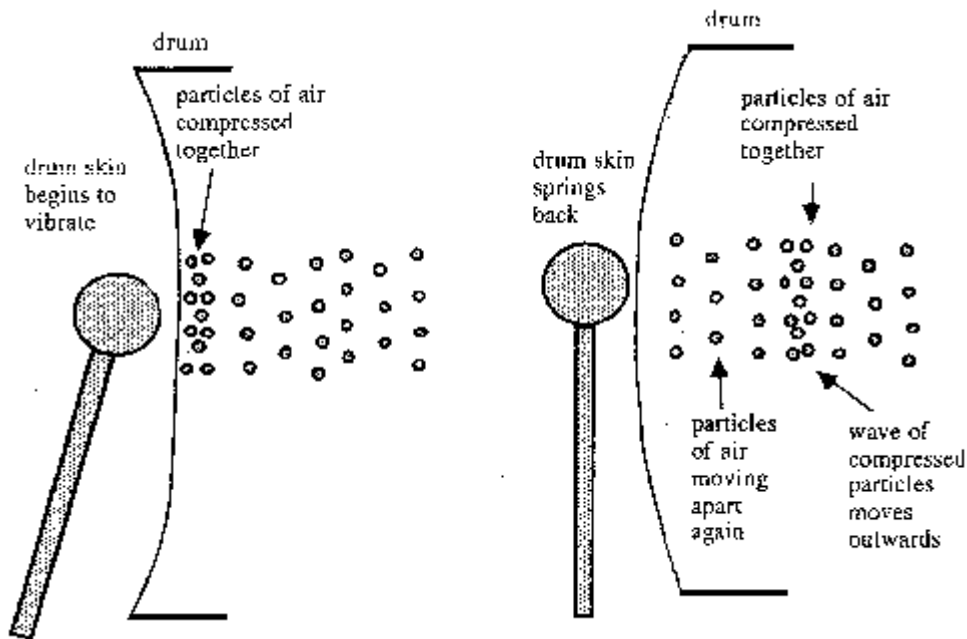


Sound

Sound is produced due to vibrations in a body. A vibration is a rapid to and fro movement of an object about its mean position. Sound waves require a medium for propagation. Sound waves can travel through solids, liquids and gases because they contain particles.

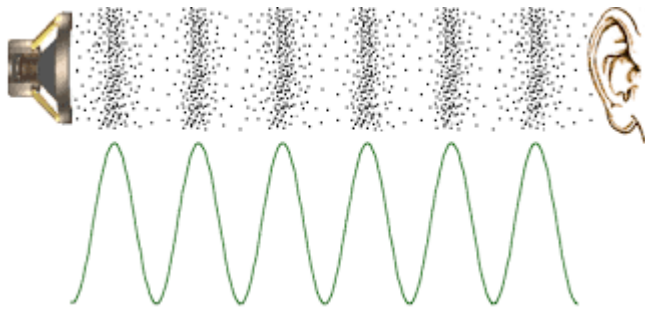
When an object vibrates it makes the particles next to it in the gas, liquid or solid vibrate too. For example, when an object vibrates in air it pushes on the air particles around it.



As the vibrating object moves towards the air particles, it squashes them together. The particles themselves are not compressed but the pressure in the air at that place rises because the particles are closer together.

As the object moves away from the air particles next to it, it gives them more space and they spread out and the pressure at that point falls.

As the object vibrates the air particles nearby also move backwards and forwards and they in turn cause other air particles further away to squash together and then spread out. This makes alternate regions of high and low pressure which travel through the air away from the vibrating object. If these changes in pressure are plotted on a graph they make a waveform similar to that shown in the figure below.



Sound waves are generated and travel in liquids and solids in the same way as they do in gases. The particles in liquids and solids are held close together by forces of attraction. In a liquid, however, the particles are further apart than in a solid and can move around one another. Sound travels very well through a liquid. It moves faster and further than it does in a gas.

The humpback whale emits a series of sounds, called songs, which travel thousands of kilometres through the ocean. It uses its song to communicate with other whales.



When sound travels through a solid, it moves faster than through a liquid because of the close interaction of particles. However, the sound does not travel so far.

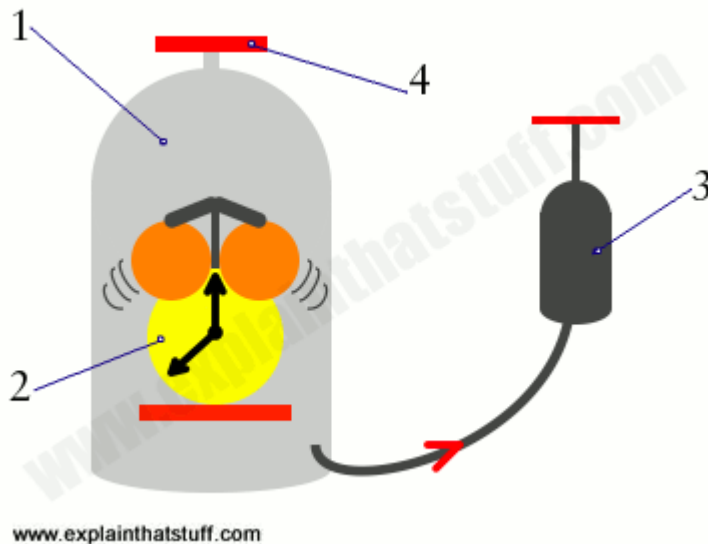
In humans, sound waves travelling through the air hit the eardrum, causing the movement of tiny bones and vibrations of tiny hair cells in the inner ear. These vibrations are then translated into nerve impulses that travel to the brain. Snakes have fully formed inner ear structures but no eardrum. Instead, their inner ear is connected directly to their jawbone, which rests on the ground as they slither. Previous studies have shown that vibrations travelling through the ground—such as the footsteps of predators or prey—cause vibrations in a snake's jawbone, relaying a signal to the brain via that inner ear.

Sound, however, cannot travel through a vacuum: it always has to have something to travel through (known as a **medium**), such as air, water, glass and metals

The first person to discover that sound needs a medium was a brilliant English scientist known as Robert Boyle (1627–1691). He carried out a classic experiment : he set an alarm clock ringing, placed it inside a large glass jar, and while the clock was still ringing, sucked all

the air out with a pump. As the air gradually disappeared, the sound died out because there was nothing left in the jar for it to travel through.

Robert Boyle's classic experiment



1. Put a ringing alarm clock inside a large glass case with a valve on top. Close the valve so no air can get in.
2. You can easily hear the clock ringing because the sound travels through the air in the case and the glass, before continuing to your ears.
3. Switch on the vacuum pump and remove the air from the case. As the case empties, the ringing clock sounds fainter and fainter until you can barely hear it at all. With little or no air in the case, there's nothing to carry the sound to your ears.
4. Switch off the pump. With the clock still ringing, open the valve on top of the case. As air rushes back in, you'll hear the clock ringing once again. Why? Because with air once again inside the case, there's a medium to carry the sound waves from the ringing clock to your ears.

<https://www.youtube.com/watch?v=CmY5R6yXq34>

<https://www.youtube.com/watch?v=CzG0ioYIIFs>