# Psychoacoustics

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## Module 4 Homework (Loudness)

Student Name: _____

**1)** (*44pts*) **Indicate whether the statement is true or false by printing T or F**.

_____ Intensity is encoded into loudness partially through the firing rate present in the auditory nerve.

_____ When comparing loudness and intensity scales, loudness seems to be a compressed version of sound intensity.

_____ For broadband signals, doubling in loudness is roughly equivalent to an increase of 3dB.

_____ Intensity weighing curves (A, B, C, or D) are used to correct equalizations of recordings meant for listening, so that they better match the ear's frequency-dependent response to intensity.

_____ A possible explanation for the large dynamic range of our hearing mechanism is the ability of outer hair cells to stretch / contract when stimulated.

_____ Equal loudness contours are graphs that plot degree of hearing damage as a function of frequency.

_____ For a 4000Hz tone and a 400Hz tone to sound equally loud, the 4000Hz tone must have a higher intensity level than the 400Hz tone.

_____ According to Stevens's Power Law, doubling the loudness corresponds to a SIL increase by 10dB.

_____ At stimulation levels 20-60dB, temporary threshold shifts (TTSs) increase very fast.

_____ A temporary threshold shift (TTS) can be considered a manifestation of fatigue.

_____ The recovery interval (RI) is the time interval between the end of a stimulus and the measurement of its TTS effect.

**2)** (*5pts*) **Which of the following is NOT a major factor that affects loudness perception?**

a) Masking
b) Duration
c) Delay
d) Eustachian tube clogging

**3)** (*5pts*) **If you were measuring noise levels with a Sound Pressure Level (SPL) meter in a quiet office space (background noise of ~ 40dB SPL), which weighting curve would you use?**

a) C
b) B
c) D
d) A

**4)** (*5pts*) **At high intensity levels, perception of fine loudness changes can be explained by the spread of excitation through different critical bands and/or nerve fibers. This theory works well for most signals, EXCEPT for**

a) sine tones above 5000Hz.
b) square waves.
c) white noise at loud levels.
d) sine tones between 500 Hz and 2000Hz.

**5)** (*5pts*) **The dynamic range of our hearing mechanism** (at around 1000Hz) **is approx**

a) 60 dB.
b) 80 dB.
c) 120 dB.
d) 200 dB.

**6)** (*5pts*) **Two possible techniques of assessing the relationship between intensity level and loudness are**

a) Steven's law and Weber's law
b) magnitude estimation and magnitude production
c) binaural matching and monaural comparison
d) intensity discrimination and frequency selectivity

**7)** (*5pts*) **JND stands for**

a) Jurgen's Natural Decay.
b) Just Nominal Dimension.
c) Just Noticeable Difference.
d) Journal of Neurological Disorders.

**8)** (*5pts*) **Stevens's law relates loudness and intensity such that**

a) loudness magnitude is proportional to some power of intensity.
b) intensity is a constant fraction of loudness.
c) loudness' magnitude scales linearly with intensity.
d) loudness and intensity are the same.

