



Study of Sound



a wave that needs a medium, the quantities that describe it, and the echo it can produce

How sound travels

- sound is produced by a vibrating body and travels as a wave through a material medium
- sound cannot travel through a vacuum, since there are no particles to pass the disturbance along
- it is a longitudinal wave: the particles vibrate along the same direction the wave travels, not across it
- the wave is a series of compressions, where particles are crowded together, and rarefactions, where they are spread apart
- the particles do not travel with the wave. Each vibrates about its own position and passes the disturbance on
- so energy travels, matter does not, which is true of every wave



the wave drawn along its line of travel with the crowded and spread regions alternating: the disturbance moves steadily to the right while each particle only shuffles back and forth about its own place

The quantities that describe a wave *

the wave relation

$$v = f\lambda$$

frequency and time period

$$f = \frac{1}{T}$$

distance for an echo, there and back

$$2d = vt$$

so the distance to the reflector

$$d = \frac{vt}{2}$$

the factor of 2 in the echo formula is the whole difficulty of that topic: the sound travels to the surface and back again, so the distance covered is twice the distance to it

What each quantity means to the ear

- frequency is the number of vibrations per second, in hertz, and it decides the pitch
- higher frequency means a higher pitch, so a whistle is high and a drum is low
- amplitude is the greatest displacement from the rest position, and it decides the loudness
- larger amplitude means louder, and loudness is measured in decibels
- quality or timbre is what makes the same note sound different on a flute and on a violin
- speed depends on the medium, not on the source: sound travels fastest in solids, slower in liquids and slowest in gases

Echo and reverberation

- an echo is a reflected sound heard as a separate sound from the original
- the ear retains a sound for about 0.1 second, which is the persistence of hearing
- so the reflected sound must arrive at least 0.1 second later to be heard separately
- at 340 m/s that means the reflector must be at least 17 metres away, since the sound covers 34 m there and back
- reverberation is the repeated reflection that makes a sound persist in a hall, and too much of it blurs speech
- it is reduced by curtains, carpets, cushioned seats and rough ceilings, which absorb rather than reflect

