Types of energy

BIG IDEAS

You are learning to:
- Describe how energy is measured
- Explain the effects of energy using the transformation model
- Describe the different forms of energy
- Recognise that energy can be thought of as having different forms (HSW)

Energy makes things happen

One way to think about **energy** is to say that energy makes things happen. When a machine or an object moves or causes an event to happen it uses energy. Therefore without energy nothing would happen. Some things are useful because they can **store** energy.

- A battery stores energy. When it is connected to a device something happens.
- A wind-up radio stores energy. When it is wound up energy is put into it and when it unwinds energy is released and the radio plays.

1 What other things can you think of that store energy?

2 Suggest where the energy in a battery comes from.

How Science Works

Light energy from the Sun is changed by plants into chemical energy. Humans gain this energy by eating plants or by eating animals that have fed on the plants. This chemical energy is changed into kinetic energy when the radio is wound up. The kinetic energy is changed into electrical energy to enable the radio to work. The radio changes it to heat, light and sound when it is switched on.

Different forms of energy

Scientists often use models when they explain ideas. There are two ways of understanding energy: the transform model and the transfer model.

Energy is measured in **joules (J)**. The joule is named after the scientist James Joule (1818–1889) who did lots of experiments to discover more about energy.

This is a very small amount of energy. Food labels show how much energy is found in the different types of food that we eat. The amount of energy in the food is usually shown in **kilojoules (kJ)**. One kJ = 1000 joules.

A **calorie** is a unit of energy that is sometimes used instead of the joule. One calorie is equal to 4.2 joules.

One joule is the amount of energy needed to heat 1 cm^3 of water by 1°C.

The energy in food is in the form of stored energy. There are many other forms of energy:

- kinetic or moving energy, e.g. in a moving bullet
- heat, e.g. from a fire
- electrical energy, e.g. in an electric current
- chemical energy, e.g. stored in chemicals and batteries
- light energy, e.g. from the Sun
- sound energy, e.g. sound from a radio travels as a wave which contains energy

- nuclear energy, e.g. energy in the nuclei of atoms is released during a nuclear bomb explosion
- potential or stored energy, e.g. a bungee jump where a store of energy is released to make something happen
- gravitational potential energy, e.g. a person on a trampoline at the top of their bounce, where their energy is due to their height.

FIGURE 1: Food labels show the energy content of foods. Which has the higher energy value – the pasta or the sweetcorn? Is this what you expected?

PETRA'S Pasta Shapes

Nutritional Information

Typical values (per 100g serving) dry weight

ENERGY	1515KJ/357Kcal
PROTEIN	12.3g
CARBOHYDRATE	73.1g
OF WHICH SUGARS	3.5g
OF WHICH STARCH	69.6g
FAT	1.7g
OF WHICH SATURATES	0.5g
OF WHICH MONO-UNSATURATES	0.5g
OF WHICH POLYUNSATURATES	0.7g
FIBRE	2.5g
SODIUM	0.3g
SALT EQUIVALENT	0.1g

SUN'S SWEETCORN

Nutritional Information

Typical values (per 100g serving) drained

ENERGY	301KJ/71Kcal
PROTEIN	3.0g
CARBOHYDRATE	12.3g
OF WHICH SUGARS	6.5g
FAT	1.1g
OF WHICH SATURATES	trace
FIBRE	2.3g
SODIUM	trace
SALT EQUIVALENT	trace

3 Which food groups do you think contain the highest amounts of energy? Make a list.

Explain your choices.

4 For each of the energy types shown above, and on page 112, think of **one** other example of where you might find that type of energy. Put your answers in a table.

5 Can you think of some devices that use more than one form of energy?

Did You Know...?

The recommended daily intake of energy (in food) for boys aged 12–15 years is 11700 kJ and for girls of the same age is 9600 kJ.

