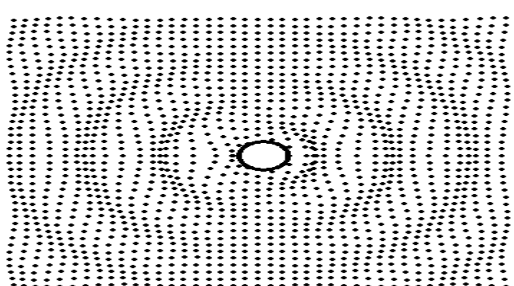
SOUND

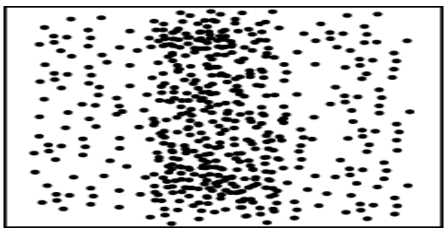
The “sound” is the propagation of a mechanical wave through matter.

When a particle of matter with electromagnetic energy is disturbed, it will alter its natural electromagnetic steady state, causing an oscillation of the particle from side to side seeking for an electromagnetic stability. This initial disturbance is known as the “source of the sound wave”.

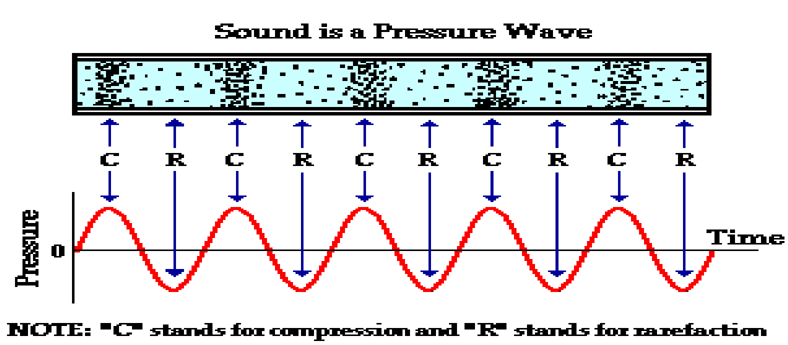
This oscillation will alter the initial state of the particles (atoms or molecules) of their surroundings, transmitting kinetic energy consecutively from the individual particles that make up the matter or substance.



Depending upon the crystal structure, the links of its molecules and the state of the matter, particles of the substance will exert pressure on other particles and will disrupt their original states with an undulated elastic behavior with a direction, frequency and duration determined until the particle energy is distributed in a the substance in an balanced form and plasticity of materials is able to adopt or release this energy without altering its natural state.



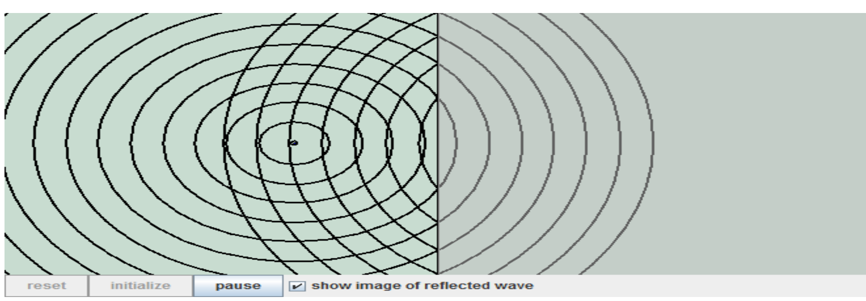
When particles of matter oscillate, they will transmit the mechanical wave to the molecules in the surface of the matter to the molecules in the air, generating a rise in pressure called “compressions”. When pressure decreases between molecules they will generate “rarefaction”, causing that the molecules collide with each other, accumulating and transporting energy and transmitting sound waves to our ears.



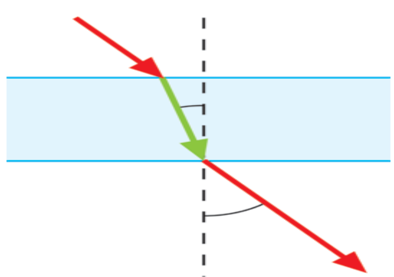
The matter by which sound goes through is called the “medium”. Through gas, plasma and liquid sound is transmitted as “longitudinal waves” (also called “compression waves”). The sound cannot be transmitted through vacuum because it is a mechanical wave that is transmitted only through matter.

When a wave reaches the surface between two media of different types in general, it will be produced two new waves, one that flows back into the starting medium and another that will pass through the boundary surface and propagate in the second medium.

