**Chapter – 17**

**1. A standing wave is established in a 120-cm-long string fixed at both ends. The string vibrates in four segments when driven at 120 Hz. (a) Determine the wavelength. (b) What is the fundamental frequency of the string?**

**Solution:**

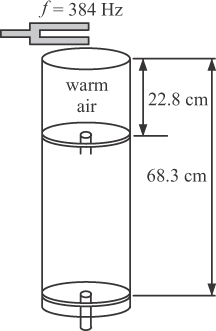
We are given *L* = 120 cm, *f* = 120 Hz.

(a) For four segments, or 

(b)  

**2. An air column in a glass tube is open at one end and closed at the other by a movable piston. The air in the tube is warmed above room temperature, and a 384-Hz tuning fork is held at the open end. Resonance is heard when the piston is at a distance d1= 22.8 cm from the open end and again when it is at a distance d2 = 68.3 cm from the open end. (a) What speed of sound is implied by these data? (b) How far from the open end will the piston be when the next resonance is heard?**

**Solution:**

****For resonance in a narrow tube open at one end,



(a) The node–node distance is

dNN = 68.3 cm – 22.8 cm = 45.5 cm

This distance is equal to half the wavelength, so,



(b) Resonance will be established when the tube length has increased by another half wavelength: 68.3 cm + 45.5 = 113.8 = 

**3. Review. A student holds a tuning fork oscillating at 256 Hz. He walks toward a wall at a constant speed of 1.33 m/s. (a) What beat frequency does he observe between the tuning fork and its echo? (b) How fast must he walk away from the wall to observe a beat frequency of 5.00 Hz?**

**Solution:**

The source moves toward the wall:

*v*s = +*v*student, *v*0 = 0, and 

The wall acts as stationary source, reflecting the wave of frequency  The observe moves toward the source: *v*s = 0, *v*0 = +*v*student, and



(a) When the student walks toward the wall  is larger than *f*; the beat frequency is





(b) When he is moving away from the wall, the sign of *v*student changes and  is smaller than f:



Solving for *v*student gives



**4.The windpipe of one typical whooping crane is 5.00 feet long. What is the fundamental resonant frequency of the bird’s trachea, modeled as a narrow pipe closed at one end? Assume a temperature of 378C**

**Solution:**

Assuming an air temperature of *T* = 37.0°C = 310 K, the speed of sound inside the pipe is



In the fundamental resonant mode, the wavelength of sound waves in a pipe closed at one end is  Thus, for the whooping crane,



and