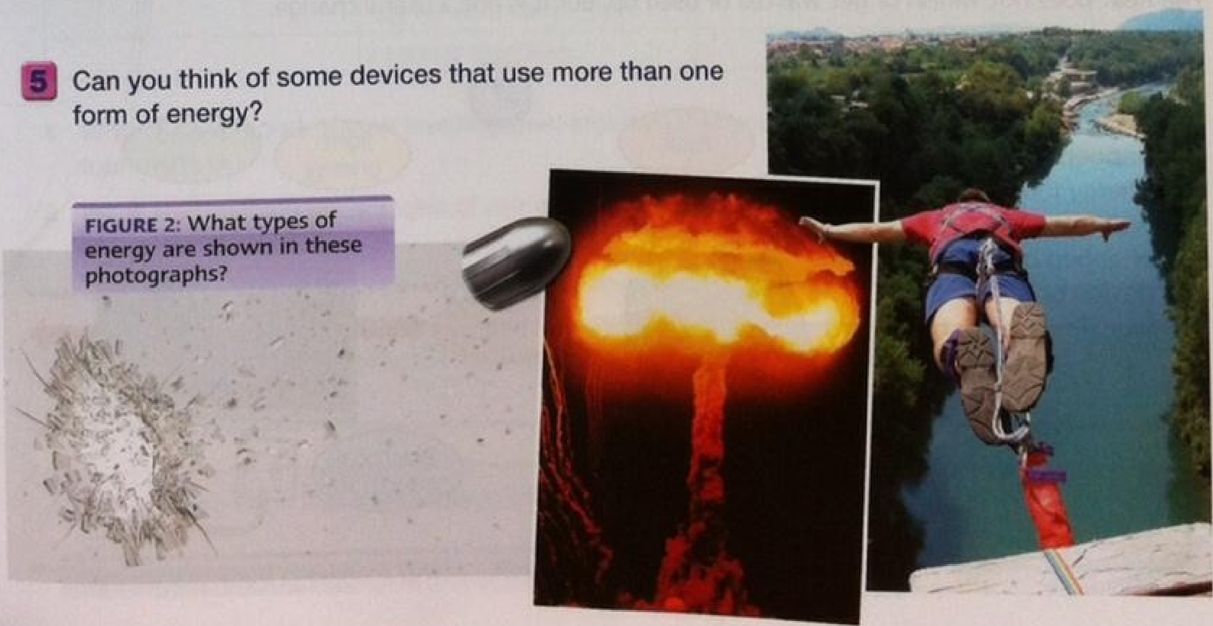


FIGURE 2: What types of energy are shown in these photographs?

Changing energy

BIG IDEAS

You are learning to:
- Describe some useful energy changes
- Understand that not all the energy changes in a device are useful
- Apply the transformation model to some devices

Energy changers

All **machines** and devices work by changing energy from one form into another. These devices can be called **energy changers**. A torch works by changing chemical energy stored in the battery into light energy in the beam. Most energy changes involve more than one type of energy. For example, an electric fire changes electrical energy into heat and light. A television changes electrical energy into light and sound.

FIGURE 1: What is the starting energy and the end energy that makes this torch light up?

1 For each of the following devices, describe what the starting energy form is and what the end energy form is:
- **a** gas cooker
- **b** radio
- **c** hoover
- **d** washing machine
- **e** clockwork toy.

2 Draw a diagram to show the energy changes in:
- **a** a kettle
- **b** a computer.

Did You Know...?

Computers in the UK left on standby use 7% of the total electricity in the country! By turning things off you help save fuel and reduce your **carbon footprint**.

Non-useful changes

Televisions also produce heat, which is an unwanted or non-useful energy change. The heat does not vanish or get wasted or used up, but it is not a useful change. This happens in all devices.

