



# SOUND

Sound is a form of energy (18) made when objects vibrate (move to and fro rapidly). As an object vibrates it sets the air around it vibrating too: molecules of the gases in the air press close together and then pull apart. These regions of higher and lower air pressure are called sound waves. They move away from the sound source in all directions, like ripples in a pond. Sounds also travel as vibrations through liquids and solids. The molecules are closer together in liquids and solids than in gases, so sounds travel through them much faster.

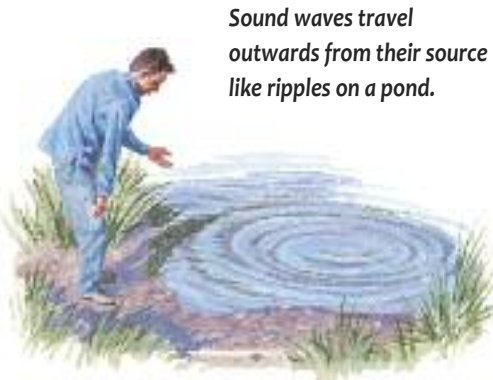
**Acoustics** The study of how sound is affected by location, for example, how sound bounces around a concert hall.

**Amplitude** The height of a wave. Sound waves with high amplitudes make loud sounds and sound waves with low amplitudes make quiet sounds.

**Decibel** The unit used to measure the volume, or intensity, of sounds. A very quiet sound, such as the rustling of leaves is about 20 decibels (dB). A very loud sound, such as a rocket taking off, is about 120 dB. Sounds over 80 dB can damage your ears.

**Echo** The sound we hear when sound waves bounce off a surface.

**Echolocation** A type of sonar used by animals such as bats and whales. The animals emit sounds and listen to their echoes in order to locate solid objects. Echolocation allows animals to hunt in dark or murky conditions where it is difficult to see.



Sound waves travel outwards from their source like ripples on a pond.

**Frequency** The number of vibrations, or sound waves, per second. Sound waves with high frequencies make high-pitched sounds. Sound waves with low frequencies make low-pitched sounds.

**Hertz** The unit used to measure frequency. One hertz (Hz) is one vibration per second.

Stringed instruments



A trumpet produces sound waves.

**Infrasonic** Sounds that are too low-pitched for humans to hear. It is thought that some animals are able to hear them.

**Intensity** The amount of energy that sound waves carry. The intensity of sound waves determines their volume.

**Music** A form of art using pleasant sounds.



Water (1530 m per second)    Air (343 m per second)    Steel (5050 m per second)

Sound travels quickest through solids, slower through liquids and slowest of all through air.

**Musical instrument** An object that is used to make musical sounds. In a cello, a bow rubs over the cello's strings to make them vibrate. The vibrations pass into the air and also to the cello's hollow body, making the sound louder and richer.

**Noise** Any kind of sound. Noise is often used as a word for unwanted sounds.

**Pitch** How high or low a note is. High-pitched sounds have high frequencies and low-pitched sounds have low frequencies.

**Resonance** The frequency at which an object will vibrate if you hit it. This is sometimes called the **natural frequency** of an object.

**Reverberation** The sound heard when sound waves continue to travel after the original source of a sound has gone.

**Sonar (SOund Navigation And Ranging)**

A technique that uses sound waves to detect solid objects. The sound waves bounce off them and reveal their position. Ships use sonar to find shoals of fish or other ships.

**Speed of sound** The speed at which sound travels. Sound travels through air at about 343 metres per second. The speed of sound varies depending on the substance it travels through. Loud and soft sounds all travel at the same speed.



The sound made by a jet engine measures about 140 dB, but it can only be heard faintly from the street because it is so far away.

The sound made by busy traffic can register between 70 and 80 dB.

An electric drill makes a sound of about 100 dB. The people that use it must wear ear-protectors.

The sound of a car horn can be up to 110 dB.

**Supersonic** Faster than the speed of sound. When objects travel faster than the speed of sound they make a loud noise called a **sonic boom**.

**Ultrasound** Sounds that are too high-pitched for humans to hear. Some animals, such as dogs and bats, can hear them. An **ultrasound scanner** is used to make images of inside the human body. It beams high-pitched sound waves into the body. A computer transforms the echoes into an image.

**Volume** The loudness of a sound. Volume is measured in decibels (dB). Some sounds are so quiet that we can only just hear them. Others are so loud that they may damage our ears. (See intensity.)

**Wavelength** The distance between one sound wave and the next. Sound waves with short wavelengths have high frequencies and make high-pitched sounds. Sound waves with long wavelengths have low frequencies and make low-pitched sounds.



Bats use echolocation to track their prey.

An ultrasound scan of a baby in the womb

## FACTFILE

★ Whales and dolphins use sound to communicate. Whalesong can travel up to 800 km under water. Whales are believed to be the loudest animal in the world. They can make sounds as loud as 188 dB. The loudest land animal is the howler monkey. Its calls can be as loud as 88 dB and can be heard up to 16 km away.

★ Sound waves can only travel through matter. Space is completely silent because there are no gas molecules for sounds to pass along.

★ Most sounds only carry a relatively small amount of energy. The sound of 200 pianos playing together produces about the same amount of energy as it would take to light one light bulb.

A watch makes a soft, medium-pitched sound.



A rocket makes a loud, low-pitched sound.



A singer makes a medium-loud, medium-pitched sound.



# LIGHT & COLOUR

Light is a kind of energy (☛ 18) that our eyes can detect, enabling us to see. It is mostly produced by very hot things. It travels in straight lines, but it can reflect (bounce) off objects. In fact, we can only see an object when light reflects from it and into our eyes, or if it produces light itself. Sunlight is not colourless, but is made up of all the colours of the rainbow: the spectrum of light.

