Electrical Circuits and Conductors

Electricity

Electricity is a form of energy used to power many everyday items, such as kettles and mobile phones. It is essential to our daily lives. Lighting buildings, watching television, using computers, cooking meals and keeping in touch with family and friends all rely on electricity.

Sources of electricity

Electricity comes from two sources, mains electricity and cells. Mains electricity is used when we turn on a light switch or plug an electrical appliance into a socket. Cells contain chemicals that create electrical energy. They are usually used to power small, portable devices, such as torches. A battery is made of two or more cells.

mains electricity

cell

battery

Power stations generate most of the mains electricity we use. Electricity travels through overhead and underground wires, known as power lines, to buildings, including homes, shops, offices and factories.

Safety

Mains electricity is very powerful. If not used carefully, it can be dangerous, causing fires, burns, electric shocks and death. Electricity can be dangerous when people overload plug sockets, touch electrical items with wet hands or touch damaged wires. It is important to use electrical appliances safely.

Components

All electrical items are made up of components, which make them work.

switch

lamp

cell

battery

wire

buzzer

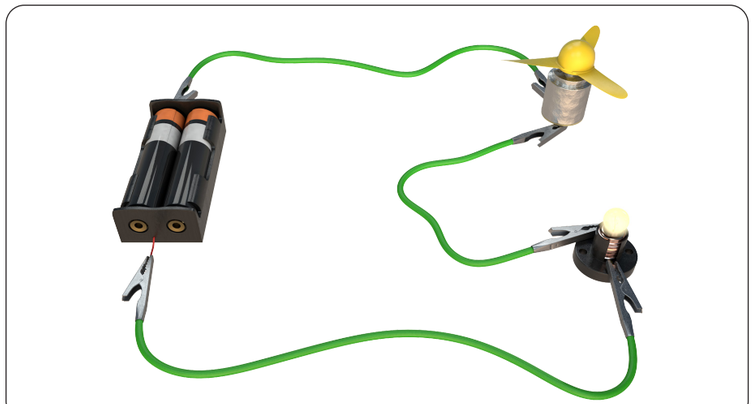
motor

Components have different jobs. A cell and battery provide electrical power. A wire connects different components and conducts electric current. A lamp emits light. A switch makes or breaks a circuit. A buzzer makes a sound. A motor creates movement.

Circuits

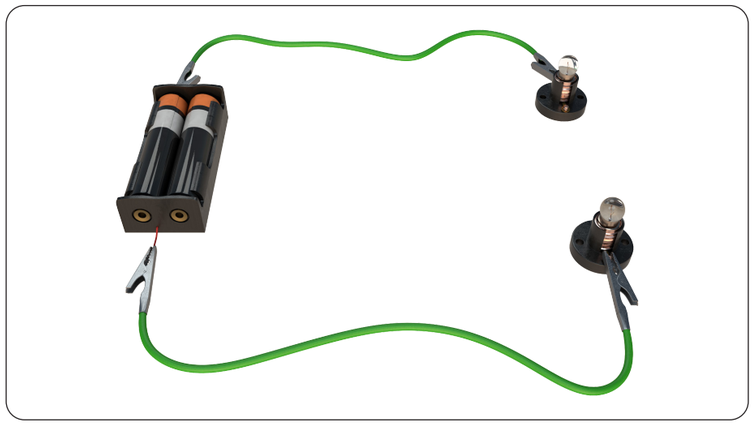
A circuit is a collection of components connected by wires through which an electric current can flow. If a circuit forms a complete loop with a single path for electric current to flow, it is called a series circuit.

When an electric current flows through all the components of a circuit, it is called a complete circuit. A complete circuit has no gaps and can make a lamp light up, a buzzer sound or a motor move.



complete series circuit

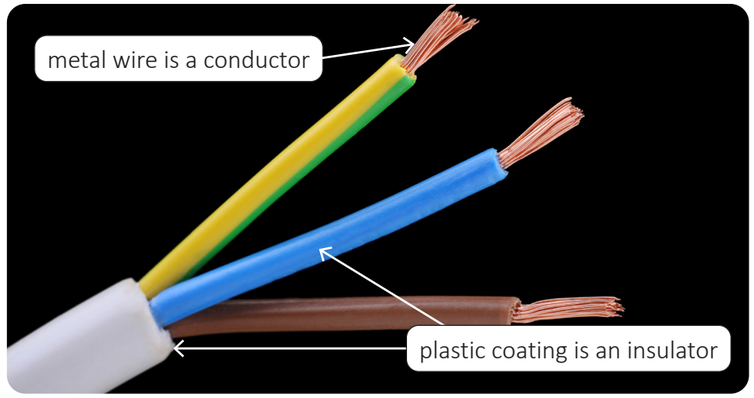
When an electric current cannot flow through all the components of a circuit, it is called an incomplete circuit. Missing wires, open switches, loose wire connections or broken components create gaps, which stop the electric current from flowing around the circuit.



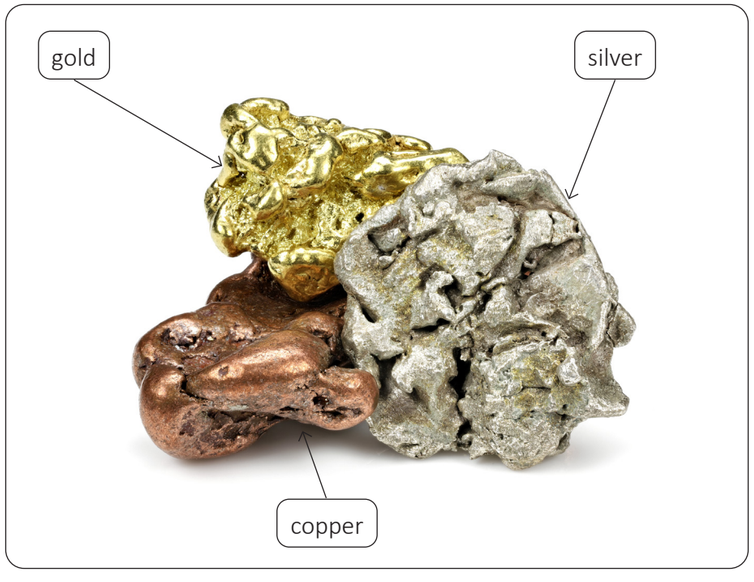
incomplete series circuit

Electrical conductivity

Electrical conductivity is a measure of a material's ability to allow an electric current to pass through it. Materials that allow an electric current to pass through them are conductive. They have low resistance. Materials that do not allow an electric current to pass through them are non-conductive. They have high resistance. Many non-conductive materials, such as plastic, are used as electrical insulators.



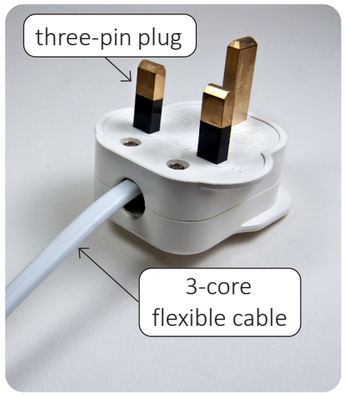
The metals silver, copper and gold are the three best conductors of electricity. Some non-metals, such as graphite, also conduct electricity. Most other materials are non-conductive.

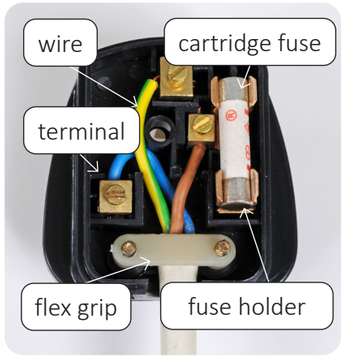


Plugs

In the United Kingdom, we use three-pin plugs with 3-core flexible cable wired into them to safely connect our electrical appliances to the mains electricity supply.

Plugs and 3-core flexible cable include parts made from metal and plastic. The metal parts are conductors and allow electric current to pass through them to make electrical appliances work. The plastic parts are insulators. They do not allow any electric current to pass through them. They cover the metal parts, so when people handle a plug, cable or electrical appliance, they do not come into direct contact with electricity.





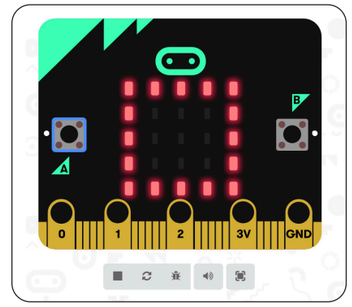
wired plug

Programmable technologies

Programmable technologies are devices that can operate automatically by following a set of instructions that have been programmed into them. Robotic vacuum cleaners, microwaves and washing machines are examples of programmable technologies. People input instructions into a device then the device performs tasks independently.

Micro:bit

A micro:bit is a small, programmable computer with an LED display, buttons and sensors. Micro:bits can be programmed to carry out a sequence of instructions.



