WORKED-OUT EXAMPLES ON NOISE POLLUTION

WOODGROVE
BANK

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Example 1

Calculate the intensity of 50 dB sound.

(Given reference intensity = 10^{-12} w/m^2).

We know that,

$$\text{Sound level } L\ (\text{dB}) = 10\log_{10}\frac{I}{I_0}$$

where, I = measured intensity

I_0 = reference intensity = $1\times10^{-12}\ \text{w/m}^2$.

$\therefore$ When sound level = 50 dB. then

$$50 = 10\log_{10}\frac{I}{1\times10^{-12}}$$

or $$5=\log_{10}\frac{I}{1\times10^{-12}}$$

or $$\frac{I}{1\times10^{-12}} = 10^5$$

$\therefore$ $$I = 10^5\times10^{-12}$$

or $$I = 10^{-7}$$

$\therefore$ The intensity is $1\times10^{-7}\ \text{w/m}^2$.

Example 2

How much is a sound of 100 dB louder than a sound of 90 dB. [Reference intensity $= 1 \times 10^{-12}$ w/m^2]

Solution:

We know that,

$$\text{Sound level L (dB)} = 10 \log \frac{I}{I_0}$$

Where, I = measured intensity

I_0 = reference intensity

In the first case, i.e. when sound level is 100 dB then,

$$L_1 = 10 \log \frac{I}{I_0}$$

or, $$\log \frac{I}{I_0} = \frac{L_1}{10}$$

or, $$\frac{I_1}{I_0} = 10^{L_1/10}$$

$$\therefore \quad I_1 = I_0 \times 10^{L_1/10} \quad \text{— (1)}$$

In the sound case, i.e. when sound level is 90 dB then,

$$L_2 = 10 \log \frac{I_2}{I_0}$$

or $$\log \frac{I_2}{I_0} = \frac{L_2}{10}$$

or $$\frac{I_2}{I_0} = 10^{L_2/10}$$

$$\therefore \quad I_2 = I_0 \times 10^{L_2/10} \quad \text{—(2)}$$

Now, $$\frac{I_1}{I_2} = \frac{I_0 \times 10^{L_1/10}}{I_0 \times 10^{L_2/10}} = \frac{1 \times 10^{L_1/10}}{1 \times 10^{L_2/10}}$$

Now, $L_1 = 100$ dB

$L_2 = 90$ dB.

$$\therefore \quad \frac{I_1}{I_2} = \frac{1 \times 10^{100/10}}{1 \times 10^{90/10}} = \frac{10^{10}}{10^9} = 10 \text{ times.}$$

So, 100 dB sound is louder than 90 dB sound by 10 times.

Example

A single machine produces 100 dB sound at time of take start. If two identical machines take start from same place and same time, what would be the total sound level?

Solution:

Consider that the first machine produces L_1 sound level at the time of taking start.

$$\text{So, } L_1 = 10 \log \frac{I_1}{I_0} \qquad \ldots (1)$$

Where, I_1 = intensity of sound level L_1

I_0 = reference intensity.

Similarly, the second machine produces L_2 sound level at the time of taking start.

$$\text{So, } L_2 = 10 \log \frac{I_2}{I_0} \qquad \ldots (2)$$

When, I_2 = intensity of sound level L_2

I_0 = reference intensity.

So, when both the machine take start from same place and same time, then the total intensity of sound

$$I_3 = I_1 + I_2 \qquad \ldots (3)$$

After, arranging the equation (1), we get

$$L_1 = 10 \log \frac{I_1}{I_0}$$

or, $$\log \frac{I_1}{I_0} = L_1 / 10$$

or, $$\frac{I_1}{I_0} = 10^{L_1/10}$$

$$\therefore \quad I_1 = I_0 \times 10^{L_1/10} \qquad \ldots (4)$$

Similarly,

$$I_2 = I_0 \times 10^{L_2/10} \qquad \ldots . (5)$$

$$\therefore \quad I_3 = I_0 \left(1 \times 10^{L_1/10} + 1 \times 10^{L_2/10} \right) \qquad \ldots (6)$$

When both the machine take start from same time and same place, then the total sound produced is –

$$L_3 = 10\log\frac{I_3}{I_0}$$

$$= 10\log\frac{I_0\left(1\times10^{L_1/10}+1\times10^{L_2/10}\right)}{I_0}$$

$$= 10\log\left(10^{L_1/10}+10^{L_2/10}\right) \qquad \ldots (7)$$

As, $L_1 = L_2 = 100$ dB.

$$\therefore \quad L_3 = 10\log\left(10^{100/10}+10^{100/10}\right)$$

$$= 10\log\left(10^{10}+10^{10}\right) = 10\log 2\times10^{10}$$

$$= 10\,(\log 2 + 10) \qquad = 103$$

So, when both the machine takes start from same place and same time, then the total sound would be 103 dB.

THANK YOU

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