Chapter II - Sound perception and noise

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Audio Engineering (MA1)

Exercise 1.

We analyze the noise of two compressors with a sound level meter. The results are :

Central frequency f_i (Hz)	125	250	500	1000	2000	4000
Level L_{p1} (dB)	84.3	80.5	77.3	72	69.3	68
Level L_{p2} (dB)	68	69.3	72	77.3	80.5	84.3

1. Let us consider L_{f_i} the different values of the noise level in each frequency band of central frequency f_i. Give the expression of the global sound level L_g.
2. Compute the equivalent sound levels $L_{g,1}$ and $L_{g,2}$.
3. What is the difference between dB and dB(A) ?
4. Compute the different levels by bands in dB(A) of the two compressors (see the weighting values per octave band in table 1).
5. Compute the equivalent sound levels in dB(A) of the two compressors.
6. What remarks can you make about the results of questions 2 and 5 ?

Table 1 – Correction levels C_A by octave bands to convert “linear” levels to weighted levels A

Frequency (Hz)	125	250	500	1000	2000	4000
Correction level C_A (dB)	-16	-8.5	-3	0	+1	+1

Exercise 2.

We want to measure the sound level of a broadband noise made by a machine in a workshop. The noise spectrum is strictly comprised between 90 Hz and 700 Hz.

1. The useful frequency band [90 - 700] Hz is decomposed in octave bands. Recall the values of the central frequencies for the standard octave bands. Verify that the lowest octave band and the highest octave band includes the bounds of the machine noise spectrum.
   A measurement is performed using a sound level meter with band pass filter in each octave bands. The results are :
2. Compute the global sound level made by the machine.

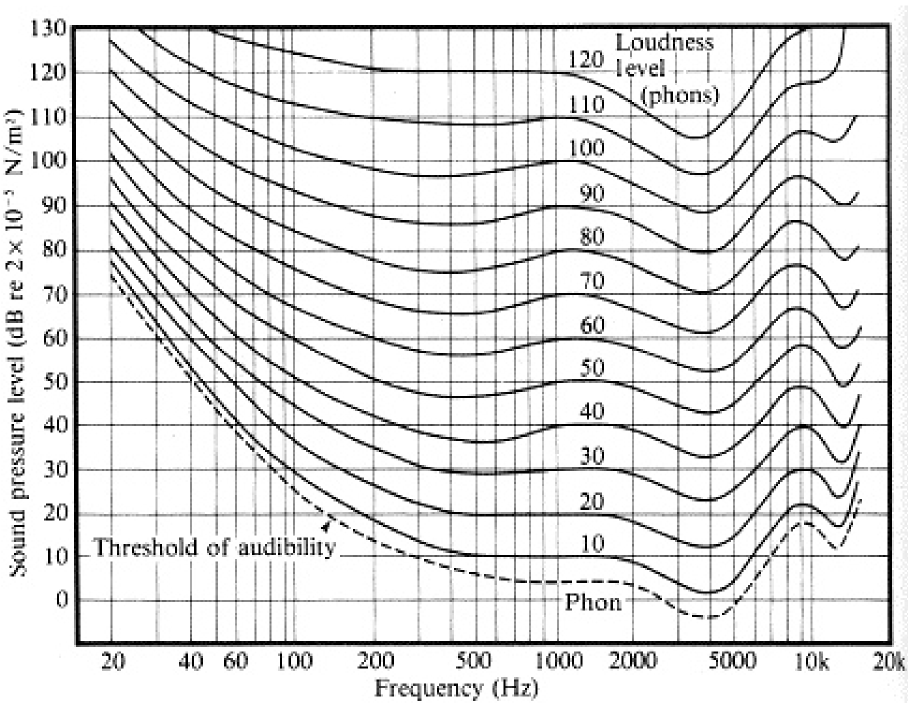
Octave band	1^{st} band	2^{nd} band	3^{rd} band
Level (dB SPL)	84	87	80

3. Compute the global A-weighted sound level made by the machine.
4. An employee works 8 hours per day in the engine shop with 4 machines. Compute the global sound level with the weighting A.
   Noise doses :
5. The swiss standards allow noises of 5760 Pa^2·s for a working day of 8 hours. Can an employee work on the machine a full day without infringing the law ?
6. The employee's day is separated by 2 pauses of 30 min in a room where the ambiant level is equal to 55 dB(A). Is it acceptable ?

Exercise 3.

1. We record two pure sounds of frequencies 1000 Hz and 63 Hz of sound levels 90 dB and 100 dB respectively. Determine the equivalent level in phones of both sounds. What sound is perceived the loudest ? What is the loudness of each one ?

2. You play back at home the records by reducing the intensities by a factor 10^4. What are the new sound levels ? What are the new loudnesses ?



Exercise 4.

The limit equivalent level in nightclubs is equal to 93 dB(A) for one hour (it corresponds to the average sound pressure level during one hour : $L_{eq} = 10.log_{10}(\frac{1}{3600}\int_0^{1h} 10^{L(t)/10}dt))$. If the DJ turns the volume up so that it presents an average of 97 dB(A) during half an hour, what must be the level for the second half an hour ?

Exercise 5.

Along a road, there is a hourly average of 500 vehicles (450 cars and 50 trucks). Compute the equivalent level, given that the pass-by duration of each vewhicle is 5 s (in average), and the individual equivalent levels of cars and trucks are :
L_{eq},5s for a car : 65 dB(A)
L_{eq},5s for a truck : 75 dB(A)

Exercise 6.

An short noise of rms value 2 Pa and duration t is measured with a sound level meter. What should you read on the display screen with the setting "fast" (i.e integration time $T = 125$ms), if the noise lasts $t = 1$ s ? $t = 500$ ms ? $t = 100$ ms ? and $t = 50$ ms ? Same questions with the setting "slow" (i.e integration time $T = 1$s).