Future of electricity

At the moment, most mains electricity is made by burning fossil fuels, such as coal, oil and gas, which pollute the environment. Fossil fuels are also running out, so alternative forms of renewable energy are needed. Renewable energy includes solar power, wind power and geothermal energy. People can also help to save electricity by turning off lights and appliances when not in use or using low energy, LED light bulbs.

solar power

Glossary

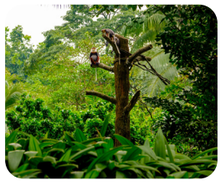
conduct	To allow electricity to pass through.
electric current	The flow of electric charge through a circuit.
LED	Light-emitting diode. A device that emits light when part of a complete circuit.
renewable	Something that can be used and then easily replaced.
resistance	The ability of a conductor to oppose the flow of electric current.

Food and the Digestive System

Producers and consumers

A producer is a living thing that makes its own food through the process of photosynthesis. Almost all producers are plants. A consumer is a living thing that feeds on other living things. All consumers fit into one of three groups depending on what they eat: herbivores eat plant parts, carnivores eat meat from other animals and omnivores eat both meat and plant parts. Animals that are hunted and eaten by other animals are called prey. Animals that hunt other animals for food are called predators.

Ecosystems



rainforest

An ecosystem is a community of living organisms and their environments that interact with each other, such as a rainforest, desert or ocean. Ecosystems have biotic, or living, features including plants, animals and microorganisms. They also have abiotic, or non-living, features, such as sunlight, water, air, soil and temperature.

desert

Interdependence

All living things depend on the biotic and abiotic features of their ecosystems to survive. This is called interdependence.

For example, the hummingbird depends on abiotic features, such as water to drink and oxygen to breathe. It also depends on biotic features, including the hibiscus flower for nutrition and trees for shelter.

Balance and change

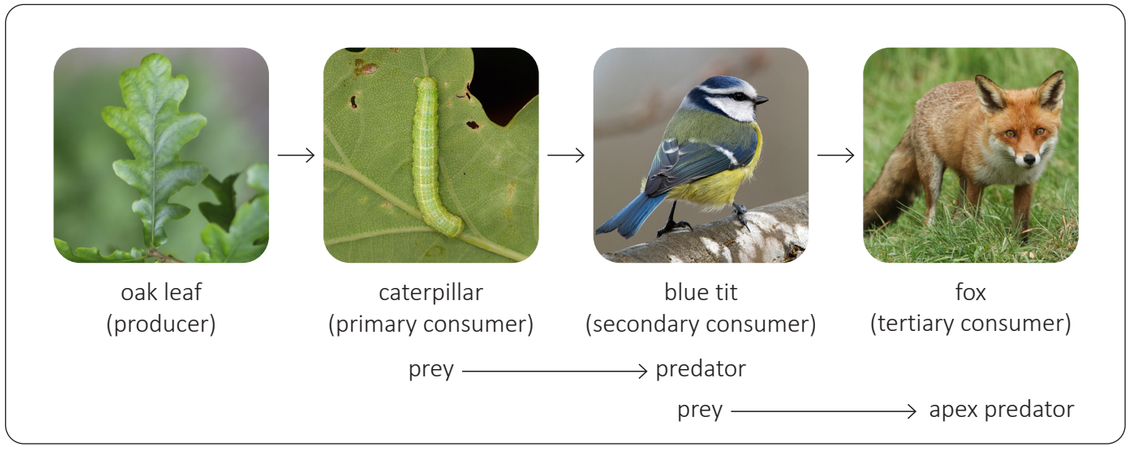
All the biotic and abiotic features of an ecosystem are finely balanced. Any change to one part will affect all the other parts. For example, a drought, or water shortage, can affect a plant's ability to grow. Animals that depend on that plant for food begin to starve and die unless they can adapt or move to a new ecosystem to survive. Human activity, such as deforestation and pollution, and natural events such as disease, floods, wildfires and drought, can damage ecosystems.

drought

Food chains

Plants and animals need energy from food to survive. A food chain is a diagram that shows how food energy is transferred from one living thing to another.

Food chains start with a producer that makes its own food. Primary consumers are herbivores that eat the producers. Secondary consumers can be carnivores or omnivores that feed on primary consumers and producers. Tertiary consumers at the end of the food chain mainly feed on the secondary and primary consumers. They are called apex predators.

