

## Measuring Sound Intensity

The loudness of sound is measured in decibels, and the number of decibels is 10 times the logarithm of the relative intensity which is measured in watts per square meter.

$$\text{Decibels} = 10 \cdot \log(\text{relative intensity})$$

A recent news article indicated that organizers of the soccer event Euro 2012 in Poland and the Ukraine plan to use the Long Range Acoustic Device (LRAD) if necessary to disperse unruly soccer fans. The Long Range Acoustic Device is a military-grade sonic cannon that has a loudness of 150 decibels.

- A. What is the relative intensity of the LRAD?
- B. How many decibels would a sound be that had a relative intensity that was one half that of the LRAD?
- C. The relative intensity of the LRAD is how many times that of a telephone dial tone which has a loudness of 80 decibels?

$$150 = 10 \log (\text{relative intensity})$$

$$15 = \log (\text{relative intensity})$$

$$10^{15} = \text{relative intensity}$$

A. Let  $r_2 = \frac{r_1}{2}$

Then  $2r_2 = r_1$

$$150 = 10 \log (2r_2)$$

$$15 = \log (2r_2)$$

$$15 = \log (2) + \log(r_2)$$

$$15 - \log(2) = \log(r_2)$$

$$14.7 = \log(r_2)$$

$$147 = 10 \log(r_2)$$

A sound with a loudness of 147 decibels has half of the relative intensity of the LRAD

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- B. Relative intensity of the LRAD =  $10^{15}$   
Relative intensity of a dialtone =  $10^8$

$$\frac{LRAD}{dialtone} = \frac{10^{15}}{10^8} = 10^7$$

The relative intensity of the LRAD is 10,000,000 times that of a dialtone.