.

2 Energy makes things happen

Purpose

To observe how different types of energy can cause a change.

Materials

- sparkler
- soil in a beaker
- matches
- torch
- tennis ball
- slinky spring
- damp piece of cloth
- peg
- coat hanger
- hair dryer

SAFETY

Do not touch the sparkler while it is burning. Allow it to cool before cleaning up.

Do not operate the hair dryer near water.

Procedure

1. Copy the table shown in the results section into your workbook. As you complete each task, record your observations in the table.
2. Stand a sparkler in a beaker of soil. Light the sparkler and observe until it goes out.
3. Turn on a torch and see what happens. Switch the torch off.
4. Drop a tennis ball off the edge of a bench and observe how it moves.
5. Compress a slinky spring on a bench and then let it go. Describe what happens.
6. Peg a damp piece of cloth to a coat hanger. Blow warm air from a hair dryer over the cloth.

Results

Copy the following table into your workbook.

Situation	Type of energy that caused the change	Changes you observed
A sparkler burns.		
A torch is turned on.		
A tennis ball falls.		
A slinky spring is compressed and released.		
Warm air is blown over a damp cloth.		

Discussion

1 a The sparkler, the torch, the tennis ball and the slinky spring all had potential energy before you completed each activity. **Identify** which type of potential energy each object possessed.

b **Explain** whether each of these four objects still had potential energy once the experiment was completed.

2 The warm air blown from the hair dryer produced a change in the damp cloth. **Identify** three examples in which heat is used to produce a similar change.