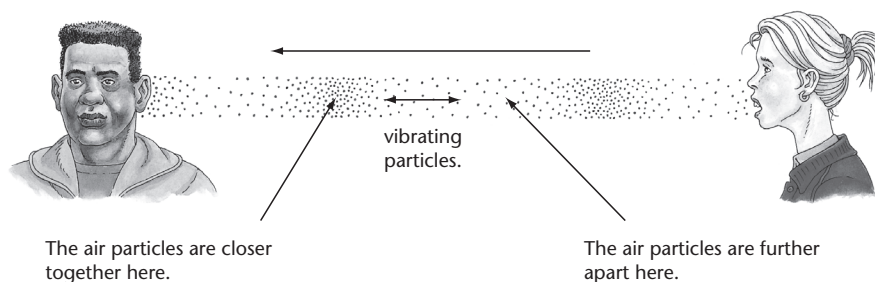


## Sound vibrations and waves

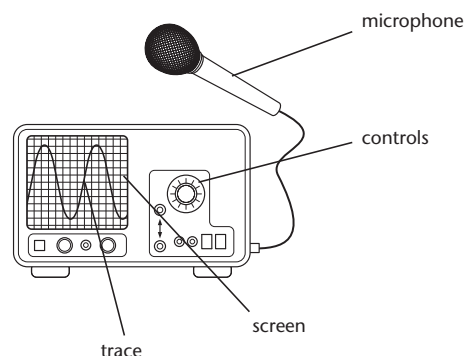
**Sound** is a form of **energy**. Sounds are made when things **vibrate**. The vibrations are passed on by particles. Sound therefore needs a substance to pass on the vibrations, so it can travel through solids, liquids and gases but not through a **vacuum**.



The speed of sound is faster through material in which particles are closer together. Closer particles hit each other more easily and so the energy is more likely to be passed from one particle to the next. When the sound energy moves from one place to another it has been **transferred**. The sound energy travels in all directions because the particles move in all directions unless something stops them.

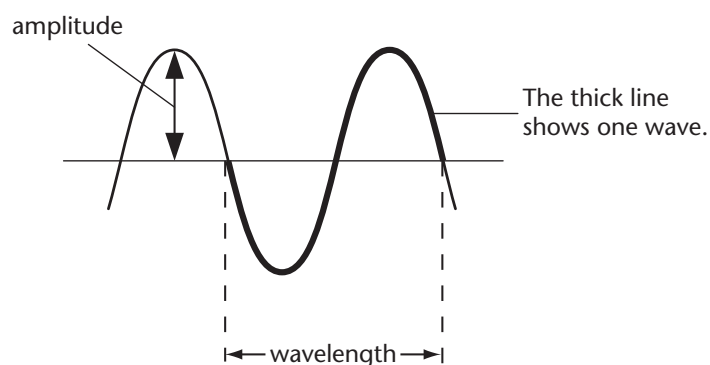
## The oscilloscope

The **frequency** of a **sound wave** is the number of complete waves passing a point each second. The unit of frequency is **hertz (Hz)**. The source of the sound is vibrating at the same number of **cycles per second** as the frequency of the wave it makes. Sound waves with a high frequency produce sounds with a high **pitch**.



Sound waves can be shown as a **trace** on an **oscilloscope**.

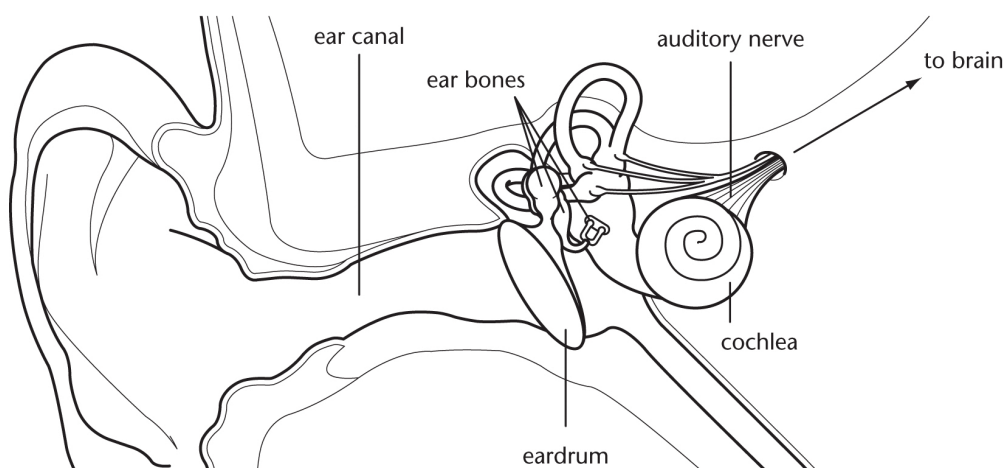
The **wavelength** is the distance between any two identical points on neighbouring waves.



Half the height of the wave is called the **amplitude**. The **loudness** or **intensity** of a sound depends on the amplitude of the wave. Louder notes have *more energy* and have waves with *bigger amplitudes*.

## Hearing and the ear

Sound waves travel through the air and into the ear. They cause the eardrum to vibrate. The vibrations are passed on to the **cochlea** in the **inner ear**, where they are changed to electrical signals called **impulses**. A **nerve** takes this message to the brain. When the message reaches the brain we hear the sound.



Loud sounds can damage the eardrum or the cochlea. People who are exposed to loud sounds for long periods of time are at risk of damaging their hearing or even suffering permanent deafness. To avoid this, people who work in loud environments wear ear protection. Unpleasant sound is often called **noise**. Wax, ear infections and getting older can also affect hearing.

We can measure how loud a sound is by using a sound intensity meter. It measures the loudness of a sound in **decibels (dB)**. The **threshold of hearing** is the quietest sound we can hear and this is 0 dB.

Soft materials **absorb** sound. Soft materials are used in **soundproofing** and for making ear protectors. The gap between the glass in double glazing contains few particles and so is also used for soundproofing.

## Sound and light

Light energy can travel through space (a vacuum) but sound energy cannot.

Light travels nearly a million times faster than sound. Light travels at 300 million metres per second (or 300 000 km/s) in air and sound travels at about 330 metres per second.

Both light waves and sound waves can be reflected. We hear a **reflected** sound wave as an **echo**.