**9)** (12pts) **Fill in the blanks:**

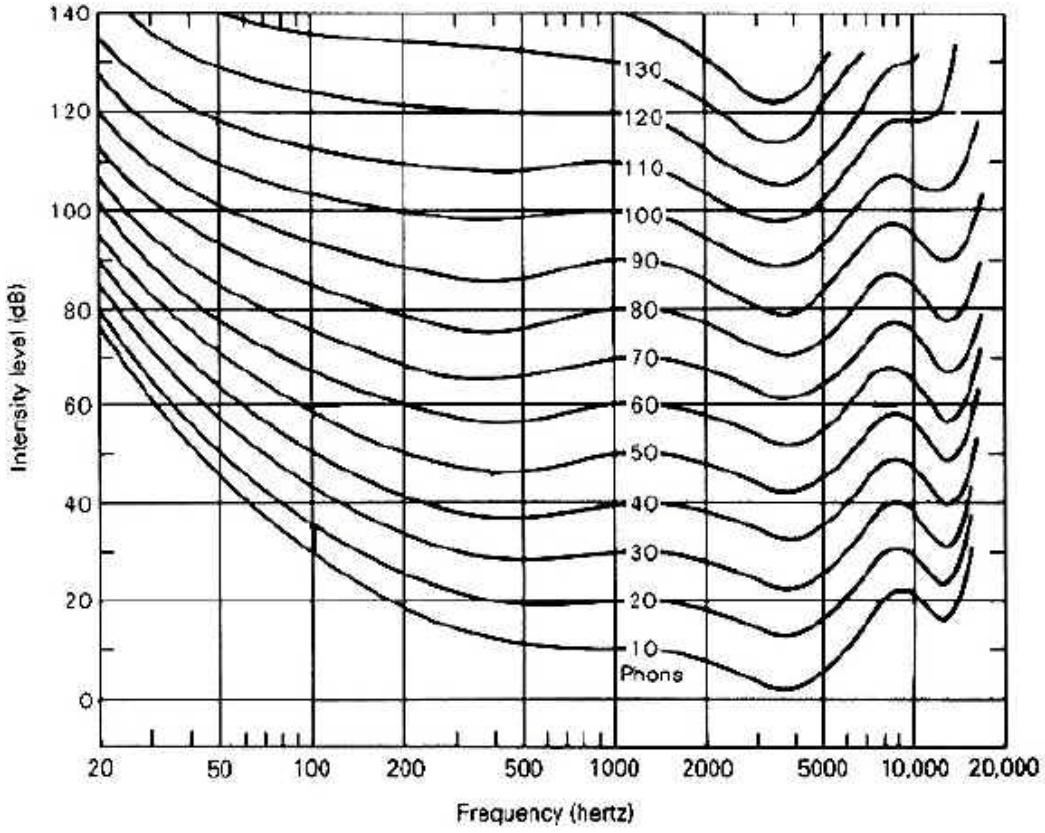
**a)** Data compression algorithms are able to reduce audio data based mainly on _____ and _____ information. **b)** The observation that Weber's fraction is not constant across intensity levels is referred to as _____. **c)** According to (b), intensity discrimination _____ (improves/reduces) as intensity level increases up to moderate (~60dB) levels and, at really high levels, does not _____ (deteriorate/improve) as much as one would expect based on IHC saturation characteristics.

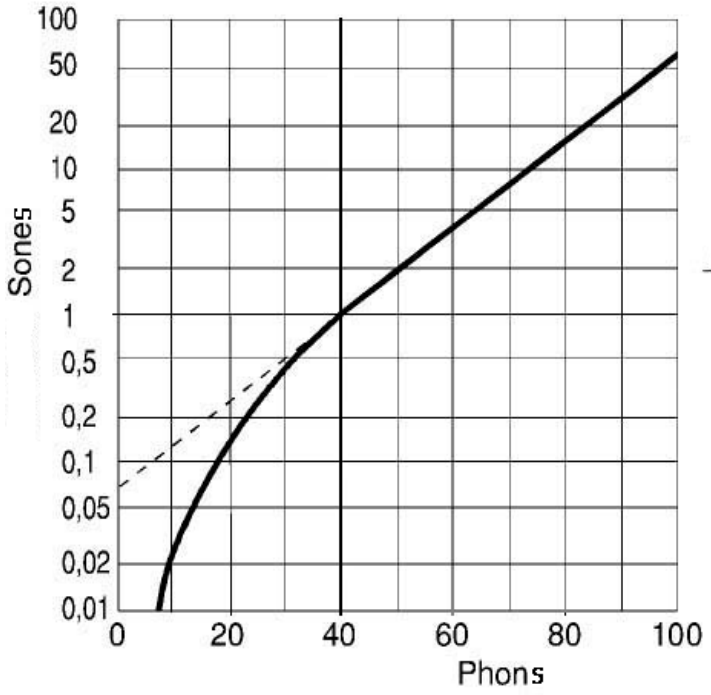
**10)** (*9pts*) **Using the two graphs on the next page [<u>show your work on the graphs</u>],**

**a)** find the loudness level (phons) and the loudness (sones) for a 100Hz tone at 60dB SIL
Loudness level (phons): _____ Loudness (sones): _____

**b)** by how many dB would you have to *increase* the SIL of a 60dB 100Hz tone so that it sounds as loud as a 60dB 4000Hz tone? SIL *increase*: _____

**c)** by how many dB would you have to *increase* the SIL of a 60dB 10000Hz tone so that it sounds as loud as a 60dB 4000Hz tone? SIL *increase*: _____




| Sones | Phon |
|---|---|
| 64 | 100 |
| 32 | 90 |
| 16 | 80 |
| 8 | 70 |
| 4 | 60 |
| 2 | 50 |
| 1 | 40 |
| 1/2 | 32 |
| 1/4 | 25 |
| 1/8 | 19 |
| 1/16 | 14 |
| 1/32 | 11 |
| 1/64 | 9 |

**[show your work on the graphs]**