

Physics of Musical Sound

Class 9

Read Chapter 7.1-8

Quiz Today!

SIL and dB Review

Intensity in W/m^2 , SIL in dB

$$SIL(dB) = 10 \times \log\left(\frac{\text{Sound Intensity}}{10^{-12} W/m^2}\right)$$

Or

$$\text{Sound Intensity} = 10^{-12} \times 10^{\left(\frac{dB}{10}\right)}$$

Read dB with sound meter (A weight for quiet, C for loud).

Combining Sound Levels

- Room (empty) with lights off 32dB
- Room (empty) with lights on 35dB
- Quick way: $35\text{dB} - 32\text{dB} = 3\text{dB}$ \rightarrow twice the intensity, so lights also 32dB.

Careful way: $32\text{dB} \rightarrow 10^{-12} \times 10^{3.2} = 1.6 \times 10^{-9} \text{W/m}^2$

$35\text{dB} \rightarrow 10^{-12} \times 10^{3.5} = 3.2 \times 10^{-9} \text{W/m}^2$

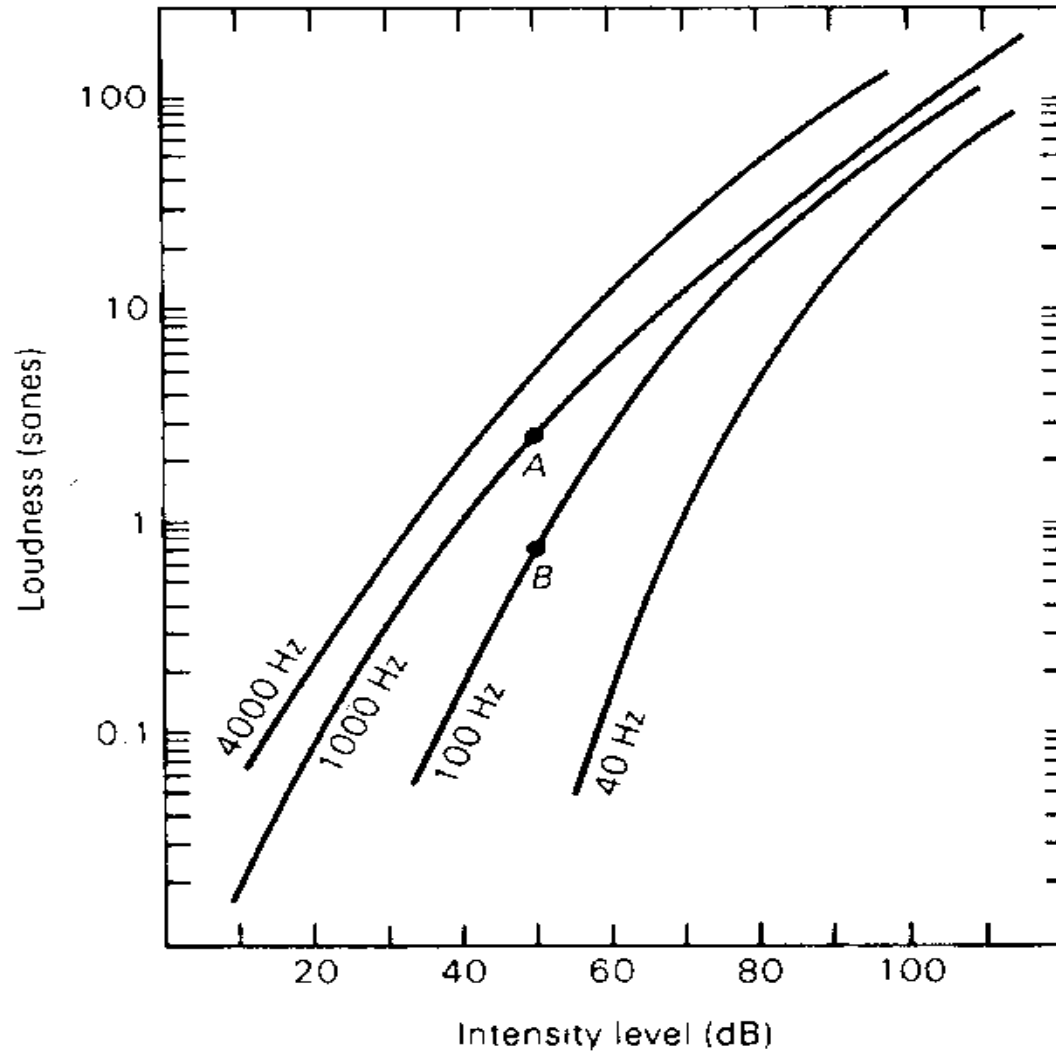
Difference is $1.6 \times 10^{-9} \text{W/m}^2$ so lights as loud as room.

Why is light sound so much more obtrusive???

