Inverse Square Law Calculations and DeciBel Level Calculations

1. Determine the deciBel level of each of the following sounds. (NOTE: different sources cite different intensity levels.)

Desription of Sound	Intensity (W/m^2)	Intensity Level (deciBels)
Threshold of Hearing	1×10^{-12}	
Broadcasting Studio	1×10^{-10}	
Mosquito Buzzing	1×10^{-8}	
Normal Conversation	1×10^{-6}	
Vacuum Cleaner	1×10^{-5}	
Busy Traffic	1×10^{-4}	
Power Mower or Thunder	1×10^{-2}	
Twisted Sister Rock Band (Mr. H's favorite)	1×10^{-1}	
Threshold of Pain	1	
Jackhammer or Nearby Plane (18')	1×10^{1}	
Explosions	1×10^{2}	

2. Determine the intensity in W/m^2 which correspond to the following deciBel levels.

    a. $\beta = 75$ dB $I =$ _____ W/m^2 b. $\beta = 85$ dB $I =$ _____ W/m^2

    c. $\beta = 95$ dB $I =$ _____ W/m^2 d. $\beta = 105$ dB $I =$ _____ W/m^2

    e. $\beta = 78.01$ dB $I =$ _____ W/m^2 f. $\beta = 79.77$ dB $I =$ _____ W/m^2

    g. $\beta = 88.01$ dB $I =$ _____ W/m^2 h. $\beta = 89.77$ dB $I =$ _____ W/m^2

3. Observe the results of your calculations in question #2 above to answer the following questions.

    a. If Sound E is two times the intensity of Sound A, then its deciBel level is _____ higher.

    b. If Sound F is three times the intensity of Sound A, then its deciBel level is _____ higher.

    c. If Sound B is 10 times the intensity of Sound A, then its deciBel level is _____ higher.

    d. If Sound C is 100 times the intensity of Sound A, then its deciBel level is _____ higher.

    e. If Sound D is 1000 times the intensity of Sound A, then its deciBel level is _____ higher.

    f. If Sound I is 10000 times the intensity of Sound A, then its deciBel level is _____ higher.

4. If a source is twice as powerful (i.e., emits twice the energy in the same amount of time), then the intensity at every location about the source will be twice as intense. The intensity at a given location is directly related to the intensity of the source. Fill in the following table.

Source of Sound	Intensity at 1 m	dB level at 1 m
One Twisted Sister Drummer	$2 \times 10^{-2} \, \text{W/m}^2$	
Two Twisted Sister Drummers		
Three Twisted Sister Drummers		

The intensity of a sound at a given location varies inversely with the square of the distance of that location from the source. A clever analogy illustrates the reason for this inverse square relationship. Consider a butter sprayer used in a restaraunt to spray butter on a toast. Toast is placed a certain distance from the nozzle (the source of butter), the button is pushed and a mist of butter is emitted from the nozzle, spreading out through space in a conical shape. If the butter is placed close to the nozzle, then the intensity of the butter landing on the toast will be greater. If the distance from the nozzle is doubled, then the butter mist will land on an area four times as large; however, that means that the intensity of butter on each individual piece is one-fourth as much. Doubling the distance makes the intensity on the same piece (the same area) one-fourth as much. By the same reasoning, increasing the distance by four times as much makes the intensity of butter on each individual piece 1/16-th as much. Whatever alteration is made in the distance from the source, the inverse square effect will be made upon the intensity.
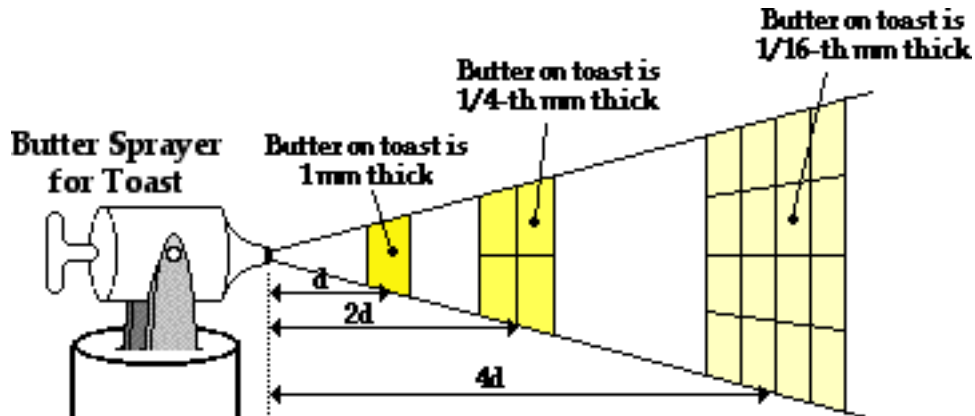
5. Suppose that the intensity level at a given location a distance **d** from a source is 16×10^{-4} W/m^2. Determine the intensity level at a distance of ...

   a. ... **2d** from the same source. _____ W/m^2

   b. ... **3d** from the same source. _____ W/m^2

   c. ... **4d** from the same source. _____ W/m^2

   d. ... **0.5 d** from the same source. _____ W/m^2

   e. ... **2d** from a source which is twice as powerful. _____ W/m^2

   f. ... **2d** from a source which is four times as powerful. _____ W/m^2

6. Use equation 15.7 of the textbook to determine the deciBel level for each of the sources and locations in question #5 above.

   a. _____ dB   b. _____ dB   c. _____ dB

   d. _____ dB   e. _____ dB   f. _____ dB

7. The deciBel level of a sound is 95 dB at a given location a distance **d** from the source. Determine the deciBel level a distance of ...

   a. ... **2d** from the same source. _____ dBels

   b. ... **4d** from the same source. _____ dBels

   c. ... **100d** from the same source. _____ dBels

   d. ... **0.5 d** from the same source. _____ dBel