

EAS 4801 - Planetary Sound

Lec#3: Wave Properties (cont)

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Measuring sound

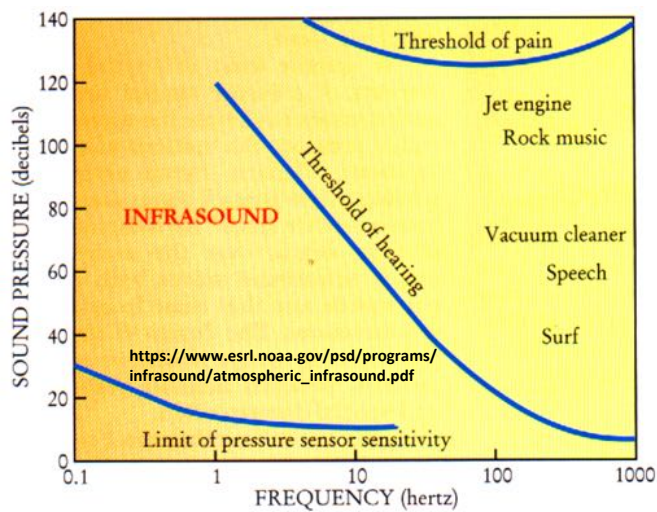
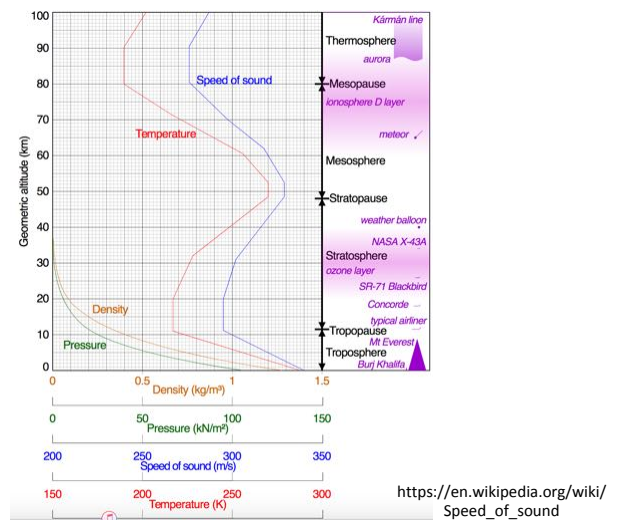
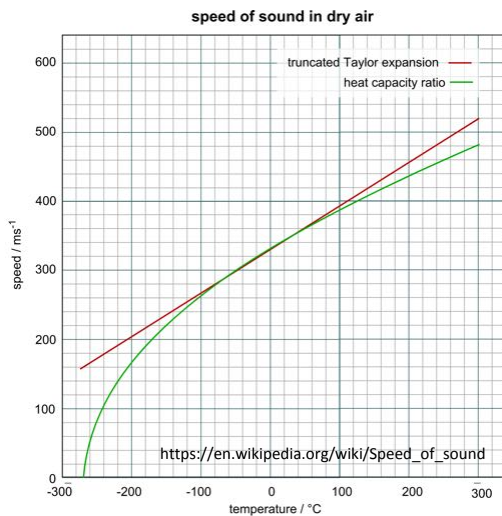
Frequency (pitch) – vibrations or cycles per second (Hz, KHz)

Speed – how fast does sound wave propagate

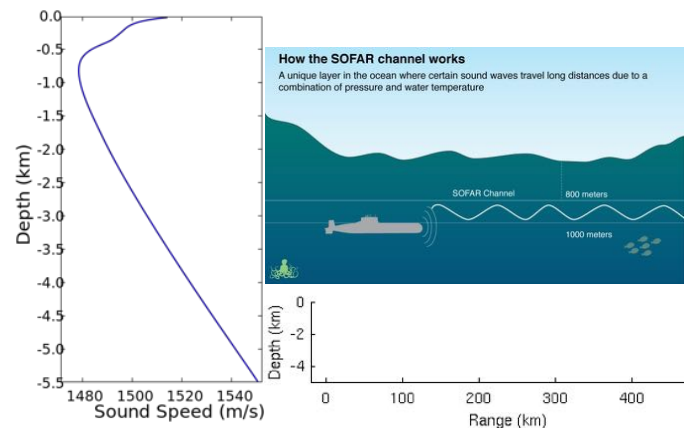
Amplitude – size of the vibration

Loudness – perceived strength of a sound (frequency dependent)

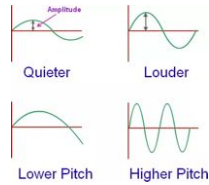
Intensity – energy carried by a sound (dB scale)



The SOFAR channel (short for Sound Fixing and Ranging channel), or deep sound channel (DSC)



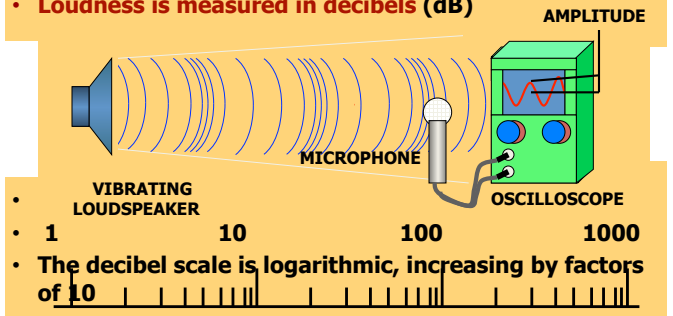
Amplitude and Loudness



- **Amplitude** – fluctuation or displacement of a wave from its mean value.
- **Loudness** - depends on the amplitude of sound wave
 - Again, the **amplitude of a wave indicates its energy**. The greater the amplitude, the greater the energy.

