

How sound travels and how we hear it

Grade 6 science (Year 7 · Class 6) · Lesson

Quick answer: Sound is made by vibrations and travels through a medium such as air, water or steel, but not through a vacuum. Loudness depends on the size of the vibration, measured in decibels, and pitch depends on the frequency, measured in hertz. Very loud sounds can damage hearing, so ears must be protected.

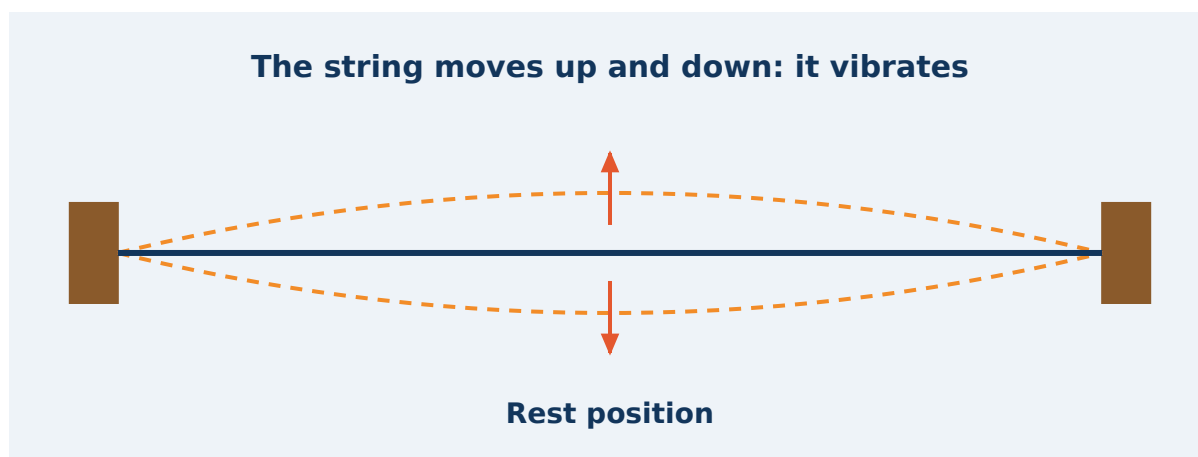
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What is sound and how is it made?

Sound is made by **vibrations**. A vibration is a fast, repeated back-and-forth movement. When you pluck a guitar string, hit a drum or speak, something vibrates: the string, the drum skin or your vocal cords. The vibrating object pushes the air around it, and this movement travels to our ears as sound.

Definition

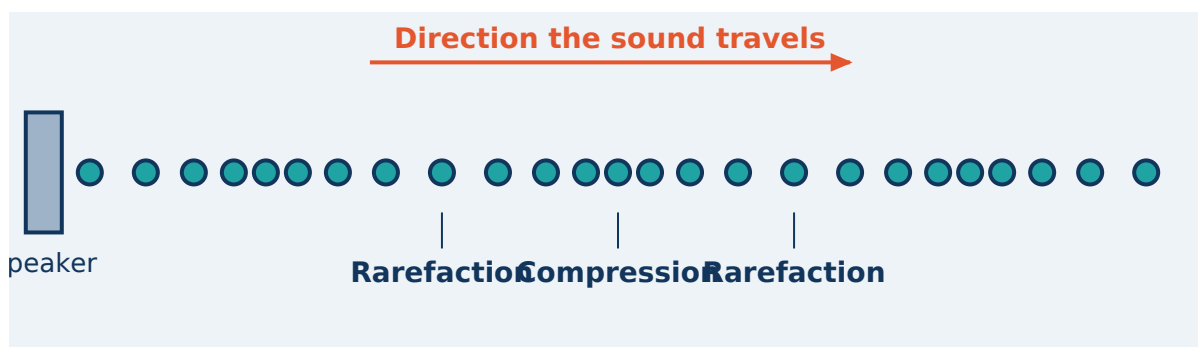
Sound is energy that travels as vibrations through a material. Every sound is made by something that vibrates.



A vibration is a repeated back-and-forth movement about a rest position.

Why does sound need a medium?

Sound travels by passing vibrations from one particle to the next. The material that carries the sound is called the **medium**. It can be a gas such as air, a liquid such as water or a solid such as steel. Where the particles of the medium are squashed together we call it a compression; where they are spread out it is a rarefaction.



Sound passes along as particles are pushed together and then spread out again.

Key rule

Sound needs a medium to travel through. It cannot travel in a vacuum, because there are no particles to pass on the vibrations.

Sound travels fastest in solids, slower in liquids and slowest in gases, because the particles are closest together in solids.

Medium	Approximate speed of sound (m/s)
Air	340
Water	1500
Steel	5000

Formula

$$d = v \times t$$

d is the distance travelled by the sound (m), v is the speed of sound (m/s) and t is the time (s).

