Week 3 - Exercise Session

Module 2 – Sound Perception

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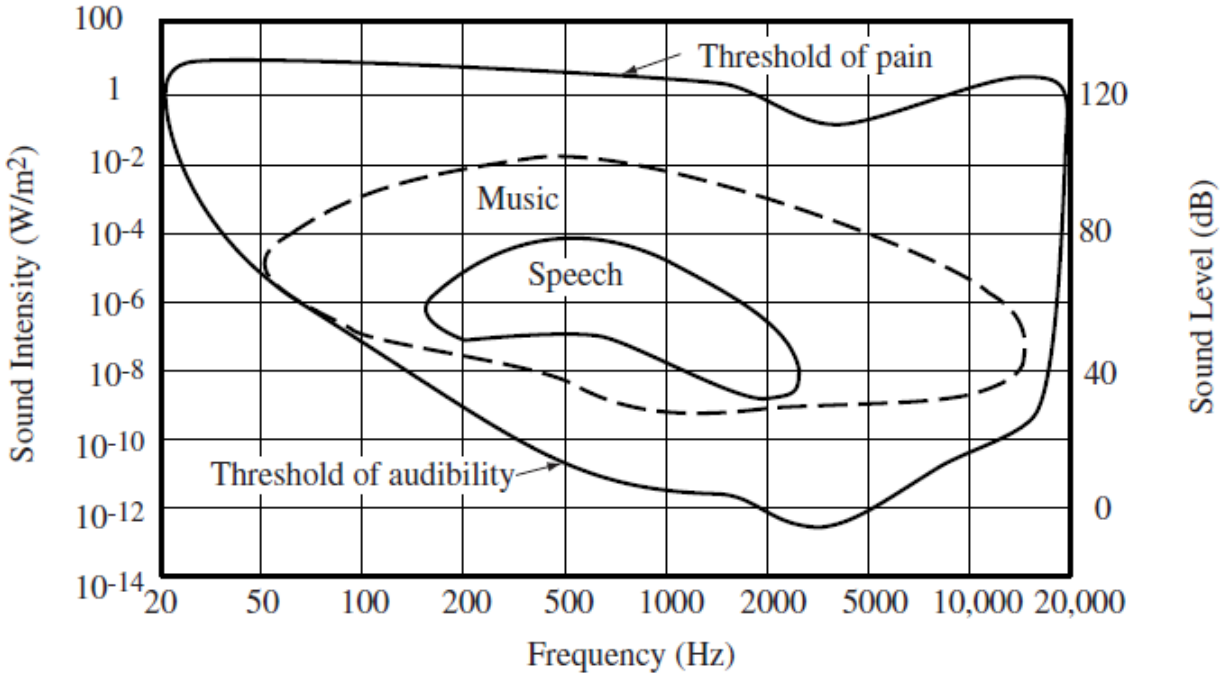
Chapter 5 – Review Questions – 1, 2, 13, 14

1) What is the intensity ratio between the threshold of pain and the threshold of audibility? – **10^16**

2) What is the frequency ratio between the highest and lowest frequencies we can hear? - **1000**



Chapter 5 – Review Questions – 1, 2, 13, 14

13) How are sounds of low frequency localized? - **Time Cues – Interaural time differences (ITDs)**

14) How are sounds of high frequency localized? **Level Cues – Interaural Level Differences (ILDs)**

Chapter 5 – Exercises – 1, 2, 4, 5

1) Assume that the outer ear canal is a cylindrical pipe 3 cm long, closed at one end by the eardrum. Calculate the resonance frequency of this pipe (see Fig. 4.8). Our hearing should be especially sensitive for frequencies near this resonance.

l = 3 cm

$c \approx 340\ m/s \qquad l = \frac{\lambda}{4}$

$$f = \frac{c}{\lambda}$$

$$\boxed{f = 2833.3\ Hz}$$

Chapter 5 – Exercises – 1, 2, 4, 5

2) At what frequency does the wavelength of sound equal the distance between your ears? What is the significance of this with respect to your ability to localize sound?

Distance between ears ~ 20 cm

Speed of sound ~ 343 m/s

$$\boxed{f = 1700\ Hz}$$

Below 1700 Hz, the sound waves are diffracted, thus head shadow effect is eliminated.

Chapter 5 – Exercises – 1, 2, 4, 5

4) Pressure is force per unit area. Calculate the pressure when a force of 500 N (approximate weight of a 110-lb person) is supported by: (110 lb ~ 50 kg)

a) Spike heels having an area of 10−5 m2 each → **25,000 kPa**

b) Standard heels having an area of 10−2 m2 each. → **25,000 Pa**

Chapter 5 – Exercises – 1, 2, 4, 5

5) Measure the distance between your ears. Divide this distance by the speed of sound (Table 3.1) to find the maximum difference in arrival time $t = (L2 - L1)/v$ that occurs when a sound comes directly from the side.

DIY!

Of the order microseconds

Chapter 6 – Review Questions – 4, 5, 9, 17

4) How large is the “just noticeable difference” in sound level? → 1dB

5) How much does the sound level decrease in a free field when the distance from the source is doubled? **~ 6 dB decrease**

9) What is the approximate sound level in normal conversation? – **Approximately 70 dB SPL**

17) Is it easier for a tone of lower frequency to mask a tone of a higher frequency, or vice versa? **Easier for lower frequency to mask a tone of higher frequency**

Chapter 6 – Exercises – 1, 2, 4

1) What sound pressure level is required to produce minimum audible field at 50, 100, 500, 1000, 5000, and 10,000 Hz? (From the graph)

2) What sound pressure level of 100-Hz tone is necessary to match the loudness of a 3000-Hz tone with *L p* = 30 dB? **Around 46 dB**. What is the loudness level (in phons) of each of these tones? **35 phons**

4) If two sounds differ in level by 46 dB, what is the ratio of their sound pressures? their intensities?

$$Sound\ level\ in\ dB = 20\log_{10}\frac{p_1}{p_2} \longrightarrow 46 = 20\log_{10}\frac{p_1}{p_2}$$

$$2.3 = \log_{10}\frac{p_1}{p_2}$$

$$10\text{^}2.3 = \frac{p_1}{p_2}$$

Pressure ~ 200

$$Sound\ level\ in\ dB = 10\log_{10}\frac{I_1}{I_2}$$

Intensity ~ 39000