Sound Source to Ears

Inverse-square law - the amount of energy lost per unit distance

free field - doubling the distance quaters the sound energy, given a point-source

Wave forms

a sine wave is periodic - take specific amount of time from one peak to the second peak.

inverse of period is frequency.

frequency - the number of complete ~~waves~~ cycles a sound wave can produce in a given amount of time

measure frequency / cycles per second = Hertz (Hz)

Sound vibrating many time p/s - high frequency

" " few time p/s - Low frequency

Wavelength - the distance from a point of a sound wave to the same point on the next sound wave

Period = T

Wave length = Greek symbol Lambda = L λ

Period: T(sec) = 1/f (Hz)

Frequency: f(Hz) = 1/T (sec)

Wavelength: L = V/f (wavelength standard or meters) m/sec or ft/sec

Waveform - graphical representation of its amp vs time

<u>Phase</u> - How far along in its [redacted] cyle a given waveform is.

if a sound wave is out of phase it can react constructively and/or destructively

2 identical sound wave 180 degrees out of phase will cancel out

Phase shift: ϕ (deg) = td × f × 360   td (time delay) (sec)

Velocity

0° C = speed 331 m/s

+1(sec) / deg in C

Speed vs Temp: V(m/s) = (331 + .60T) (T = Temprature in Celsi…

Humidity absorbs more High f than Low f

f response - the range of f that an audio System will transmit within a lvl range

f response curves - are a graphical rep of the f response measured with f in a logarithmic Scale on the x-axis, amp in dB on y-axis

Sound Intensity

Intensity: $I\,(W/m^2) = (W/m^2)$ W = power = WATTS

m^2 = area = square meters

Human Ear - Low as 10^{-12} W/m2

High as 1 W/m2

Decibel (dB) - used to express power, but it does'nt measure power. It is in fact a ratio of two power levels

Intensity (dB): $b(dB) = 10 \log(P_i/P_o)$ the intensity of a referance level.

Threshold of hearing is 0 dB: ~~$b = 10 \log(10^{-12}$ W/m2 /~~

$b = 10 \log(10^{-12}\ W/m^2 / 10^{-12}\ W/m^2) = 10 \log 1 = 0$

bel - measuring unit named after Alander Graham Bell (the decibel is equal to one-tenth of bel)

Colt .45 / 25 Feet	140
Threshold of Pain	130
	120
Underground TRAIN	110
	100
Average Home HiFi level	90
Average Factory	80
	70
Average conversation	60
Average OFFICE	50
Residential Ambiant Noise	40
Quiet Wisper (5')	30
	20
	10
threshold of hearing	0

dB SPL TABLE

Pitch

Human's hear from 20 Hz – 20,000 Hz (audibly)

Bats [redacted] can hear – 100,000 Hz (1 MHz)

Dogs can hear – 50,000 Hz

Above 20,000 Hz = Ultrasonic (INCORRECT / Supersonic) = Soundwave

Below 20 Hz = INfRASONIC (INCORRECT / SUBSONIC) = SOUNDWAVES

High wavelengths ABOVE 1kHz cannot Reach both ears at the same time. One is favored + provide Direction on the horizontal plane. Vertical not so good.

Fundamental – The inital vibration of sound, fundamental frequency is the strongest sound we hear (AKA – fundamental frequency)

Overtones – combination of fundamental and various mutiples of fundamental (AKA – Harmonics)

Timbre – When overtones are added to fundamentals, the charature of the sound is changed.

Octave – 12 semitones – the difference between 2 f where the ratio between them is 2:1 (Ex. 400 Hz : 200 Hz / C, C sharp and so on)

Equal Loudness

<u>Harmonic Distortion</u> - the production of harmonics that don't exist in ~~a specific~~ the original signal

<u>Tone</u> - act of making a sound

Ear most sensitive to sounds in the 3kHz to 4kHz

To equal loudness - 1.5kHz @ 110 dBSPL, tone @ 40 Hz has to be 2dB greater than the actual SPL, while 10kHz must be 8dB ~~greater~~ " than the 1.5kHz tone to be preceived as loud

Average, optimum listening level of 83 dB SPL

The loudness of a tone can also affect the preceived pitch of the sound

intensity of 100 Hz tone increased from 40 to 100dBSPL the ear will preceive a pitch <u>decrease</u> of about 10%

The interaction of tones with one another - 3 things can occur:

Beats - the result of the ear's inability to separate closely-pitched notes.

Combination Tones - two load tones differ more than 50Hz

Masking - the phenomenon which prevents the ear from hearing softer sounds underneath loud tones

Locate Direction

Binaural localization - the ability of using the two ears that most of us are given to determine from where a sound sorce appears

- Inter-aural intensity differences
- Inter-aural arrive-time differences
- Pinnae of the Ears

(P.10)

dBu: voltage Ref point 0.775 Vrms (20 log equation)

dBV: different voltage Ref point (1.000V RMS)

dBm: electrical power Ref point (1mW into 600-ohm load,

dBW: " " " " (1W)

dBr: arbitrary Ref level which must be specified

dBFS: voltage Ref used when specifying ditial audio converters (FS = Full Scale) Refers to max voltage level possible before digital overload of the converter

dBPWL: acoustic power Ref point, Rarely used

dBSPL: acoustic pressure Ref point, frequently used. Sound pressure measured per unit area in a given location; measured in dynes per cm^2, or Newtons per m^2 (20 Log equation is used)

dB SPL = $20 \log (P_1/P_0)$ P_0 is absolute value .0002 dynes/cm^2, or .000002 Newtons/m^2