# DeciBels and Intensity Calculations
## Lesson Notes

## Learning Outcomes

- How do you calculate the deciBel rating from the intensity value and vice versa?
- How do changes in the distance from the source factor into these calculations?

## The Equations

The deciBel scale is a logarithmic scale that compares the intensity of a sound to the intensity of the **threshold of hearing** ($1.0 \times 10^{-12}$ W/m$^2$).

$$dB = 10 \cdot \log (I / I_o)$$ where $I$ = intensity of sound, $I_o = 1.0 \times 10^{-12}$ W/m$^2$

The intensity of a sound ($I$) can be calculated from its deciBel rating ($dB$) using the equation …

$$I = I_o \cdot 10^x$$ where $I_o = 1.0 \times 10^{-12}$ W/m$^2$, $x = dB/10$

Watch the video and show your organized solutions to the following example problems:

## Example 1

Determine the deciBel rating of a sound that has an intensity level of $2.85 \times 10^{-5}$ W/m$^2$.

$dB = 10 \cdot \log (I / I_o)$

dB = deciBel rating
I = intensity (W/m$^2$)
$I_o = 1.0 \times 10^{-12}$ W/m$^2$
Log: a button on your calculator

## Example 2

Determine the intensity of a sound that has an deciBel rating of 97.2 dB.

$I = I_o \cdot 10^x$

I = intensity (W/m$^2$)
$I_o = 1.0 \times 10^{-12}$ W/m$^2$
x = dB/10
dB = deciBel rating

## Intensity, Distance, and Power

The intensity ($I$) of a sound at any distance ($R$) from the sound source with power ($P$) is given by the equation …

$$I = \frac{P}{4 \cdot \pi \cdot R^2}$$

$P$ is a property of the sound source (Watts). $R$ is the distance from the source (in meters). $I$ is the intensity in W/m$^2$.

The intensity-distance relationship is often written as a proportionality statement:

$$I \propto \frac{1}{R^2}$$

Doubling R ⇒ I becomes 1/4-th the original value
Tripling R ⇒ I becomes 1/9-th the original value
Halving R ⇒ I becomes 4 times the original value

**Example 3**

Determine the intensity a distance of 2.8 m from the 450-Watt speakers in your room.

**Example 4**

The intensity a distance of 1.6 m from a source is $7.2 \times 10^{-4}$ W/m$^2$. Determine the intensity a distance of …

a. 3.2 m from the source:

4.8 m from the source:

6.4 m from the source:

**Example 5**

The deciBel rating a distance of 1.6 m from a source is 54.2 dB. Determine the deciBel rating a distance of …

a. 3.2 m from the source:

b. 4.8 m from the source:

c. 6.4 m from the source: