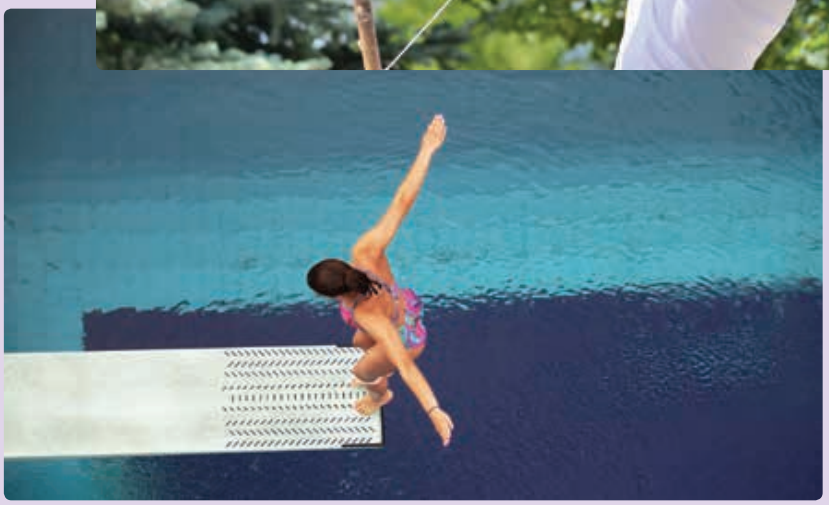
YOUR QUEST

Potential energy and kinetic energy

All substances and objects possess **potential energy**. But you can't tell unless something happens to transform the potential energy into a different type of energy. In the case of fireworks it's obvious when they explode. When a diver dives from a platform or diving board, the **kinetic energy** they gain on the way down is transformed from the energy stored in them because of their height above the ground. And the energy stored in the stretched string of a bow is transformed into the kinetic energy of the arrow when it is released.



THINK

1 Copy and complete the table below. One example has been completed for you.

Object	What to do to release the stored energy	Potential energy is usefully transformed into . . .
Torch battery	Switch it on	electrical energy and light energy
Chocolate		
Petrol		
Dynamite		
Olympic diver on platform		
Match		
Stretched elastic band		

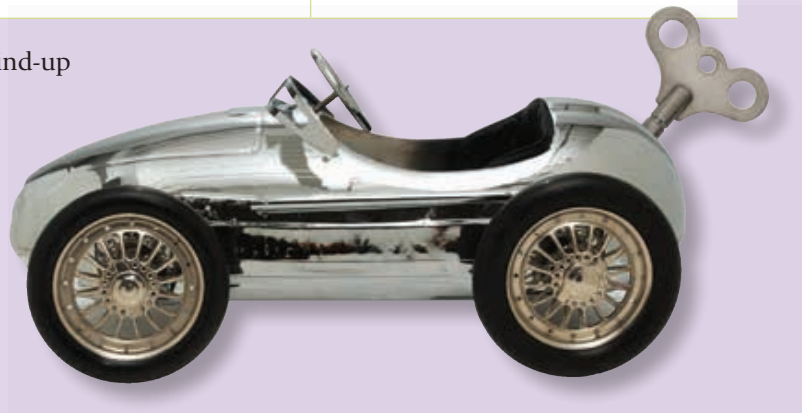
2 Answer the following questions about the wind-up toy shown on the right.

(a) Where is the energy stored when it is wound up?

(b) What do you have to do to allow the stored energy to be transformed into different forms?

(c) Name two forms of energy into which the potential energy is transformed.

(d) From where does the energy come that allows the user to wind up the toy?



Matter and energy: Making things happen

Types of energy

Potential energy
(stored energy that, when released, is converted to other forms such as kinetic, sound, heat or light energy)

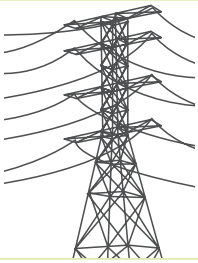
Gravitational
(potential energy of an object elevated above the ground)

Elastic
(energy stored by an elastic object that is stretched, such as a spring or rubber band)

Chemical
(energy stored in chemicals that, when reacted together such as in burning reactions, release heat, sound or light)

Nuclear
(energy stored in the nucleus of atoms that can release energy slowly, such as in a nuclear reactor, or quickly, such as in a nuclear explosion)

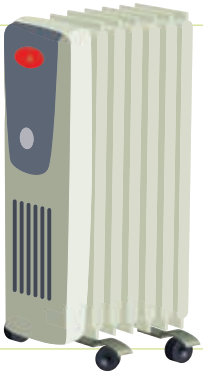
Electrical
(energy supplied to homes by powerlines and available to your appliances via power outlets in the home)



Other types of energy
(often converted from potential energy, these are more easily observed by our senses)

Kinetic
(energy possessed by objects that are moving)

Heat
(energy that causes objects to gain temperature)



Light
(energy that may be released, for example, when an object is hot or by a nuclear reaction in a star)

Sound
(energy carried by the air in a room and detected by the ear)

What is energy?