**Bioluminescence** The ability of some animals to produce light. The light is generated by chemical reactions (☛ 14) in the animal's body.

**Concave lens** A shaped piece of glass or plastic that is thicker at its edges than at its centre. It makes light rays diverge (spread out). When you look through a concave lens, objects appear smaller than they really are.

By placing two mirrors in a tube you can make a periscope, a device used to see around corners. Light coming in at one end is reflected through to the viewer at the other end.



Light is produced in a bulb when the filament is heated by an electrical current.

Female glow-worms (a type of beetle) emit light when they are ready to mate.



**Convex lens** A shaped piece of glass or plastic that is thicker at its centre than at its edges. It brings light rays together at a single point called a focus. When you look through a convex lens, objects appear larger than they really are.

**Diffraction** The spreading out of light rays as they pass through a narrow gap.

**Focus** The point where rays of light meet when directed by a lens or mirror.

**Lens** A shaped piece of glass or plastic that bends light rays.

**Light filter** A piece of coloured, transparent plastic or glass that allows light of its own colour to pass through it, but stops all other colours. Light filters are often used in stage lighting, to change the colour of a light. If a blue filter is placed over a white light, the light that shines on to the stage will be blue.

**Luminescence** Light that is created at low temperatures, usually caused by certain chemical reactions or electricity.

**Mirage** A trick of the eye, that makes far away objects look much closer than they really are. Mirages happen when light from the sky is reflected off a layer of hot air just above the ground or the sea. They are commonly seen in deserts.

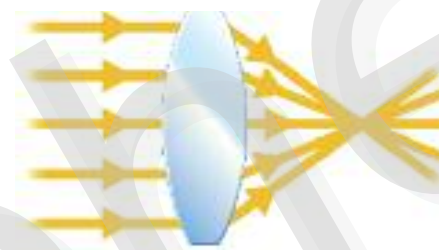
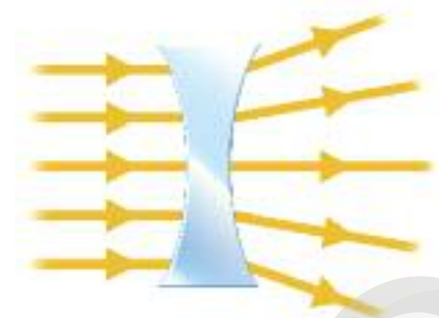
**Mirror** A sheet of glass with a thin layer of metal on the back. Mirrors form images by reflecting light from the surface of the metal.

**Opaque** A material that does not allow light to shine through it.

**Pigment** A substance that is added to another substance to give it colour.

**Primary colours** Any of the three colours that can be mixed together to form all other colours. The primary colours of light are red, green and blue. They can be mixed to make any colour. When all three are mixed together they make white light. In paints, which contain pigments, the primary colours are red, yellow and blue.

A concave lens (top) and convex lens (bottom).



A magnifying glass is a convex lens.



A prism refracts white light, splitting it into every different colour of the spectrum.

**Prism** An angled block of transparent material such as clear glass or plastic. As light waves pass through a prism, they change speed and are bent, or refracted. Longer waves of red light refract least. Shorter waves of violet light refract most. The other colours of the spectrum spread out in between.

**Rainbow** An arch of colours that forms across the sky when the Sun shines from behind you at rain falling in front of you. The raindrops act as millions of tiny prisms, each splitting the white light in sunlight into every colour of the spectrum.

**Reflection** The bouncing of light rays off an object. Smooth, shiny, light surfaces reflect more light than rough, dark ones.

**Refraction** The bending of light rays as they travel through different transparent materials. This occurs because light travels at different speeds through different materials. At the boundary between two materials, the light changes speed and is bent from its straight path.

**Shadow** A dark shape or area produced when an opaque object stands between a surface and a source of light. Shadows are formed because light can only travel in straight lines and cannot bend around the opaque object.

**Spectrum of light** The section of the electromagnetic spectrum (☛ 28) that we can see. It is formed of all the different colours that make up white light: red, orange, yellow, green, blue, indigo and violet.



When the three primary colours of light, red, blue and green are added together they make white light.

**Speed of light** The speed at which light travels through empty space. This is about 300,000 km/s—about seven and a half times around the Earth in one second. The speed of light is the speed limit for the Universe: nothing can travel faster.

**Translucent** A material that allows light to pass through it, but which spreads the light rays out in all directions. We can make out shapes behind translucent materials but we cannot see them clearly. Tracing paper and ice are both translucent materials.

The colour wheel shows how the different colours of light add up to make white light. When you spin the wheel, the colours whirl around so fast that the eye cannot follow them. Inside the eye each colour merges with the others so the eye sees all the colours at once—and all colours of light added together make white light.

## FACTFILE

- ★ It takes sunlight more than eight minutes to travel nearly 150 million km from the Sun to the Earth.
- ★ In one year, light travels 9.46 trillion km. This distance is called a light year.
- ★ The colour of an object depends on which colours it absorbs and which it reflects. For example, a leaf looks green because its surface absorbs all the colours in white light, except green, which it reflects.
- ★ The eye contains a natural convex lens which focuses an image on to the retina at the back of the eye.
- ★ Concave lenses are used in glasses for people who are short-sighted (they have difficulty seeing objects far away from them). Convex lenses are used for people who are long-sighted (they have difficulty seeing objects close to them).

**Transparent** A material that transmits light, or allows light to pass through it. We can easily see through transparent materials, such as glass. We can see the glass because a tiny amount of light is reflected off the material.

A rainbow shows all the different colours of the spectrum.