

If Noise is Sound, What is Sound?

Sound is a form of energy that is transmitted through the air. In transmitting sound, the air particles vibrate and cause rapid cyclic pressure changes that are sensed by the ear. Sounds are characterised by their frequency and amplitude (level).

A sound event as a physical phenomenon can be fully described by four parameters:

1. the strength or sound pressure, mostly expressed in terms of the amplitude of the sound pressure waves, and is usually measured as sound pressure levels in decibels (dB);
2. the frequency or pitch, measured in Hertz (most noises consist of a mixture of sounds with various pitches and frequencies, and hence do not have a recognisable pitch in any musical sense);
3. the fluctuation of sound with time (also known as the time history), measured as sound pressure level as a fluctuation of time; and
4. sound character, which describes the particular features of a sound (eg, tonal and harmonic qualities).

Decibels, which are a logarithmic unit, are used for a number of reasons. Firstly, because sound pressures (measured in Pascals or Pa) vary from very small values to very large, and secondly because, as the human ear responds logarithmically to a change in level it provides a much better approximation to the human perception of relative loudness. If decibels were not used a scale would be needed consisting of 10^{13} divisions to cover the range of minimum detectable sound level (2×10^{-5} Pa) to pain level (60Pa). The following table best expresses the range providing typical dB(A) levels of different noise sources.

Sound Source (dB(A))	Sound Source (Pascals)	Sound Pressure Level
0	0.00002	threshold of hearing
20	0.0002	rustle of leaves
30		soft whisper
40	0.002	mosquito buzzing
50		average townhouse
60	0.02	ordinary conversation
70		busy street
100	2.0	power mower
120	20	leaf blower
129	60	threshold of pain
135	120	rock concert
140	200	jet engine at 30m
180	200000	rocket engine at 30m

However, the ear is not equally sensitive to all frequencies of sound, instead it is most sensitive in the 1 kHz to 5kHz range and least sensitive at extremely high and low frequencies. To compensate for this, sound level

meters, usually have a circuit weighting, which has been found to approximate the human perception of sound. This weighting is called the “A” weighting. Measurements made using this weighting are expressed in dB(A) units, i.e. “A” weighted sound pressure level.

Whilst this gives rise to a convenient scale for measurement purposes, confusion can exist when we try to interpret decibel or dB levels and level changes into subjective response. The problem is that the human ear responds to continuous sound sources in a subjective and non-linear way. That is, for a small increase in sound levels we may perceive it to be much louder than it actually is. It is probably best explained in the table below

Change in Level (dB) ie an additional increase to existing sound level	Subjective Effect
1	smallest audible change in level. It would be noticed only if the two sounds were presented in quick succession.
3	just perceptible – the smallest audible change which can be detected over a period of time
5	easily perceptible
10	the human ear will consider that the sound has approximately doubled in loudness. So a car passing at 70 dB(A) sounds twice as loud as one passing at 60 dB(A)

Some other interesting Points about Sound and the Decibel Scale are: -

If two sources have the same sound pressure level and are operated together, the resulting sound pressure level will usually be 3 dB greater than either of the individual sound pressure levels.

If we have two sources and one is 10 dB less than the other, the resultant sound pressure level will be less than 0.5 dB above the sound pressure level of the noisier source.

When the distance from a **single point source** is doubled the decibel value of that sound pressure level usually will have decreased by 6 dB. Thus if we move from one metre from the source to two metres from the source the sound pressure level will drop by 6 dB. If we move to four metres, the sound pressure level will drop by another 6 dB. Conversely, if we halve the distance to the source, the sound pressure level will increase by 6 dB.

When the distance from a **line source** such as a stream of traffic is doubled the decibel value of that sound pressure level will usually decrease by only 3 dB.

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