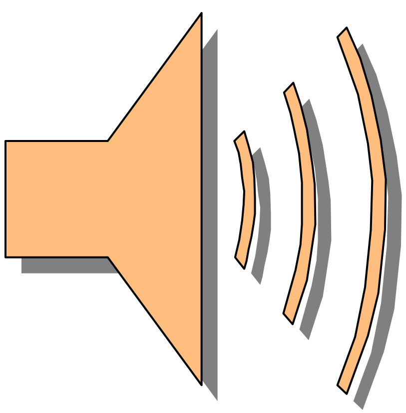
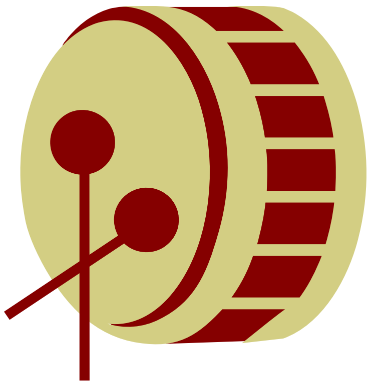
Chapter 3 (Hall)

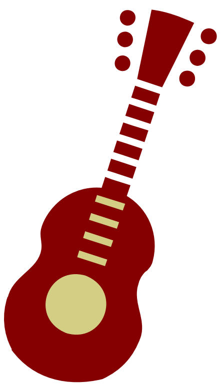


Sources of Sound

Outline

- Classifying sound sources
- Percussion instruments
- String instruments





Introduction to the processes of sound generation

- **Origin of all sounds**: Vibrating objects produce sounds as they disturb the surrounding air.
  - How objects can be set in vibration.
  - How vibrations can be sustained or made to continue for a long time.
  - How well the energy of vibrations can be transferred into the air.
- <u>It is a combination of these factors that determines the strength of the resulting sound waves</u>.

Classifying sound sources

- *Natural* versus *artificial* sounds
  - Nature provides many sounds in our environment.
  - Most music consists of sound deliberately produced through consciously controlled processes.
- *Original* versus *reproduced* sounds
  - Faithfulness with which the replica mimics the original.
  - Physical processes of recording, storing, and reproducing the sound.
- Transient versus steady sounds
  - Transient sounds: Temporary and quickly die away. Occur when sources are set in vibration and left alone thereafter. Example: plucking a guitar string.
  - Steady sound: Continue at the same level.
- According to the means of sound production: for example, wind instruments or string instruments.

Transient versus steady sounds

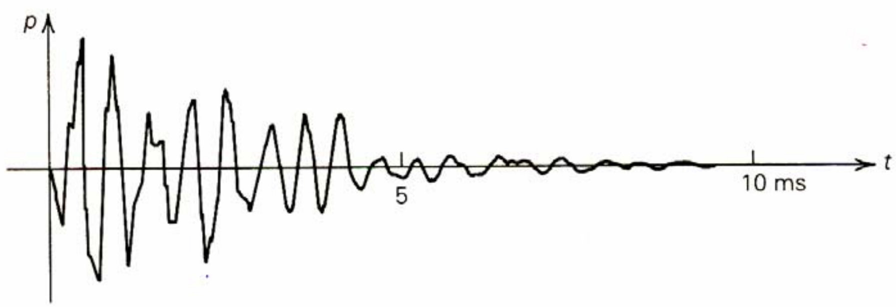


FIGURE 3.1 Oscilloscope trace of the transient "clack" sound from a short wooden stick struck by metal rod. Compare this with the steady sounds of Figures 2.4 and 2.5 (page 22), whose waveforms repeat over and over again with the same amplitude.

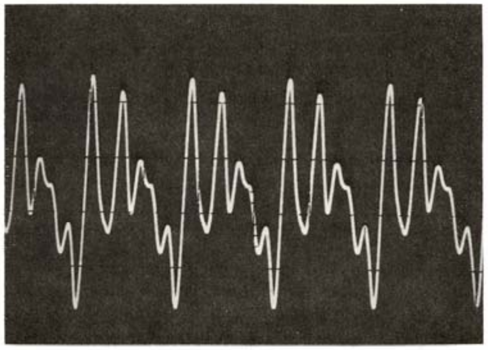


FIGURE 2.4 Oscilloscope trace generated by the author's voice, singing the vowel $\bar{o}$ at a pitch near A_2 ($f = 110$ Hz). As will be explained in Section 2.3, this tells how the air pressure upon the microphone varies (vertically) as time passes (horizontally). The segment shown here lasted only 45 ms.

