Characteristics of Steady Single Tones

- Amplitude (intensity) – loudness
- Vibration frequency – pitch
- Wave shape – timbre, tone color or quality
- Figure 6.9

Loudness and Intensity

- 60 dB: eardrum moves $10^{-8}$ m
- 120 dB: eardrum moves $10^{-5}$ m
- Nerve cells are on/off devices; each sends a pulse the same size – strong stimulation results in more pulses (single nerves send pulses more often & more nerves reacting)
- The sensation of loudness is an interpreted by the brain

Loudness

- **Sone** is the unit for loudness
- 1 sone is a 1000-Hz sine wave at 40-db sound level
- Figure 6.10
  - Point A: 50-dB, 1000-Hz $\rightarrow$ 2.3 sones
  - Point B: 50-dB, 100-Hz $\rightarrow$ 0.7 sones
- For frequencies and intensities of musical interest, every 10-dB increase in sound level will double the loudness in sones

Pitch and Frequency

- Different frequencies cause different parts of the basilar membrane to vibrate so that the brain received pulses from different nerves
- Pitch is relative
- Octave: two notes with a frequency ratio of 2:1 – they sound very much alike

Example 6-9

- From 180 Hz to 400 Hz
- From 400 Hz to 700 Hz

Pitch and Loudness

- Loudness – the magnitude of the sensation produced by a sound; the “amount” of sound
- Loudness (in sone) is how many times larger (or smaller) the sensation is judged to be, relative to a tone of SIL = 40 dB at 1000 Hz
- Loudness level (in phons) is equal to the SIL at 1000 Hz that produces the same magnitude of sensation
- Figure 6.13
Fletcher-Munson Diagram

- Figure 6.12
- Example: Recorded 90 phons both at 1000 Hz and 50 Hz and played back with reduced intensities at 0.01%

Timbre and Instrument Recognition

- Waveform
- Transients: the beginnings (attacks) and endings (decays)