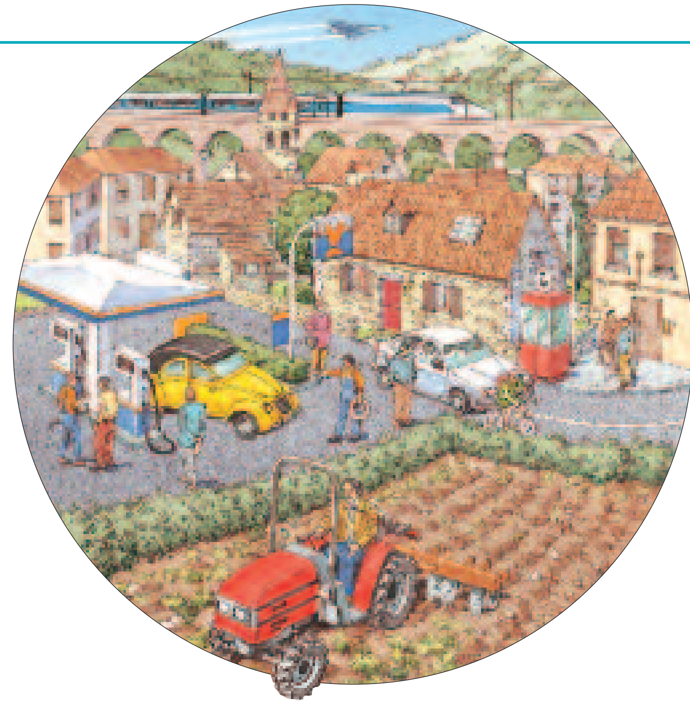
Energy

ENERGY is the ability to make things happen, cause changes and carry out work. Any change anywhere in the Universe, from a tiny meteorite hitting a planet to an exploding star, means that energy is at work. In daily life, energy is all around us in many different forms. Light and sound energy travel through the air as waves. Heat is a form known as thermal energy. Movement or motion is, too, and is called kinetic energy. Objects even have energy because of their place or position. This is called potential energy. A boulder on a hilltop has potential energy because gravity tries to pull it down. As the boulder begins to roll its potential energy changes into kinetic energy.

Energy from the Sun bathes our world. It is in two main forms, light and heat. It takes more than 8 minutes to travel nearly 150 million kilometres through space to Earth.

Energy can cause changes and it can change itself. It can convert between one form and another. The boulder rolls down the hill, converting some of its potential energy to kinetic energy. Water also flows downhill with kinetic energy. We can harness this kinetic energy in a hydro-electric power station and convert it into electrical energy *(see page 30)*, yet another form of energy. Electricity is very useful in our modern world. It can be transported long distances along wires. It can be converted to other forms of energy, like light from a light bulb, heat in an electric kettle and sound from a loudspeaker.



Energy is all around, present in different forms and changing from one form to another. Without energy our world would be completely dark, cold, still and silent.

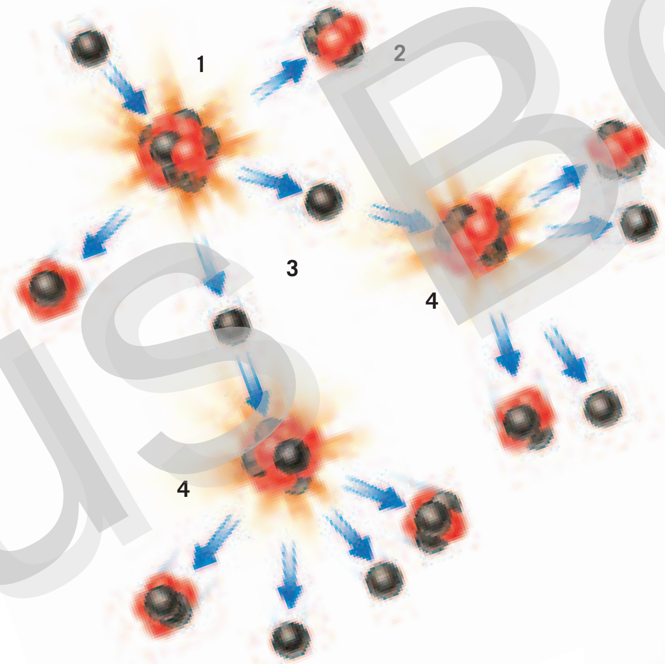
Matter contains chemical energy, in the links or bonds between atoms *(see page 12)*. The bonds need energy to form and they release this energy when they are broken. We make use of chemical energy in fuels such as petrol. The bonds break as the fuel burns and releases heat.