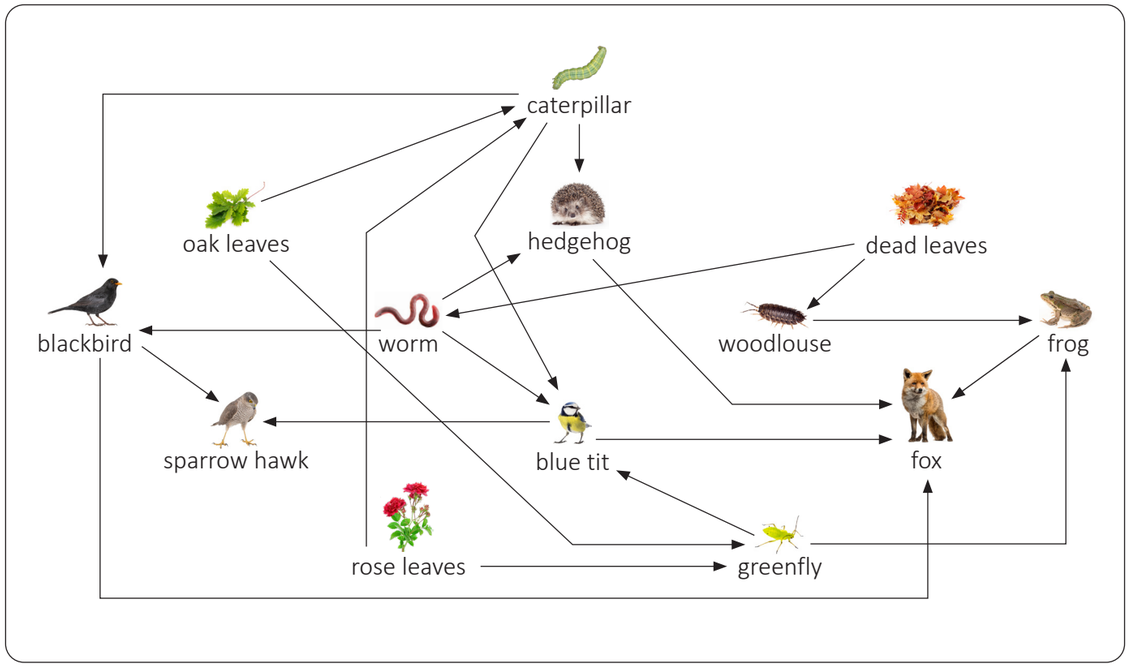


a food chain

Food webs

All the different food chains in a specific ecosystem can be linked together to make a food web.

Food webs show how different plants and animals in an ecosystem are connected through their interdependence.

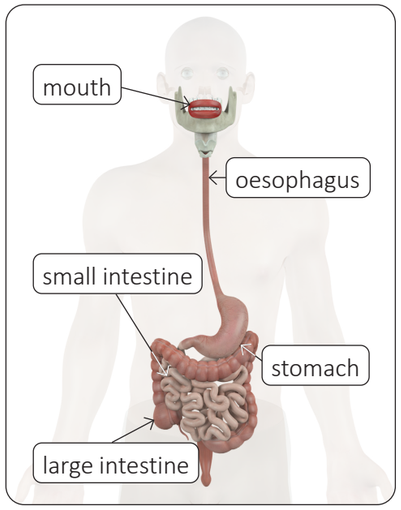


a food web

Digestion

Digestion is the process where food is broken down into small particles that can be absorbed by the body.

The digestive organs all work together to digest food.



digestive organs

Mouth

Digestion starts inside the mouth. The tongue rolls the food around and the teeth break it into smaller pieces by biting and chewing. Digestive enzymes in saliva break down the food further so the food can be swallowed.

Oesophagus

The food travels through the pharynx, or throat, then into the oesophagus. Muscles squeeze the food along the oesophagus and into the stomach.

Stomach

Inside the stomach, the food is mixed with digestive enzymes and digestive acid to chemically break it down into tiny particles. Muscles also squeeze and churn the food.

Small intestine

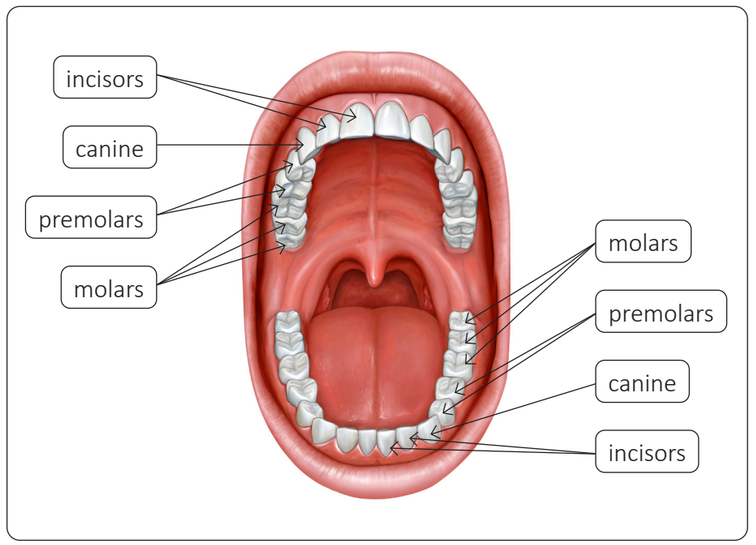
The small intestine has muscular walls which squeeze the food along its length. Chemicals from organs called the liver and pancreas break the food down further to release nutrients, which are absorbed through the intestinal wall into the bloodstream.