Worked example 1

During a storm in Accra, thunder is heard 6 s after the lightning flash. Light arrives almost instantly, so the delay is the travel time of the sound. How far away is the lightning? Use 340 m/s.

$$d = v \times t = 340 \times 6 = \mathbf{2040 \text{ m}} \text{ (about 2 km).}$$

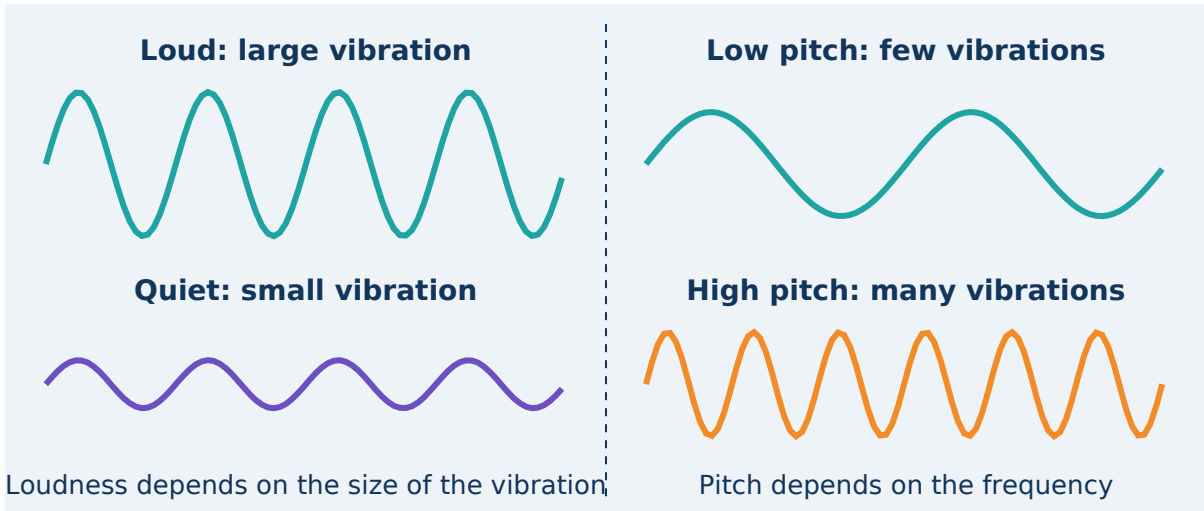
Worked example 2

A walker in the Rift Valley shouts towards a cliff and hears the echo 3 s later. How far away is the cliff?

The sound travels to the cliff and back, so the total distance is $340 \times 3 = 1020 \text{ m}$. The cliff is half of this: $1020 \div 2 = \mathbf{510 \text{ m}}$ away.

What are loudness and pitch?

Loudness depends on the size of the vibration: a bigger vibration carries more energy and gives a louder sound. We measure loudness in decibels (dB). **Pitch** depends on the frequency, which is the number of vibrations each second. A higher frequency gives a higher pitch. Frequency is measured in hertz (Hz); 1 Hz is one vibration per second. Humans hear roughly from 20 Hz to 20 000 Hz.



Wave traces from a microphone: height shows loudness, number of waves per second shows pitch.

Worked example 3

A guitar string vibrates 1800 times in 6 s. Calculate its frequency.

Frequency = number of vibrations ÷ time = 1800 ÷ 6 = **300 Hz**.

Sound	Typical loudness (dB)
Whisper	30
Normal conversation	60
Busy road	80
Live music concert	105
Jet engine nearby	140

How can you protect your hearing?

Sound enters the ear and makes the eardrum vibrate. Tiny bones pass the vibrations to the inner ear, where nerves send signals to the brain. Very loud sounds, especially above about 85 dB for a long time, can damage the delicate parts of the inner ear and cause permanent hearing loss. To protect your hearing, wear ear defenders or earplugs near loud machines, keep the volume of headphones low, take breaks from loud places and stand farther from loudspeakers.

Common mistake

Loud and high-pitched do not mean the same thing. A deep drum can be very loud with a low pitch, and a small whistle can be quiet with a high pitch. Loudness depends on the size of the vibration; pitch depends on how fast it vibrates.

Lina's tip

Remember: bigger vibration means louder, faster vibration means higher. Picture a wave trace: a taller wave is louder, and more waves squeezed into the same time is a higher pitch.

Key points to remember

- Sound is made by vibrations and needs a medium
- Speed of sound: about 340 m/s in air, 1500 m/s in water, 5000 m/s in steel
- Loudness depends on the size of the vibration (dB)
- Pitch depends on frequency, in hertz (Hz)
- Sounds above about 85 dB for long times can damage hearing

How sound travels and how we hear it: frequently asked questions

What is sound?

Sound is energy that travels as vibrations through a material such as air. It is made whenever an object vibrates, like a drum skin, a string or vocal cords.

Why can sound not travel through a vacuum?

Sound needs particles to pass on the vibrations from one place to the next. A vacuum has no particles, so there is nothing to carry the sound.

What is the difference between loudness and pitch?

Loudness depends on the size of the vibration and is measured in decibels. Pitch depends on the frequency, the number of vibrations each second, and is measured in hertz.

How fast does sound travel?

In air at room temperature sound travels at about 340 m/s. It is faster in water, about 1500 m/s, and faster still in steel, about 5000 m/s.

How can you protect your hearing?

Wear ear defenders near loud machines, keep headphone volume low, take breaks from loud places and stay away from loudspeakers. Sounds above about 85 dB over long periods can cause permanent damage.