The human body needs energy to drive its life processes like heartbeat, breathing and movement. The energy is present in chemical form as the nutrients in our food. We digest the food to obtain the energy and store it as body starches and sugars.

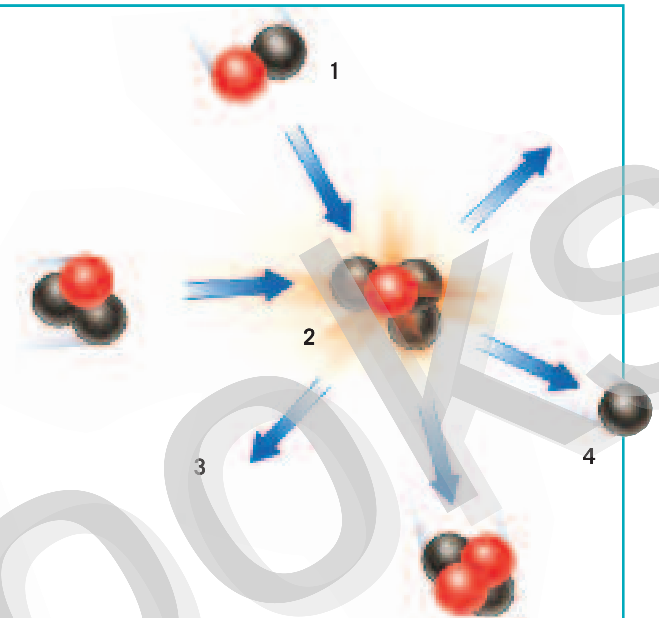
Chemical energy in the body in the form of blood sugar is taken to muscles. The muscles convert it into the energy of motion so we can move about.

Conserving Energy

Energy can be changed or converted from one form to another. But it is never destroyed or created, lost or gained. It is conserved—the amount stays the same. At the end of a process or event, the total amount of energy is the same as at the beginning. For example, the chemical energy in a car's petrol is converted into the same amount of energy as the car's motion, heat and sound. The principle of energy conservation means the total amount of energy in the Universe is always the same.

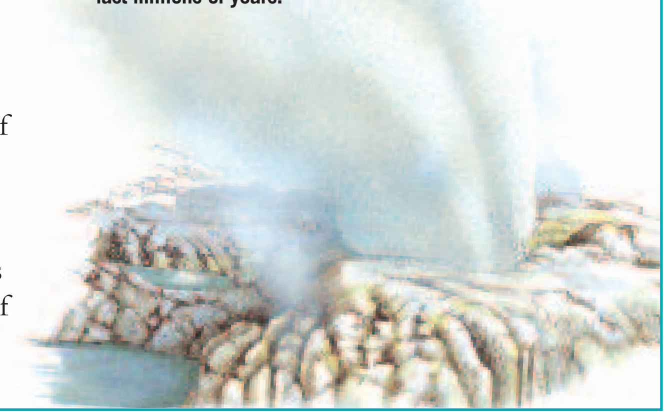


Another form of energy is matter itself. Matter can be converted into energy and energy can be changed into matter. This conversion is used in nuclear power stations *(see above)*. A nuclear particle called a neutron smashes into the nucleus of a uranium atom (1). The nucleus breaks into two parts (2). This releases large amounts of heat and other energy and also two more fast-moving neutrons (3). These smash into more uranium nuclei and so on in a chain reaction (4). Splitting of nuclei is known as **nuclear fission.** During the process bits of matter cease to exist and become vast quantities of energy instead.



A similar process of changing matter into energy happens naturally in the Sun *(above)*. The Sun is made mainly of hydrogen. Tremendous temperatures and pressures at its centre squeeze or fuse together the nuclei of the atoms (1) to form the nucleus of a helium atom (2). Vast amounts of energy are given off (3) which emerge from the Sun mainly as light and heat. A neutron may also be given off to continue the reaction (4). Since the nuclei join or fuse, this is called **nuclear fusion.** Compared to fission used in our nuclear power stations, fusion power would cause less radioactive wastes and pollution. Fusion power may be the energy source of the future.

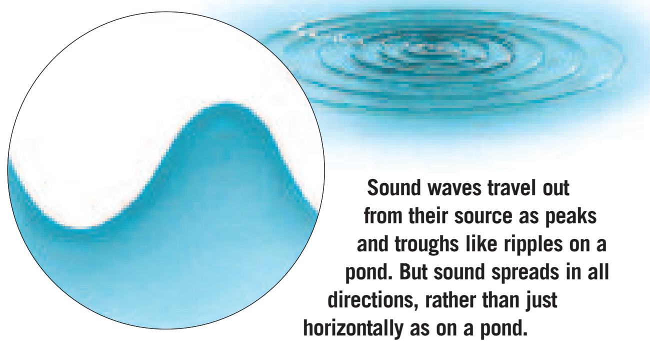
Geothermal energy from hot rocks deep in the Earth causes geysers, jets of hot water and steam. This form of energy will last millions of years.