Energy is a word that you sometimes use to describe how active you feel. Sometimes you don't seem to have any energy. At other times you feel like you have enough energy to do just about anything. Energy is defined as 'the ability to do work'. That is, it is the ability to make something observable happen.

We know that:

- all things possess energy even if they are not moving
- energy cannot be created or destroyed. This statement is known as the **Law of Conservation of Energy**. It means that the amount of energy in the universe is always the same.
- energy can be transferred to another object (for example, from a cricket bat to a ball) or transformed into a different form (for example, from electrical into sound)
- energy can be stored.

Types of energy

Light energy, sound energy, thermal energy and kinetic energy are all very easily observed. All objects that move have kinetic energy. **Electrical energy** can be seen if there is a spark or a lightning strike, but you

1 At the very top of a jump, the bouncer is momentarily stopped — he has no kinetic energy. But he does have gravitational potential energy due to his height above the trampoline. As the force of gravity pulls the bouncer down, some of his potential energy is transformed into kinetic energy.

2 As the bouncer strikes the trampoline, his kinetic and gravitational potential energy are transferred to the trampoline's surface and springs. The energy is momentarily stored in the springs. It is called elastic potential energy.

3 At this point, the bouncer pushes off the trampoline. The elastic potential energy is transformed back into kinetic energy and some gravitational potential energy.

4 As the bouncer rises again, his kinetic energy is transformed into gravitational potential energy again. At the top of the jump, the bouncer has no kinetic energy, just gravitational potential energy.

Types of energy changes involved in bouncing on a trampoline

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Energy in disguise

Did you know that all energy is constantly being transformed and transferred from one object to another? There's more going on in your world than meets the eye.

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can't see it when it's moving in wires. You become aware of it when it is changed into other forms, for example into light in a fluorescent tube or into sound in an iPhone.

Stored energy is known as potential energy because it has the 'potential' to make something happen. There are several different forms of potential energy, some of which are described in the following examples.

- A ball held above your head has **gravitational potential energy**. This form of energy becomes noticeable when you drop the ball and its stored energy is transformed into kinetic energy.
- A battery contains **chemical energy** but this is not noticeable until the battery is connected in an electric circuit. When that happens the chemical energy is transformed into electrical energy, which in turn is transformed into other types of energy — to make things glow, get hot, produce sounds or move. It is the chemical energy stored in food and drinks that gives you the energy to live and be active. The chemical energy in fuels is transformed to operate cars and other vehicles, keep you warm and generate electricity.
- The **elastic potential energy** stored in a stretched elastic band is released when you let go of one end. The stored energy is transformed into kinetic energy.
- **Nuclear energy** is the energy stored at the centre of atoms, the tiny particles that make up all substances. The energy we receive on Earth from the sun has been transformed from nuclear energy. Under the right conditions, nuclear energy can be transformed into electrical energy in a nuclear power station. Unfortunately it can also be transformed into thermal energy in nuclear weapons.
- Electrical energy can also be stored. For example, if you rub a plastic ruler with a cloth it can become charged. You can't see the stored electrical energy but you can tell it's there when the ruler bends a slow stream of water from a tap.

An unavoidable loss

Every electrical appliance you use, whether powered by batteries or plugged into a power point, converts electrical energy into other forms of energy. Most of that energy is usually converted into useful energy — but some is converted into forms of energy that are wasted or not so useful. But all of the electrical energy is converted — that's the Law of Conservation of Energy in action. The table below shows some examples of energy conversion by electrical appliances. None of the wasted energy is actually lost.

Energy conversion by appliances

Appliance	Electrical energy usefully converted to . . .	Electrical energy wasted . . .
Microwave oven	thermal energy of food	heating air in the oven, plates and cups etc.
Television	light and sound	heating the television and the surrounding air
Hair dryer	thermal energy and kinetic energy of air	as sound
Electric cooktop	thermal energy of food	as light and heating the surrounding air

This loss of useful energy is also apparent when you step on the brake pedal in a car — not all the energy you transfer to the pedal is used to stop the car. Much of it is lost in the brakes themselves and to the surrounding air as heat. The same applies to using the brakes of a bicycle. Also, when you drop a tennis of cricket ball it never bounces back to its original height because some energy is lost as heat. On a larger scale it is seen in power stations, where the fuel, falling water, solar energy or any other energy source is used to produce electricity; some of the energy of the source is transformed to heat, warming the power equipment, the surrounding air and the water used as coolant. The 'loss' of useful energy is unavoidable.

Some types of lighting waste more energy than others. Old-fashioned incandescent light bulbs convert more energy to wasted heat than to light. They emit light only when the filament inside gets white hot. Fluorescent lights and LEDs (light-emitting diodes) waste very little energy. Almost all of the electrical energy is converted to light, so you use much less energy to produce the same amount of light than you would using an incandescent bulb.