3 Describe what you think happens to energy that is non-usefully changed by a device or a machine.

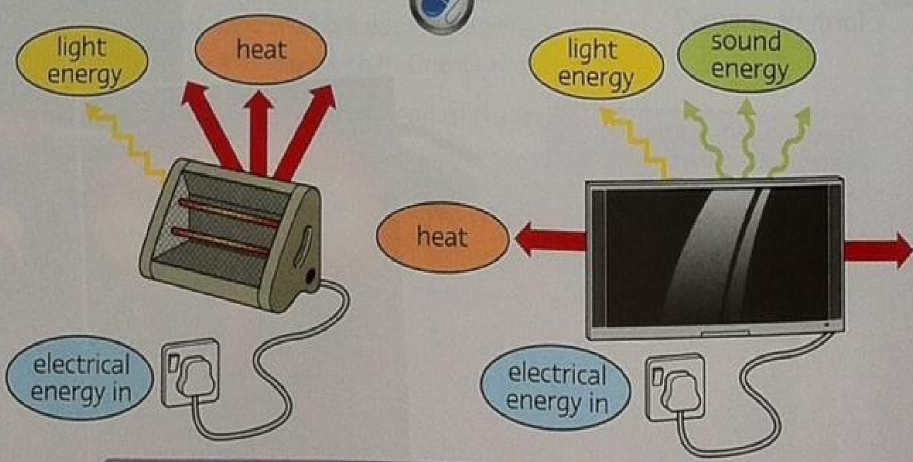


FIGURE 2: What are the non-useful energy changes in these two devices?

Science in Practice HSW

Everyday energy changers

We often use electrical **appliances** at home and in industry because they can transfer energy easily, at the flick of a switch. This makes sure that an appliance only changes energy when it is needed to work.

Electrical energy is easily changed into heat, light, sound and movement by a range of devices. Electricity is also very useful because it is clean and non-polluting.

Your teacher will provide you with a range of things that change energy from one form into other forms. For each of the objects, decide:
what the input energy is and
what the output energy is.

FIGURE 3: All these devices use electrical energy.

- Use a table like the one below to record your answers.
- Underline the useful output energy forms in each case.

Input form of energy	Energy changer	Output form(s) of energy
electrical	light bulb	light and heat
	solar panel	
	clockwork toy	
	immersion water heater	
	buzzer	
	stopclock	
	xylophone	
	candle	
	green plant	
	toy car on a ramp	
	reacting chemicals	

1 Write a brief report of your investigation. Include what you did and what you have found out.

2 What are the main advantages of using electricity as an initial form of energy in a range of devices?

3 If you repeated the investigation, what would you change to improve the quality of your results?

4 Why do you think that most energy changes produce heat at some stage in the process?

Tracking energy transfers

BIG IDEAS

You are learning to:

- Use the transfer model of energy
- Recognise when energy is not usefully transferred
- Use Sankey diagrams to show energy transfers

FIGURE 1: These events need energy transfers to make them happen.

Drawing energy transfers

In the transfer model, the energy is located in one place. When something happens it is transferred to another place by a process.

Energy is transferred *from* the Sun to the leaf by light.

The weight lifter transfers energy *from* his muscles to the bar by moving his arms.

How do we track what happens to energy when it is transferred? It is useful to be able to draw a diagram to show how energy is transferred. This is called an **energy transfer diagram**.

Input and output energy

Energy is transferred to a bulb by electricity and then from the bulb to the surroundings by the heat and light.

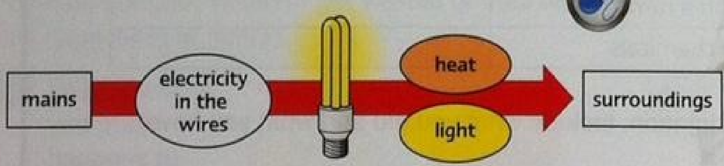


FIGURE 2: How is energy transferred by a light bulb?

1 Write a sentence on the transfer of energy in:
a an electrical drill **b** a diesel car **c** a television

2 Draw energy transfer diagrams for the following. On each one label the useful energy transfer.
a a television **b** a hoover **c** a kettle

3 For each device in **Q2**, say what you think happens to the energy that is not usefully transferred. Why do you think this is?

Sankey diagrams

A **Sankey diagram** is used to show the *relative* amounts of energy transferred by a device. The width of each arrow shows how much energy is transferred. For example, the energy efficient light bulb below is provided with 100 J of energy as electricity and transfers 25 J as heat and 75 J as light. The widths of the output arrows show these proportions.

How Science Works

Comparing the energy used by different light bulbs – demonstration

We can compare the amount of energy used by different types of light bulbs by measuring the amount of energy that is supplied to each one using a joule meter. A joule meter can be connected to the electricity supply going into the different light bulbs. Compare the amount of energy used by a standard filament lamp and a low energy light bulb.

