Properties of Sound

Sound is a longitudinal wave, consisting of alternate areas of high pressure (compressions) and low pressure (rarefactions).

For sound to be transmitted, there must be a medium the wave can travel through. Sound has an amplitude, frequency, and wavelength.

The speed of sound in air is 343 m/s at 20 ^{O}C and increases by 0.6m/s every ^{O}C increase.

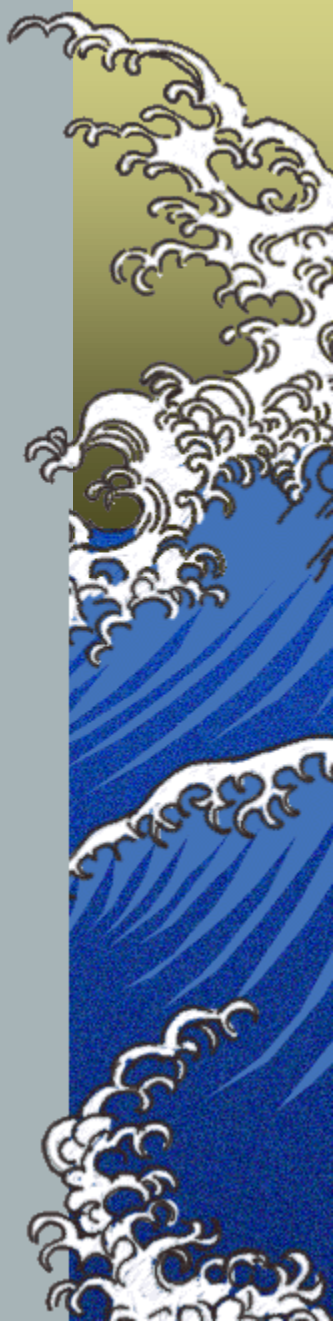
In general, the speed of sound is faster in liquids and solids.

Sound Level

The loudness of a sound is the sound level. It is measured in a quantity called decibels. (dB) It is dependent on the amplitude of the pressure (compression) wave.

The sound level is a comparison between the faintest audible sound and the sound you hear. The faintest audible sound is 0 dB. If the sound level is increased by a factor of 10, the sound level increases to 20 dB.

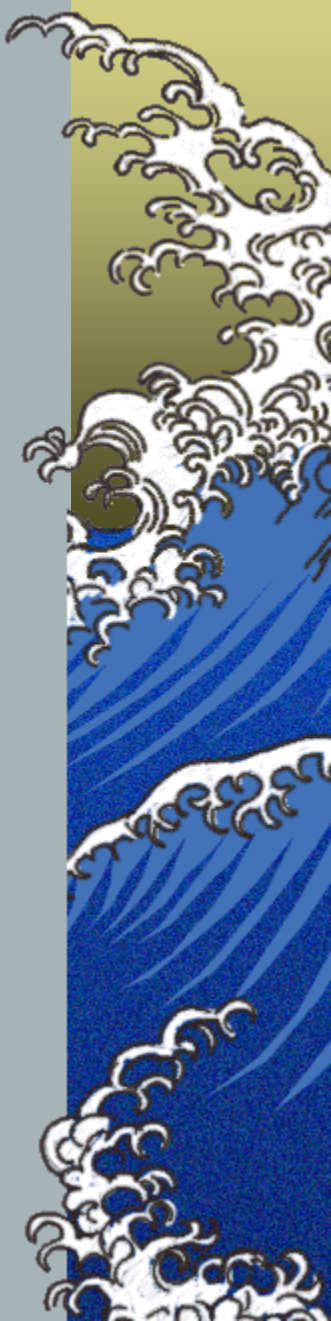
Exposure for long periods of time to large sound levels (100 dB or higher) can cause permanent ear damage.



Pitch & Frequency

Pitch is the highness or lowness of a sound as interpreted by human ears. It is simply a measure of frequency.

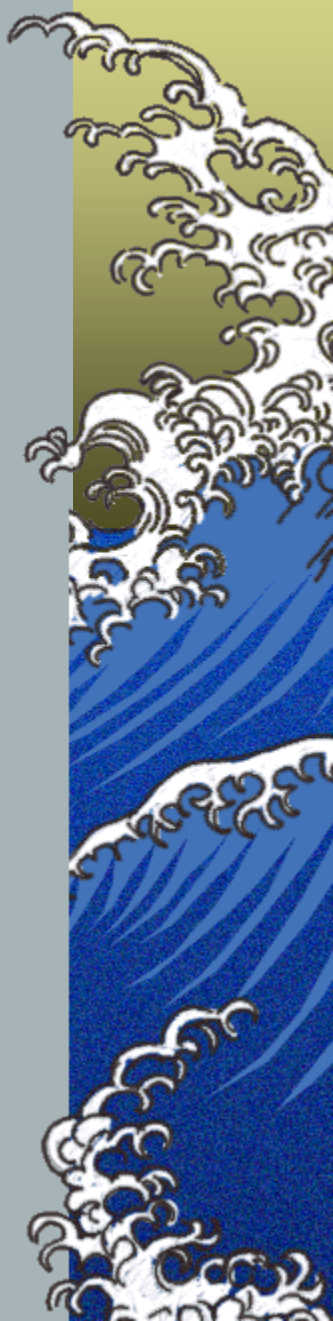
The higher the frequency, or the number of compressions per second, the higher the pitch.



Doppler Effect

When a sound source is stationary, no matter where a person is, that person will hear the pitch that the source is producing.

When a sound source is moving, different people can hear different things. As the source moves toward you, the frequency of the sound is greater because both the sound and source are moving toward you. The waves are crowded into a space ahead of the source.



