**Activity 5.3.4 Measuring Sound Intensity**

Have you ever had to cover your ears because the sound was too loud? Perhaps outside an airport or near a jackhammer? How loud a sound seems to be depends upon who is listening to the sound. How loud something seems is subjective and not easily measured. What music seems fine to you may bring a very different response from your parents! However what makes one sound seem louder than another is the AMOUNT of energy that the sound source is sending toward the listener in the form of pressure variations in the air. This is the intensity of the sound and it can be measured--- it is objective. A meter that measures sound levels must calculate the pressure of the sound waves traveling through the air. These will give a measurement of sound intensity called decibels, a scale that Alexander Graham Bell first devised. Mr. Bell is known for another invention. What is it?

The decibel scale is logarithmic scale that goes up by powers of ten. Every increase in 10 decibels (dB) on the scale is equivalent to a tenfold increase in sound intensity, which roughly corresponds with loudness. So a 30 dB sound is 100 times louder than a 10 dB sound. A sound that is 100 dB (for example a jackhammer) is 1,000,000,000 times louder than a sound of 10 dB (leaves falling to the ground).

1. Sound intensity is another difficult measure to graph. Try making a bar graph for the following table.

|  |  |
| --- | --- |
| Average Perception | Relative Intensity I/I0 |
| Threshold of hearing | 1 |
| Whisper | 100 |
| Quiet home, private office | 10000 |
| Average conversation | 100,000 |
| Noisy home, average office | 1,000,000 |
| Average street noise | 100,000,000 |
| Noisy factory | 10,000,000,000 |
| Elevated train, deafening | 100,000,000,000 |
| Threshold of pain for ears | 10,000,000,000,000 |

1. What happened to most of the bars?
2. Now make a bar graph for the table below.

|  |  |
| --- | --- |
| Average Perception | Decibels (dB) |
| Threshold of hearing | 0 |
| Whisper | 20 |
| Quiet home, private office | 40 |
| Average conversation | 50 |
| Noisy home, average office | 60 |
| Average street noise | 80 |
| Noisy factory | 100 |
| Elevated train, deafening | 110 |
| Threshold of pain for ears | 130 |

1. Which bar graph do you prefer and why?

Noise level in decibels = , where *I*0 is the intensity of a sound that can barely be heard. Assume or 10-16 watts/cm2. The expression gives the relative intensity of sound. This is similar to the way in which we compare the amplitude of an earthquake to a reference value.

1. The typical loud band of today plays with an intensity of 10-5 watts per cm2.
2. What is the decibel level of a loud band?
3. How much more intense is loud music than average conversation?
4. If a sound doubles in intensity, by how many units does its decibel rating increase?
5. An elevated train makes 110 decibels of noise. If you are standing on the platform and a train is arriving from both directions does that mean there will be 220 decibels of noise?
6. The intensity of the sound of rustling leaves is . What is the decibel level?
7. A slamming door has a decibel level of 80. What is the intensity of the sound?

About 10 million Americans suffer from noise-induced hearing loss. It can be caused by a one-time exposure to a loud sound or repeated exposure to loud sounds over time. The amount of time your hearing is exposed to a sound affects how much damage will be caused. A bulldozer idling is loud enough at 85 dB to cause permanent damage to a person using it for just an 8-hour workday. A gunshot ranges from 140 to 190 dB and can cause immediate hearing damage.

1. A sound with a decibel level of 85 or higher is likely to cause a person permanent ear damage and hearing loss. Which of the following sounds will likely cause hearing loss?
2. A vacuum cleaner with a sound intensity of
3. An airplane at takeoff with a sound intensity of 1200
4. A lawn mower with a sound intensity of