Large intestine

Food that cannot be digested is squeezed from the small intestine into the large intestine, where excess water is absorbed. The undigested waste, known as faeces, exits the body through the rectum and the anus at the end of the large intestine.

Teeth

Human teeth begin to grow when a baby is around six months old and continue growing until a child has 20 teeth. These are called primary teeth. These begin to fall out at around six years old and 32 permanent teeth then grow. There are four types of teeth:



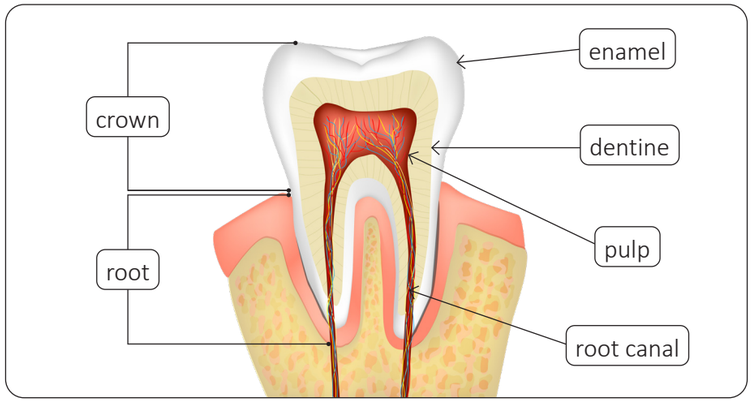
Carnivore, herbivore and omnivore teeth

Animals have different types of teeth depending on the food they eat. Carnivores usually have large canines for ripping and tearing meat. Herbivores usually have sharp incisors for cutting plant material and large flat molars for grinding. Omnivores usually have a mixture of teeth: canines for tearing meat and large, flat molars for grinding plants.



Tooth structure

A tooth has a very hard, outer layer called enamel to protect against bacteria and hot and cold temperatures. Dentine under the enamel gives the tooth its structure and colour. Pulp in the middle of the tooth contains nerve endings and a blood supply which continues through a space in the root called the root canal. These nerves send pain messages from the tooth to the brain.



Oral hygiene

Oral hygiene is the practice of keeping the mouth and teeth clean to protect against the buildup of bacteria called plaque, which can lead to tooth decay and gum disease. To ensure good oral hygiene, it is important to:

- Avoid consuming too many sugary foods and drinks.
- Brush teeth twice a day with fluoride toothpaste.
- Visit the dentist at least once a year.

Glossary

bacteria	A type of microorganism, some of which can cause disease.
fluoride	A chemical that can be added to toothpaste to prevent tooth decay.
microorganism	A living thing that is too small to be seen without a microscope.

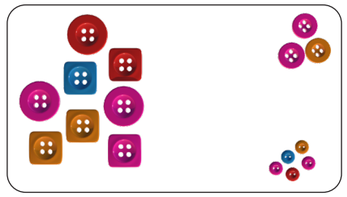
Grouping and Classifying

Classification

Classification is the arrangement of living and non-living things into groups or categories. It involves breaking down a large group into smaller groups based on their observable features. There are three types of classification: single-stage classification, multi-stage classification and serial ordering.

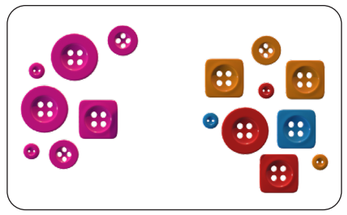
Single-stage classification

Single-stage classification involves separating a large group of objects into smaller groups based on a single property, such as size.



Sorted into three groups: large, medium and small.

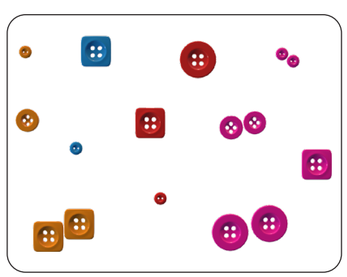
Another type of single-stage classification involves sorting objects according to whether they have a specific property or not. For example, we could ask the question ‘Is it pink?’



Sorted in two groups: pink and not pink

Multi-stage classification

Multi-stage classification involves asking repeated questions about specific properties, to sort groups into subgroups again and again until all the objects in one group are the same.



