

14.5: Intensity and Loudness of Sound



Figure 12.3.1

A friend whispers to you in a voice so soft that she has to lean very close so you can hear what she's saying. Later that day, your friend shouts to you from across the gymnasium. Now her voice is loud enough for you to hear her clearly even though she's several meters away. Obviously, sounds can vary in loudness.

It's All About Energy

Loudness refers to how loud or soft a sound seems to a listener. The loudness of sound is determined, in turn, by the intensity of the sound waves. **Intensity** is a measure of the amount of energy in sound waves. The unit of intensity is the **decibel (dB)**.

Decibel Levels

The Figure below shows decibel levels of several different sounds. As decibel levels get higher, sound waves have greater intensity and sounds are louder. For every 10-decibel increase in the intensity of sound, loudness is 10 times greater. Therefore, a 30-decibel "quiet" room is 10 times louder than a 20-decibel whisper, and a 40-decibel light rainfall is 100 times louder than the whisper. High-decibel sounds are dangerous. They can damage the ears and cause loss of hearing.

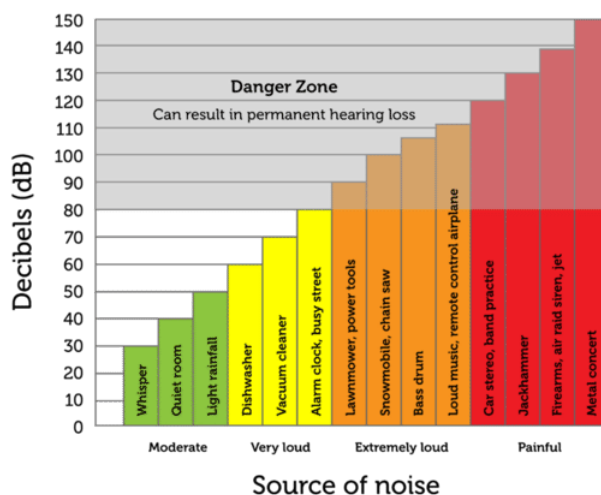


Figure 12.3.2

Q: How much louder than a 20-decibel whisper is the 60-decibel sound of a vacuum cleaner?

A: The vacuum cleaner is 10,000 times louder than the whisper!

Amplitude and Distance

The intensity of sound waves determines the loudness of sounds, but what determines intensity? Intensity results from two factors: the amplitude of the sound waves and how far they have traveled from the source of the sound.

- **Amplitude** is a measure of the size of sound waves. It depends on the amount of energy that started the waves. Greater amplitude waves have more energy and greater intensity, so they sound louder.
- As sound waves travel farther from their source, the more spread out their energy becomes. You can see how this works in the Figure below. As distance from the sound source increases, the area covered by the sound waves increases. The same amount of energy is spread over a greater area, so the intensity and loudness of the sound is less. This explains why even loud sounds fade away as you move farther from the source.

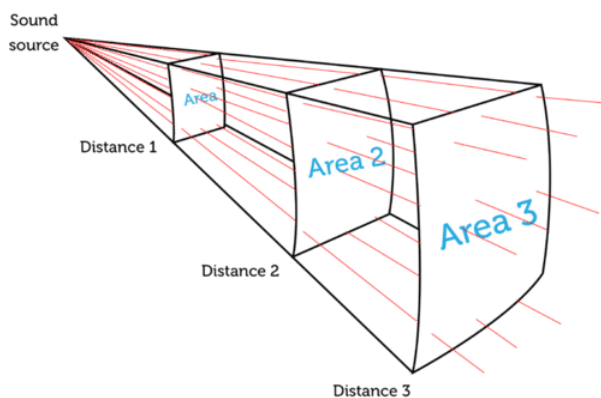


Figure 12.3.3

This diagram represents just a small section of the total area of sound waves spreading out from a source. Sound waves actually travel away from the source in **all directions**.

Q: Why can low-amplitude sounds like whispers be heard only over short distances?

A: The sound waves already have so little energy that spreading them out over a wider area quickly reduces their intensity below the level of hearing.

The spectrum of sound varies for different musical instruments, which is why they all sound different playing the same musical note. Observe the Amplitude vs Frequency graph, known as the Fourier Transform, on the top right graph in the Pan Flute simulation below to learn more:

Summary

- Loudness refers to how loud or soft a sound seems to a listener. The loudness of sound is determined, in turn, by the intensity, or amount of energy, in sound waves. The unit of intensity is the decibel (dB).
- As decibel levels get higher, sound waves have greater intensity and sounds are louder. For every 10-decibel increase in the intensity of sound, loudness is 10 times greater.
- Intensity of sound results from two factors: the amplitude of the sound waves and how far they have traveled from the source of the sound.

Review

1. Define loudness and intensity of sound. How are the two concepts related?
2. What is the unit of intensity of sound?
3. At what decibel level do sounds start to become harmful to the ears and hearing?
4. Relate amplitude and distance to the intensity and loudness of sound.

Additional Resources

Study Guide: Waves Study Guide

Real World Application: Playing with Trash

Video: Characteristics of Sound Waves - Overview



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