Chapter 20

Sound

What is SOUND?

- A wave produced by a vibration of matter.
- A longitudinal wave. (See Figs. 20.1 & 20.2).
  - Compression: medium bunches up.
  - Rarefaction: medium stretches out

Examples:

- A plucked guitar string.
- Vibrating air column in a flute.
- Hand clap (produces a pulse rather than a continuous train of waves.)

Sound Description

- Intensity: Relates to the amplitude of the sound. (The "loudness" of the sound.)
- Pitch: Relates to the frequency of the sound. (High pitch is high frequency.)
- Speed: Depends on the properties of the medium (including temperature).

$$v_{air} = v_{@0C} + 0.6T_C = 331.5 \text{ m/s} + (0.6 \text{ m/s/C}^\circ)T_C.$$

Example: v_{air} at 24 °C is 344.7 m/s

Wave Speed

Recall from (Chapter 3 & Chapter 19):

Speed = Distance /Time

Wave Speed, v = Wavelength / Period = λ/T.

Since $T = 1/f$, then $f = 1/T$, so $v = \lambda f$.

The wave speed only depends on the properties of the medium through which the disturbance passes.

Forced Vibration & Resonance

Forced Vibrations: Occurs when a vibrating object forces another object to vibrate.

Resonance: Occurs when the frequency of the forced vibrations matches the natural frequency of the object.

Beats: Time interference

- These occur when two tones of slightly different frequencies are sounded together.
- At some times and places, crest meets crest (or trough meets trough). Interference is constructive.
- At other times and places, crest meets trough. Interference is destructive. (See Fig. 20.21.)
- "Beat frequency" $= f_{Beat} = |f_1 - f_2|$

Example

A tuning fork has a frequency of 480 Hz. A second tuning fork has a frequency of 488 Hz.

Calculate the "beat frequency" heard when these two tuning forks are sounded together.

Ans. $f_{Beat} = |f_1 - f_2| = |480 \text{ Hz} - 488 \text{ Hz}| = 8 \text{ Hz}$

So, the listener would hear variations in loudness with a frequency of 8 Hz.