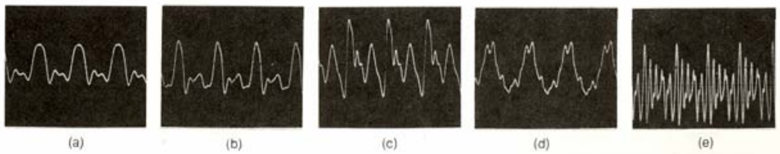
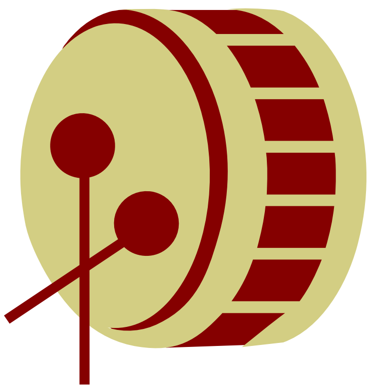


FIGURE 2.5 Sample waveforms produced by different sound sources. (a) A flute, (b) a trumpet, (c) a soprano saxophone, (d) a violin, all playing A_4 ($f = 440$ Hz); these $3\frac{1}{2}$ cycles last approximately 8 ms. (e) A bassoon playing A_2 ($f = 110$ Hz), for which these $4\frac{1}{2}$ cycles take approximately 40 ms. Do not attach too much absolute significance to these waveforms, because some details depend on where the microphone was located.

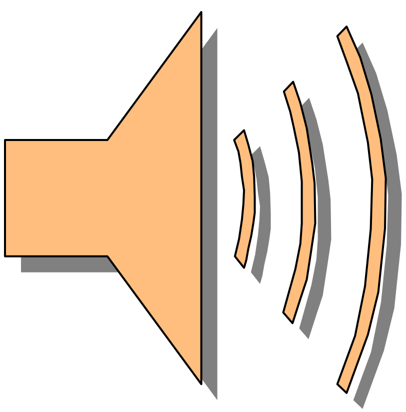
Percussion instruments



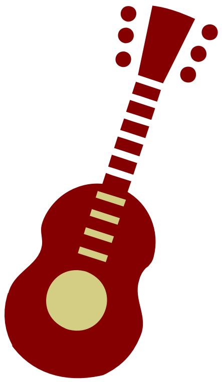
- **How is sound produced by a percussion instrument**?
  - Strike the surface.
  - A distortion (such as a dent) is caused at the point of impact.
  - The surface is elastic and the distorted part springs back.
  - The distortion is passed on to the adjoining material.
  - The vibration of the surface in turn causes the adjoining air to vibrate, creating a sound wave traveling to your ear.

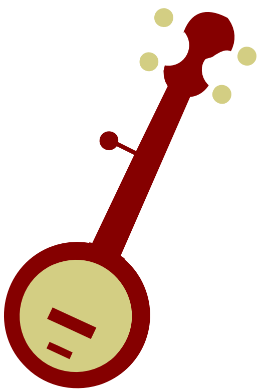
Some properties of the sound near a struck object

- The sound may be *loud* or *soft*, which depends on two factors:
  - The amplitude of the vibrations of the solid object and the surface area that is vibrating.
  - Larger surface area moves a much greater amount of air and -- a much louder sound.
- The sound is *transient*-it soon dies away. What has happened to the energy that was originally present in the vibration?
  - As the surface of the vibrating object pushes on the surrounding air, it delivers energy to the air-sound carries away some of the original energy.



String instruments





- **How is sound produced by a string instrument**?
  - Plucking the strings.
- **Why is a box or soundboard used**?
  - The string is very thin: only a small bit of air is moved-weak sound. To create a loud sound a soundboard or a box is used on which the strings on mounted. The larger surface area moves larger amount of air creating loud sound.

An example of the string instruments: guitar

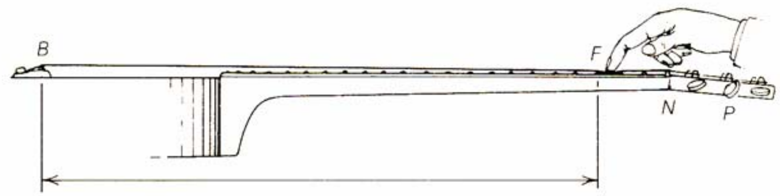


FIGURE 3.4 A guitar string is held above the neck by a bridge *B* on the body and another bridge *N* (customarily called the nut) on the neck near the tuning peg *P*. The arrows indicate the length of string allowed to vibrate when the string is held against one of the frets *F*.

- Fundamental frequency:

$$f_1 = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

  - T: Tension in the string and μ is the mass per unit length.
- Several notes can be obtained from each string y using different portions of its length.
  - The shorter the active string length, the higher pitch the note will have.