Intensity and Loudness

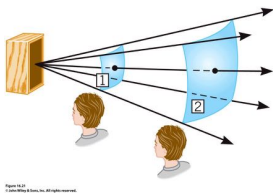
- **The intensity of a sound is proportional to the square of the amplitude of the sound wave. ($E \approx I \approx A^2$)**
- **Loudness is measured in decibels (dB)**



- **The decibel scale is logarithmic, increasing by factors of 10**

Sound Intensity ($E \approx I \approx A^2$)

- Sound intensity is the sound power as it passes through a given area
- $I = P / \text{Area} \dots$ (W/m^2)
- So... $I = P / 4\pi r^2 \dots$ for a sphere



Sound Intensity ($E \approx I \approx A^2$)

- Sound Intensity is not the same as Sound Intensity Level!!!
- $I_0 = 1 \times 10^{-12} \text{ W}/\text{m}^2$ (threshold of hearing 0 dB)
- Intensity Level, β , is a comparison of two sound intensities (Ratio)

$$\beta = (10 \text{ dB}) \log_{10} (I / I_0)$$

Sound Level (dB' s)

$$\beta = (10 \text{ dB}) \log_{10} (I / I_0)$$

- If the intensity, I , exceeds the reference intensity, I_0 , by a factor of 4, the intensity level is???

$$\beta = (10 \text{ dB}) \log_{10} (4)$$

$$\beta = 6 \text{ dB}$$

Can we measure sound intensity? – YES!

Units of Sound Level Intensity: decibels (dB), which is a *logarithmic* scale

An increase in 10 decibels of sound level intensity, or 10 dB, is perceived to be *two times* louder (2^1)

Example: Normal conversation is 60 dB, and a vacuum cleaner is 80 dB

4x's

Question: How is the change in sound perceived? (vacuum cleaner compared to normal conversation? (2^2))

Typical Sound Intensities

Near total silence -	0 dB
A whisper -	15 dB
Normal conversation -	60 dB
A lawnmower -	90 dB
iPod (at full volume) -	100 dB
A car horn -	110 dB
A rock concert or a jet engine -	120 dB
A gunshot or firecracker -	140 dB

Rule: Each 10 dB is ten times the sound intensity! Therefore, the difference between a gunshot and total silence is **10¹⁴ times** the **INTENSITY!!**

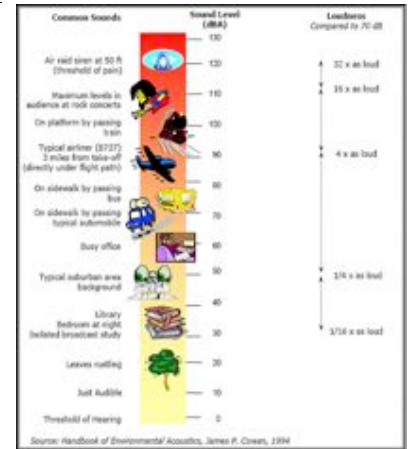
NOTE: The Sound **LEVEL** would be 2¹⁴ or 16,384 X's greater!!

Other notable sound intensities

85 dB - Raise your voice so that others may hear (time for hearing protection!!!)

90 dB for eight hours: Damage to your ears

140 dB sound: Immediate damage to ears



120 dB: The F/A-18 Hornet



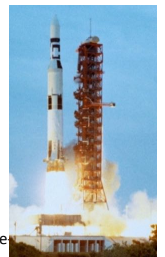
What is the loudest sound or noise in the world?

194 dB is the maximum undistorted sound pressure level that can be transmitted through sea-level atmosphere on Earth. Anything more than that, the sound wave will be "clipped" at the bottom, since vacuum-like absolute pressure would be reached (0 Pa).

The Tunguska meteoric event of 1908 is calculated to have reached 300 dB. This massive explosion flattened 80 million trees over an area of 2000 square kilometres.

The launch of a Saturn V rocket can reach 220 dB.

<https://www.quora.com/What-is-the-loudest-sound-or-noise-world>

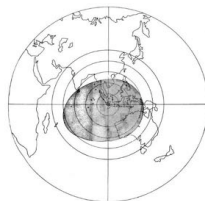


The loudest sound or noise

The eruption of the Krakatoa volcano probably reached 230 dB on 27 August 1883. This was so powerful that the sound wave circled the globe four times. The crack was distinctively heard from over 5000 km away, more or less like from New York to Los Angeles.

The loudness of the blast heard 160 km (100 mi) from the volcano has been calculated to have been 180 dB.

It was so powerful that it ruptured the eardrums of sailors 64 km (40 miles) away on ships in the Sunda Strait



<https://www.discovermagazine.com/environment/the-loudest-sound-ever-heard>



Volcano Eruption in Papua New Guinea
<https://www.youtube.com/watch?v=BUREX8aFbMs>



What's this sound?