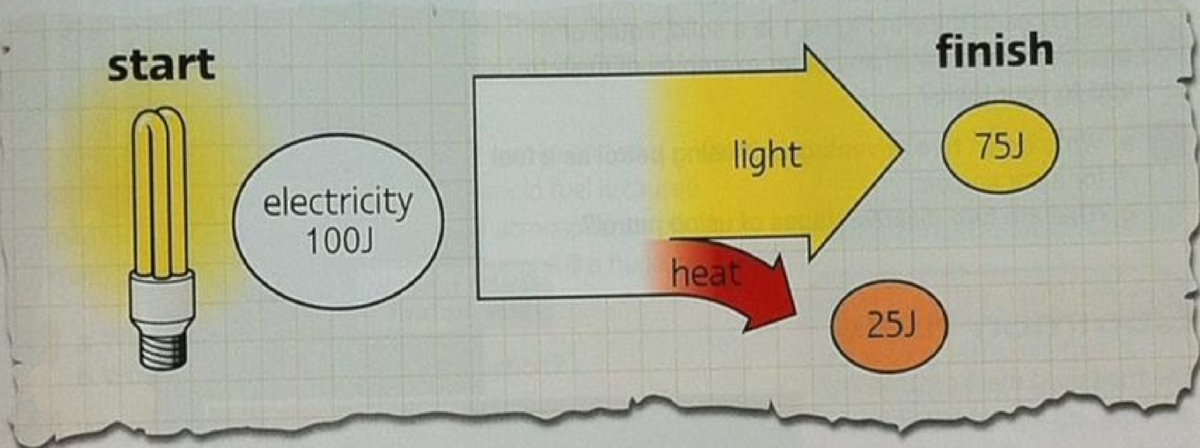
What do you notice about the amount of energy supplied to each bulb?

Does this affect the brightness of the bulb?

How could you find out?

How could you find out which one transfers most heat to the surroundings?

HSW



4 On squared paper, draw a Sankey diagram for each of the following energy transfer devices.

a An electric drill that transfers 500 J of electricity into 100 J of heat,100 J of sound, and 300 J of energy stored as movement.

b A diesel car that transfers 5000 J from fuel into 2000 J of energy stored as movement, 1000 J of sound and 2000 J of heat.

c A television that transfers 300 J of electricity into 200 J of heat, 50 J of light and 50 J of sound.

5 For each device in **Q4**, say what you think happens to the energy transferred as heat.

Exam Tip!

When you are asked to draw a Sankey diagram in the exam, remember:

- you need to draw Sankey diagrams to scale (you will often be provided with squared paper to help you do this)
- total output energy is equal to total input energy
- the examiner will be checking that you understand that energy is not made or destroyed during an energy transfer.

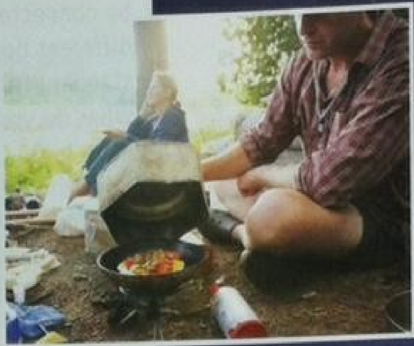
What are fuels?

BIG IDEAS

You are learning to:
- Understand what a fuel is
- Identify some examples of fuels
- Investigate the products of combustion (HSW)

What are fuels?

You may have heard the word '**fuel**' being talked about. A fuel is a source of energy. We use a lot of energy in our world and fuels provide most of it. We use fuels all the time. There are many different types of fuel. There are fuels that are solids, liquids and gases.



1 Make a table to show whether the fuel used by each thing in Figure 1 is a solid, liquid or a gas. Can you think of any other examples of fuels to add to your table?

2 **a** Write down **two** advantages of using petrol as a fuel for a car engine.
b What are **two** disadvantages of using petrol?

FIGURE 1: All these use fuels.

Common fuels

The fuels used most commonly are **coal**, **oil** and **natural gas**. In many parts of the world the only available fuel is wood. In very poor parts of the world people burn cow dung or peat. Often these people have to travel large distances to gather their fuels and they are careful about how they use them.