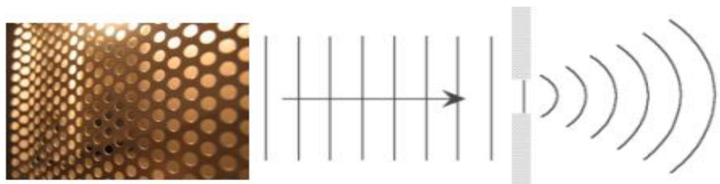
The first phenomenon is called reflection



And the second is called refraction.

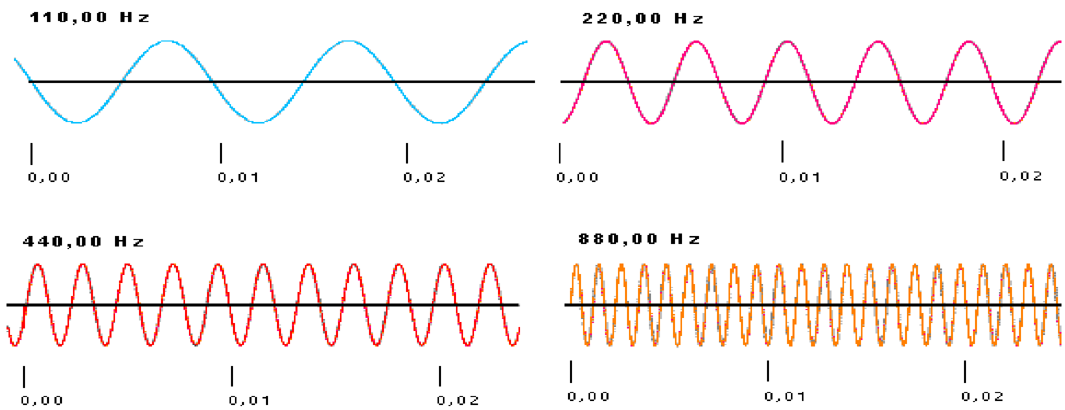


The waves are able to cross holes and go around obstacles interposed in their path in a phenomenon called “diffraction”. When a wave source reaches a plate with a center hole or slit, each point of the wavefront portion will be limited by the slit will transform in an emitting source of secondary waves with an identical frequency.



Sound waves are characterized by the following properties: frequency, wavelength, wave number, amplitude, sound pressure, sound intensity, sonority, sound speed and direction. It can also have identified “wave fronts”

The “frequency” is an objective and measurable magnitude related to periodic waveforms. With the frequency we measure the number of vibrations per unit of time. Its unit of measurement is the hertz (Hz), which is to say that the sound has 1 vibration every 1 second.



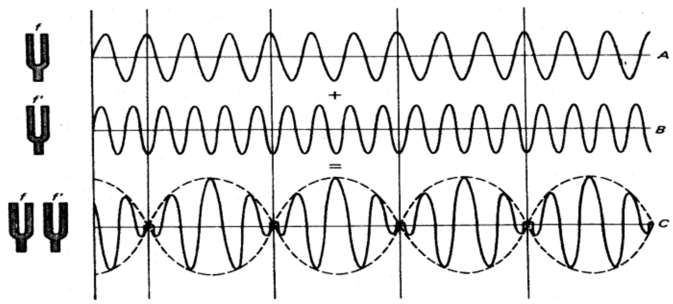
The "sound pressure" is the difference in a particular medium between the local average pressure and pressure in the sound wave. The sound pressure is measured in the logarithmic scale of decibels.

The "loudness" or "sound intensity" is the amount of energy carried by a unit of time that passes through an area perpendicular to the direction of propagation. It can be strong, weak or soft, and is proportional to the square of the frequency and the square of its amplitude and decreases with distance from the source.

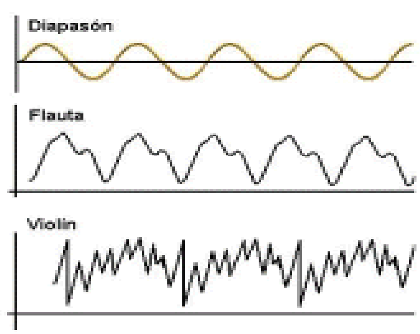
La línea ondulada en rojo, de mayor amplitud, equivale a un sonido más fuerte que **la línea azul**, de menor amplitud.

The subjective sensation of the intensity is called "sonority" and depends on the frequency, bandwidth and duration of the sound.

The “tone” is a subjective magnitude and refers to the height or severity of a sound which assigns a musical scale to distinguish it. The tone of a sound increases with frequency (bass sounds have low frequencies and treble sounds have high frequencies, although among frequencies between 1000 and 3000 Hz tone is relatively independent of the intensity).



The “timbre” is the quality by which you can distinguish one sound from another even emit a sound with the same frequency due to fundamental differences in their matter and depends on the particular characteristics of the molecules from the source of sound.



