AP Physics Study Guide

Physics of Hearing

From Simple Studies, https://simplestudies.edublogs.org & @simplestudiesinc on Instagram

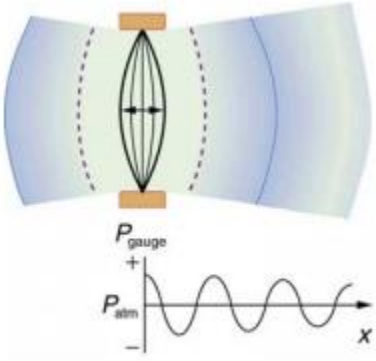
All images are from the Openstax college physics textbook

Hearing is the perception of sound

- It has important applications beyond hearing
    - Sounds above 20,000 Hz are **ultrasound**, and those below 20 Hz are **infrasound**
- The perception of frequency is called **pitch**
    - Ex: **notes** from an instrument have different pitches
- The perception of intensity is **loudness**
    - **Phon** is the unit used to express loudness
- We call our perception of these combinations of frequencies and intensities **tone** quality, or **timbre** of the sound

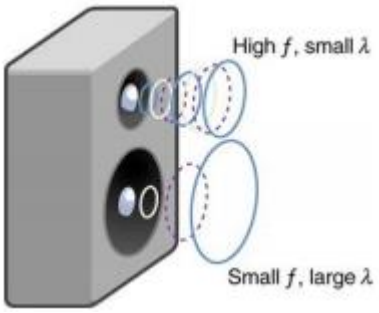
Sound is a disturbance of matter that is transmitted from its source outward

- Sound is a wave
    - Some energy transfers into the air, but a small part goes into compressing and expanding the surrounding air



There is a relationship between the speed of sound, its frequency, and its wavelength:

- $v_w = f\lambda$
    - The higher the frequency, the smaller the wavelength
    - The same relationship is given for all waves



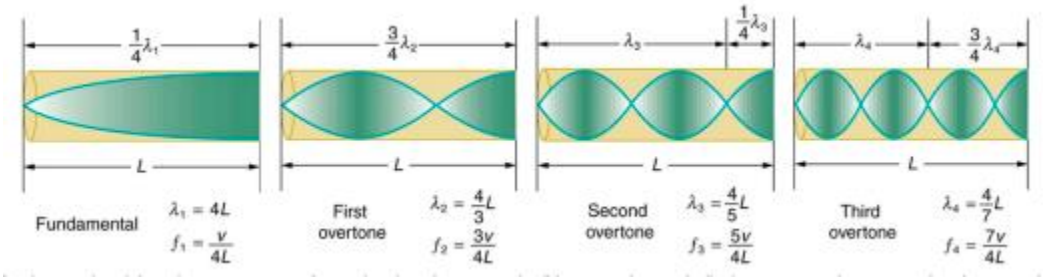
- In air, the speed of sound is related to air temperature
    - $v_w = (331\ m/s)\sqrt{\frac{T}{273\ K}}$

The sound of a motorcycle buzzing by is an example of the **Doppler effect**

- It is an alteration in the observed frequency of a sound due to motion of either the source or the observer
    - The actual change in frequency due to relative motion of source and observer is called a **Doppler shift**

Sound interference and resonance have the same properties as defined for all waves

- In air columns, the lowest-frequency resonance is called the **fundamental**
- The resonant frequencies of a tube are:



  - $f_n = n\frac{v_w}{4L}, n = 1,3,5...$ for a tube closed at one end

  - $f_n = n\frac{v_w}{2L}, n = 1,2,3...$ for a tube open at both ends