Serial ordering

This type of classification involves sorting objects into an order based on a property. For example, these socks can be sorted according to size, with the smallest at one end, leading to the largest at the other end.

How classification is used

Scientists use classification to put living things into groups. The science of classifying and naming living things is called taxonomy.

Classification helps scientists identify and study living things and understand the origins and evolution of a species. New living things are still being discovered today.

Classification keys

Classification keys use multi-stage classification to identify living things. They work by observing a living thing then answering the yes or no questions until it is identified. For example, we can identify the animal below by answering the questions in the classification key.

Classification of living things

Scientists divide all living things into five kingdoms. These include the animal kingdom and the plant kingdom.

Animal kingdom

All animals in the animal kingdom are classified as either invertebrates or vertebrates.

Invertebrates

Invertebrates do not have backbones. Instead, they have soft bodies or a hard outer shell or exoskeleton. They are further classified into three groups: annelid, mollusc and arthropod. Arachnid, crustacean, insect and myriapod are four types of arthropod.

annelid

mollusc

arthropod

arachnid

crustacean

insect

myriapod

Vertebrates

Vertebrates have backbones. They are covered with skin, feathers, scales, fur or hair. Vertebrates are further classified into five groups.

amphibian

bird

fish

mammal

reptile

Plant kingdom

Plants are important for life on Earth. All plants in the plant kingdom are classified as either vascular or non-vascular. Vascular plants are further classified into three groups.

plants with seeds – flowering

plants with seeds – cone-bearing

plants with spores

Glossary

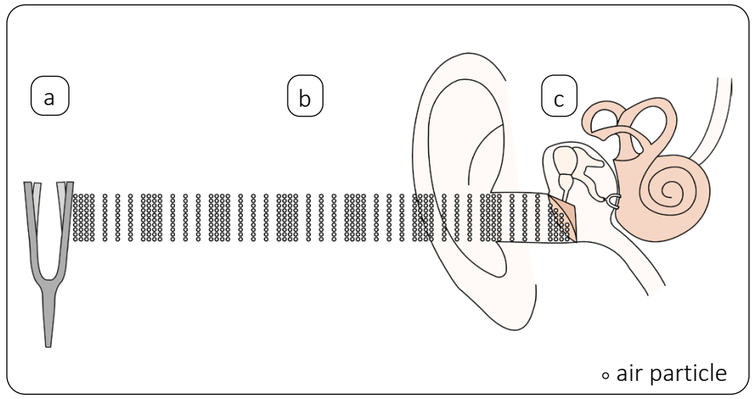
backbone	A column of bones in the middle of the back of vertebrate animals.
classify	Arrange in groups or categories according to shared qualities or characteristics.
evolution	A process where living things change some of their physical or behavioural characteristics slowly over a very long time.
origin	Where something begins.
vascular	A plant with tubes that carry water and nutrients.

Sound

What is sound?

Sound is energy produced by vibrations from a sound source. Sound travels in waves through a medium, such as a solid, liquid or gas, to our ears. Most of the sound waves we hear travel through air, which is a gas. Where there is no medium for sound waves to travel through, such as in space, there is no sound.

How we hear sound



a. When energy is put into a sound source, it starts to vibrate, quickly moving back and forth repeatedly in a in a regular pattern.

b. These vibrations disturb the tiny particles of the medium that is close by, such as air, and they start to vibrate. They collide with the air particles next to them and pass the vibration energy along in sound waves.

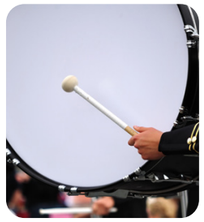
c. When the sound waves enter the ear, they make the eardrum vibrate. These vibrations pass through small bones called ossicles and are turned into electrical signals in the spiral-shaped cochlea. These signals travel through the cochlear nerve to the brain and are interpreted as sounds.

Volume

The volume of a sound is how loud it is. It is measured in units called decibels (dB). Energy affects volume. The larger the force of energy put into the sound source, the louder the volume; the smaller the force, the quieter the volume. Distance also affects volume. The nearer the sound source, the louder the volume. The further away the sound source, the quieter the volume.

Pitch

The pitch of a sound is how high or low it is. Pitch is measured in units called hertz (Hz). Humans can hear between 20 and 20,000 Hz but dogs can hear higher-pitched sounds. Fast vibrations produce high-pitched sounds, such as the sound of a whistle. Slow vibrations produce low-pitched sounds, such as the sound of a bass drum.

