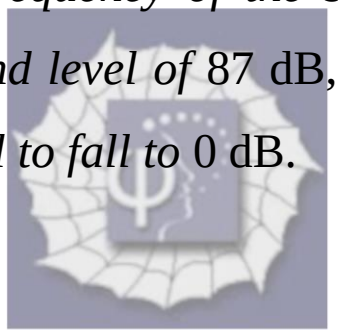
149.

Problem 20.34 (RHK)

The ***reverberation time*** *of an auditorium or concert hall is the time required for the sound intensity* (*in* $\mathrm{W\ m^{-2}}$) *to decrease by a factor of* 10^6. *Suppose that in a particular concert hall, the reverberation time for a note of a certain frequency is* 2.6 *The reverberation time depends on the frequency of the sound. If the note is sounded at a sound level of* 87 dB, *how long will it take for the sound level to fall to* 0 dB.



Solution:

The intensity of sound of 87 dB can be calculated from the definition of sound level, *SL*, which is defined by the formula

$$SL = 10 \log \frac{I}{I_0} ,$$

where

$I_0 = 10^{-12}\ \mathrm{W\ m^{-2}}$,

or

$I = I_0 \times 10^{SL}$.

For SL = 87 dB, I will be

$$I = 10^{8.7} \times 10^{-12}\ \text{W m}^{-2} = 10^{-3.3}\ \text{W m}^{-2}.$$

It is given that the intensity of sound of a particular frequency in a concert hall drops by a factor of 10^{-6} in 2.6 s. If the intensity has to drop to SL of zero it means that the intensity should drop down to $10^{-12}\ \text{W m}^{-2}$.

The time required for the sound level to drop down from 87dB to 0 can be estimated as follows:

$$10^{3.3} \times \left(10^{-6}\right)^{n} = 10^{-12}.$$

This requires

$$3.3 - 6n = -12,$$

or

$$n = \frac{15.3}{6} = 2.55.$$

The time required for the sound of 87 dB to 0 dB will therefore be $2.55 \times 2.6\ \text{s} = 6.63\ \text{s}$.