

T&T6 7.11 Log function question

The loudness L of a sound (measured in dB) is given by the formula $L = 10 \log_{10}(I/I_0)$ where I_0 is the threshold of hearing ($1 \times 10^{-12} \text{ Wm}^{-2}$) and I the intensity of the sound.

(i) If thunder can have a range of loudness between 100-110 dB, what is the corresponding range of intensities in Wm^{-2} ?

(i) If $L = 100 \text{ dB}$
then $I = ?$

$$\begin{aligned} n &= \log_b a \\ \Leftrightarrow a &= b^n \end{aligned} \quad \left. \begin{array}{l} \div 10 \\ \div 10 \end{array} \right\}$$

In the same way
If $L = 110 \text{ dB}$
then $I = ?$

$\div 10$

Corresponding Range
of Intensities

$$100 = 10 \log_{10} \left[\frac{I}{1 \times 10^{-12}} \right]$$

$$10 = \log_{10} \left[\frac{I}{1 \times 10^{-12}} \right]$$

$$\left[\frac{I}{1 \times 10^{-12}} \right] = 10^{10}$$

$$I = 10^{10} (1 \times 10^{-12}) \Rightarrow I_{100} = 10^{-2} \text{ Wm}^{-2}$$

$$110 = 10 \log_{10} \left[\frac{I}{1 \times 10^{-12}} \right]$$

$$11 = \log_{10} \left[\frac{I}{1 \times 10^{-12}} \right]$$

$$\frac{I}{1 \times 10^{-12}} = 10^{11}$$

$$I = 10^{11} (1 \times 10^{-12}) \Rightarrow I_{110} = 10^{-1} \text{ Wm}^{-2}$$

$$I = 0.01 - 0.1 \text{ Wm}^{-2}$$

(ii) The threshold of pain is generally assumed to be 10 Wm^{-2} .

Find in dB the loudness of a sound that starts to cause pain

(ii) If $I = 10 \text{ Wm}^{-2}$
 $L = ?$

use calculator
to evaluate

$$L = 10 \log_{10} \left[\frac{I}{1 \times 10^{-12}} \right]$$

$$= 10 \log_{10} \left[\frac{10}{1 \times 10^{-12}} \right]$$

$$L_{10} = 130 \text{ dB}$$