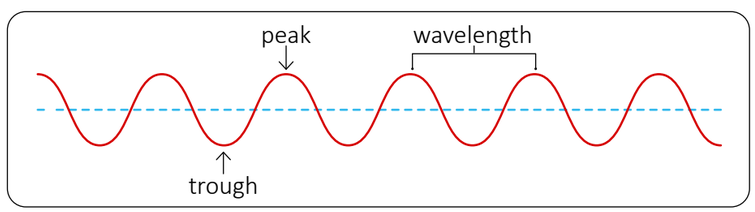


Representing sound waves

Sound waves can be represented by a wavy line in a sound wave diagram.

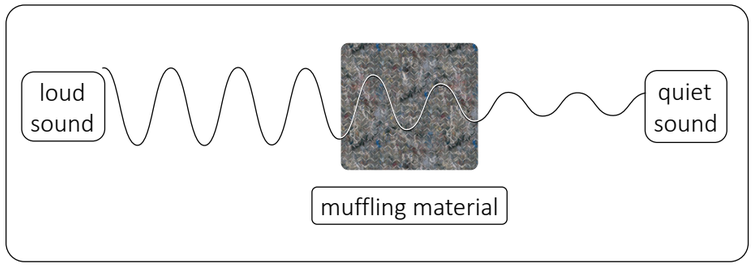
Volume is represented by the size of the peaks and troughs; large peaks and troughs represent a loud volume and small peaks and troughs represent a quiet volume.

Pitch is represented by the distance between each peak, called the wavelength. A long wavelength represents a low-pitched sound, and a short wavelength represents a high-pitched sound.



Muffling sound

Being exposed to very loud or continuous sounds can damage hearing. It can also lead to increased stress, tiredness and health problems. Materials that muffle sound absorb a lot of sound energy and reduce the volume of sound reaching our ears. Earplugs, ear defenders and soundproofing materials all muffle sound.



Glossary

cochlea	The spiral-shaped part inside the inner ear that turns vibrations into electrical signals.
eardrum	A thin layer of tissue inside the ear through which vibrations pass.
medium	A material, such as a solid, liquid or gas, that transfers energy from one place to another.
ossicles	Three tiny, linked bones inside the ear through which vibrations pass.
particle	A single piece of matter that is too small to be seen.
vibrate	To quickly move back and forth repeatedly.

States of Matter

Most matter exists in one of three states: solid, liquid or gas. Each state of matter has its own properties.

Properties of solids

- Solids can be held.
- They keep their shape and do not flow.
- They always take up the same amount of space.
- They cannot be compressed.

Examples

metal

wood

plastic

Properties of liquids

- Liquids cannot be held easily.
- They flow and can be poured.
- They take the shape of the container they are in.
- They cannot be compressed.

Examples

water

oil

milk

Properties of gases

- Gases cannot be held.
- They have no fixed shape and fill the available space in the container.
- They can be compressed.
- They are normally invisible.

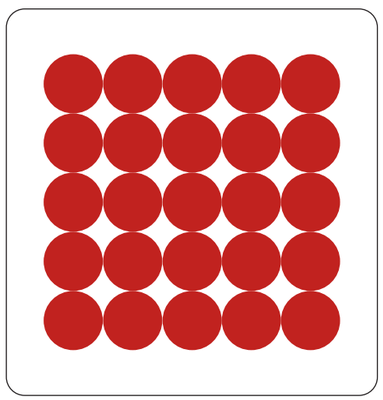
Examples

air

helium

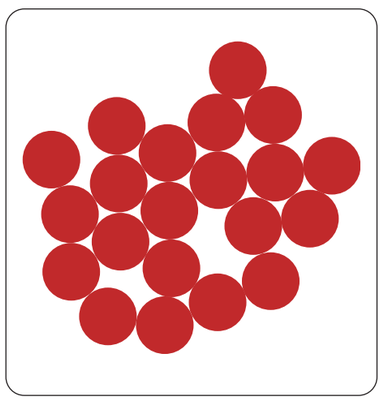
Particle theory

All matter is made from tiny particles. Particles are single pieces of matter that are too small to be seen. The arrangement of particles in solids, liquids and gases explains their different properties.



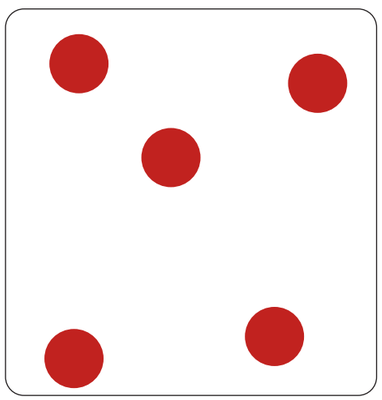
In a **solid**, the particles are close together, arranged in a regular pattern and cannot move around each other.