Diferentes timbres sonoros

The “duration” of the sound can be short or long.

The “speed of sound” depends on the fundamental properties of matter through which vibrations pass. The vibrations are transmitted by elastic mediums, usually air and water. The speed of sound in gas is temperature dependent.

The sound has a speed of 331.5 m / s when: the temperature is 0 ° C, atmospheric pressure is 1 atm (sea level) and has a relative humidity of 0% (dry air). Although it depends very little of air pressure. At 20 ° C, at sea level, the speed of sound is 343 m / sec. In fresh water, at 20 ° C the speed of sound is 1482 m / s.

Through iron, the speed of sound is 5.9 km / sec.

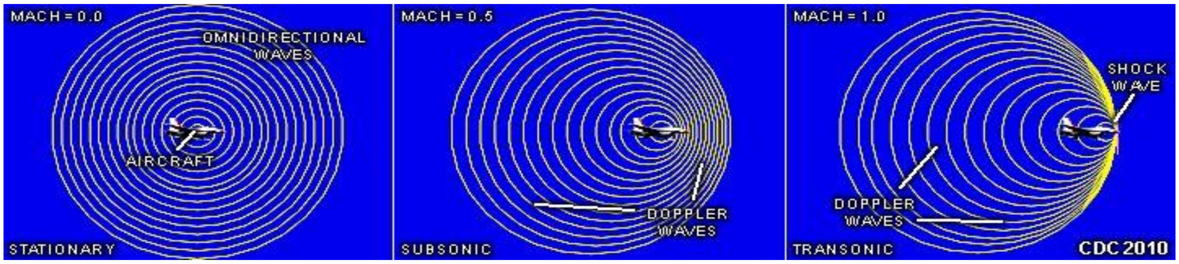
Substance	Temp (°C)	Speed (m/s)
Gases		
Carbon Dioxide	0	259
Oxygen	0	316
Air	0	331
Air	20	343
Helium	0	965
Liquids		
Chloroform	20	1004
Ethanol	20	1162
Mercury	20	1450
Water	20	1482
Solids		
Lead	–	1960
Copper	–	5010
Glass	–	5640
Steel	–	5960

The higher the density of the material, the greater the speed of propagation of the sound wave.

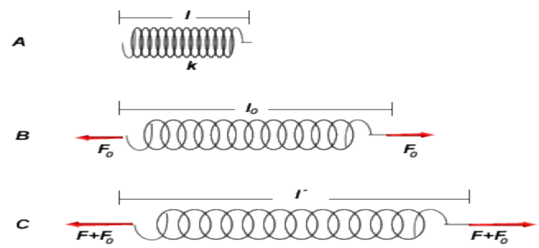
In solids, joints of particles propagate disturbances propagating from one side to the other side depending of the stress state of the medium. Sound in fluids takes the form of pressure fluctuations. In gases, the disturbances propagate through collisions of molecules that compose them. That's why sound travels faster through solids than gases.

When an object moves through the air at the speed of sound (331 meters/sec or 1200 km/hour) or "Mach 1″ (as a matter of fact, the Earth travels at 108,000km/hour with respect to the Sun, or around 750,000 km/hour with respect to the galactic center), an observer of that object will not detect any sound until he reaches the sound source. The pressure towards the object will be very intense (shock wave) because the wave fronts are added, but will be perceived as a sonic punch as it passes the pressure wall

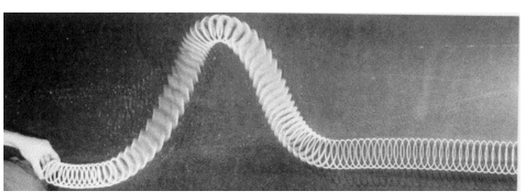
When the object exceeds the speed of sound, the object actually moves opposite to the sound wave. The sound source will pass an observer before the observer can hear the sound it creates.



Depending on the “direction” of the wave, propagation are classified as “longitudinal waves” when the vibration of the wave is parallel to the direction of propagation of the wave (as concentric circles that expand when you throw a stone into a pond).