Coal, oil and natural gas contain large amounts of stored energy and release a lot of heat when they are burnt. Wood is not as good as it takes more of it to produce the same amount of energy. Peat is a poor fuel as it does not release much energy.

3 What are the **four** most commonly used fuels?

4 Compare oil with wood as a fuel.

Did You Know...?

In China, fuel was always in short supply so cooking food needed to be a quick process. This is why 'stir fry' cooking evolved in China.

coal combustion controlled fuel low grade fuel

Combustion

FIGURE 2: Combustion reactions can cause great damage.

Burning fuels is a **combustion** reaction. It uses **oxygen** from the air. An equation can be used to show what happens during combustion:

fuel + oxygen → carbon dioxide + water (and heat)

Combustion reactions can be **controlled** or **uncontrolled**.

Unfortunately, burning fuels in any way creates **pollution**. Because most fuels contain impurities, they cause atmospheric pollution when they are burnt. Large amounts of the gases carbon dioxide, sulphur dioxide and nitrogen oxides are produced. These gases are released into the atmosphere where they can contribute to acid rain and global warming.

Burning coal produces large amounts of smoke and soot. When coal was a common industrial and household fuel it caused respiratory illnesses in people and lots of atmospheric pollution. In many parts of the developing world this is still a huge problem.

Exam Tip!

Fuels are not *forms* of energy (such as kinetic or heat or light energy) but they are *stores* of energy or energy *resources*.

Did You Know...?

It has been estimated that in Sub-Saharan Africa up to 80% of the population still relies on wood, animal dung, crop residues and grasses as a source of fuel. These are examples of **low-grade fuels**.

5 **a** What is a combustion reaction?
b What are the products of combustion?

6 What problems does burning fuels cause?

7 What are the disadvantages of burning low-grade fuels?

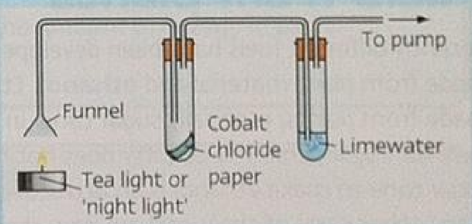
8 Why do many countries still use low-grade fuels for heating, cooking and industry?

9 Explain how you could measure the different amounts of heat released when different fuels combust?

10 How could we measure the amount of heat energy that is produced when the candle burns. What difficulties need to be overcome?

How Science Works

Investigating combustion – demonstration



The apparatus above is set up to show the products of combustion. When the candle burns, the products are drawn through the two test tubes. The cobalt chloride paper changes colour in the presence of water and the limewater changes colour in the presence of carbon dioxide.
What do you observe when the candle is lit?

HSW

Energy release from fuels

BIG IDEAS

You are learning to:

- Recognise how energy from fuels is released
- Compare the amount of energy in different fuels
- Consider some of the alternatives to using fossil fuels as an energy source

Why we use certain fuels

FIGURE 1: Would you choose a liquid, solid or gas fuel to make this racing car go?

There are advantages (they come in liquid, gas and solid forms) and disadvantages (they cause pollution) of using fuels as our source of energy. The kind of fuel that we use depends on:

- what is available
- how much it costs
- what job we want it to do.

To release the energy that is stored in a fuel we need to **burn** it. The amount of energy that a fuel releases when it is burnt depends on:

- how much of the fuel is burnt
- the amount of energy that is stored in it.

1 What needs to be done to a fuel to release the energy stored in it?

2 What does the amount of energy released from a fuel depend on?

Fuels from plants

Recently different fuels have been developed using technology. Examples are **bio-diesel**, which is made from plant material and **ethanol**. Ethanol is a liquid fuel that is sometimes called alcohol. It is made from plants, especially sugar cane. In Brazil, where it is warm and wet, growing conditions are ideal for sugar cane. The country does not have large resources of fossil fuels to burn, so growing sugar cane to make ethanol is an attractive alternative. Ethanol is even used in cars instead of petrol. Many other parts of the world are now starting to grow crops used to make ethanol.

3 **a** State **two** advantages of using ethanol as a fuel.
b State **two** disadvantages of using ethanol as a fuel.

4 Why have more countries started to grow sugar cane?