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Sound Unit Conversion Chart

Quick reference guide for acoustic measurement units

Sound Pressure Level Units

Unit	Symbol	Description	Reference
Decibel SPL	dB SPL	Sound pressure level	20 µPa (threshold of hearing)
Decibel A-weighted	dBA	Frequency-weighted to match human hearing	20 µPa with A-weighting
Decibel C-weighted	dBC	Less filtering, used for peak levels	20 µPa with C-weighting
Phon	phon	Perceived loudness level	Equal to dB SPL at 1 kHz

Sound Pressure Units

Unit	Symbol	SI Equivalent	Description
Pascal	Pa	N/m^2	SI unit for pressure
Micropascal	µPa	10^{-6} Pa	Used for reference sound pressure
Bar	bar	10^5 Pa	Non-SI pressure unit
Microbar	µbar	0.1 Pa	Older reference unit

Perceived Loudness Units

Unit	Symbol	Description	Reference
Sone	sone	Linear scale of perceived loudness	1 sone = loudness of 40 phons
Phon	phon	Logarithmic scale of loudness level	Equal to dB SPL at 1 kHz

Note: Doubling the sone value represents a doubling of perceived loudness.

Sound Power and Intensity Units

Unit	Symbol	SI Equivalent	Description
Watt	W	J/s	SI unit for sound power
Watt per square meter	W/m²	J/(s·m²)	SI unit for sound intensity
Decibel sound power level	dB SWL	-	Relative to 10^{-12} W
Decibel sound intensity level	dB SIL	-	Relative to 10^{-12} W/m²

Common Sound Unit Conversions

From	To	Conversion Formula	Example
Sound Pressure (Pa)	dB SPL	$dB\ SPL = 20 \times \log_{10}(p/p_0)$	0.02 Pa ≈ 60 dB SPL
dB SPL	Sound Pressure (Pa)	$p = p_0 \times 10^{(dB/20)}$	94 dB SPL = 1 Pa
Sound Power (W)	dB SWL	$dB\ SWL = 10 \times \log_{10}(W/W_0)$	0.001 W = 90 dB SWL
dB SWL	Sound Power (W)	$W = W_0 \times 10^{(dB/10)}$	120 dB SWL = 1 W
Phon	Sone	$sone = 2^{((phon-40)/10)}$	60 phons = 4 sones
Sone	Phon	$phon = 40 + 10 \times \log_2(sone)$	2 sones = 50 phons

Note: p_0 = 20 μPa (reference sound pressure) and $W_0 = 10^{-12}$ W (reference sound power)

Typical Sound Levels

Sound Source	dB SPL	dBA	Subjective Impression
Threshold of hearing	0	0	Just audible
Rustling leaves	20	10-20	Very quiet
Whisper	30	30	Quiet
Library	40	40	Quiet
Normal conversation	60-65	60-65	Moderate
Busy traffic	70-80	70-80	Loud
Heavy truck (15m)	90	90	Very loud
Jackhammer	100	100	Very loud
Rock concert	110-120	110-120	Uncomfortably loud
Threshold of pain	130	130	Painful
Jet engine (30m)	140	140	Painfully loud

Key Sound Equations

- **Sound Pressure Level:** $L_p = 20 \times \log_{10}(p/p_0)$ dB, where $p_0 = 20$ μPa
- **Sound Power Level:** $L_w = 10 \times \log_{10}(W/W_0)$ dB, where $W_0 = 10^{-12}$ W
- **Sound Intensity Level:** $L_I = 10 \times \log_{10}(I/I_0)$ dB, where $I_0 = 10^{-12}$ W/m²
- **Addition of sound levels:** $L_{total} = 10 \times \log_{10}(10^{L_1/10} + 10^{L_2/10} + ... + 10^{L_n/10})$ dB
- **Distance attenuation:** $L_2 = L_1 - 20 \times \log_{10}(r_2/r_1)$ dB for point sources
- **Sone to phon conversion:** phon = $40 + 10 \times \log_2(\text{sone})$
- **Phon to sone conversion:** sone = $2^{(\text{phon}-40)/10}$

Practical Examples of Sound Conversions

Converting Pressure to dB

A sound pressure of 0.632 Pa corresponds to a sound pressure level of 90 dB SPL. This is calculated as: $20 \times \log_{10}(0.632/0.00002) = 20 \times \log_{10}(31600) \approx 90$ dB SPL. This sound level is comparable to standing next to a lawnmower and can cause hearing damage with prolonged exposure.

Adding Sound Levels

When two sound sources of 80 dB and 80 dB combine, the result is not 160 dB, but 83 dB. This is calculated as: $10 \times \log_{10}(10^{(80/10)} + 10^{(80/10)}) = 10 \times \log_{10}(2 \times 10^8) \approx 83$ dB. This demonstrates that doubling the sound energy results in a 3 dB increase in sound level.

Perceived Loudness

A sound measured at 70 dB SPL (at 1 kHz) corresponds to about 70 phons. This converts to approximately 8 sones, calculated as: $2^{((70-40)/10)} = 2^3 = 8$ sones. This means the sound is perceived as 8 times as loud as a 40-phon reference tone (which is 1 sone).

Distance Attenuation

A sound source measures 90 dB at 10 meters. At 40 meters, the sound level would be approximately 78 dB, calculated as: $90 \text{ dB} - 20 \times \log_{10}(40/10) = 90 \text{ dB} - 20 \times \log_{10}(4) \approx 90 \text{ dB} - 12 \text{ dB} = 78$ dB. This illustrates the inverse square law for sound propagation from a point source.