

Student study guide: Nature of sound, properties of sound, and combining sound waves

The nature of sound:

Key points:

- Sound comes from a series of vibrations and travels through a medium (such as the air) in waves.
- The speed of sound depends on the **elasticity**, **density**, and **temperature** of the medium.

Vocabulary:

- **Elasticity** describes how quickly a medium's molecules return to their original positions after being disturbed by sound waves. Molecules that return to their original shape quickly are ready to move again more quickly. Therefore they can vibrate at higher speeds. Sound can travel faster through mediums that vibrate faster.
- **Density** describes the mass of a substance per unit of volume. Sound waves travel faster in less dense materials than in more dense materials.
- **Temperature** refers to the heat of a medium. Molecules at higher temperatures have more energy, and therefore can vibrate faster. As a result, sound waves can travel more quickly through warmer mediums.

Properties of sound:

Key points:

- A sound wave with a higher **intensity** sounds louder than one with a lesser intensity. Loudness is measured in **decibels**.
- **Pitch** depends on the **frequency** of the sound wave.

Vocabulary:

- **Intensity** – the amount of energy a sound has over an area. The same sound is more intense if you hear it in a smaller area. In general, we call sounds with a higher intensity louder. Intensity is measured in **decibels**.
- **Loudness** cannot be assigned a specific number, but intensity can. The human ear is more sensitive to high sounds, so they may seem louder than a low noise of the same intensity.
- **Decibels (dB)** – The unit of measurement for the intensity of sound. A whisper is about 10 decibels while thunder is about 100 decibels.
- **Pitch** helps us distinguish between high and low sounds. Pitch depends on the frequency of a sound wave. (In music, we can see how four different properties affect the pitch of a stringed instrument: **length**, **diameter**, **tension**, and **density**. A string with a greater diameter – a thicker guitar string, for example – will produce a lower pitch than one with a lesser diameter.)
- **Frequency** – the number of wavelengths that fit into one unit of time. (Usually measured in number of vibrations per second.)
- **Doppler effect** – the principle that explains why we hear sounds differently when we, or the source of a sound, are moving.
- **Ultrasound** – sound waves with frequencies so high they are above the range we can normally hear.
- **Infrasound** – sound waves with frequencies so low they are below the range we can normally hear.

Combining sound waves:

- Musicians combine tones to create a desired effect in the listener (pleasure, sadness, etc.)
- **Timbre** is the quality of a sound that can't be described by its pitch or loudness. Musicians sometimes refer to timbre as the "color" of a sound.

Most information in this study guide is from the NDT Resource Center website "Introduction to Sound" copyright 2001 Iowa State University.

<http://www.ndt-ed.org/EducationResources/HighSchool/Sound/introsound.htm>

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Data recording worksheet

BOTTLE	LENGTH OF COLUMN OF AIR (cm)	HEIGHT OF WATER (cm)	PITCH PRODUCED BY BLOWING ACROSS TOP OF BOTTLE	PITCH PRODUCED BY TAPPING PENCIL ON SIDE OF BOTTLE
Bottle A				
Bottle B				
Bottle C				

1. Look at your data table. How does the length of the column of air affect the pitch?

2. Based on your observations in this lab, what statements can you make about the relationship between the sounds produced and the medium through which the sound travels?

3. Can your group figure out how to play a simple melody or create one of your own, like a musician or composer? Try with your group to create a beat of three or four notes that repeat with a pleasing sound. If you don't think music is a future career for anyone in the group, cheat and see if you can sound out the notes to a simple children's song like "Mary Had a Little Lamb," "Twinkle, Twinkle Little Star," or the ABCs.