This arrangement means that solids keep their shape, always take up the same amount of space and cannot be compressed.



In a **liquid**, the particles are close together but arranged randomly, which means they can move around each other.

This arrangement means that liquids can flow, take the shape of the container and cannot be compressed.

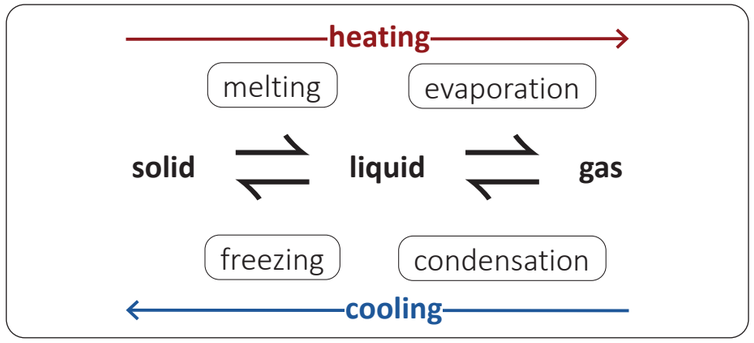


In a **gas**, the particles are far apart, randomly arranged and can freely move.

This arrangement means that gases have no fixed shape, fill any container and can be compressed.

Changing state

Materials can exist as solids, liquids or gases. However, some materials change state when heat is added or removed. The processes involved in changing state are melting, freezing, evaporation and condensation. These changes are reversible.



When a solid is heated, it melts into a liquid.

When a liquid is heated, it evaporates into a gas.

When a gas is cooled, it condenses into a liquid.

When a liquid is cooled, it freezes into a solid.

States of water

Water exists in three states on Earth: solid ice, liquid water or gaseous water vapour.

solid

liquid

gas

Melting and boiling points

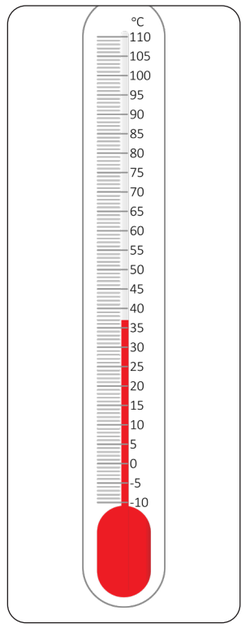
When solid water (ice) is heated to 0°C, it begins to melt. This is called its melting point.

When liquid water is heated to 100°C, it begins to evaporate. This is called its boiling point.

Different materials have different melting and boiling points. For example, solid gold melts at 1063°C and liquid argon evaporates at -189°C.

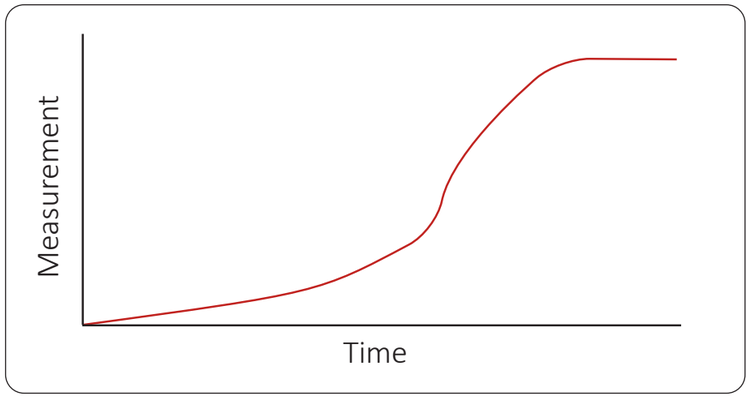
Measuring temperature

Temperature is a measure of how hot or cold something is. It is measured in degrees (°) using a thermometer. The Celsius scale, which was invented by Anders Celsius in 1742, is used in the United Kingdom to measure temperature. In a liquid thermometer, the liquid rises and falls in the tube as the temperature rises and falls. The scale on a thermometer has marked and unmarked divisions. This thermometer reads 37°C.



Line graphs

A line graph is a way of displaying data that shows a relationship between two things, or variables. Many line graphs show changes over time. The line can be straight or curved and have flat sections or slopes that are shallow or steep. Flat lines mean there is no change over time. The steeper the line, the faster the change.



Glossary

arrangement	The way in which things are placed.
compress	To squash.
gaseous	In the form of a gas.
matter	What all things are made from.
process	A series of actions taken to achieve a result.
reversible	Capable of being reversed so that the previous state is restored.
variable	A factor, such as an object or condition, that changes during an investigation.