Chapter 12

Thursday, February 25, 2021 8:37 AM

I. Characteristics of Sound
   a. Sound is a mechanical wave
      i. Requires matter and travels as a longitudinal wave
   b. Speed of sound is dependent on material
      i. Denser means faster
      ii. Sound at 20°C travels at 343 $\frac{m}{s}$
   c. Relationship between pitch and frequency
      i. Pitch is directly proportional to frequency and the other way around

II. Graphs of Sound
   a. Displacement Graph: Plots the movement of each particle relative to their respective equilibrium points
   b. Pressure Graph: Plots the changing pressure of each point in the wave relative to the equilibrium pressure
   c. $f(s) = m$
      i. Period: Wavelength
      ii. Amplitude: Midline to peak
   d. $f(x) = m$
      i. Wavelength: Node to Node, Antinode to Antinode

III. Sources of Sound
   a. String Instruments: The string vibrates as a standing wave of lowest resonant frequency (the fundamental frequency)
      i. $v = \sqrt{\frac{F_T L}{m}}$
      ii. $f_1 = \frac{v}{\lambda} = \frac{v}{2L} = \frac{1}{2}\sqrt{\frac{F_T}{mL}}$
      iii. Increasing Fundamental Frequency
         1) Increase tension
         2) Decrease length
         3) Decrease mass
   b. 1st Harmonic: 1/2 the wavelength
   c. Wind Instruments: Sound is formed by the vibration of standing weaves in the air columns
      i. Open Tubes: Node - Node
         1) First Harmonic (Pressure Graph)
            a) $\lambda_1 = 2L$
            b) $v = \lambda f$
            c) $f_1 = \frac{v}{2L}$
         2) Universal Rules
            a) $L = \frac{n\lambda_n}{2}$
            b) $f_n = \frac{v}{\lambda_n} = \frac{nv}{2L} = nf_1$
      ii. Closed Tube
         1) First Harmonic
            a) Node at opening; antinode at closed end
            b) $\lambda_1 = 4L$
            c) $v = \lambda f$
            d) $f_1 = \frac{v}{4L}$
         2) Universal Rules
            a) $L = \frac{n\lambda_n}{4}$
            b) $f_n = \frac{nv}{4L} = nf_1$

IV. Interference of Sound Waves; Beats
   a. Scenario:
      i. If two speakers in different locations emit the same frequency of sound
         1) Constructive interference occurs at certain spots, making it loud
         2) Destructive interference occurs at certain spots, making the sound soft or absent
   b. Beats
      i. Two frequencies that are similar but unequal will have partially constructive/destructive interference
      ii. When we hear beats, we hear the max amplitudes of the resulting wave
      iii. Beat Frequency: Frequency of the max amplitudes of the resulting waves
         1) Equals the difference between two frequencies

V. Doppler Effect: Apparent change in frequency due to relative motion between source and receiver
   a. Bug Example
      i. Case 1: Stationary bug bobbing up and down in water
         1) Ripples are concentric circles equally spaced
         2) Observers on both sides of bug see ripples of same frequency
      ii. Case 2: Bug moves and bobs up and down in water
         1) Centers of succeeding circ les move in direction of bug's motion

- When a wave changes mediums, the frequency stays the same

Note: L is $\frac{1}{2}$ the wavelength

Open tubes are measured in $\frac{1}{2}$ wavelengths (Even or odd)
$\frac{2}{n}$ Harmonic Wavelength

Closed tubes are measured in $\frac{1}{4}$ wavelengths (Odds)
$\frac{4}{n}$ Harmonic Wavelength