Perceptual Loudness

- Loudness is NOT exactly the same as Sound Intensity Level. SIL is a physical measurement-- ratio of actual intensity to standard intensity in dB.
- Perceptual Loudness
 - Pick a sound as reference.
 - Play that sound then another. Ask lots of people how much louder the new sound is than the standard.
 - Repeat for lots of sounds of same frequency but different SIL.
 - Build up a picture of relation between SIL and Loudness.
- Reference is 40dB, 1000Hz. Called 1 **Sone**.
- On average n Sones is n times as loud as 1 Sone.

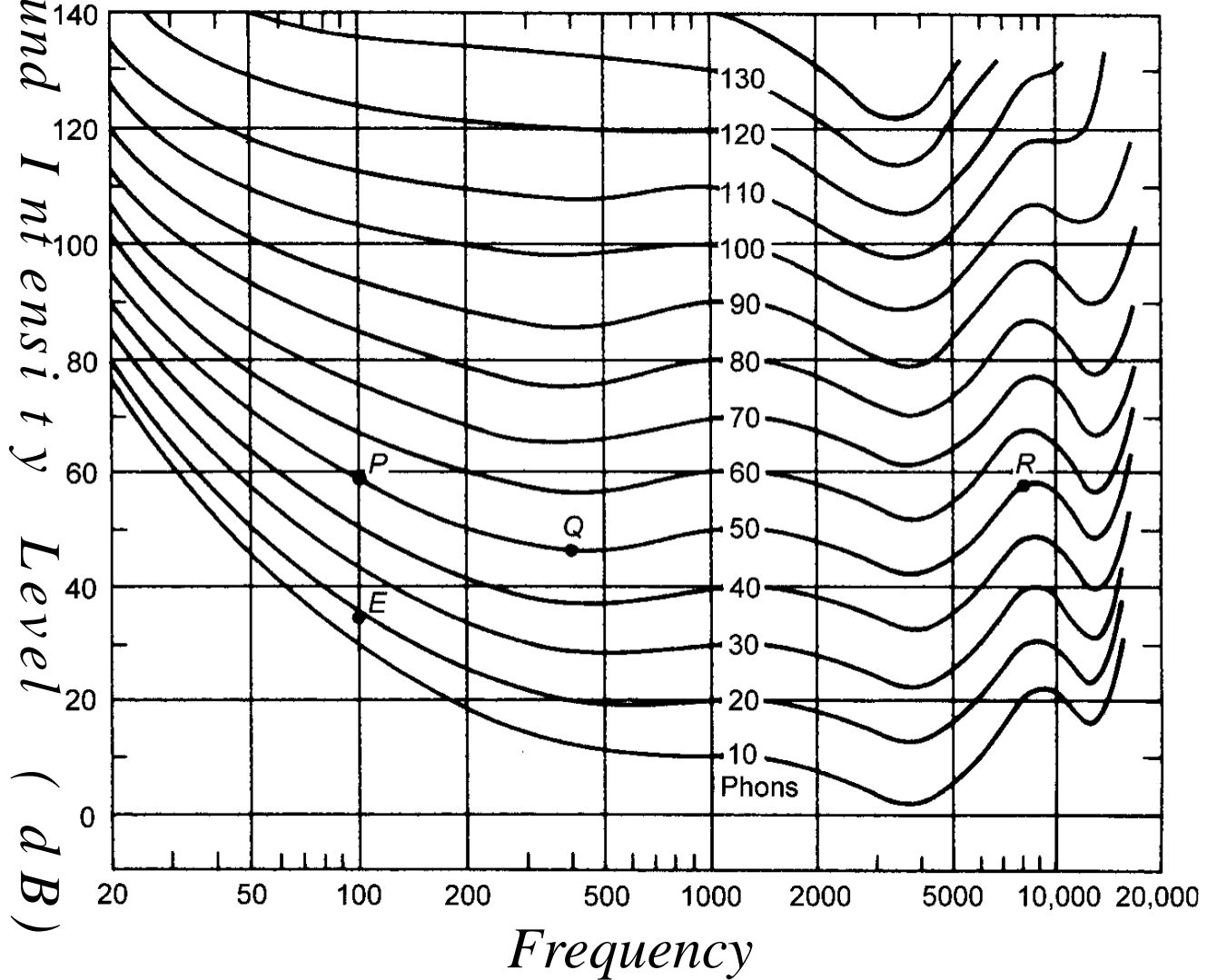
Perceptual Loudness



Frequency and Loudness

- Two sounds of same SIL and different frequency may have different loudness.
- Studied in same way as Sone but varying frequency as well as intensity. Result is Fletcher-Munson curves.
- 1 line tells how intense sound has to be sound equally loud.
 - Note **dips** in F-M correspond to **MORE** sensitivity!
- In general ear most sensitive near 4kHz (resonance) and less at high and esp. at low f.

Frequency and Loudness



Masking

- Two sounds played together tend to increase in loudness as frequency separation increases beyond Critical Band
 - Remember related to region on basal membrane that vibrates.
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