Sound

ONE OF THE MOST familiar forms of energy in daily life is sound. We hear natural sounds like birdsong and wind. We hear the noise of vehicles and machines, and sounds such as speech and music from radios, televisions and stereo systems. We also rely on sounds to communicate when we talk to others.

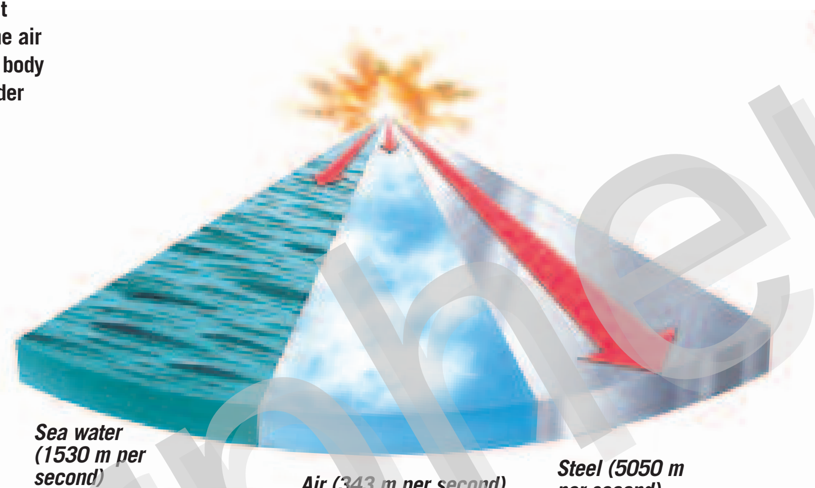
Sounds are made by objects that vibrate (move to and fro rapidly). As an object vibrates, it alternately pushes and pulls at the air around it. The air is squashed and stretched as the molecules of the gases in air are pressed close together and then pulled farther apart. These are regions of high and low air pressure. They pass outwards away from the object in all directions. They are called sound waves.



Sound waves travel out from their source as peaks and troughs like ripples on a pond. But sound spreads in all directions, rather than just horizontally as on a pond.

Sound waves start as the energy of movement in the vibrations. This is transferred to the energy of movement in air molecules. As the sound waves spread out they widen and disperse, like the ripples on a pond after a stone is thrown in. So the sound gradually gets weaker and fades away. However if there is a hard, smooth surface in the way, such as a wall, then some sound waves bounce off it and come back again. The bouncing is known as reflection and we hear the returning sound as an echo.

An object that vibrates to produce sound waves is a sound source. A bow rubs over the cello's string and makes it vibrate. The vibrations pass into the air and also to the cello's hollow body making the sound louder and richer.



The speed of sound varies depending on the substance it travels through. Atoms in steel are closer than molecules in air, so the vibrations of sound move faster and further.

Sounds also travel as vibrations through liquids, such as water, and solids, such as metals. The atoms or molecules are closer together in liquids than in air, and even closer still in solids. So sounds travel through them much faster.

Pitch and Volume

Sound has two important features *(see chart below)*. One is pitch. A low-pitched sound is deep, like a roll of thunder or a booming big drum. A high-pitched sound is shrill, like a snake's hiss or the tinkle of a triangle. Pitch depends on the frequency of sound waves—the number of waves per second. High-pitched sounds have high frequencies.

An ultrasound scanner beams very high-pitched sound waves into the body. The echoes are analysed by a computer to form an image, like this baby in the womb.

Some sounds are so high-pitched that our ears cannot detect them. They are known as ultrasounds. Many animals, like dogs and bats, can hear ultrasounds.

The first craft to go faster than sound in air was the Bell X-1 rocket plane, nicknamed *Glamorous Glennis*. Pilot Charles "Chuck" Yeager flew it at 1126 kilometres per hour over California in 1947 breaking the "sound barrier".

The second important feature of sound is its loudness or volume. Some sounds are so quiet that we can only just hear them, like a ticking watch or the rustling of leaves. Other sounds are so loud, like the roar of engines or the powerful music in a disco, that they may damage the ears. Sound volume, or intensity, is measured in units called decibels (dB). Sounds of more than 80–90 decibels can damage our hearing.