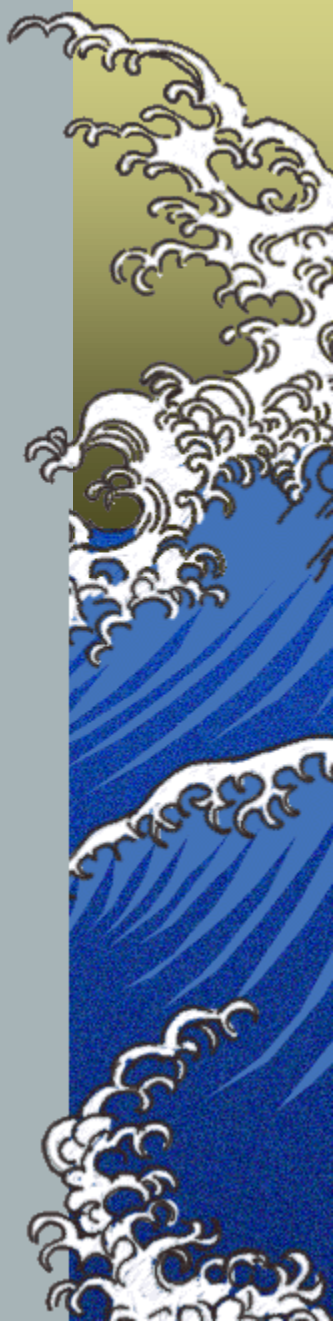
Doppler Effect

When the sound source moves away from you, the sound is moving toward you, but the source is moving away, there by lowering the frequency.

The Doppler Effect also works if the listener is moving and the source is stationary.

An equation that allows you to determine the new frequency of a sound made by a moving object is:

$$f_d = f_s \frac{(v - v_d)}{(v - v_s)}$$



Sources of Sound

In order for sound to be produced, something must cause compressions or vibrate.

Vocal cords vibrate to produce the human voice.

In brass instruments, the lips vibrate to produce the sound.

In reed instruments, the reed vibrates in relation to the mouthpiece.

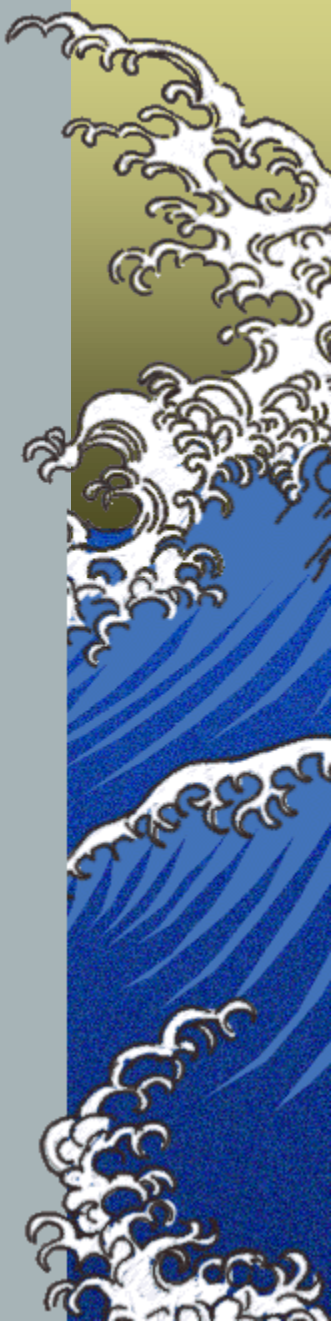
In string and percussion instruments, a wire or surface of a drum is hit, causing vibrations.

Resonance

On musical instruments, the length of the tube can alter the frequencies of the notes played.

The loudness is due to the resonance of the instrument with the sound.

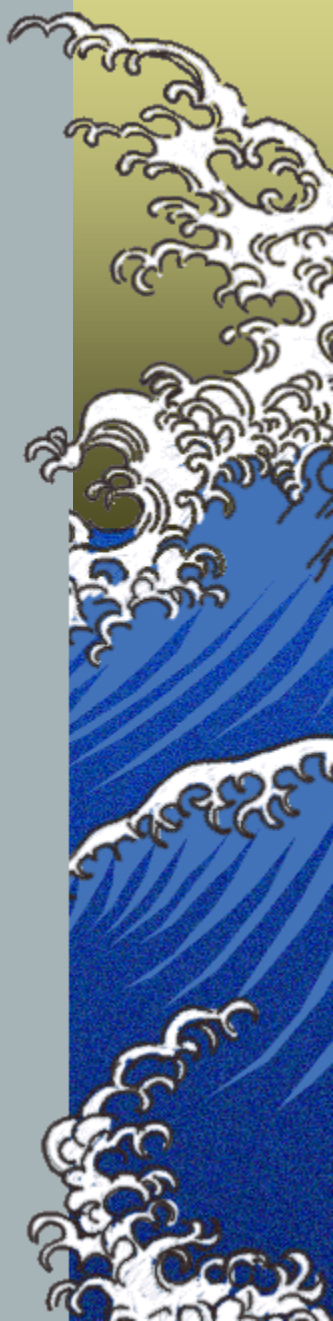
When a wave reaches the bottom of the tube, the wave is reflected back toward the source. When the reflected high pressure wave reaches the source at the same time another high pressure wave is produced, the result is a larger amplitude and standing wave, and a louder sound.



Resonance Lengths

An closed pipe resonator has resonance lengths equal to intervals of quarter wavelengths, such as λ/4, 3λ/4, 5λ/4, etc.

An open pipe resonator has resonance lengths equal to intervals of half wavelengths, such as λ/2, λ, 3λ/2, etc.



Consonance & Dissonance

Consonance - several pitches (frequencies) played together that produce a pleasant sound. Sometimes called a chord.

Dissonance - several pitches played together that produce an unpleasant sound.