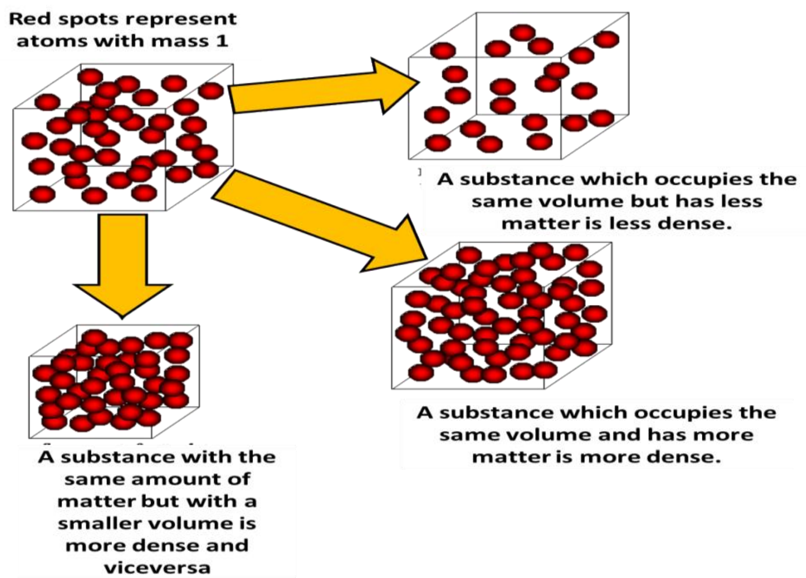


And “transverse waves” when the vibration of the wave is perpendicular to the direction of the wave, characterized by the formation of mountains and valleys. In air, sound propagates through longitudinal waves in solids in longitudinal and transverse waves.



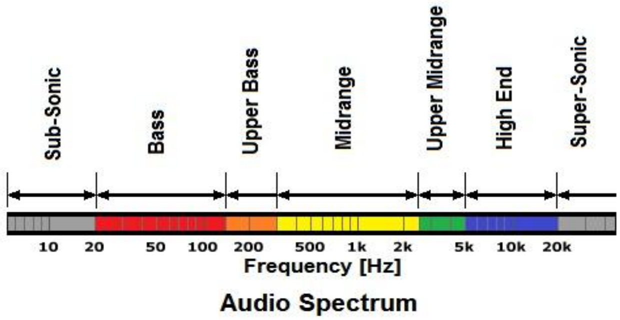
The waves bounce against a barrier, change direction when moving from one medium to another, add their effects in a very special way and can save skirting obstacles or corners.

Their behavior is affected by the “density” and “pressure” of the particles in the medium (affected by temperature), the motion of the medium (which can block or transport the direction) and the viscosity of the medium that can attenuate it.

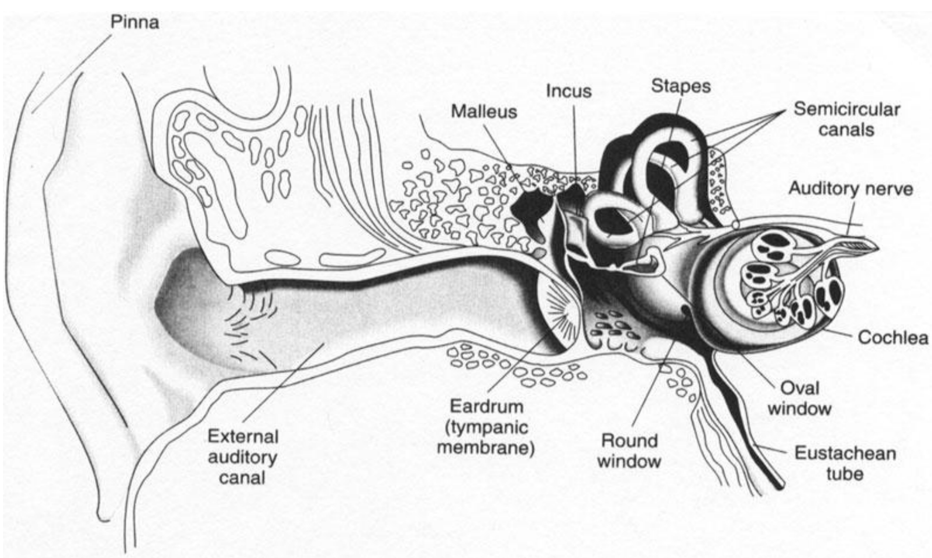


The “wave front” is the geometric place of the transmitting medium in which various sound waves converge at the same instant.

Not all of the sound waves can be perceived by the human ear, which is sensitive only to those frequencies between 20 and 20,000 Hz, may vary from one person to another. Frequency perturbations below 20 Hz are called infrasound (sound sources generated large as earthquakes and volcanoes) and those frequencies above 20,000 Hz, are called ultrasound. Dogs can detect frequencies higher than 20 kHz, but are deaf to any sound below 40 Hz



When a sound wave reaches the eardrums of our ears will cause a vibration to be transmitted to the base in the oval window membrane wihch is 20 to 30 times smaller than the eardrum, thus amplifying the pressure wave from the eardrum and transmitting it to a system of fibers that are deformed by the sound, stimulating the auditory nerve endings, producing an electromagnetic transmission that will be sent to the brain.



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